FISHES OF THE SOUTHERN OCEAN

Edited by
O. GON
and
P. C. HEEMSTRA

This comprehensive scientific guide to the fishes of the circum-Antarctic Southern Ocean has been compiled by an international team of scientists under the guidance of O. Gon and P.C. Heemstra of the J.L.B. Smith Institute of Ichthyology in South Africa. It is the most comprehensive book yet published on Antarctic fishes and complements the FAO manual on the fisheries resources of the Southern Ocean and the CCAMLR/BIOMASS-sponsored review of the status of exploited Antarctic fish stocks.

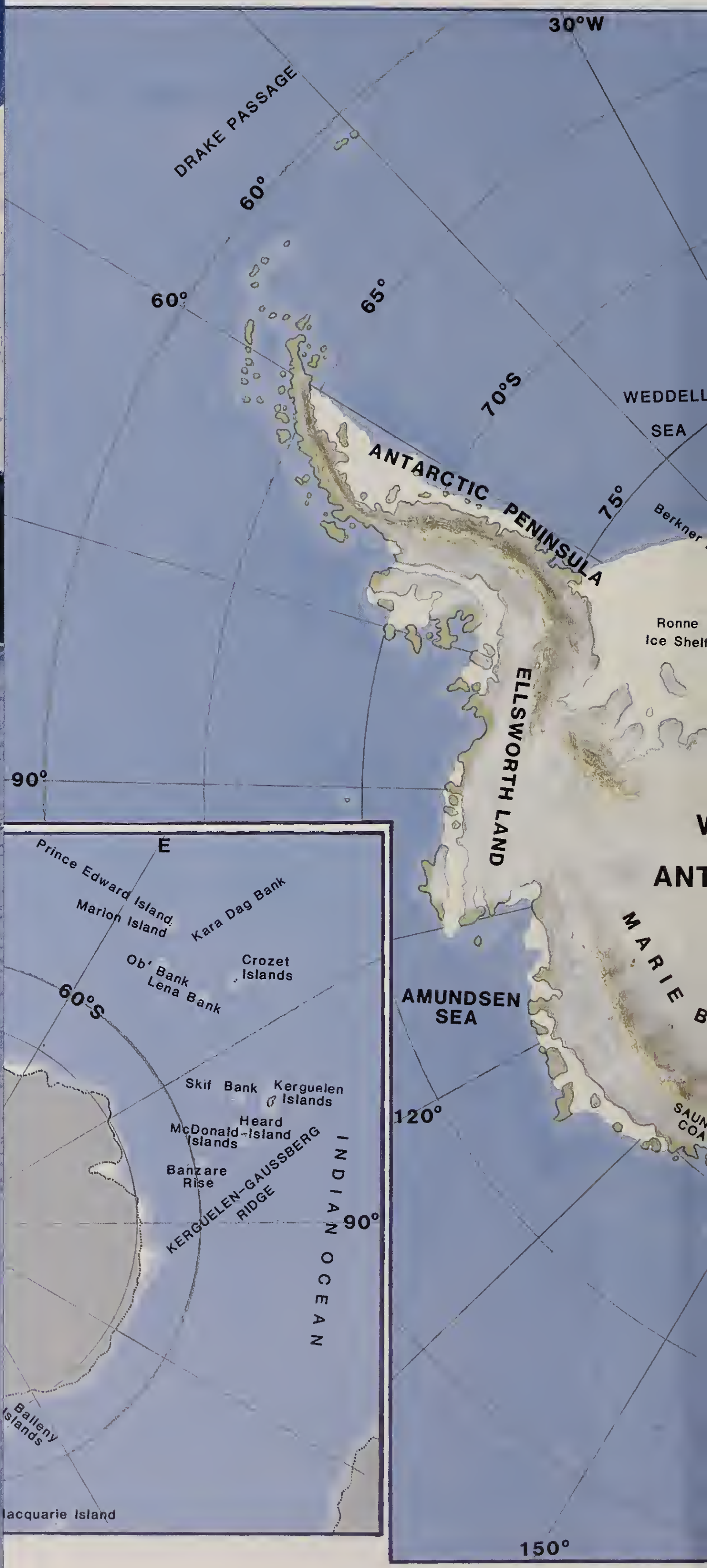
Fishes of the Southern Ocean provides accounts of the taxonomy, biology and distribution of all Antarctic fishes. The introductory chapters include an historical review of Southern Ocean ichthyology, a review of Antarctic oceanography, and a general introduction to the fishes of the Southern Ocean, including the origin and composition of the fauna, their peculiar adaptations to cold conditions, and their conservation and exploitation. The systematic section includes keys for the identification of all families, genera and species of Antarctic fishes. All but three of the 272 species and subspecies are meticulously illustrated, and their geographical distribution is shown on a map. A glossary explains the technical terms used in the book, and a comprehensive bibliography and scientific index are provided.

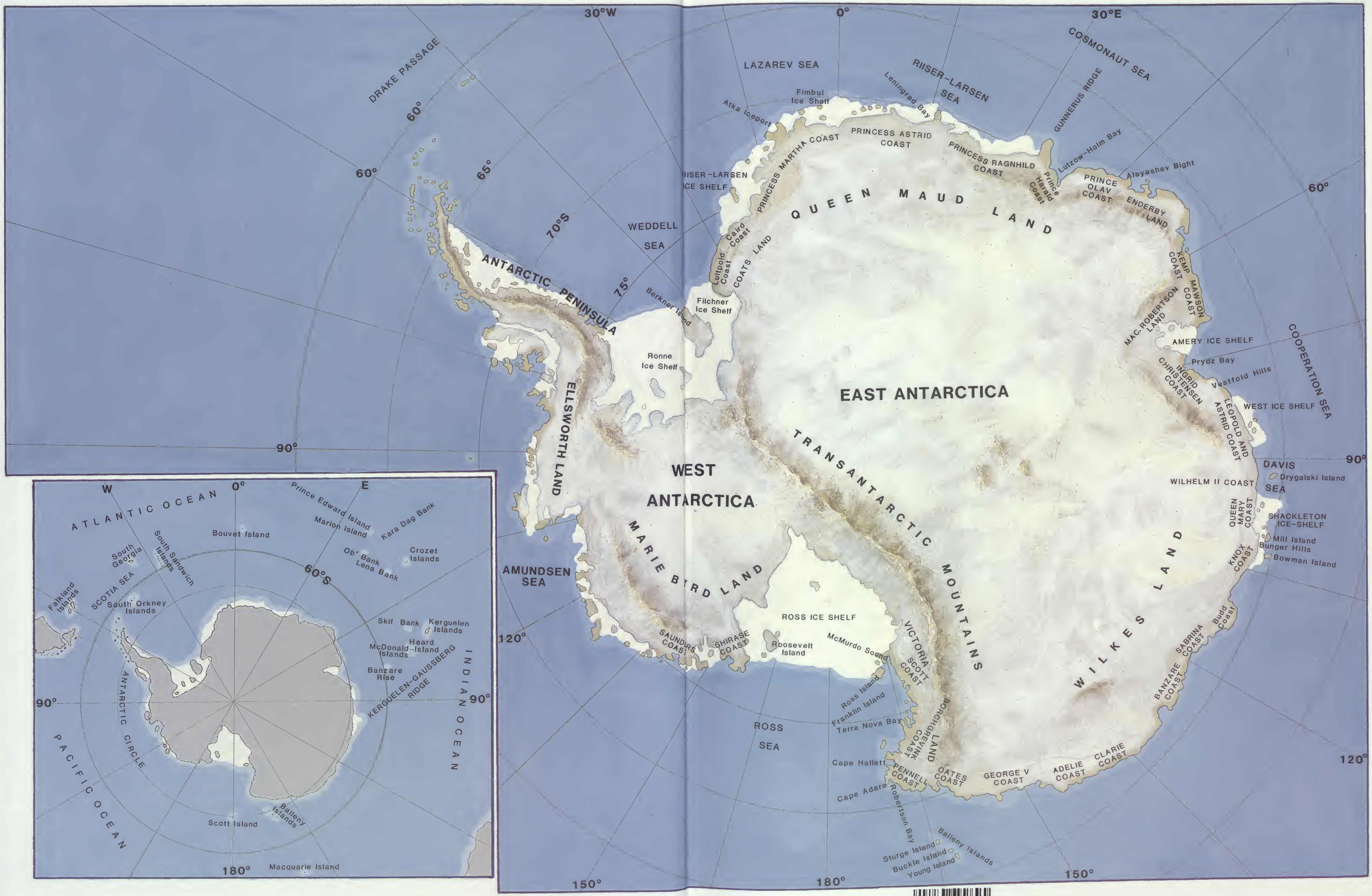
The book includes some of the best illustrations available on the fishes of the Antarctic. The drawings are the product of a rigorous approach to natural history illustration that requires hours of painstaking study and regular consultation between artist and scientist to ensure absolute accuracy. The majority of the illustrations are by D.P. Voorvelt, the senior artist at the J.L.B. Smith Institute of Ichthyology.

Fishes of the Southern Ocean is published by the J.L.B. Smith Institute of Ichthyology in collaboration with the Sea Fishes Trust, a non-profit, fund-raising organisation that administers funds for the publication of books on behalf of the Institute.

This volume, which took six years to produce, will be invaluable not only to Antarctic scientists and resource managers but also to scientists with a broad interest in the marine environment and to laymen with an interest in conservation and biodiversity.

Front cover: The cover depicts the change in species composition from the sub-Antarctic islands of the Indian Ocean through the open ocean to the Antarctic continental shelf. The illustrated fishes represent (from left to right) the families Nototheniidae, Congiopodidae, Bathylagidae, Oreosomatidae, Myctophidae, Bathydraconidae, Channichthyidae and Artedidraconidae.

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60°
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Fimbul Ice Shelf
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PRINCESS MARTHA COAST
PRINCESS ASTRID COAST
PRINCESS RAGNHILD COAST
Prince Harald Coast
PRINCE OLAV COAST
Alayashev Bight
ENDERBY LAND
60°
65°
RIISER-LARSEN ICE SHELF
70°S
WEDDELL SEA
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Caird Coast
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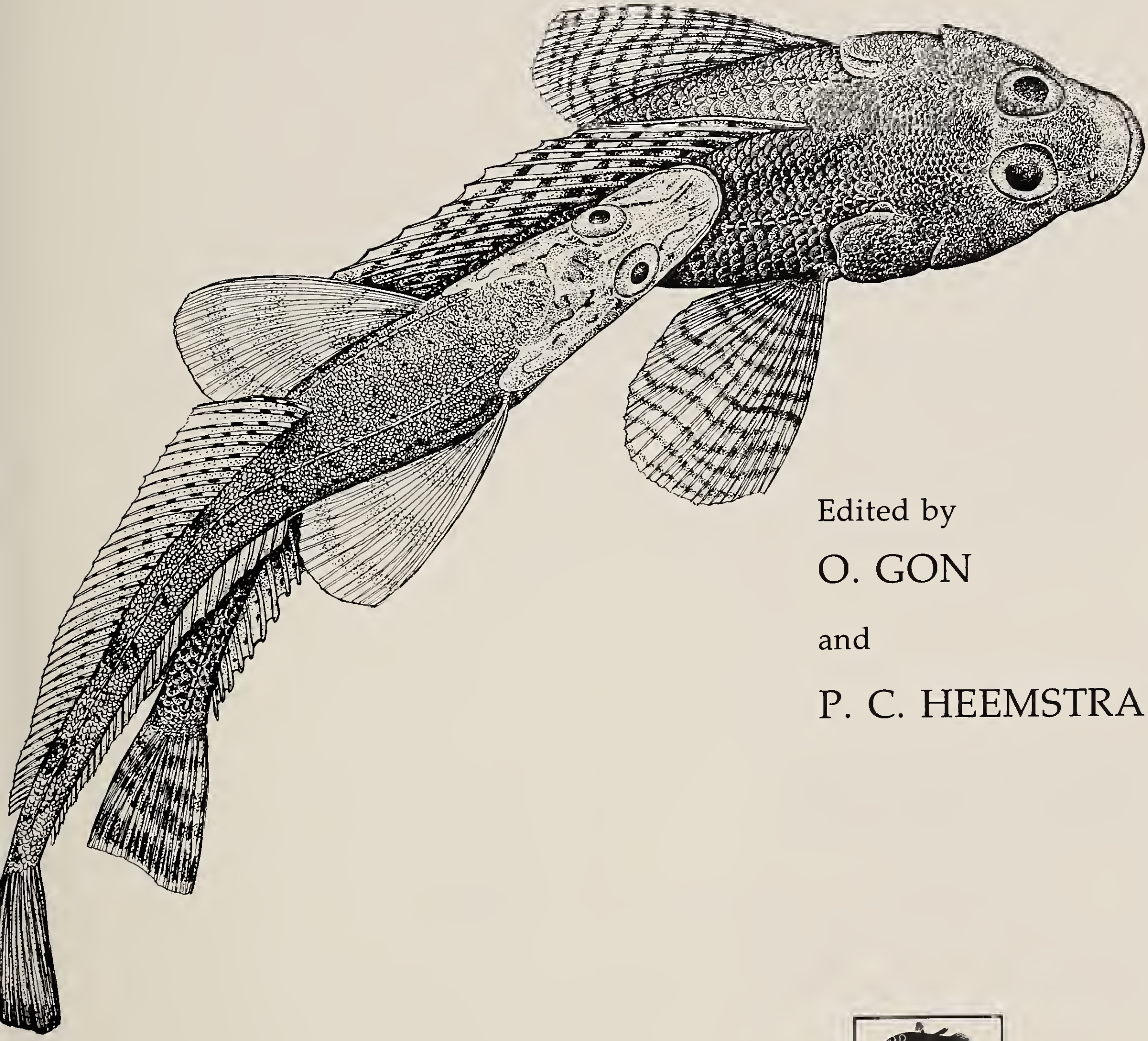

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Foreword

In recent years, and especially since the initiation of the BIOMASS (Biological Investigations of Marine Antarctic Systems and Stocks) Programme ten years ago, a large amount of information on the taxonomy and biology of Antarctic fishes has accumulated in many laboratories and institutions the world over. This, together with the fact that the last revisionary review of Antarctic fishes was produced by J.R. Norman (1938) more than half a century ago, was reason enough to undertake the production of a reference book that reviews current knowledge on the taxonomy, distribution and biology of Southern Ocean fishes.

Thus, at a meeting of the BIOMASS Working Group on Fish Ecology held in August 1984, O. Gon of the J.L.B. Smith Institute of Ichthyology, Grahamstown, South Africa, introduced the Southern Ocean fish book project to a group of leading Antarctic ichthyologists. The proposal was immediately and enthusiastically endorsed by the group, and further, they agreed that the proposed book should be complementary to two other international projects already under way—the *FAO Species Identification Sheets* edited by W. Fischer and J.-C. Hureau (1985), and the *Guide to the Otoliths of Southern Ocean Fishes by* T. Hecht (1987).

From the beginning, it was recognised that the proposed treatise should be assembled in the same way as the now widely-acclaimed book *Smiths' Sea Fishes*, i.e. with contributions of different family accounts by a group of international experts each according to his/her own specialty. P.C. Heemstra, who was co-editor of the *Smiths' Sea Fishes* book, was invited to co-edit the Southern Ocean fish book. This new book includes contributions by 32 ichthyologists from 11 countries who document 272 species belonging to 49 families. Most of the new and highly accurate species illustrations were specially and meticulously prepared for this volume by the talented scientific artist D.P. Voorvelt of the J.L.B. Smith Institute, and will be treasured by the ichthyological community.

Fishes of the Southern Ocean is a valuable synthesis of information on the taxonomy and biology of Antarctic fishes. The information provided will force ichthyologists to review current ideas on the origin, evolution and biogeography of the fishes of the Southern Ocean.

The organisers, editors, and authors of this valuable book are to be congratulated for their significant contribution to Antarctic Ichthyology.

College Station, TX 77843, U.S.A.
January 1990

Sayed Z. El-Sayed
Executive Council Chairman, BIOMASS

Preface

The J.L.B. Smith Institute of Ichthyology has had a longstanding involvement in the study and conservation of the fishes of Africa and adjacent oceans. Following the completion of *Smiths' Sea Fishes* book (in 1986), we were attracted by the opportunity to make a contribution to the understanding and conservation of the fishes of the circum-Antarctic Southern Ocean. Initially this seemed to be an impossible task, as South Africa had no Antarctic fish taxonomists and our museum holdings of Antarctic fishes were poor. Furthermore, the conservation of the biota of the Southern Ocean is a formidable challenge. The ocean covers about 35 million square kilometres, which is about 15% of the world's ocean surface, and it is a difficult and expensive environment in which to work. Our initial investigations revealed, however, that the taxonomy of Antarctic fishes was in disarray and that the lack of a recent synthesis on their biology was hampering conservation efforts. We therefore decided to take the plunge. We were confident that our good contacts in international taxonomic circles, established originally by J.L.B. and Margaret Smith and extended more recently by P.C. Heemstra and O. Gon, as well as the experience gained in compiling the *Smiths' Sea Fishes* book, would make it possible for us to produce a useful contribution to Antarctic ichthyology.

We were fortunate to have the support of a well-established infrastructure of national and international scientific organisations that were prepared to help us organise the project. The staff of the J.L.B. Smith Institute responded magnificently, and the South African Scientific Committee for Antarctic Research (SASCAR) of the Council for Scientific and Industrial Research provided operating costs for the project over seven years. We are particularly grateful to P.R. Condy, J.P. de Wit, B.R. Allanson and W.R. Siegfried of SASCAR for their support. We were also fortunate to receive the immediate backing of the BIOMASS Working Group on Fish Ecology, which gave the project international recognition and ensured the uniformly positive response from all the scientists who were invited to contribute to the volume.

To offset the costs of printing and selling a relatively small number of copies, scientific books are usually quite expensive. We are grateful for the support of numerous commercial companies which, under the auspices of the Sea Fishes Trust chaired by D.S. Henderson, covered the origination costs of this book. Because of this secure financial backing, we decided to publish the book ourselves, and thereby avoid the extra costs of a commercial publisher. It is our hope that this book will be affordable to students, scientists and resource managers, as well as to institutional libraries, and that it will reach as wide an audience as possible. The free exchange of information is the basis of scientific cooperation under the Antarctic Treaty and is essential to the understanding of this unique ecosystem. We trust that this volume, produced by a multinational team of scientists, will contribute to this objective.

This work has nevertheless revealed considerable gaps in our knowledge of the Antarctic ichthyofauna and we hope that, by revealing those gaps, we will stimulate further research on this unique and fascinating fish community.

Grahamstown, South Africa
October 1990

Michael N. Bruton
Director
J.L.B. Smith Institute of Ichthyology

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Systematic Contents

A historical review of Antarctic ichthyology

R.K. Headland

The development of Southern Ocean fishing and investigation of the fish of the region has been somewhat episodic, with a rapid increase over the last quarter century. In this chapter, the author endeavours to provide a concise account of this up to the decade after the adoption of the Antarctic Treaty (1961). Summaries of the knowledge available at different times have been published (Dollo 1904; Norman 1938; Rofen & DeWitt 1961; Andriashev 1965, 1987; McElroy 1984) which corresponded to the several episodes of exploration—these have been most useful sources.

The majority of the writings about early fishing industries in the Southern Ocean refer to the catching of whales and seals—the contemporary concept of fish was far broader than that now current. Indeed, *Whale Fishery* ordinances were promulgated up to the end of shore-based whaling in Antarctic regions (1965). There are comparatively few early references to true fish in early Southern Ocean literature, even the voyages of Captain James Cook largely neglect the group. What is probably the earliest reference is, however, well worth quoting. A United States sealing vessel, *Aspasia* (Fig. 1), commanded by Edmund Fanning, left New York in January 1800. After visiting several ports and sealing at Tristan da Cunha *Aspasia* arrived at South Georgia in September of that year. The vessel anchored in "Woodwards Harbour" in the Bay of Isles; the account reads:

> On the 19th of September, our lieutenant of marines, while prosecuting his favorite sport of fishing, was so fortunate as to discover a very welcome addition to our supply of fresh provisions. He has but just anchored his boat by the edge of the kelp, not dreaming of such great luck in store, when a fine cod, some eighteen inches or so in length, was taken by him; this was followed by his frequently catching them in pairs. A mess of these was sent to our neighbors, the captain and officers on board the English ship Morse, who were equally astonished with ourselves at finding cod-fish in these waters, never having dreamed thereof, and expressed themselves as much indebted for the present and information. These fish were found to be the largest in deep water, or the deeper the water the larger the fish; some were taken weighing between thirty and forty pounds. A car, made out of a large cask, was kept well filled with them, and enabled us to afford every mess a supply, when desired. (Fanning 1833)

This may be regarded as the discovery of Antarctic fisheries—with a remarkably precise date (19 September 1800). Fanning (1833) also recorded that, during the 1800–01 sealing season, there were 16 British and United States sealing vessels operating at South Georgia; although several of these may have been shallops, the date corresponds to one of the most active years during the first peak of sealing

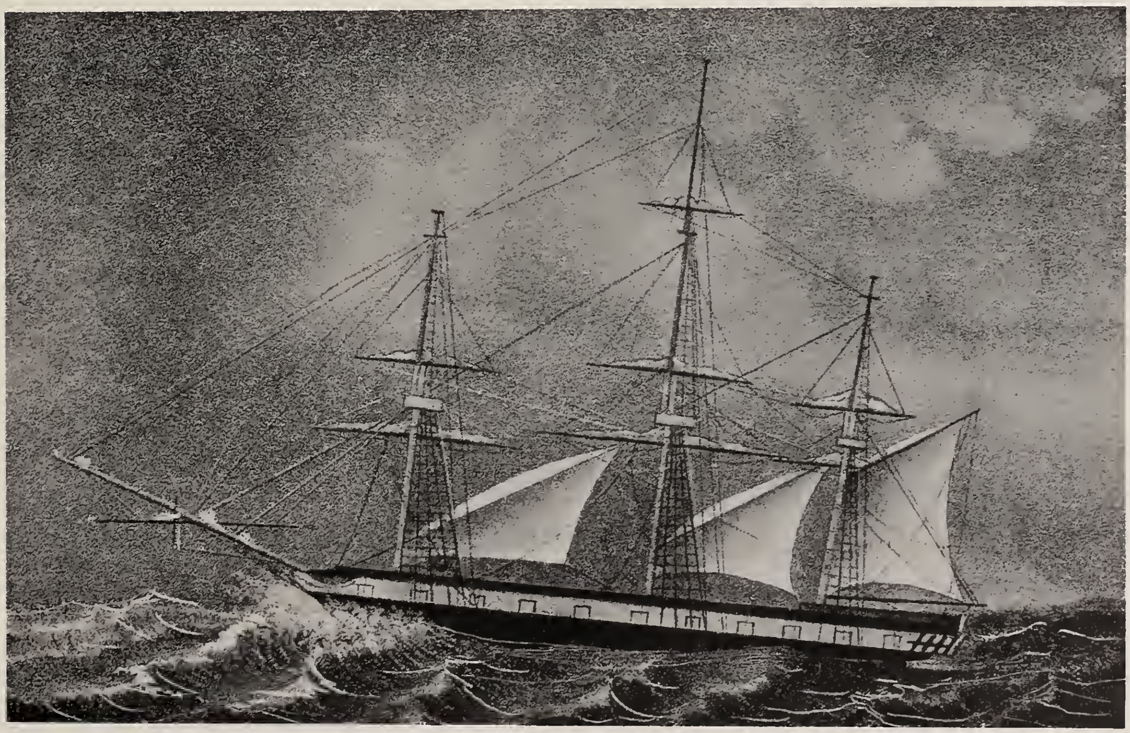

Fig. 1. The *Aspasia,* Cape Horn, bearing N. by E. 50 leagues (from Fanning 1833)

at the island (Headland 1984, 1989). One may reasonably assume that the presence of the fish became common knowledge and they were a useful supplement to the poor diet aboard the sealing vessels, although this is not mentioned in the sparse sealers' literature available. Ross (1847), however, describes the use and preservation by drying of fish by a sealing gang who lived for some years on the Crozet Islands. (The author can attest that the exceedingly co-operative nature of South Georgia fish, when it came to catching them in large numbers, prevailed a decade ago; presently, however, far fewer abound.)

During the last century the only far southern fishing operations recorded were those by French and other settlers from Mauritius working on Saint-Paul Island (Headland 1989). This island has a history of at least three fishing enterprises each of which ended in failure; although currently a rock-lobster industry is successful there as is the one off Gough Island.

Three major Antarctic expeditions at about the same period all made comprehensive biological collections: the 1837–40 French naval expedition led by Jules-Sébastien César Dumont d'Urville aboard *Astrolabe* accompanied by *Zélée*, the 1838–42 United States Exploring Expedition led by Charles Wilkes aboard *Vincennes* with five other vessels, and the 1839–43 British naval expedition led by James Clark Ross aboard HMS *Erebus* accompanied by HMS *Terror*. Unfortunately a rare combination of adversity greatly reduced their contributions to ichthyology (in contrast to the study of many other groups). The French expedition took comparatively few fish specimens, and none of those described are from Antarctic waters (Jacquinot & Guichenot 1853).

The United States collections were not fully described because of financial difficulties. Two volumes of ichthyology, by Louis Agassiz, were proposed from the expedition but were among those which were never printed (Haskell 1942). Over 1,000 pages of text and hundreds of illustrations had been prepared for them which, despite surviving immersion in a river after a train crash, were prevented from publication for financial reasons by an Act of the United States Senate. The Antarctic collections were later lost, but some subsequent use has been made of the other material (Rofen & DeWitt 1961)

The material of the British expedition fared a little better although John Richardson, in his introduction to the section on fish in the expedition's report, wrote:

> The specimens thus obtained filled many casks, and numerous jars and bottles, and it were greatly to be wished that so much industry had met with the full measure of success that it deserved; but we have to regret that, during a voyage protracted for upwards of four years and a half, including every possible change of climate, and during which the ships were buffeted by many severe gales, and sustained innumerable shocks in forcing their way through ice-packs of the Antarctic Seas, the specimens suffered very severe damage. Owing to the deterioration of the spirits in jars that were crowded with fish, and the long continued action of the brine, where that liquid was employed, very many specimens entirely perished, or merely fragments of skeletons could be rescued from the mass. (Richardson 1844b)

Nevertheless much useful material was reported; especially the excellent sketches drawn by Joseph Dalton Hooker which included nine *Notothenia* species (John Richardson established the genus), a *Chaenichthys,* and two *Harpagifer* species from among those taken in Antarctic waters. Some specimens were extracted from the stomachs of seals and one account gives an early insight into one of the special perils of ichthyology: "A remarkable circumstance occurred on board the *Terror* . . . While her people were engaged chopping away a thick coat of ice from her bows, . . . a small fish was found in the mass . . . It was carefully removed for the purpose of preservation, a sketch of it made, and its dimensions taken by Dr. Robertson, but it was unfortunately seized upon and devoured by a cat. . . . we have introduced a copy of the design, merely to preserve a memorial of what appears to be a novel form, discovered under such peculiar circumstances." (Ross 1847). Thus was the fate of the first known example of Antarctica's most celebrated and its unique group of fish—the icefish.

The next major episode of Southern Ocean exploration began with the voyage of HMS *Challenger,* continued with those observing the Transit of Venus on 9 December 1874, and ended with the first International Polar Year of 1882–83. Ichthyology was a major component of the *Challenger* Expedition, but only a brief excursion was made into the Southern Ocean. The collections amounted to 13 new species taken off the Prince Edward and the Kerguelen islands, and two in the Pacific Ocean sector (Günther 1878, 1880). For the Transit of Venus, Britain, France, Germany, and the United States established observations on four peri-Antarctic islands which also undertook a wide variety of other investigations. The expeditions largely neglected the fish, only two new species were collected, although a variety of generalised observations were recorded. In contrast, the German International Polar Year Expedition, based on South Georgia from August 1882 to September 1883, made a comprehensive collection of fish which was described in considerable detail; four of these were new species (Fischer 1885).

A major change in national policies on Antarctic explorations followed a resolution of the 1895 International Geographical Congress in London: "That this congress record its opinion that the exploration of the Antarctic Region is the greatest piece of geographical exploration still to be undertaken. That in view of the addition to knowledge in almost every branch of science which would result from such a scientific exploration, the congress recommend that the scientific societies throughout the world should urge in whatever way seems to them most effective, that this work should be undertaken before the close of the century." (Headland 1989). The consequences of this recommendation for ichthyology, as well as virtually every other branch of science, was an unprecedented amount of Southern Ocean research throughout the "Heroic Era".

The first published results was the detailed and comprehensive report of the Belgian Antarctic Expedition of 1897–1899 led by Adrien Gerlache de Gomery aboard the *Belgica*. In 1899 this expedition made the first wintering south of the Antarctic circle and collections included those made with fish traps lowered through the sea-ice; four new species were obtained (Dollo 1900a-d) and the monograph includes some Magellanic species and a series of illustrations (Dollo 1904). The account included a "Carte des Trente Points de l'Antarctique et de la zone Subantarctique où de poissons été observés d'une manière prècise" which provided a graphic indication of the paucity and discontinuity of ichthyological knowledge up to 1904 (Dollo 1904). The work also concentrated on the phylogeny and biogeography of Southern Ocean fish.

This was followed by similar detailed reports of ichthyological research conducted during the German Deep Sea Expedition of 1898–99 (led by C. Chun aboard *Valdivia)* (Brauer 1902, 1906–1908), British Antarctic Expedition of 1898–1900 (C.E. Borchgrevink, *Southern Cross)* (Boulenger 1902), German South Polar Expedition of 1901–03 (E.D. von Drygalski, *Gauss)* (Pappenheim 1911, 1912, 1914; Lampe 1914), Swedish South Polar Expedition of 1901–04 (N.O.G. Nordenskjöld, *Antarctica)* (Lönnberg 1905a, b), British National Antarctic Expedition of 1901–04 (R.F. Scott, *Discovery)* (Boulenger 1907), Scottish National Antarctic Expedition of 1902–04 (W.S. Bruce, *Scotia)* (Regan 1913), French Antarctic Expedition of 1903–05 (J.-B.A. Charcot, *Français)* (Vaillant 1906a), British Antarctic Expedition of 1907–09 (E.H. Shackleton, *Nimrod)* (Waite 1911), French Antarctic Expedition of 1908–10 (J.-B.A. Charcot, *Pourquoi Pas*?) (Roule & Despax 1911; Roule *et al*. 1913), British Antarctic Expedition of 1910–13 (R.F. Scott, *Terra Nova)* (Regan 1914a, b, 1916a), and the Australasian Antarctic Expedition of 1911–14 (D. Mawson, *Aurora)* (Waite 1916). This expeditionary work was interrupted by the First World War but accomplished, in a little over a decade, more research and exploration than in the entire previous history of Antarctic expeditions. In total, 63 new species of fish were collected during the "Heroic Era" of Antarctic exploration. Another couple of decades were necessary, however, before all the results were published. The first discovery of Antarctic fish fossils, on Snow Hill Island and Seymour Island, was made during this period by the Swedish South Polar Expedition 1901–03 (Woodward 1908).

In 1905, during this period, the earliest attempt at commercial fishing from the Southern Ocean was made shortly after Captain Carl Anton Larsen, from Norway, established the first Antarctic whaling station, at Grytviken, South Georgia (Lönnberg 1906) (See Hureau & Slosarczyk, this volume, for a detailed history of the commercial fisheries).

After the Antarctic whaling industry was well established, the possibility of commercial fishing was considered by an Interdepartmental Committee on Research and Development in the Dependencies of the Falkland Islands. The comprehensive report produced (Allen 1920) examined several aspects of the proposal, including South American fish market prospects and the economics of the industry in general. The Report was published in April 1920 and in August the Falkland Islands and Dependencies Government reacted by promulgating a revised *Ordinance to Regulate the Sea Fisheries* which remained in force until 1944 (Falkland Islands 1920 and 1944). The Dependencies (which then included South Georgia, the South Sandwich Islands, South Orkney Islands, South Shetland Islands, and the Antarctic Peninsula) were notable among other Antarctic regions in this respect because the whaling industry was far more strongly established there than elsewhere in the Southern Ocean. These administrative acts were consequently made far earlier than for many other Antarctic regions. Another consequence of the Report of the Interdepartmental Committee was the establishment of the Discovery Committee under the Colonial Office in London. The 14 Discovery Expeditions organised over the period from 1925 to 1951 covered all parts of the Southern Ocean. This was the longest continuous research effort in the Southern Ocean before the modern national programmes were established. Much research was accomplished and detailed accounts appeared in the huge series of the *Discovery Reports* (Hardy 1967). The large collections obtained during these expeditions, aboard the *Discovery*, *Discovery II*, and *William Scoresby*, were the basis for a number of studies culminating in a series of ichthyological monographs by J.R. Norman (1930, 1935, 1937a, 1938). The review of the coastal fishes of Antarctica (Norman 1938) included revisions of the notothenioid families and the family Zoarcidae. Amongst the fish examined by Norman (1938) was a small collection made by the British Graham Land Expedition (1934–37). The biological limit of the Southern Ocean, the Antarctic Convergence, was detected and interpreted by British and German expeditions both of which sailed from 1925 to 1927; *Discovery* led by S.W. Kemp (Hardy 1967), and *Meteor* led by A. Merz (Speiss 1926). The nine Norwegian expeditions financed by C.L. Christensen (mainly aboard *Norvegia)* and the British, Australian and New Zealand Antarctic Research Expedition led by D. Mawson aboard *Discovery* also made major contributions to research during the period of the 1920's and 1930's. The result of this period of fisheries investigations was to double, at least, the knowledge available and to gain accurate data for comparative studies to be made in recent times.

Despite their present conspicuous expeditionary presence in Antarctica, United States fish collections between Charles Wilkes' expedition (1838–42) and the mid-1940s were few and incidental. Exceptionally a small number of fish were collected by the two United States Antarctic Expeditions led by R.E. Byrd (1928–30 and 1933–35) and the United States Antarctic Service Expedition of 1939–41 (Rofen & DeWitt 1961).

Apart from minor fish collections made during the United States Operation Highjump (1946–47), resumption of Antarctic ichthyology after the late 1940s is marked by a brief period with a large Norwegian involvement. The Norwegian Antarctic Expedition led by H. Holgersen aboard *Brategg* in 1947–48 was followed by the Norwegian-British-Swedish Expedition led by J. Giever aboard *Norsel* in 1949–52. The former conducted only part of the planned ichthyological programme as the fishing gear was lost near Peter I Island. Fish were collected off this island as well as Deception Island (Nybelin 1951). The latter expedition obtained specimens of four species of fish found in the stomachs of seals from Princess Martha Coast (Nybelin 1952). At the same time, a French expedition (1949–51) collected fish in Adélie Land (Blanc 1952).

At South Georgia, during the 1951–52 whaling season, a Norwegian ichthyologist, Steinar Olsen, was contracted to survey the fisheries potential around the island by the whaling company Tønsbergs Hvalfangeri of Husvik. This was at a time when stocks of whales appeared to be diminishing and the company became interested in the production of fish oil and meal using the machinery existing at its whaling factory. The survey indicated possible success for the industry and the next season two Norwegian fishing vessels with experienced crews were deployed from the island. The quantity of fish taken was much less than expected; this, combined with a depression in the price of fish and whale oil, led to the end of the project (Headland 1984; Hureau & Slosarczyk, this volume). Nonetheless, Olsen's (1954, 1955) works on *Notothenia rossii, Chaenocephalus aceratus, Champsocephalus gunnari,* and *Pseudochaenichthys georgianus* were the beginning of studies of the biology of Antarctic fish species which had a potential for commercial exploitation. Shortly afterwards, research into the physiology of Antarctic fishes began with investigations of freezing resistance, metabolism and respiration (Walvig 1958, 1960; Wohlschlag 1960–64), and the discovery of the absence of haemoglobin and erythrocytes from the blood of channichthyid fishes (Ruud 1954, 1958), thereafter often referred to as "white blood".

Coordinated national and international ichthyological research in the Southern Ocean began in the late 1950s. Particularly comprehensive programmes were conducted by Soviet Union and United States expeditions. More investigations began after the start of the International Geophysical Year (1957–58) when an unprecedented concentration of attention was applied to Antarctic regions (for example, the number of scientific stations in Antarctica quadrupled in a few seasons which greatly enhanced the opportunities for laboratory studies of fish in Antarctica).

The Soviet Union's involvement in Antarctic ichthyology began with cruises of the *Ob'* (1955–58) and collections made by biologists aboard whale catchers, mainly from the *Slava* fleet (Andriashev 1965). The Soviet Union programme, the most intensive at the time, encompassed the Antarctic and adjacent regions, open ocean, and the continental as well as insular shelves. By 1961, the Zoological Institute in Leningrad had nearly 3000 specimens of 85–90 species collected south of the Antarctic Convergence (Rofen & DeWitt 1961), including a number of new species and many new records of distribution. The research on these collections was published in a series of papers during the late 1950s and 1960s, including Andriashev's (1965) review of the Antarctic fish fauna. Further investigations were undertaken off the Kerguelen Islands in 1961–62 followed by, in 1964–65, the first of many voyages by *Akademik Knipovich*. During the same season a fleet of four Soviet trawlers were operating off the South Orkney Islands.

After a virtual break of more than 100 years, United States ichthyological research in the Southern Ocean resumed with the beginning of the Stanford University Antarctic Biological Program in 1958. Fish collections were made at the Ross Sea (USS *Glacier*), and Weddell Sea and off the Antarctic Peninsula (USS *Edisto)* (DeWitt & Tyler 1960), and a United States ichthyologist participated in the New Zealand Oceanographic Institute expedition to the Ross Sea aboard HMNZS *Endeavour* (Reseck 1961; Miller & Reseck 1961). From McMurdo station, fish were also collected using traps and hand-lines lowered through holes in the ice blasted by dynamite. Shortly after the conclusion of the International Geophysical Year expeditions a checklist and a bibliography of Antaractic fish were compiled by Rofen & DeWitt (1961).

Between 1962 and 1967, the United States Antarctic Research Program of the National Science Foundation deployed USNS *Eltanin* as an oceanic laboratory for investigation of the Southern Ocean and adjacent seas. The area of operations included the waters off the southern coasts of South America, and the Antarctic Peninsula, Scotia Sea, Drake Passage, northern Weddell Sea and the South Pacific Ocean from Chile to New Zealand. The abundant collections made from *Eltanin* (particularly of pelagic fish) were initially the Stanford University and University of Southern California collections and are now lodged with the California Academy of Sciences, San Francisco, the Los Angeles County Museum of Natural History, and the National Museum of Natural History, Washington D.C. A number of new species of liparidid, nototheniid and zoarcid fishes have been described from *Eltanin* collections, some very recently (Anderson 1988; Stein & Thompkins 1989).

At this time a particularly useful Antarctic bibliographical contribution was published in 1962, *Antarctic Bibliography*, by the United States Library of Congress. This appears as a periodical and has proven an excellent record of ichthyological (and most other) literature. A United States Navy bibliography (Roscoe 1951) included a summary of previous Antarctic bibliographies of which the Belgian (Denuncé 1913), British (Mill 1901), German (Breitfuss 1933), and Norwegian (Aagaard 1930) ones in particular included listed ichthyological works. *Antarctic Bibliography* later produced a supplement to cover the period from 1951 to 1962. Similarly, the Scott Polar Research Institute's periodical *Polar and Glaciological Abstracts* which had its origins in 1931, although not as comprehensive regarding fish, is a useful continuing bibliographical source. More recently individual bibliographies have appeared for many of the peri-Antarctic islands—details may be found in the periodical bibliographies.

After the International Geophysical Year, several other countries continued or incorporated ichthyological research in their Antarctic programmes. The *Umitaka-Maru* of the Tokyo University of Fisheries, made the first of many fisheries investigation voyages during the 1957–58 season, operating off Dronning Maud Land. Belgian scientists worked along the Princess Ragnhild Coast (Gosse 1961, 1966). French investigations continued work off Kerguelen Islands (Blanc 1958, 1961; Hureau 1964, 1966, 1970) and resumed work off Adélie Land (Blanc 1961; Hureau 1962a, 1963, 1970). Argentine expeditions began investigations of fish off the South Orkney Islands and the Antarctic Peninsula (Bellisio 1964, 1965, 1966).

The harsh conditions, inadequate fishing vessels, imperfect gear and unspecialised technology, caused early attempts at commercial Antarctic fishing to fail. As in other oceans, severe exploitation preceded the development of coordinated fisheries research and conservation measures. Most of the papers published during the period reviewed here (until 1965) are included in the fish section of the *General Bibliography of Antarctic and Subantarctic Biology* collated by Arnaud *et al.* (1967).

The early period of Antarctic ichthyology was characterized by isolated exploratory expeditions and basic taxonomic work. In the first half of the twentieth century, ichthyological research combined taxonomic reviews of various groups with fundamental descriptive work. In the present period (after about 1965) ecological and physiological studies have increased, and taxonomic studies have become somewhat less prominent. As is only too apparent in the present volume, there remains much to learn on the taxonomic composition, relationships and biogeography of the fish of the Southern Ocean.

The Oceanography and Fish Distribution of the Southern Ocean

J.R.E. Lutjeharms

Introduction

The Southern Ocean has some unique characteristics as a major component of the world ocean. Amongst these are the near-circular symmetry of most of its physical and chemical characteristics, the immense expanse of cold surface water, globally by far the largest, as well as the most pronounced seasonal variation at the sea surface of any comparable ocean basin. Clearly, the distribution of these physical and chemical variables in space and time should also be reflected in the distribution patterns of biological organisms, especially the fishes. It is the purpose of this chapter to describe in general terms what is known about the physical properties and processes in the Southern Ocean that may influence the creation of specific biogeographical boundaries and habitats. In order to identify those physical variables, complexes of variables or dynamic processes that may be particularly implicated in Southern Ocean biogeography, it is necessary to establish briefly what is presently known about oceanic biogeography in general and about Southern Ocean ichthyogeography in particular.

Oceanic biogeography

Identifying the co-occurrence of a range of certain organisms and of physical variables, is generally recognised as a first step in oceanic biogeography, towards a fundamental understanding of why species are distributed in a certain way (Knox 1968). Biogeographical boundaries in the open ocean are therefore assumed to be directly related to the physical properties of the ocean, or indirectly to them, through the effects of lower trophic levels on higher ones (Backus 1986). It has, however, been exceptional to find one or two physical factors which influence the distribution of a particular pelagic species; rather it has been recognised that a suite of factors is usually responsible. While some species show pelagic distributions closely correlated with certain physical variables, others may be far more widely distributed (Johnson 1986), implying a life history interacting with different, or a different range of, physical variables. It has also become increasingly recognised that not only static physical oceanographic variables determine the distribution of species but that indeed the variations in such variables or the *physical processes* taking place may play a crucial role (Olson 1986). In the portrayal of open ocean biogeographical patterns, large coherent regions therefore coincide with specific biological assemblages, not only because they are structurally different, but also because they are functionally different (McGowan 1986) and the timing and nature of their response to ordinary seasonality or large episodic perturbations differ as well.

These general principles of oceanic biogeography and habitat recognition have been applied to the Southern Ocean since early this century. Regan (1914b) identified three circumpolar zones delimited, as he perceived, by the 6 °C and the 12 °C surface isotherms. Thirty-three years later Nybelin (1947) still regarded this classification as very well founded, except that he considered the 4 °C isotherm during the warmest month of the year as coinciding more closely with the extreme limits of the pack-ice and thus a better delimiter of the Antarctic zone, the one closest to the continent. The generally weak delimitation of faunal provinces by surface isotherms was taken an important step further when it was first recognised that these isotherms corresponded to generic features of the Southern Ocean circulation, namely the *Antarctic Polar Front* and the *Subtropical Convergence* (Norman 1938). These concepts were based on the important contributions of Deacon (1937a,b) to the physical oceanography of the Southern Ocean. On a more regional scale, smaller than these macroscale circumpolar features, there is as yet no clear agreement among biogeographers as to the limits or comparative ranking of regions, provinces or other biotic subdivisions (Hedgpeth 1970).

It is difficult, if not entirely impossible, to separate the geographic distribution of higher species such as fish from that of the organisms on which they depend for a food supply. In many cases the distribution of organisms further down the food chain is better known and their relationships to physical parameters or processes therefore better understood (Ekman 1953). So for instance, the great stores of pelagic *Euphausiidae* (Amos 1984; Miller & Hampton 1989) in certain areas may be responsible for the presence of certain fish species congregating here to profit from this rich source of food (Nast *et al.* 1988). The distribution of krill may in turn have a definitive relationship to areas of high production of plant organic matter (Solyankin 1984). In general, the distribution in the Southern Ocean of a wide range of other invertebrate groups that may act as a food species for fish (Bé *et al.* 1969; Hedgpeth 1969) show a strong resemblance to that based on the distribution of fish.

Physical factors influencing fish distribution in the Southern Ocean

From the foregoing, a number of key concepts emerge concerning the relationships between fish species and physical oceanographic factors. First, the geographic distribution of fish species, as well as their food organisms in the Southern Ocean, is still undersampled and therefore poorly understood. Since the influence of physical factors may interact closely with the life history of fishes, and since the life history of Southern Ocean fish species in many cases is not known, an important complicating factor is introduced. Second, the nature and behaviour of water masses in the Southern Ocean is not well understood. Increasing data collection efforts over the past few decades have led to a better geographic description of salinities, temperatures and fronts. It is important, however, to recognise the fundamental conceptual principle that fronts are not *features* but *processes*. A reasonable understanding of these processes is therefore required to judge their role in the distribution of fish species. This is only beginning to be addressed. The relationship between fish geography and physical factors for the Southern Ocean can therefore at present be described in only the coarsest geographic terms (McGowan 1986).

Bearing in mind the concept that usually a complex or suite of physical factors influence the distribution of particular pelagic species (Backus 1986), a number of factors have been identified that co-occur in a general manner with the biodistributions. By far the most important in the Southern Ocean seems to be the different zones. These zones are highly, but not entirely, correlated with the locations of oceanic fronts or, from a different point of view, with the distribution of water temperatures. Since the locations of the thermal fronts also coincide with the distributions of salinity and nutrients, it is difficult to separate the influence of the various environmental parameters on species distribution. Some (e.g. Andriashev 1965) have held that the fronts possibly act as strong ichthyogeographic barriers, due to the flow regimes associated with them. This still has to be established unambiguously.

The distribution of pack-ice and changes in its seasonal and inter-annual coverage also has important ichthyogeographic implications, probably for a number of reasons. It has been recognised that certain fish species are adapted to the under-ice habitat. Second, the melting of the pack-ice establishes a limited area of high vertical stratification and releases into this water column a variety of organisms that live in and on the underside of the ice. This biologically rich area is rapidly depleted and shifts southward with the retreating ice edge in the austral summer.

The very rich benthic ecology is also dependent on the distribution of ice, but more particularly on the tidal amplitudes. Tidal ranges may therefore play an important determining role in certain coastal areas of Antarctica and adjacent islands.

Perhaps of overriding importance to the understanding of marine ichthyogeography is the variability in time and in space of physical environmental factors. In the Southern Ocean the impact of strong seasonal changes in the marine habitat is probably dominant. Since the Southern Ocean in winter is a very hostile environment for oceanographic observations the bias of information is strongly toward austral summer records. Seasonal changes in the marine environment are therefore as yet not fully documented. Mesoscale turbulence, such as eddies, meandering of fronts etc. and other variability (Gordon 1988) on a smaller time and space scale may be instrumental in the enhanced dispersal or concentration of marine organisms thus establishing certain geographic patterns or special faunal provinces (Kock 1985).

It has been demonstrated that hydrological mechanisms with different physical scales interact with different biological processes (Murphy *et al.* 1988). Hydrological conditions may exhibit large inter-annual variations and this variability could therefore have an important influence on the living resources in general (Sahrhage 1988). The effect of spatial variability and inter-annual variations may even overshadow seasonal differences, such as has been demonstrated for the phytoplankton biomass and primary production of the Southern Ocean (El-Sayed 1988), for the primary production at the marginal ice zone (Smith *et al.* 1988) and for the postlarval abundance of fish (Kellerman 1986). An understanding of the physical scales of various hydrological features and how they interact with certain parts of the life history of fish as well as with fish food organisms is therefore critical to a proper understanding of variations in the fish distribution in the Southern Ocean.

To place all the above-mentioned environmental parameters, and especially the circulation patterns in proper perspective, a description of the general geography is required. This is presented in Fig. 1.

Geography of the Southern Ocean

The Southern Ocean consists of the southern parts of the Pacific, Indian and Atlantic oceans. Since its circulation is for the greater part circumpolar and thus differs fundamentally from the anti-cyclonic gyres of the basins of the latter three oceans, it has geographically been considered as a separate ocean. The southern boundary of the Southern Ocean is the Antarctic continent. The northern border is not physiographically fixed, but is usually considered to coincide with the geographic location of the Subtropical Convergence (STC). This front forms the northern limit of the sub-Antarctic area and exhibits sharp and strong horizontal gradients in a number of parameters such as surface temperature, but only along certain sectors such as south of Africa. In other areas, such as west of South America, these gradients are so faint that the existence of a front is in doubt (Fig. 1). This definition for a northern border to the Southern Ocean is therefore a rather open one. In some cases the Antarctic Polar Front (APF) is taken as the northern boundary. Since this bisects the flow of the Antarctic Circumpolar Current which is the main feature of the Southern Ocean, this is not an entirely happy choice. The limits chosen for this review are shown in Fig. 1 and coincide roughly with the location of the APF.

The main physiographic features of the ocean are depicted in Fig. 1. Since the locations of the continents and deep-sea ridges directly influence the circulation patterns and the potential for the exchange of water below 3,000 m between basins (Mantyla & Reid 1983), they may have a decisive influence on the biogeography of some fish species.

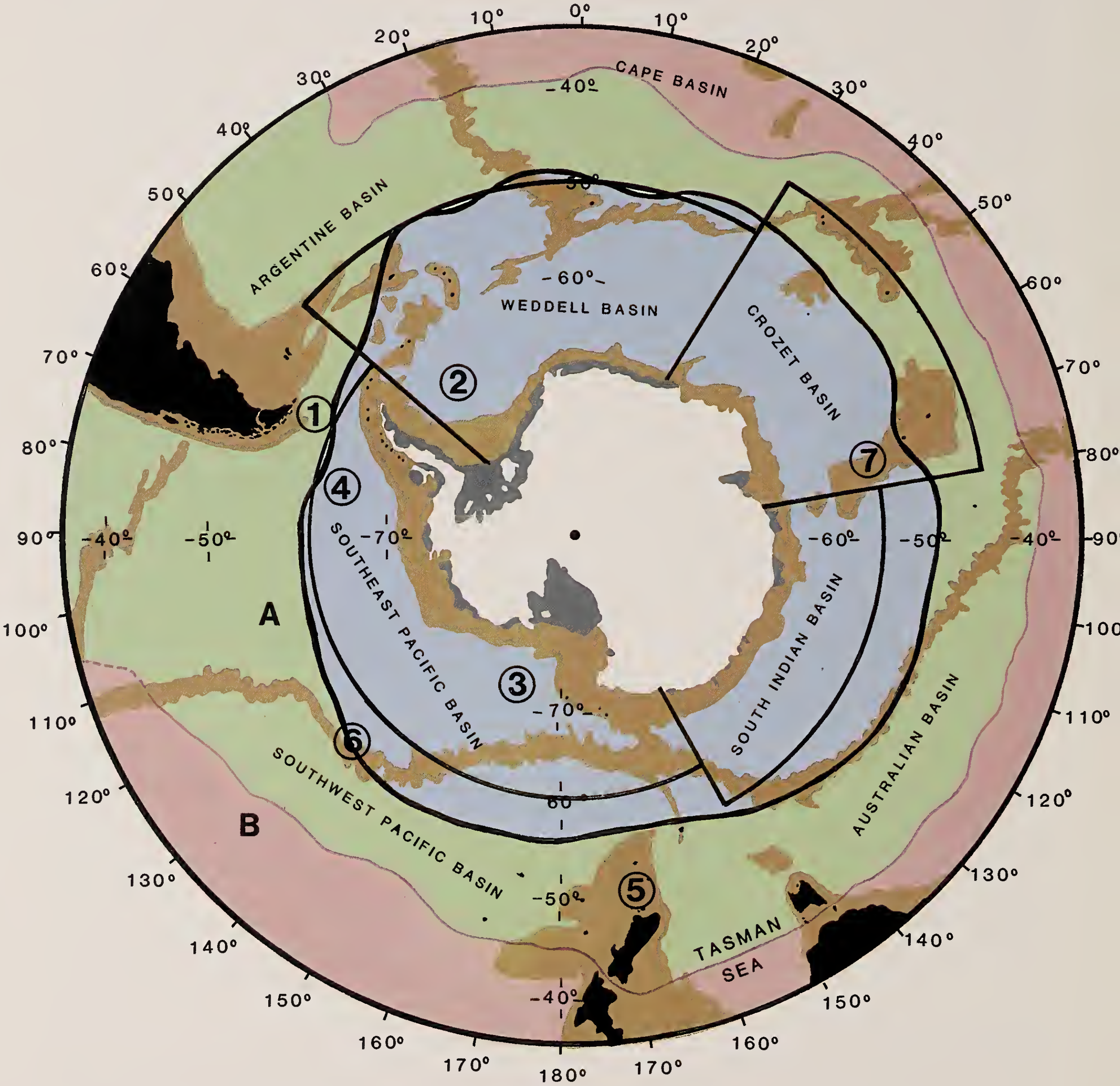

Fig. 1. The general geography of the Southern Ocean with bottom topography (after Lutjeharms 1977 and Gordon *et al.* 1978). Areas less than 3,000 m deep are in brown. Some notable features are: (1) the Drake Passage, (2) the Weddell Sea, (3) the Ross Sea, (4) the Bellingshausen Sea, (5) the Campbell Plateau and the Macquarie Ridge, (6) the Eltanin fracture zone, and (7) the Kerguelen Plateau. The line labelled **A** is the estimated mean position of the Antarctic Polar Front while that for the Subtropical Convergence is labelled **B**

First, it should be noted that the continent of Antarctica is asymmetically distributed about the South Pole with the greater part of this land mass lying in the eastern hemisphere. Second, the continent has a narrow shelf (Dell 1972), except in the Weddell, Ross and Bellingshausen seas (see Fig. 1). In contrast to most other continental shelves, the shelf is deep, about twice as deep as the norm and the shelf break lies at depths of 500 to 600 m below sea level. Further, troughs in the bottom topography of the continental shelf run parallel to the coast, forming a broad moat, between the coast and the edge of the continental shelf (Deacon 1964).

In general, oceanic rims complicate the pattern of fish distributions; and, because of its peculiar morphology, this is particularly true for the continental shelf of Antarctica. The shelf fauna here is rich and exhibits a higher degree of endemism than for any comparable area (Andriashev 1965). The deep innershelf depression mentioned above invalidates the usual schemes of vertical zonation and may be responsible for the fact that the number of bottom fish species only decreases at depths of 500–600 m instead of at depths of 100–200 m as in the Arctic Ocean. Furthermore, these depressions in the shelf may act as preferred habitats by some fish. Supposed differences in the biogeography between East and West Antarctica first ascribed to differences in extent of the continental shelf (Nybelin 1947), even though the physical environment is very similar, have subsequently been shown to be incorrect (Ekman 1953).

With the exception of the eastern Pacific sector of the Southern Ocean, the ocean directly surrounding Antarctica is enclosed by a set of mid-ocean ridges running roughly parallel to the Antarctic coastline. This annular basin is divided into three sub-basins by the Antarctic Peninsula-Scotia Arc system, the Kerguelen Plateau and the bridge between the ridge system and the Antarctic continental shelf south of the Campbell Plateau (Fig. 1). These sub-basins are the Weddell-Crozet basin in the South Atlantic and South Indian Ocean sectors, the South Indian basin in that ocean sector and the South-east Pacific basin. The adjoining basins, on the northern side of these ridges, such as the Australian basin and the Argentine basin, are fully open to the northern oceans.

Islands on the ridges, such as Kerguelen, Marion, Bouvet etc. may have clearly demarcated endemic species. These species may find habitat protection at the islands due to the particular topography of the shelf associated with the islands.

It should further be noted that although the ocean physiography around Antarctica is generally perceived as a circumpolar trough, this is a misconception. Following any line of latitude around the South Pole will demonstrate the great changes in depth experienced by any water mass following this route. Organisms advected by the Antarctic Circumpolar Current would therefore experience large latitudinal excursions on crossing ridges, such as for instance at the Eltanin fracture zone (Fig. 1), on a circumpolar progression. The circumpolar distribution of fish might therefore not be expected to be concentric (Hureau 1973).

Distribution of temperature and stability

Generally, the distribution of sea surface temperatures in the Southern Ocean is conceived as concentric rings centred at the pole. In the same way as for the physiography, this is a simplification bordering on a misconception. This is evident from Fig. 2 where the surface isotherms for summer and for winter are presented. These portrayals are based on data collected over many years with rather wide interstation spacing. Fluctuations from year to year are therefore evened out, and smaller-scale features such as thermal fronts are not shown as sharp as would be observed at sea. The dominant large-scale features are nevertheless evident.

First, the latitude of individual isotherms differs markedly from one ocean sector to the next. In summer, for instance, the 4 °C isotherm is found at 50 °S north of the Weddell Basin and in the Crozet Basin (Fig. 2a) but south of 60 °S for most of the South-east Pacific Basin. In winter this pattern is maintained except that the isotherm in question is the 2 °C one (Fig. 2b). Second, in summer the cyclonic circulation of the Weddell gyre is evident as a tongue of colder water at about 60 °S and a counterpointing tongue of warmer water closer to the coast in the same basin (Deacon 1964). Other perturbations in the presumed concentric flow are to be found at the Kerguelen Plateau, the Ross Sea and at the Eltanin fracture zone (Fig. 1).

With the onset of winter (Fig. 2b) all individual isotherms on average lie further to the north than in summer. No sea surface isotherms are shown for the greater part of the ocean area south of 60 °S in winter since at this time of year it is covered by pack-ice. The Weddell Basin circulation is therefore totally obscured at this time. The marked effect on the flow on passing through the Drake Passage is, however, very noticeable in the isotherm distribution in winter (Fig. 2b).

Detail of surface temperature distributions is to be found in a number of articles on the results of such readings, particularly from Antarctic supply vessels (e.g. Nagata *et al.* 1988; Zillman 1970). These results in general show that significant variability occurs in the thermal nature of fronts, in their inter-annual and intra-annual location and in the extent of seasonal shifts. Lutjeharms & Valentine (1984) have carried out a statistical analysis of about a hundred records of sea surface temperature between Africa and Antarctica. They found that the surface thermal expression of the APF lay in a zonal band of about 300 km with no clear longitudinal or long-term pattern. Similarly, mean

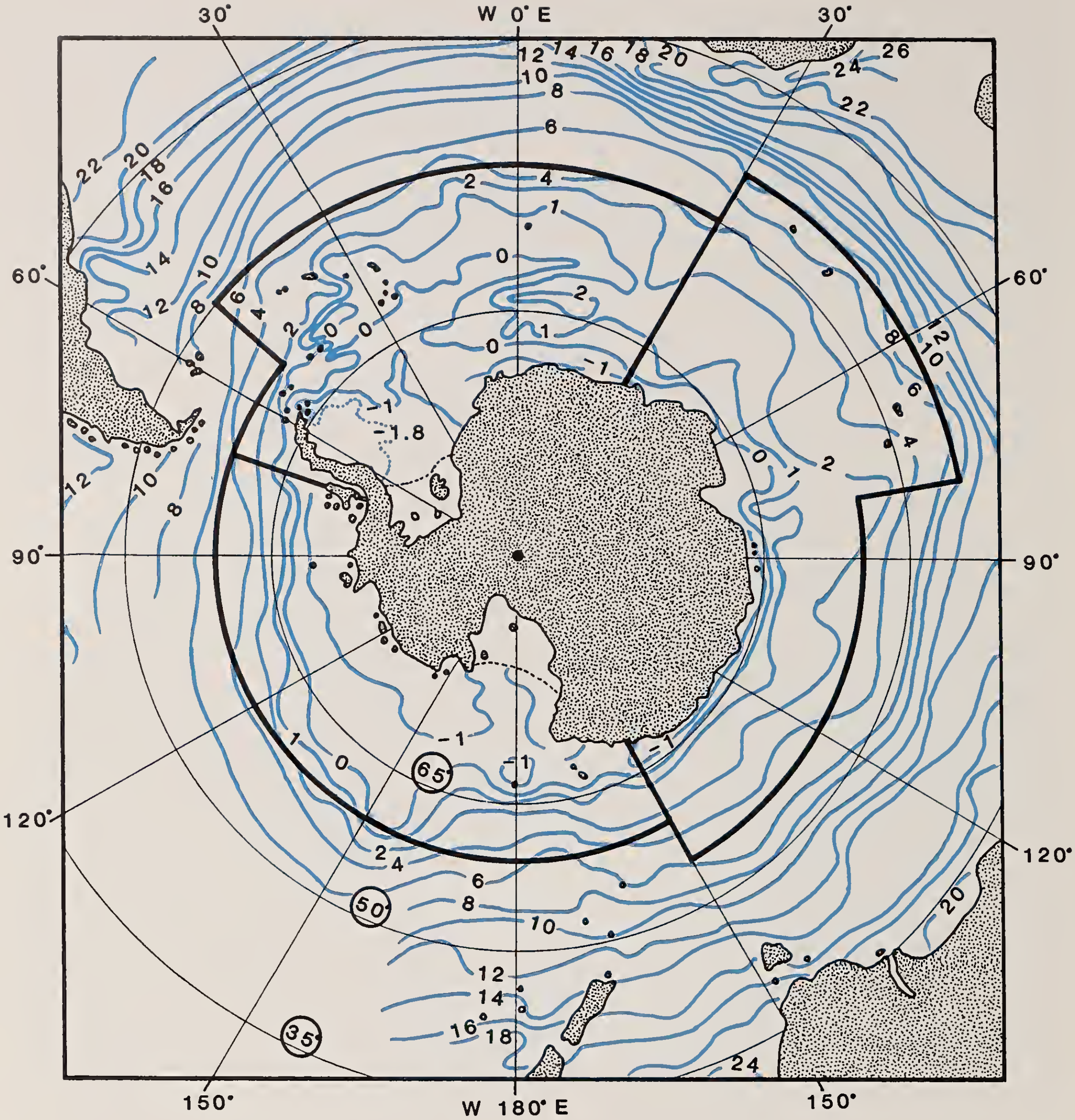

Fig. 2a. Sea surface temperature of the Southern Ocean for the summer months January to March (after Gordon *et al.* 1982)

characteristic temperatures of the front exhibit a standard deviation of at least 1 °C. It is therefore apparent that marine organisms have to be adjusted not only to the strong seasonal change in surface temperatures, but also to considerable variability at any one location and from year to year.

Thermal perturbations which probably are unique to the Southern Ocean are the large and persistent openings in the winter pack-ice called polynyas. One such ice-free region, the Weddell Polynya, has been observed to persist for a number of years (Comiso & Gordon 1987). It is thought that these polynyas are maintained by deep ocean convection, thus increasing the vertical flux of heat, but decreasing the water column stability. The effect of such a large expanse of open water in the pack-ice on marine life has only recently begun to be studied (Ekau 1988), but clearly adds an extra unpredictable environmental perturbation to the temperature distribution.

Even though the strong seasonal changes as well as the latitudinal shifts in isotherms are important environmental constraints for all marine biota in the surface layers of the Southern Ocean, the stability of the surface layers caused by vertical temperature distribution is of even greater importance. The production of phytoplankton in the surface layers of this ocean is directly related to the radiant energy

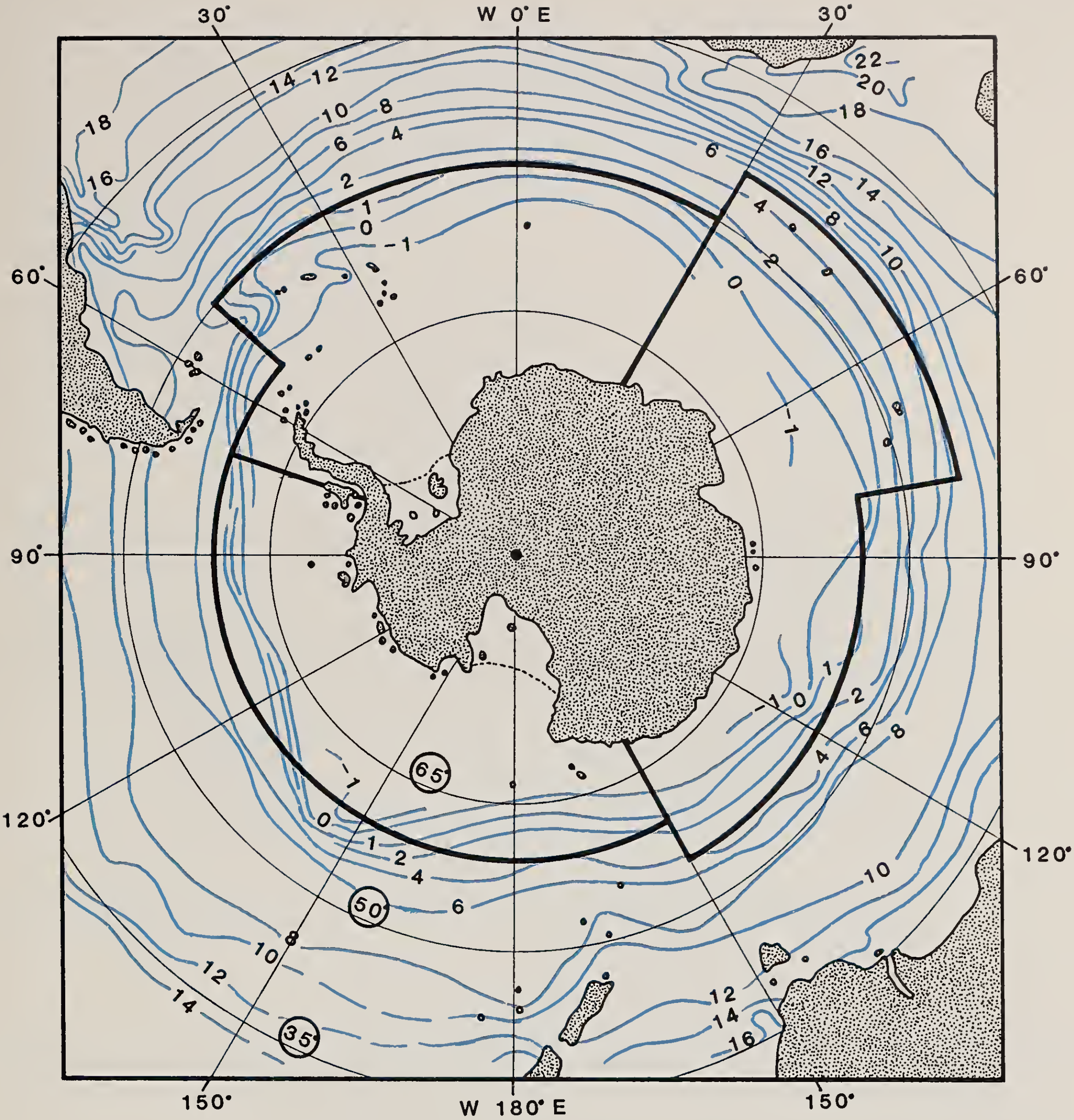

Fig. 2b. Sea surface temperature of the Southern Ocean for the winter months July to September (after Gordon *et al.* 1982)

or sunlight received (El-Sayed 1988). It has therefore been assumed that light is the limiting factor in the primary production. Tranter (1982), however, points to the accumulating evidence that the phytoplankton production is rather determined by the stability of the water column. Since the seasonal peak for these two factors is in phase, it is difficult to separate their influence. However, the amount of light available for photosynthesis is determined not only by the angle of incidence of sunlight, but also by how deep organisms are in the water column. Because light attentuates with depth, plant production is limited by the depth of surface mixing.

The mixed surface layer is in general deepest near the APF and near the continental slope (Foster 1984). It is shallowest south of the front where, due to wind and other forces, there is upwelling of deeper, warm water and thus an intense shallowing of density surfaces (Gordon 1988). According to Gorshkov (1978) the thickness of the surface mixed layer over the year, as expressed by the maximum depth of convectional mixing, is between 100 and 150 m just northward of the ice-edge (Fig. 3). It increases slowly to about the location of the APF where it dips down to about 300 m. North of this front there are three restricted areas of greater depth of convection mixing: north of the Ross Sea, south of Australia and in the South Atlantic. Once again this portrayal represents the average distribution for all available readings, biased seasonally as well as geographically, and not taking into account

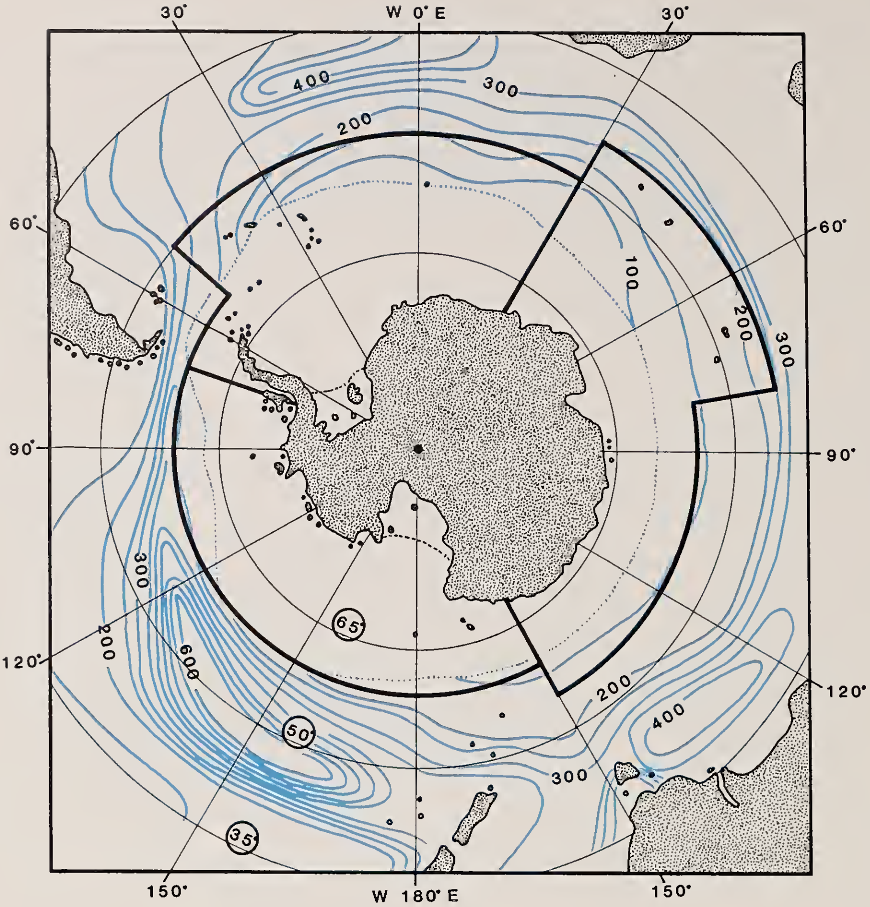

Fig. 3. Thickness of the surface layer, as expressed by the maximum depth of convectional mixing (after Gorshkov 1978)

meso-scale nor short-term effects except as included in the average. Most of the area of interest for this volume (Fig. 3) is covered by ice. Only in the area of the sub-Antarctic Islands between 30 °E and 80 °E is the depth of vertical mixing really effective and here it lies between 100 and 200 m deep. These deep mixed layers are brought about by the oceanic heat loss to the atmosphere north of the APF and thus the formation of Sub-Antarctic Mode Water in the sub-Antarctic zone (Gordon 1988).

Apart from this general overall distribution there is the overriding seasonal establishment of stability by the seasonal melting of the pack-ice adding a layer of fresh and therefore less dense water in the upper 150 m. This layer would cover the full ocean area south of the APF until freezing and ice-formation by a process of salt-rejection would remove the stability imposed by the layer of fresh water. In a medium that otherwise is fairly homogenous and deeply mixed by winds and sea-ice formation, this process of stabilizing no doubt facilitates the retention of plankton within the euphotic zone (Ainley & Jacobs 1981). This retention is also reflected in the vertical distribution of zooplankton. In summer zooplankton is found closer to the surface, but is more plentiful in coastal waters; in winter it is found at great depths (El-Sayed 1988).

In many studies it has been shown that primary production increases rapidly with increases in water column stability and it has been postulated that this is the limiting factor to production. Primary productivity is also higher at fronts where interleaving of adjacent water masses enhances stability (Allanson *et al.* 1981). Normally wind-induced mixing is sufficient to keep the water column stability well below optimal for primary production. Clarke (1988) feels that the effects of light, nutrient limitation, stability and grazing are complex and interactive, varying from area to area and making it unlikely that any single factor will be totally dominant. The main factor determining the surface turbulence and mixing and thus the breakdown of stability is wind stress. Wearn & Baker (1980) have shown that the area of greatest wind stress lies over the Crozet Basin and the northern South Indian Basin (Fig. 1), and most particularly south of Australia. Otherwise it decreases towards Antarctica.

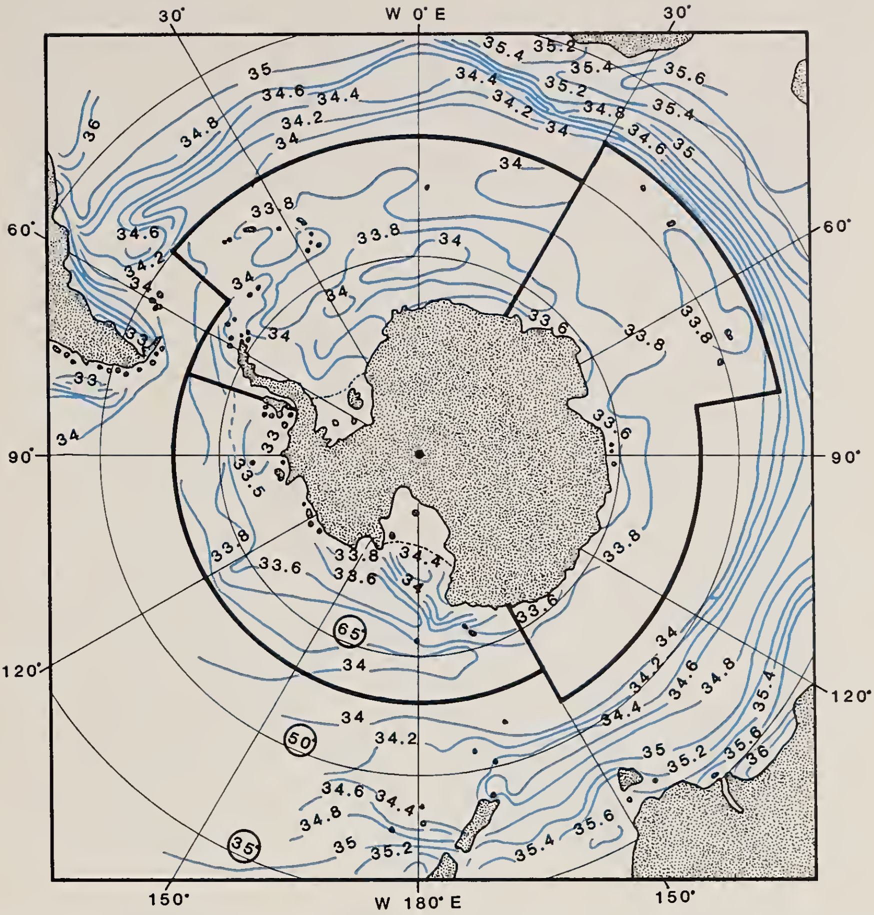

Fig. 4a. Distribution of salinity at the sea surface of the Southern Ocean for the winter months July to September (after Gordon *et al.* 1982)

Priddle *et al.* (1988) have furthermore demonstrated the drastic effect the breakdown of the hydrographic structure in the surface layer over a large area has on the abundance of krill.

Along the continental shelf of Antarctica water mixes during winter and produces a well-mixed water column to the bottom due to thermohaline changes that are not related to wind stress. This is also thought to occur in durable polynyas. In both cases stability in the water column will be very small. This will be discussed in more detail under the heading of thermohaline water movements.

Distribution of salinity at the sea surface

The distribution of salinity at the sea surface is for the greater part a product of the same processes and mechanisms that generate the surface distribution of temperature shown in Fig. 2. The surface distributions for salinity for both winter and summer are shown in Fig. 4.

During winter the greater part of the Southern Ocean is covered by pack-ice (Fig. 10). Salinities all lie within the range 33.8 to 34.2 per mille (Fig. 4a). Strong gradients in surface salinities are observed only to the north, at the STC, being particularly marked in the South Indian Ocean and at the Brazil-Falkland Current confluence. South of Australia this front is less strongly indicated by surface salinities and in the South Pacific sector of the Southern Ocean it is non-existent.

The distribution of surface salinities in summer (January to March) shows the influence of the previous winter's ice which has melted (Fig. 4b), as well as the general excess of precipitation (100 cm) over evaporation (50 cm) (Edmond 1975). The frontal systems of high horizontal salinity gradients to the north are on the whole not much changed in either position or intensity between seasons. Over the area of interest for this discussion, surface salinities lie between 33.5 and 34.0 per mille, with the exception of the Ross Sea where salinities of greater than 34.4 are to be found. The briny waters that initiate the formation of Antarctic Bottom Water are generated here (Gordon 1971a), as well as on the

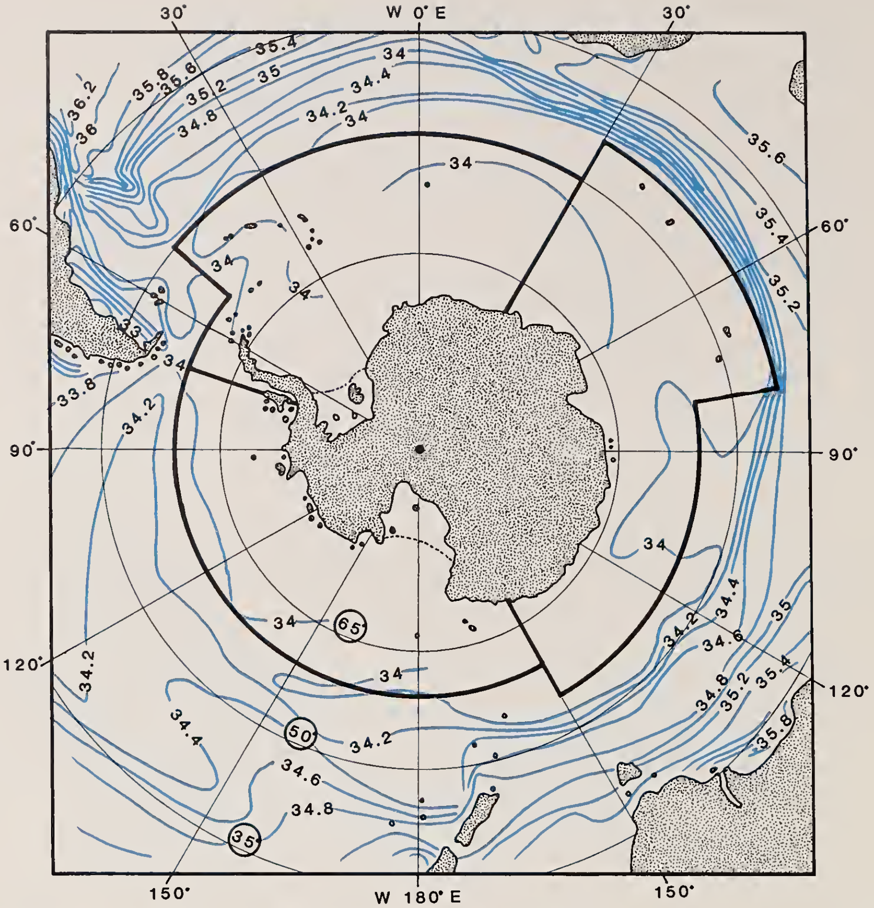

Fig. 4b. Distribution of salinity at the sea surface of the Southern Ocean for the summer months January to March (after Gordon *et al.* 1982)

Weddell continental shelf. The core of the Weddell basin circulation exhibits a slightly raised sea surface salinity, which may be due to the closer proximity of the Deep Water temperature maximum to the sea surface here than in other parts of the Southern Ocean (Fig. 7) and a smaller vertical haline gradient (Gordon *et al.* 1982). The difference is small and in all probability not important from an ichthyological point of view. The seasonal changes might, however, be significant.

Distribution of sea surface nutrients

Unlike the distribution of surface salinities, the distribution of nutrients may have a significant effect on the zoogeography, mainly through its influence on the phytoplankton and the primary productivity in the water column. There is, however, at present some disagreement on the level of biological productivity in the Southern Ocean and on the exact role of nutrients in general and individual nutrients in particular on the primary productivity (e.g. Holm-Hansen *et al.* 1977; Jennings *et al.* 1984).

In order to understand these issues it is important to look first at the surface distributions of the three major nutrients, namely silicate (SiO_3), phosphate (PO_4) and nitrate (NO_3), shown in Fig. 5. The values are in μmol/l at 100 m depth. The number of stations at which good quality data was available is much lower than for temperatures and salinities. There are therefore some noticeable geographic gaps in the data distribution. The first apparent feature of the circumpolar distribution of the nutrients is the decrease in values of all nutrients northward, away from the continent. Second, where sufficient data is available, the effect of the internal circulation of the Weddell Gyre and the Ross Sea is evident (Fig. 5a). The highest values for nutrients are found in these two areas.

The decrease in values for nutrients away from Antarctica is not uniform. The silicate is relatively homogeneous up to the location of the APF, as interpreted from surface isotherms (Fig. 2). Whereas values in excess of 90 μmol/l can be found in the Weddell Sea, values greater than 20 μmol/l are found in only very few spots outside the area of interest for this discussion. This does not hold for the phosphates and nitrates. These nutrients are uniformly high over a much greater area and only decrease

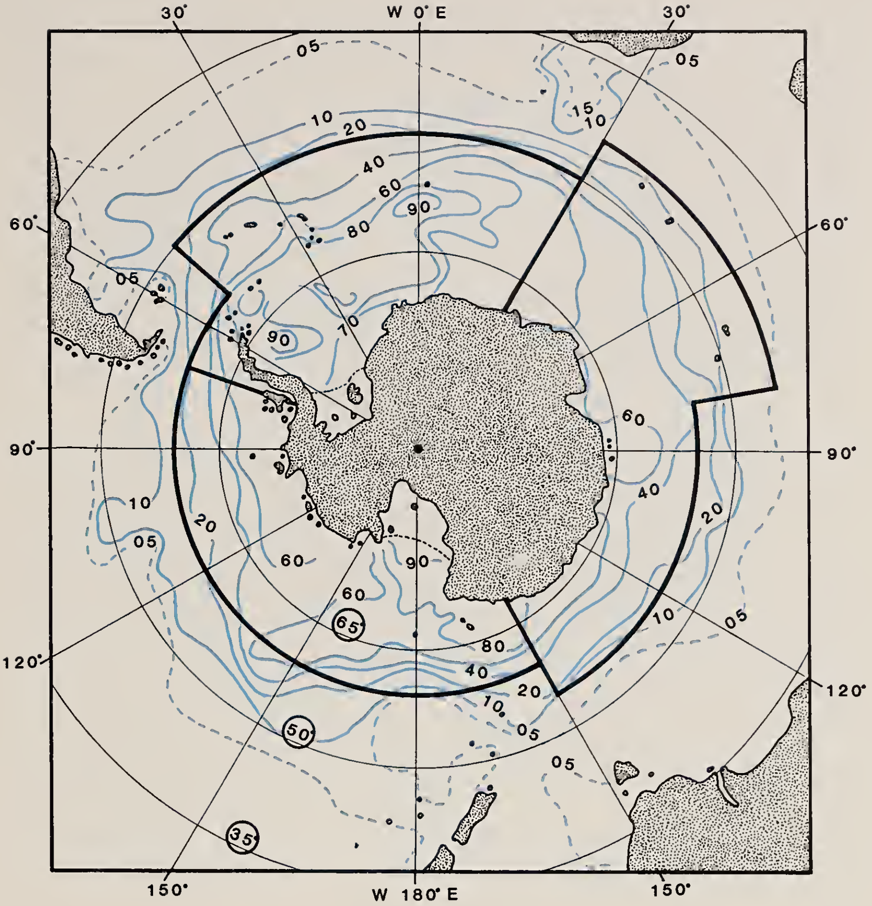

Fig. 5a. Geographic distribution in the Southern Ocean of the major nutrients at 100 m, measured in μmol/l: silicate (after Gordon *et al.* 1982)

markedly in the vicinity of the STC, i.e. outside the area of interest as indicated by heavy black lines in Fig. 5. This frontal limitation of nutrient distributions is particularly evident in all longitudinal lines of closely-spaced nutrient measurements across the Southern Ocean (e.g. Allanson *et al.* 1981; Lutjeharms *et al.* 1985b). Recent measurements along the Greenwich meridian present this phenomenon very clearly (Whitworth & Nowlin 1987). On this transect nitrates rose from 1.25 to 1.75 across the STC, phosphates went from 0.85 to 1.45, a rise of 0.6 μmol/l, while the silicates showed no perceptible increase. South of the APF most nutrients rose only slightly, including nitrite (NO_2), but silica went from 5 μmol/l to about 60. This difference in surface distribution of nutrients is reflected in the plankton biology (Edmund 1975). The APF forms a major faunal boundary: to the north, organisms that secrete carbonate shells such as coccolithophorids, foraminifera and pteropods are dominant; south of the front, diatoms which have silica tests are abundant.

The surface distributions in Fig. 5 are roughly representative of at least the upper 200 m of the water column in the Southern Ocean (Whitworth & Nowlin 1987). The concentrations of nutrients in general increase with depth in the underlying Deep Water. According to Foster (1984) there is no clear correlation between the surface distribution of nutrients and localized upwelling, although the warm Deep Water probably is the source of the high concentrations of nutrients in the surface water over the vast expanse of the Southern Ocean.

Conventional wisdom holds that primary productivity in the Southern Ocean is not nutrient-limited, but limited by water column mixing and light availability (e.g. Tranter 1982; Witek *et al.* 1982). Even at the peak of phytoplankton growth, the concentration of nutrients remains well above the limiting values (El-Sayed 1985). Phosphates are the nutrients that exhibit the most discernible seasonal variations (with a marked decline during late spring and early summer) although other nutrient concentrations also decline wherever blooms occur (Jennings *et al.* 1984). Holm-Hansen *et al.* (1977) think it likely, however, that in the sub-Antarctic, i.e. between the STC and the APF, where silica is

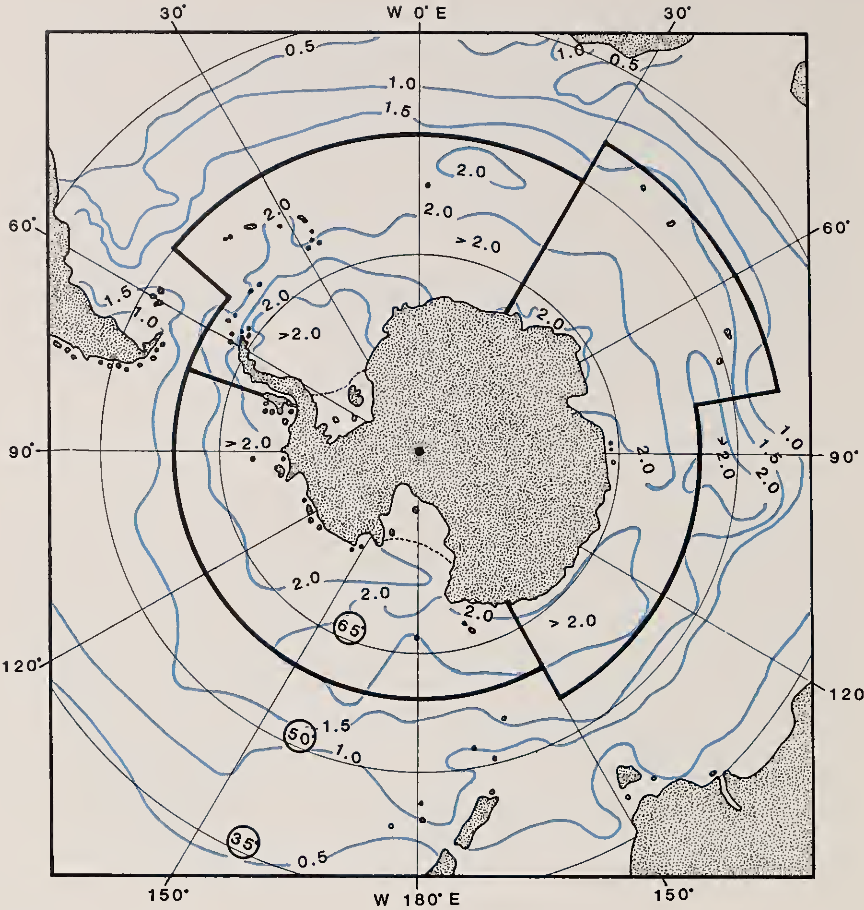

Fig. 5b. Geographic distribution in the Southern Ocean of the major nutrients at 100 m, measured in μmol/l: phosphate (after Gordon *et al.* 1982)

low, this deficiency may be a limiting factor. Jennings *et al.* (1984) have found that nutrient depletion may be extremely patchy with unaltered remnants of winter surface water found in the proximity of areas where a considerable reduction in nutrient depletion had previously occurred. The possibility, therefore, exists that the exact role of nutrients in both the Antarctic and sub-Antarctic surface waters is not yet fully understood and that present concepts may be limited by the present data collection, which is strongly biased towards summer and coarsely distributed in both time and space.

The distribution of nutrients at the sea surface is partially a function of the surface currents, and the distribution below the surface is also a function of the thermohaline movement of the deeper water layers.

Southern Ocean currents

In general, currents in the Southern Ocean fall into two categories. First, the horizontal advection in the upper layers. For the greater part of the food chain from phytoplankton to fish this horizontal current is probably the most important, being implicated in the dispersal of organisms and in the creation of specific marine habitats (Kock 1985). For fish it is particularly important for planktonic larval stages (Ekman 1953). Second, there is the flow regime at depth, usually shown as the meridional movement of various specific water masses (e.g. Fig. 7). These two types of currents are, naturally, components of the same water movement. In the depiction of the water movement at depth, there is evidence of considerable movement of water in the vertical plane. This is discussed in detail under thermohaline movements.

The influence of surface currents on the biota and on the biogeography has two temporally different effects. The large, average and long-term mean circulation is related to the large-scale distribution of organisms and larvae, while the meso-scale currents are probably responsible for short-term pertubations in the distribution of biota in a certain location at a specific time. A rather apt example in support

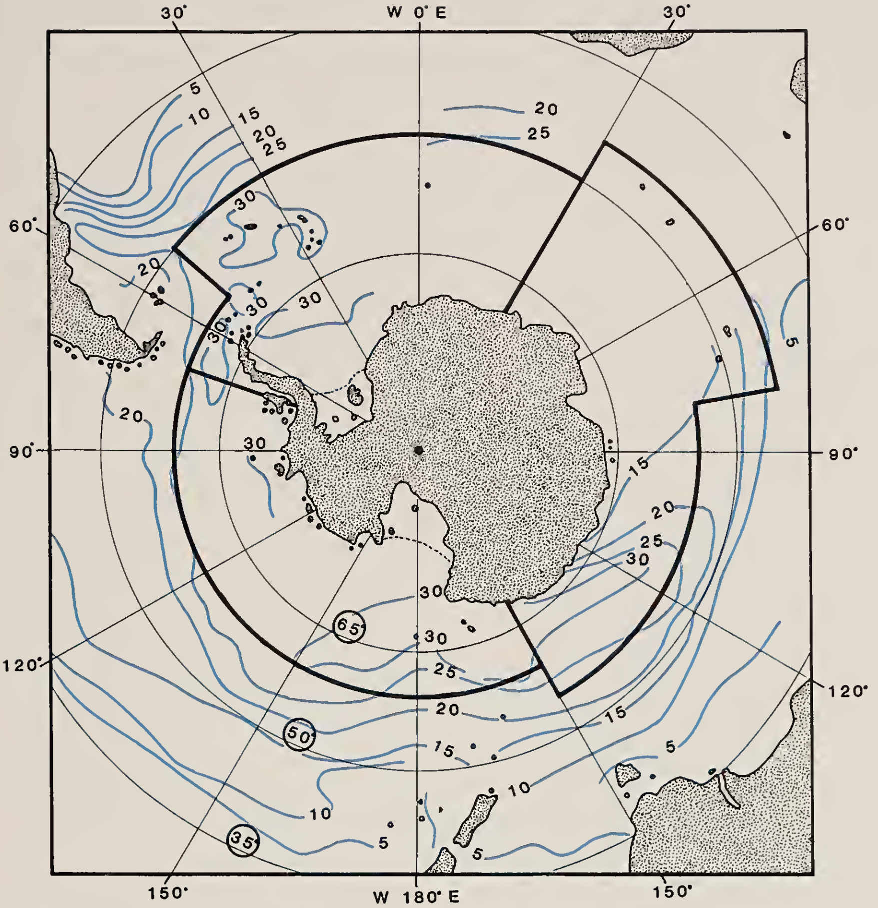

Fig. 5c. Geographic distribution in the Southern Ocean of the major nutrients at 100 m, measured in μmol/l: nitrate (after Gordon *et al.* 1982)

of this concept has been presented by Bogdanov & Solyanik (1971). Observations of occasional concentrations of krill (*Euphausia superba)* in the vicinity of South Georgia could not be explained in the context of the mean distribution of krill relative to the average position of the APF. Only by invoking sporadic, meso-scale influxes of surface water across the Front could these specific observations be explained. The geographically averaged, long-period, mean surface flow is discussed first.

The surface currents of the Southern Ocean are probably at present best described by the portrayal of Gordon *et al.* (1978) presented in Fig. 6. By far the greater part of this ocean's surface flow moves cyclonically around Antarctica forming the Antarctic Circumpolar Current (ACC). Flow in the opposite direction is found to occur in a consistent manner only in a narrow zone adjacent to the continent called the Eastwind Drift (Fig. 7). The surface speeds are not geographically uniform. Close to Antarctica current speeds in general are low, increasing northward. A meandering band of noticeably stronger currents within the ACC may be observed in all parts of the Southern Ocean (Fig. 6). In the south Atlantic sector this band is rather diffuse, lying at about 45 °S. South of Africa it is found further south, following the Atlantic-Indian mid-ocean ridge (Fig. 1). On crossing the ridge into the Crozet Basin it once more becomes diffuse. Data from surface drifters in this area (Hoffman 1985) support the divergence of flow north- and southward at about 40 °E. To the north, the Agulhas Return Current (Gründlingh 1978) strongly enhances the northernmost flow of the ACC. This axis becomes the main core of the ACC lying further and further south as the water flows eastwards. South of Australia it once again tends to follow the mid-ocean ridge which separates the South Indian Basin from the Australian basin (Fig. 1).

The core of the ACC bifurcates at the Campbell Plateau south of New Zealand, the major portion taking the southern route (Fig. 6). The flow follows the mid-ocean ridge, but after crossing it at the Eltanin fracture zone (Fig. 6; Fig. 1) it once more becomes diffuse. At the Drake Passage the flow is

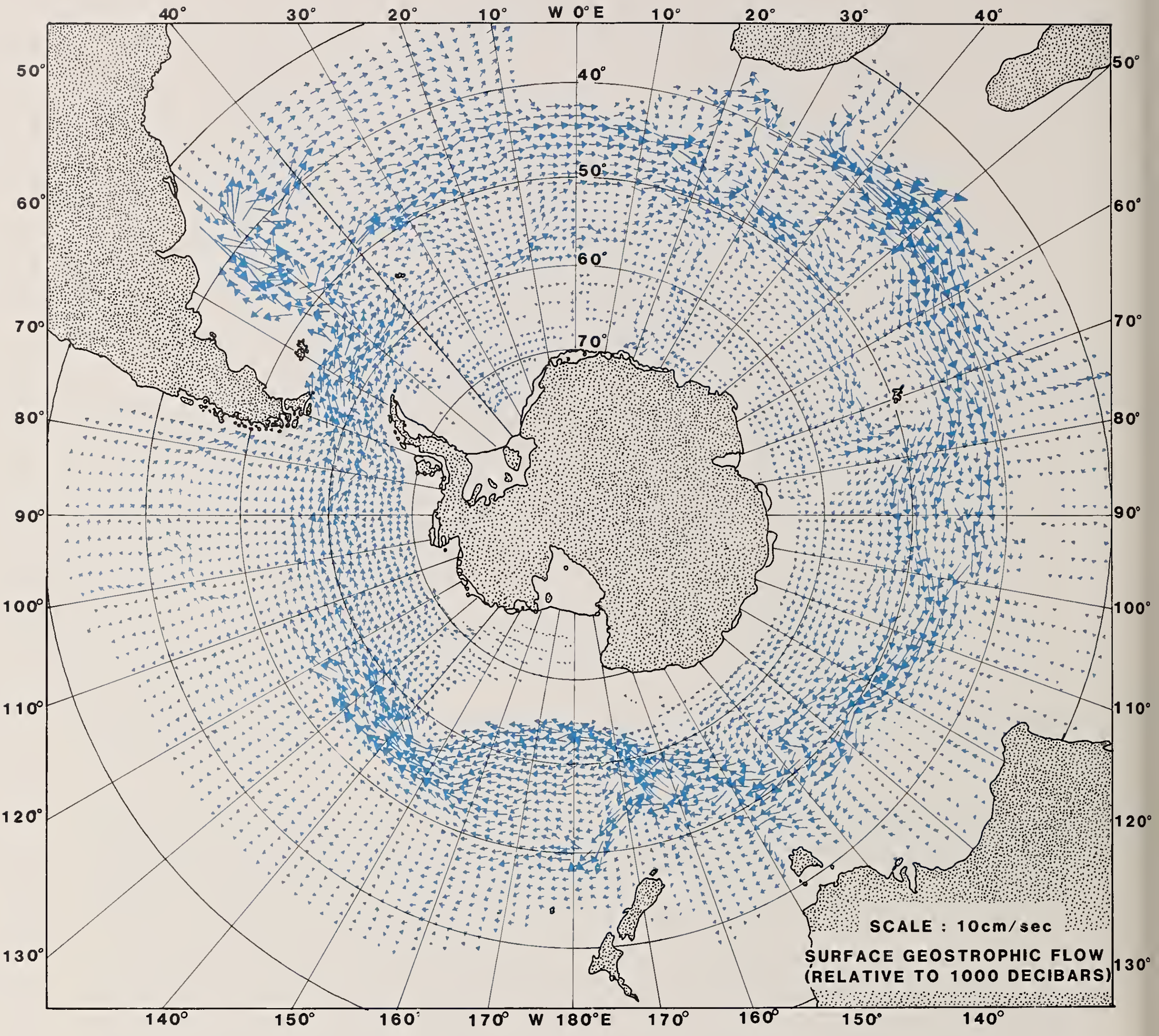

Fig. 6. Sea surface currents for each 1° latitude by 2° longitude grid, geostrophically calculated relative to the 1,000 decibars-level (after Gordon *et al.* 1978)

again intensified and has a noticeable northward component. East of the choke point a dimly perceived core is evident just north of 60 °S latitude. North of here the Brazil-Falkland confluence also creates a core of current.

On comparing the location of this current core of the ACC with that of the APF, it is apparent that, with the exception of the area south of New Zealand and south of Madagascar, they more or less coincide. Closer examination of the current intensity in the ACC with the aid of current meter moorings (Baker *et al.* 1977; Nowlin & Klinck 1986) has shown that the main flow of the current contains filamentous cores of enhanced flow rate that coincide with the location of the main frontal regions, namely the Sub-Antarctic Front, the APF and the Continental Water Boundary (Whitworth 1980). This is on a finer scale, however, both in time and space, than the depiction of Fig. 6.

Many of the eggs and larvae of pelagic organisms are found in the top few metres of the ocean. The drift rates of these are a function of the wind stress, water transport by surface waves as well as currents caused by density distributions such as discussed above (John 1984). To establish and measure this drift is not easy. A large number of drifting buoys, tracked by satellite, have given a first indication of the drift rates (Hoffman 1985; Patterson 1985; Daniault & Ménard 1985; Piola *et al.* 1987). The drift patterns in general correspond to those shown in Fig. 7. A bunching of drifters at the main frontal regions, suggesting the convergent nature of these fronts at the sea surface (Hoffman 1985) has been observed. One may therefore expect an accumulation of non-motile organic material, such as eggs and larvae, at these fronts.

Sea surface drift in the Southern Ocean has been further investigated by using plastic drift cards. These cards move with the top few centimetres of the water and, although they are not tracked, give indications of the direction and rate of movement of the surface skin of the water column (Stander *et al.* 1969) between the place of deployment and the final place of recovery. A decade-long study has shown that there is significant equatorward surface exchange between the Southern Ocean and the subtropical ocean gyres (Lutjeharms *et al.* 1988) in this surface layer. Average zonal drift rates lie between 10 and 16 km/day but increase with latitude up to the zone demarcated by 40° and 45 °S. Zonally averaged drift rates of buoys are higher and specifically show higher drift rates on crossing

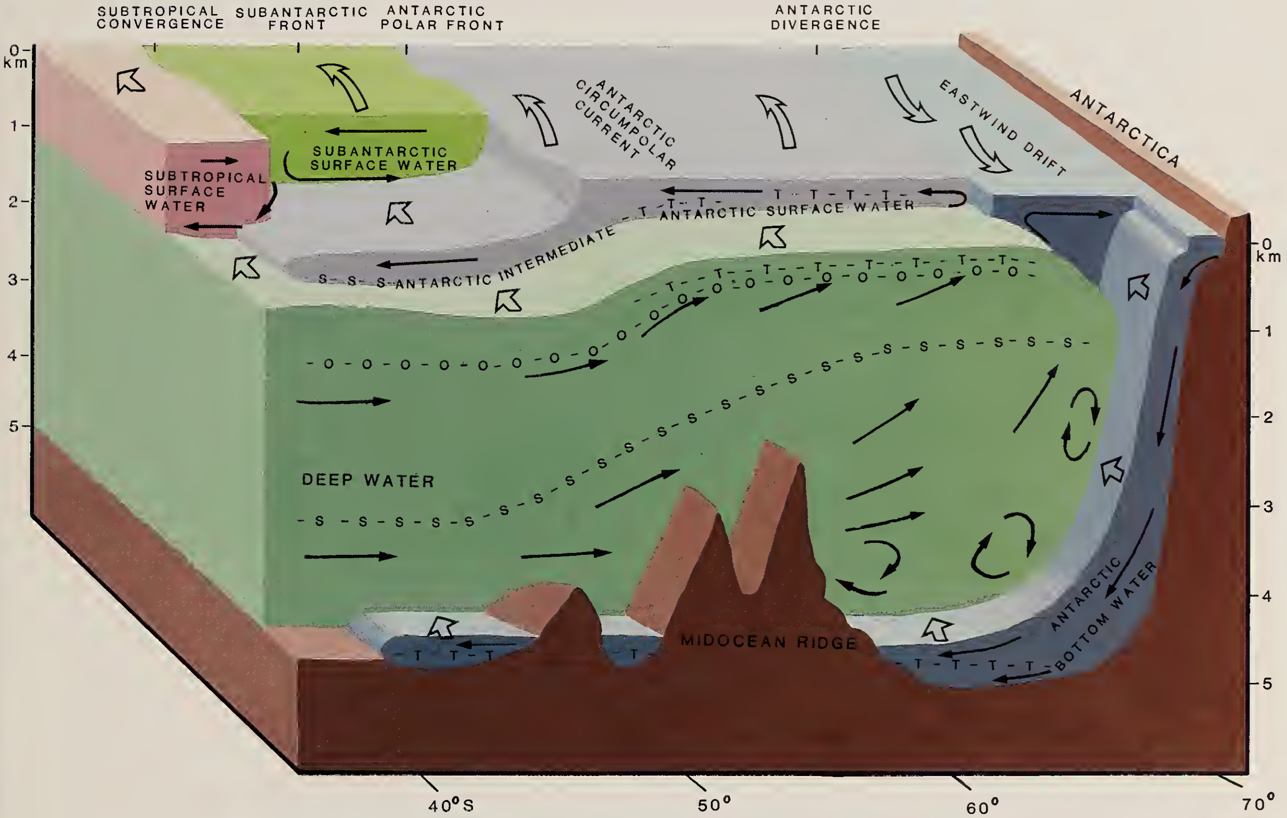

Fig. 7. A schematic presentation of the present understanding of the water types, their disposition and movement in a Southern Ocean sector south of Africa. Open arrows denote lateral drift; solid arrows inferred vertical movement. In the Deep Water the characteristic temperature maximum, the oxygen minimum and the salinity maximum layers are indicated by broken lines T, O, and S. The temperature minimum of the Antarctic Surface Water and the salinity minimum layer of the Sub-Antarctic Intermediate Water are also shown by lettered, broken lines (after Lutjeharms *et al.* 1985b)

mid-ocean ridges. These results are particularly significant for the dispersal patterns and dispersal rates of immotile organisms as well as fish eggs and larvae.

Although the large-scale, average flow pattern of the Southern Ocean is dominated by the ACC, three areas with singular flow patterns should be noted. These are the circulation close inshore, as well as in the Weddell gyre and in the Ross Sea (Fig. 1). Of these the circulation in the Eastwind Drift (Fig. 7) is perhaps least well known. The monitoring of the drifts of icebergs in this zone has shown (Tchernia & Jeannin 1980) that this zone is not wide and that there is considerable exchange between this flow regime on, or close to, the continental shelf and the water masses to the north. It is unlikely to be continuous along the full coastline of Antarctica. Pelagic organisms in the water over the shelf will therefore most probably not be retained there by the water movement alone.

The general flow patterns in both the Ross and Weddell seas are cyclonic. That of the Ross Sea is geographically much more restricted (Treshnikov 1964) and may be significantly influenced by the wide continental shelf and the substantial permanent ice cover. The Weddell gyre covers the Weddell Basin (Fig. 1) and is a very important component of the circulation of the Southern Ocean. It is here that most of the bottom water of the world oceans is generated (Fig. 7). It is also the flow regime in which the largest concentration of krill (*Euphausia superba)* are found and it is thought that the circulation in the Weddell gyre plays an important part in the natural history of krill (Marr 1962; Miller & Hampton 1989). Although of major importance for both the physics and the biology of the ocean, many features of its circulation are poorly understood. One of the main reasons for this is that the greater part of the Weddell Basin is covered by pack-ice in winter and is therefore inaccessible to most ship-borne research. It is believed that the circulation consists of a narrow, intense flow along the east coast of the Antarctic Peninsula, merging with the flow of the ACC through the Drake Passage to form the Weddell-Scotia confluence at about 60°S (Patterson & Sievers 1980). The northern boundary of the flow eastward is thought to lie between 55° and 60°S. At its eastern termination between 20° and 30°E the gyre is completed by southward movement in deep and bottom layers (Deacon 1979), but there seems to be little evidence of southward movement near the surface. The gyre is completed by westward flow along the Antarctic coast in the Weddell basin (Gordon 1988).

This narrative has described the large-scale, long-term average of the surface flow. The second scale of surface currents that influences biogeography is the meso-scale and shorter time scale. The large, long-term scales are in effect the averages over time and space of the more immediate, meso-scale features. These short-term features are important because our present knowledge of current patterns is based on direct observations of such meso-scale features. Eddies may entrap and retain organisms thus influencing their productivity and distribution. Upwelling in eddies may cause increased stratification in the water column and in this way light enhancement for phytoplankton (Tranter 1982), thus causing higher primary productivity. A study of the formation of topographic eddies over the Antarctic banks (Lanin 1985) has indicated their contribution to the capture and downward transportation of pelagic plankton. These studies are, however, in the way of being exceptions. Little work has been done on the detail of local physical processes and their possible effect on the fish fauna of the Southern Ocean.

Analysis of the drift of weather buoys in the Southern Ocean (Patterson 1985) has shown that most of the kinetic energy of the surface circulation is indeed in the eddy field. The distribution of this eddy field is not geographically homogeneous but concentrated in certain specific locations. This has been demonstrated by using a number of disparate data sets such as historic hydrographic data (Lutjeharms & Baker 1980), satellite altimetric data (Cheney & Marsh 1983) and drifter tracks (Piola *et al.* 1987). The areas of maximum eddy kinetic energy coincide with the termination regions of the western boundary current regimes of the southern hemisphere such as the Agulhas, the Brazil and the East Australian currents. In the area of the ACC they coincide with the location of the core of this current and particularly where this current crosses major bottom topographic features (Colton & Chase 1983). This is not entirely unexpected as the conditions for baroclinic as well as barotropic instabilities are met in the ACC (Nowlin & Klinch 1986). Eddies have been observed during many research cruises in the Southern Ocean (e.g. Savchenko *et al.* 1978) and, in particular, eddies have been observed to form at frontal regions by a process of pinching-off (Peterson *et al.* 1982; Bryden & Heath 1985; Lutjeharms & Valentine 1988).

Some important biogeographical forcing factors emerge from these results. First, frontal regions are not impervious biotic barriers, but may be penetrated by the formation of eddies, particularly at certain specific, recognized geographic locations. Second, the distribution of many organisms may be extremely patchy, a large proportion being imbedded in eddies foreign to the immediate environment. Third, in the open ocean, organisms may experience degrees of environmental stress that are directly related to the short-term, meso-scale variability of the geographic areas in which they find themselves, and these degrees of stress may vary enormously over the geographic extent of the Southern Ocean.

Southern Ocean fronts

One of the most characteristic hydrographic features of the Southern Ocean is the presence of a number of strong, persistent and circumpolar fronts. As was noticed before, the fronts interrupt the gradual increase in temperature and salinity in moving northward from Antarctica by dramatic, localised increases. The surface characteristics of the Southern Ocean are to an important degree determined by the presence, the location and the characteristics of these fronts. To a large extent the biological zonation of the ocean is therefore not so much a function of lying north or south of a particular latitude, but rather a function of lying north or south of a particular front. Andriashev (1965) has, for instance, presented some outstanding and clear-cut examples of the APF acting as a strong ichthyogeographical barrier. He, as well as Norman (1938), Ekman (1953) and Dell (1972) have therefore considered the rich Antarctic fauna as being distributed in three zonal regions bordered by fronts, with a high fish species endemism for each.

The two most prominent surface fronts are the STC, which forms the natural northern border of the Southern Ocean, and the APF. The latter previously was called the Antarctic Convergence (Mackintosh 1946). The average locations of both are portrayed in Fig. 1. The location of the APF coincides on the whole, as mentioned above, with the core of the Antarctic Circumpolar Current. In the South Atlantic and South Indian sectors of the Southern Ocean it is found at about 50°S; in the South Pacific sector it lies further south, at about 60°S (Fig. 1). The STC lies at about 40°S in most ocean sectors. In the south-eastern Pacific it has not been observed while in the south-western Atlantic locating its surface expression is complicated by the presence of the Brazil-Falkland Current confluence.

Historically these major fronts have been charted by ships occupying deep oceanographic stations far apart. In the more recent past measurements have been made routinely much closer together. This has established much more knowledge on the meso-scale phenomena associated with the fronts. Unfortunately the geographic distribution of these more closely spaced measurements are very scattered. With these finer resolution data has come the recognition that an additional front should be identified as such, namely the Sub-Antarctic Front (SAF). South of Australia, Zillman (1970) described it as the most prominent feature of the sea surface temperature decrease, exceeding the horizontal thermal gradient of the STC as well as the APF. Sievers & Emery (1978) have described it as occurring in the Drake Passage. Its existence south of Africa was first established by Lutjeharms *et al.* (1981) who have shown that it presents itself here as a subsurface temperature gradient lying between 3° and 5°C about 400 km north of the APF. Hoffman (1985) has analysed a large number of closely-spaced sections distributed over most of the Southern Ocean and has established that the SAF is a circumpolar feature with distinct and recognisable physical features. Establishing the circumpolar continuity of such physical features is important since it may coincide with the circumpolar continuity of certain biota, such as plankton species (Baker 1954).

The frontal systems in the South Pacific have been described by Gordon (1971b). He found that the thermal structure across the APF is variable, but that a consistent pattern can nonetheless be identified. A double polar front zone exists, with a warm water zone separating the two. The water masses and fronts south of New Zealand were also investigated by Houtman (1967) who suggested that the double front is a function of meso-scale meandering in the APF. Edwards & Emery (1982) working south of Australia also found that the APF was particularly convoluted here. The presence of such meanders in the fronts and eddies has convinced Emery (1977) to consider the frontal regime as an Antarctic Polar Frontal Zone, a complex transition region between Antarctic and Sub-Antarctic Surface Waters. Deacon (1983) has pointed out that this is particularly true for the area between Marion and Heard islands, where there seems to be more interchange and less clear gradation between these two water types.

The location and nature of the fronts south of Africa has also received considerable attention (e.g. Nagata *et al.* 1988). Their locations and characteristics at the sea surface (Lutjeharms & Valentine 1984) as well as at greater depth (Lutjeharms 1985a) have been determined in detail. Here too the sometimes diffuse nature of the fronts, their shifts in location and the seasonal changes in their characteristics have been established (Lutjeharms 1985b). Nowlin & Klinck (1986) have estimated that meridional shifts in the location of, for instance, the APF of at least 100 km may be normal. This has made the ichthyogeography of the area difficult (Duhamel 1987).

What could be the mechanism for this diffuse and fluctuating nature of the Southern Ocean fronts? One has already been mentioned. Since conditions in the general flow are conducive to both baroclinic and barotropic instability, the formation of meanders and the shedding of eddies at the fronts may be expected (e.g. Joyce *et al.* 1981). This, however, is on the meso-scale and shorter temporal scales. It may explain much of the physical as well as biological detail observed at fronts during individual research cruises. It may also explain some of the biogeographical distributions which otherwise are difficult to interpret. Boden & Parker (1986) have for instance shown that the zooplankton found at the Prince Edward Islands in the sub-Antarctic, include characteristic species from both the Subtropical as well as the Antarctic regions. Similarly, Miller (1985) was able to show that the marked faunal dissimilarity between Gough Island and the Prince Edward Islands could be attributed solely to the proximity of different fronts to the respective islands. Although it has previously been recognised that these fronts are not impervious biological barriers (Voronina 1962), this heterogeneity of species probably points to the role of long-lived meso-scale eddies with diverse origin in the distribution of plankton. On average, and over the longer term, however, the physical and consequently the biogeographical zonation of the Southern Ocean is strong (Deacon 1982).

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Apart from the fact that the surface expressions of the fronts in the Southern Ocean act as porous biogeographical barriers, these fronts in themselves are special biological regimes. Marra & Boardman (1984) have, for instance, found a doubling of chlorophyll *a* at the ice-edge zone. Plancke (1977) observed sharp increases in biomass and productivity at the STC. South of Africa it was found that peaks in both chlorophyll *a* and potential primary production occurred at the STC, the APF and at the Continental Water Boundary (Allanson *et al.* 1981; Lutjeharms *et al.* 1986). These peaks in primary production are also reflected in the distribution of higher organisms, notably that of birds (Ainley & Jacobs 1981; Abrams 1985), confirming that frontal regions are specialised habitats for substantial parts of the food chain, probably including fish. The fundamental reasons for this are not well understood. Where fronts exhibit surface confluence, they may be areas of accumulation for drifting material (Ainley & Jacobs 1981). The step-like structure in the isotherms at Southern Ocean fronts may furthermore be instrumental in causing greater stability in the upper water column, thus retaining phytoplankton in the euphotic zone and enhancing productivity (Lutjeharms & McQuaid 1986). The specific role fronts play in the ecology of the Southern Ocean is still to be determined; a preliminary suggestion is that it may be small, but important.

The physical driving forces for the individual fronts are not well understood. A conceptual portrayal of the three dimensional movement of the water masses of the Southern Ocean is given in Fig. 7, and in it the causes for some fronts are suggested.

Thermohaline water movement in the Southern Ocean

Many of the distinctive water types found in the water column of all oceans are formed and have their origin in the Southern Ocean. When the vast area of this ocean freezes into a pack-ice cover in winter, enormous amounts of salt are released in the form of brine extruded from the freezing ice. The salinity of a large water mass in thus increased. When this ice melts in the austral summer, a surface layer of low salinity overlies much of the Southern Ocean. The warmer Deep Water of north Atlantic origin in turn rises to the sea surface here and loses vast amounts of heat to the overlying atmosphere. Through these processes of salinity increase and decrease, and loss of heat, a number of new water masses are formed that, by virtue of their new-found densities and the prevailing wind-stress, find new locations in the water column. This is conceptually portrayed in Fig. 7. These mostly thermohaline movements are important not only for those fish that spend most of their natural life deeper than the surface waters, but also for all those organisms, such as krill, which have different life stages at different depths (Marr 1962). Ekman (1953) has stressed the importance of abyssal bottom water movement for the distribution of certain fish larvae during their planktonic stage.

Through a process of cooling, as well as salinity increase due to freezing and mixing with adjacent shelf water, a very dense water mass is formed on the continental shelf and slope. It then flows down to the ocean bottom, to become Antarctic Bottom Water which moves northward to fill all the ocean basins (Mantyla & Reid 1983). On a temperature-salinity (T/S) curve it presents itself as a temperature minimum. It is believed that this distinctive water mass is for the greater part formed in the Weddell Sea, although minor generating areas may be in the Ross Sea and at other places along the continental shelf of Antarctica. The formation of Antarctic Bottom Water may not be a gradual process, but may occur in the form of sudden pulses or events. It is not known whether there are significant variations in the formation rate or volume from year to year or what biological effects such variability may have.

Between the coastal and continental shelf water and the water further offshore there is the Antarctic Divergence, the location of which is supposed to coincide with the line demarcating the border between the average easterly and westerly wind regimes (Deacon 1977). It is not always distinct in north-south sections of oceanographic observations in contrast to the Continental Water Boundary which can be very distinctly defined. The Antarctic Surface Water is relatively fresh once the pack-ice has melted, and once the surface has been warmed, it exhibits a marked subsurface temperature minimum. It drifts northwards where it subducts below the Sub-Antarctic Surface Water to flow northwards as a recognisable salinity minimum. The line at the sea surface where it subducts locates the APF. One definition for locating the APF is where the subsurface temperature minimum intersects the 200 m isobath. Between this thin surface water layer and the Antarctic Bottom Water there is the immense wedge of warmer Deep Water, with lower salinity and oxygen. South of the APF this water slowly upwells giving off much of its heat to the atmosphere. Between the APF and the STC the Sub-Antarctic Surface Water is intersected by the Sub-Antarctic Front. Sievers & Emery (1978) defined it as a subsurface temperature gradient lying between the 3 ° and 5 °C isotherms. It forms the northern border of the Antarctic Polar Frontal Zone, or what may be considered as the furthest extent of the direct influence of this front via eddies etc. Its location may be influenced by the average wind stress, but this has not yet been determined unambiguously.

Once again, this portrayal (Fig. 7) is an average both in time and in space. On any one occasion at any specific location a large number of meso-scale features with a range of lateral and vertical dimensions may complicate the picture. For the life history of any particular marine organism the behaviour of the meso-scale hydrographic features may be crucial. For instance, it has been established that persistent open areas or ice-free zones in the winter pack-ice may be caused by chimneys of deep convection (Gordon 1982). Due to its remarkable surface effect this circulation feature is very conspicuous. Many other flow features that are not as visible may also affect Southern Ocean organisms. The individual or cumulative effect of meso-scale features on marine organisms are yet to be determined. The assumption being made here is that the long-term average, such as that portrayed in Fig. 7, approaches the cumulative effect of short-term, limited scale hydrographic features.

In the vicinity of certain bottom topographic features, the hydrography and hence the biological environment may be anomalous compared to the average such as in Fig. 7. This is true for such coastal features as the Ross Sea and the Antarctic Peninsula coastline as well as for islands. Some of the zoogeographic subdivisions of the Southern Ocean (e.g. Kock 1985) place great stress on the islands as important zoogeographic subregions. Much work has been done in this regard in the vicinity of islands such as South Georgia (e.g. Bogdanov & Solyanik 1971; Mackintosh 1972; Permitin 1977). One of the more remote island groups that may be a good case in point is the Prince Edward Islands. It has long been believed that due to the presence of these islands an "island effect", enhancing the biological productivity of the direct ocean environment, may exist. Some investigators (Grindley & Lane 1979)

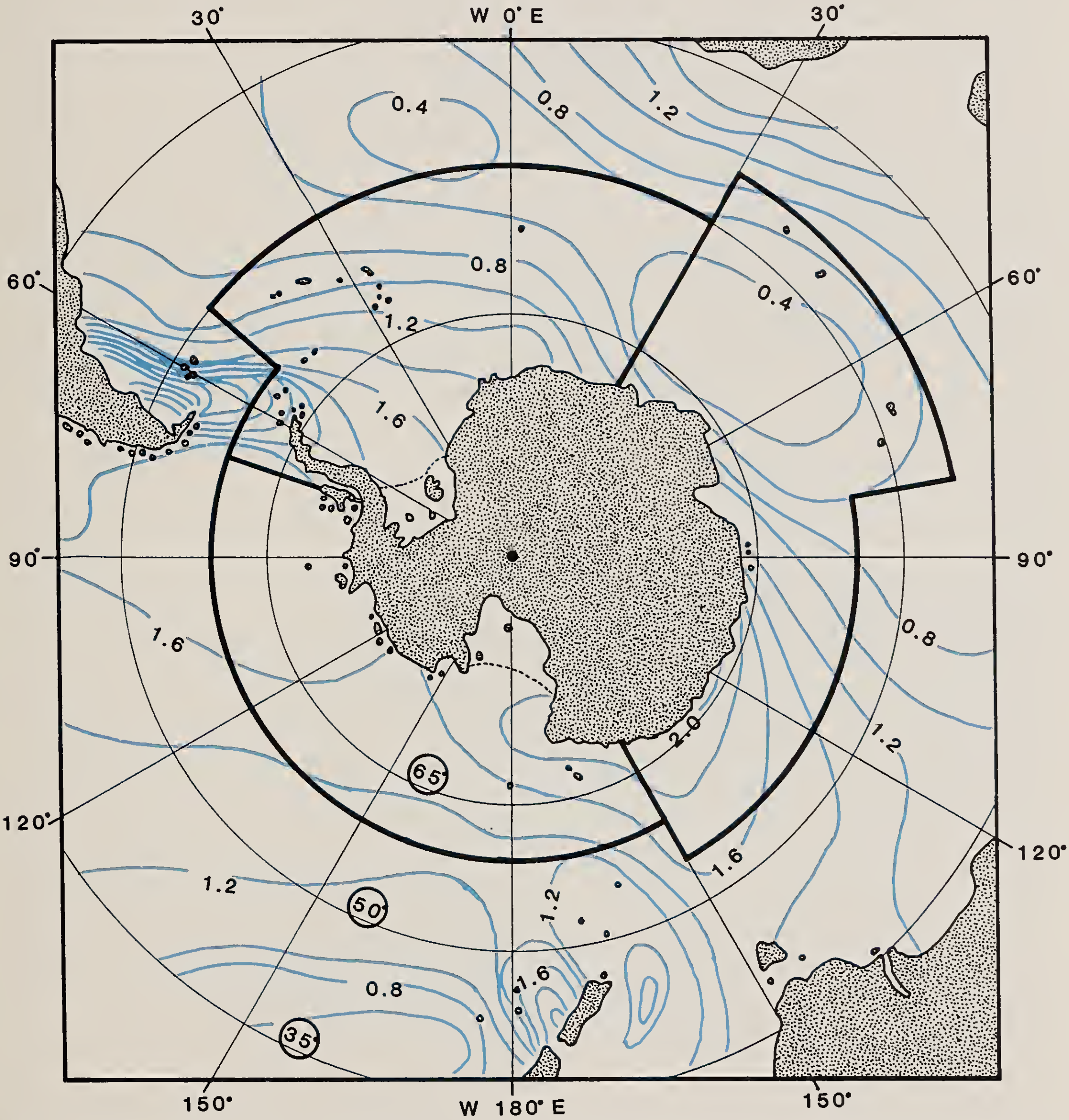


Fig. 8. The greatest magnitude of the tidal range in the Southern Ocean in metres (after Gorshkov 1978)

claimed to have found upwelling in the lee of these islands, which could contribute to greater primary productivity. Others were not able to find this, but suggested a slipstream of meso-scale turbulence which might have the same effect (Allanson *et al.* 1985). More recent results indicate that the increased productivity might be limited to a very restricted area in the immediate vicinity of the islands.

Tides

One of the important factors that may influence the benthos of islands in the Southern Ocean as well as that around the Antarctic Continent is the amplitude and the phases of the tide. Rocky intertidal zonation may be a direct result of tidal amplitude (Doty 1957; Knox 1968). A knowledge of tidal cycles and amplitudes is therefore basic to an understanding of littoral zonation, exposure times and the general ecology of intertidal animals.

Of all coastal regions in the world ocean, the Antarctic continent and sub-Antarctic islands are particularly poorly served with sea level measurements, especially so in the South Atlantic and South Indian Ocean sectors of the Southern Ocean. There are only 75 stations at which sea level records were obtained on the Antarctic continent itself and in the adjacent coastal region (Lutjeharms *et al.* 1985a). Of the tidal stations in Antarctica, 43% are on the Antarctic Peninsula, 24% around the Ross Sea and the remaining 25 measurements are spread in a geographically very inhomogeneous manner. No records could for instance be found indicating that any measurements have ever been undertaken between the Ross Sea (160 °W) and the Antarctic Peninsula (70 °W). Furthermore, the quality of some of the data collected for these historic tidal stations may be suspect.

Based on this limited data set, it is found that the range of the tide in the area of interest is small (Fig. 8). Except for a small stretch of Antarctic coastline south of Australia and the northern part of the Antarctic peninsula, the range does not exceed 2 m. In the two areas mentioned it does not exceed 2.5 m. The tidal range at the eastern end of the Magellan Strait is 13 m, but this is exceptional for the Southern Ocean as a whole. The type of tide differs for the individual coastlines of the area (Knox 1960). Along the South African, New Zealand, east Australian and east South American coastlines it is predominantly a semidaily tide, while along the west coast of South America and the south coast of Australia it may be typified as an irregular semidaily tide. The islands in the vicinity of New Zealand experience a semidaily tide. The west coast of the Antarctic Peninsula has regular diurnal tides; the east coast irregular semidaily tides. Along the Antarctic coastline south of Africa a mixed, predominantly semidiurnal tide was observed.

Based on the sparse data set, the main conclusion that may be reached is that the tidal range is small and lies between 0.5 and 2.5 m depending on the location. The creation of special benthic environments may therefore be a function more of wave action than of tidal action although these of necessity interact.

Wave action in the Southern Ocean

Wave action at the coast of Antarctica is extremely limited due to the presence of solid pack-ice in winter and broken pack-ice for most of the summer. The portrayal of maximum wave heights for the Southern Ocean (Fig. 9) shows that the boundary of the pack-ice at about 60 °S is the limit to which wave action can be calculated. A further zone parallel to this has very few observations, so that most of the wave height isolines are speculative. The results portrayed here are wave height estimates made from on board ships in the area. These data are therefore uncalibrated and at times suspect. What is clear is that with the exceptions of small areas south of New Zealand, in the mid-Pacific and at 30 °W, Antarctica is surrounded by a band of maxima wave heights of about 20 m. It can therefore be expected that the sub-Antarctic islands such as Marion, Crozet and Kerguelen which lie in this zone will at times experience very heavy wave action, whilst the zoogeographical subregions along the Antarctic coast will be affected by a much more tranquil wave climate.

Only a few studies of wave behaviour in the Southern Ocean have been carried out using different and more modern data sets, such as satellite altimetric data. These investigations (Mognard *et al.* 1983) show a similar pattern of highest significant wave heights at 50 °S in the Indian Ocean sector of the Southern Ocean. That this short data set agrees with the larger mean may be entirely coincidental. The significant wave heights did not exceed 6 m on this occasion (August 1978). Wave height increases are strongly correlated with increases in wind stress (Mognard *et al.* 1983). Wind stress (Trenberth *et al.* 1989) is a physical factor which has important biological implications, since it aids the mixing of the surface layer. Since stability of the upper water column is a crucial element in retaining nonmotile organisms such as phytoplankton in the euphotic zone it has been suggested, as discussed above, that not light, nor temperature, but stability may be the limiting factor in primary production of the Southern Ocean (Clarke 1985).

Ice cover for the Southern Ocean

All ocean areas exhibit seasonal behaviour manifested in variations of sea surface temperature, wind stress, intensity of incident light, etc. In many ocean areas the seasonal variations are small and the

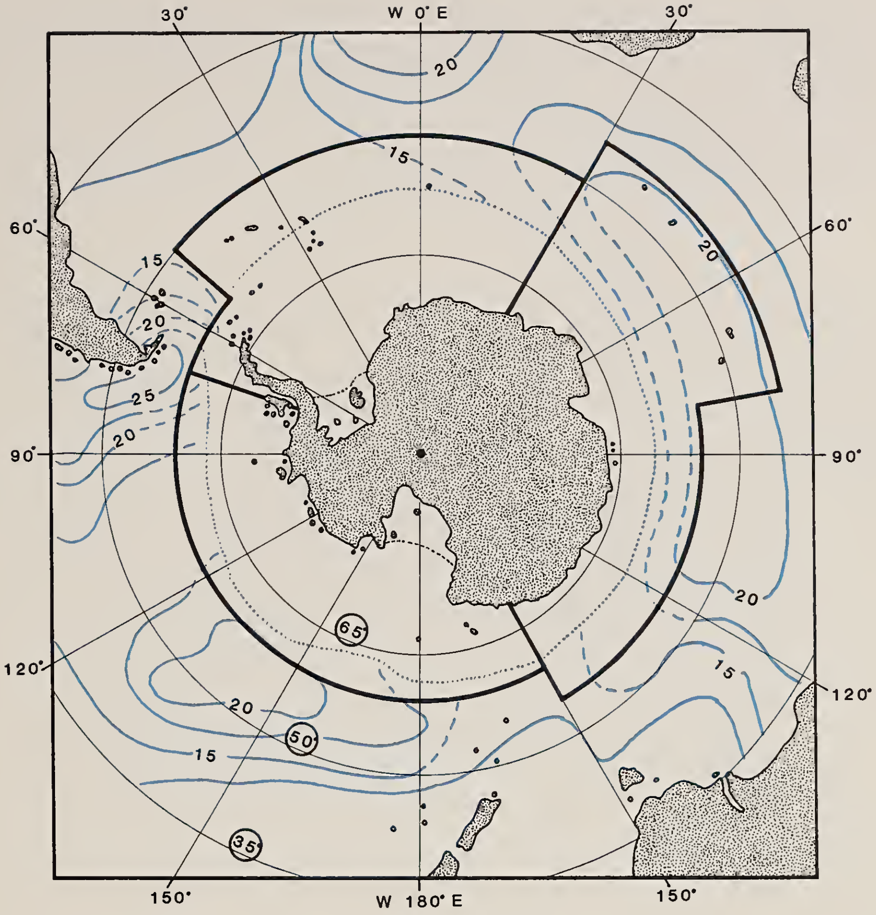


Fig. 9. Maximum wave height (in metres) for the month of October, which is reasonably representative for the greater part of the year (after Gorshkov 1978). Broken lines denote lack of data; dotted lines denote the edge of the pack ice

inter-annual changes are as large if not larger. This is not the case in the Southern Ocean. Here the seasonality is extreme and plays a dominant role in the physics and chemistry of the surface layers and also in the corresponding life history of organisms. The most visible, and obviously one of the most important, seasonal factors is the increase and decrease in ice cover.

Ice cover is the most important environmental factor in the biology of large parts of the Southern Ocean (El Sayed 1985). A range of organisms are especially adapted to life on the ice-water interface of the pack-ice, and certain plankton species are adapted to life in the miniscule brine-channels in the ice itself. With the melting of the ice all these organisms are released into the water column and form a rich ecosystem that moves southward with the onset of summer as the ice edge retreats poleward. The movement of this rich front is followed by a host of higher order animals including birds (Ainley & Jacobs 1981) and even whales. The seasonal expansion and contraction of the ice cover therefore constitutes a variable annual pulse to which the components of the system are closely synchronized (Tranter 1982). The pack-ice severely reduces the effect of wind stress on the momentum transfer between atmosphere and ocean, the penetration of light and the influence of mixing by waves.

The distribution of both fast-ice and pack-ice is thought to have a significant influence on the distribution of fish. The abbrasive action of pack-ice (Knox 1960) is, for instance, held responsible for the nearly complete absence of true littoral Antarctic fishes (Andriashev 1965). Some benthic fish species have, on the other hand, been found only under fast-ice. At coastlines of islands further north, with higher temperatures and freedom from permanent as well as pack-ice, a comparatively rich intertidal flora and fauna is developed (Knox 1968).

The variable extent of sea-ice is shown in Fig. 10. In a normal year the winter pack-ice halves the area of open water south of the APF (El Sayed 1985). These data are from the observations from ships spanning many years, but lately have been from microwave instruments of satellites, which are not

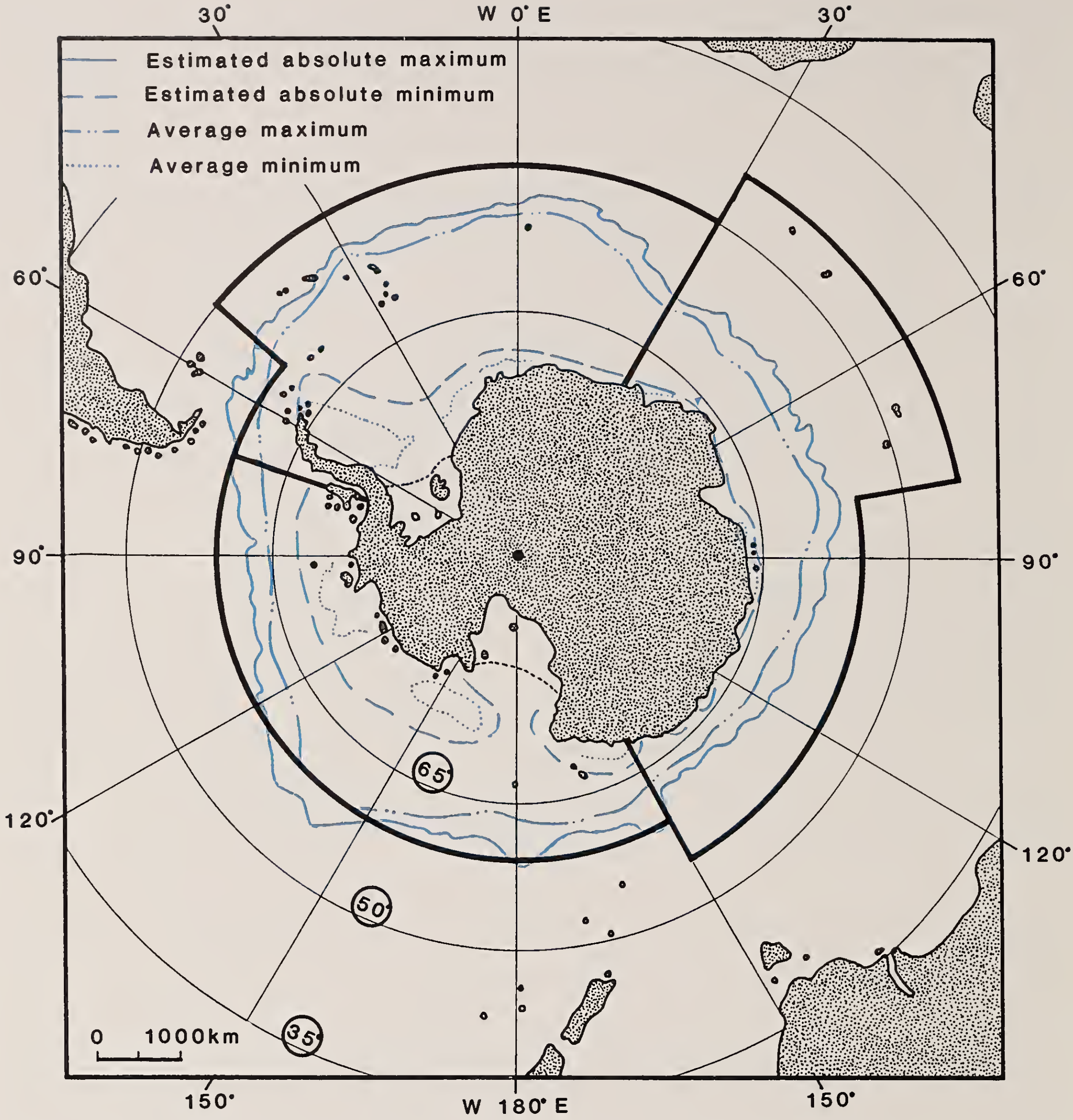


Fig. 10. The extent of sea-ice in the Southern Ocean as estimated extreme values as well as established average values (after Ackley 1981). Values are for the period 1971–1976

hindered by persistent cloud cover. From the latter data series it has become apparent that there are large inter-annual variations in the extent of ice cover (Radok *et al.* 1975).

Seasonally, the ice cover does not extend in a simple south-north progression and regression, but proceeds much more irregularly, especially in the Weddell Sea and Ross Sea regions (Foster 1984). In the Weddell Sea the influence of both the oceanic and atmospheric circulations are sharply felt, with a tongue of ice extending from the tip of the Antarctic Peninsula early in the season. The growth to the final extent of ice-cover is quite rapid in the austral spring and the decay even more rapid in the early austral summer. The ice-cover is at a minimum in February-March and a maximum in August-October. From 75 to 80% of the sea-ice melts and freezes each year. The only areas in which perennial ice is regularly found other than along the coast, are the western Weddell Sea and the Bellingshausen Sea (Foster 1984).

It is important to remember that the pack-ice is at no time a solid, impenetrable barrier. During the continuous movements of the ice, leads continuously form, close or freeze over. Through these leads there is a considerable flux of heat. Katabatic winds blowing offshore, extremely strong at certain locations, drive the pack-ice away from the coast thus clearing large bands parallel to the coast which rapidly freeze over, but which equally rapidly may be blown open again, thus keeping tracks of coastal water in contact with the atmosphere. In addition, large openings in the middle of the pack-ice, called polynyas, may persist for a full season or even occur in more or less the same spot for a number of consecutive years (Comiso & Gordon 1987). These, it is believed, are often subtended by chimneys of deep convection. The effect these recurring perturbations in the ice cover have on the biota of the direct vicinity is not known.

Conclusion

From the above it is apparent that the physical and chemical characteristics of the Southern Ocean and its temporal changes are in many respects exceptional for an ocean basin. One could therefore confidently expect that these unique static and kinematic properties would be reflected in the distribution, life histories and nature of the biota to be found in this ocean. To the extent that the zoogeography, and particularly the ichthyogeography, of the Southern Ocean is known, this does indeed seem to be the case.

A number of physico-chemical factors appear to be of special relevance. First amongst these is the strong and all-encompassing seasonality of the Southern Ocean system. This is made evident in the changing pack-ice cover, and thus in the distribution of momentum transfer to the surface water, mixing, temperature, salinity and static stability of the surface water as well as the productivity of the water column. Although surface temperatures change with the seasons, the range is small and the vast geographical expanse of the Southern Ocean remains essentially a cold water regime throughout the year. Unlike most other open ocean regions, primary production in this ocean is not limited by nutrient availability, but rather by the strongly seasonal variations in light incidence and stability of the water column. The non-concentric, annular sweep of the Antarctic Circumpolar Current may limit the latitudinal dispersion of organisms in this ocean more than in the anticyclonic gyres of the subtropical ocean basins in the rest of the world ocean. Latitudinal advection of organisms may be achieved by residing in certain water masses that enter or leave the Southern Ocean.

Most of the special physico-chemical features of the Southern Ocean mentioned here are features of the perceived long-term, large-scale, average behaviour of the water masses. It is becoming increasingly recognised that the short-term, meso-scale dynamics of oceans may be the scale to which organisms are adapted. With the advent of sophisticated technologies such as remote sensing as well as instrumentation that can be left in place for years at a time, many of these features are now being studied and are becoming better understood. It has, for instance, recently been learnt that the greater part of the kinetic energy of the currents is not in the mean motion, but in the eddy motion. This eddy energy is not evenly distributed, but concentrated in certain geographic parts of the Southern Ocean. Its stability in space and time is not yet known. How these factors affect the distribution of organisms is also as yet unknown.

One of the most elementary reasons for this ignorance remains the lack of suitable data and information. The Southern Ocean is probably known considerably better from a physico-chemical point of view than from an ichthyological one, particularly in the pelagic area. The present data base for the distribution and life history of Southern Ocean fish is insufficient to exactly correlate the distribution of fishes with what is known about the physics of the region. This also holds true for many of the prey species of the fish.

The Origin and Evolution of the Antarctic Ichthyofauna

M. E. Anderson

Most recent theoretical contributions relevant to a discussion of the origin and evolution of Recent Antarctic fishes (Andriashev 1965; DeWitt 1971; Briggs 1974) are essentially restatements of previous works (Regan 1914b; Berg 1933; Nybelin 1947; Hubbs 1952) with little new data to support them. Earlier authors characterized the Recent fauna as being composed of two parts: (1) the dominant perciform Notothenioidei, originating with a temporally imprecise Tertiary cooling and isolation of Antarctica, and (2) other teleosts and skates (Rajidae) implicated in a Quaternary dispersal into high latitudes of the Southern Ocean as a result of world-wide, Pleistocene ocean cooling, chiefly along the western coastlines of the Americas and Africa.

Over the last twenty years, we have seen great improvements in knowledge of Southern Ocean palaeoceanography and the structure of ocean circulation (see Kennett 1980; Haq 1981; Lutjeharms this volume) and continental drift theory by the processes of plate tectonics (Hallam 1973). These physical data, coupled with recent fossil discoveries and preliminary phylogenetic inference on the origin of the Notothenioidei, allow a more rigorous analysis of the origin of the Recent fish fauna (e.g. Miller 1987; Eastman & Grande 1989). The first thing that becomes apparent is that earlier authors were seemingly correct in correlating the radiation of notothenioids to the cooling and isolation of Antarctica. This important event is now timed with the close of the Eocene, about 38–40 million years ago, when the existing coastal Antarctic fauna almost completely disappeared to be replaced by a proliferation of the new, cold-adapted forms.

Plate tectonics and Southern Ocean habitats

The geophysical revolution in earth sciences, begun over twenty years ago, has provided us with a mechanism to support continental drift theory, the main factor concerning long-term physical changes to biotopes. From this we know that the continents and ocean floors (earth's crust, or lithosphere) are composed of relatively rigid material that lies atop a "plastic" upper mantle layer, the asthenosphere. The outer crust is broken into several plates, or continental blocks, all in motion, probably as a result of disturbances, usually thought to be convection currents, in the asthenosphere. At the mid-oceanic ridges along the margins of major plates, new crust is formed by volcanism that pushes plates apart. On the opposite side of these plates, crust can be subducted under oceanic trenches. This global conveyor belt of crust formation and resorption, called sea floor spreading, split a single land mass, Pangaea, into two super continents, one in the Northern Hemisphere (Laurasia) and another in the Southern Hemisphere (Gondwana) by the end of the Triassic Period. By the end of the Jurassic Period, about 135 million years ago, the South Atlantic was born along a great rift (now called the Mid-Atlantic Ridge), the subcontinent India was drifting toward Asia and Australia-Antarctica, still connected, spun around the higher latitudes of the Southern Hemisphere (they would separate in the late Cretaceous; Fig. 1).

Among the important physical changes to marine biotopes in the Cretaceous were increases in salinity to coastal regions experiencing drift, a global rise in sea level and a general decline in temperatures that continued into the early Palaeocene (Funnell 1971; Stanley 1986). The oceans were still fairly warm, as evidenced by the deposition in shallow coastal areas and epicontinental seas of black anoxic mud or evaporites. A circumglobal, temperate shelf fauna (Weddellian Province) developed in the Southern Hemisphere (Zinsmeister 1976). As Gondwana broke up, a progressive formation of local environmental conditions began, coupled with changing oceanic circulation and the global cooling. Identifiable water masses were the result, characterized by their particular temperature-salinity parameters, dissolved oxygen, phosphate, etc. A circum-Antarctic current that aided in a thermal isolation of the continent seems to have developed in Late Oligocene times (Kennett 1980). Soon afterwards, probably about 20 million years ago, the Antarctic Convergence developed, expanding northward to its present position between latitudes 50°-60°S, with concomitant development of the continental ice pack. Herron & Tucholke (1976) suggested that eastern and western Antarctic continental landmasses may have been on different plates in the Cretaceous and early Tertiary and that western Antarctica may have fragmented into smaller subplates. Miller (1987) suggested the intervening Aluk Plate may have been an early Miocene vehicle for the exchange of South American and Antarctic ichthyofaunas before the creation of Drake's Passage. Coupled with climatic changes at the end of the Cretaceous, seasonal effects of landmasses (producing changes in local currents, upwelling, etc., affecting productivity) caused marine faunas to exhibit "provinciality" (Valentine & Moores 1974). Provincial faunas, or those with restricted distributions, characterize marine habitats today, as opposed to typical widespread, even global, distributions characteristic of the Triassic, Pangaean earth. Post-Triassic environmental changes effected the historical transformation of marine faunas through varying patterns of biological extinction. These were the result of adaptive failures of species influencing feeding, modification of reproductive strategies, the establishment of home ranges, and the avoidance of over-predation to name a few.

Fig. 1. Continental reconstruction during Late Cretaceous times showing the Weddellian Province (in black) of Zinsmeister (1976). Redrawn after Dietz & Holden (1970), Pindell & Dewey (1982), and Barron (1987)

Biogeographic regions

Lönnberg (1905b) and Regan (1914b) were the first to define an "Antarctic Region" on the basis of physical and biological characteristics. Lönnberg took issue with Dollo's (1904) provisional Antarctic zone (restricted to the area south of the Antarctic Circle) by pointing out that organisms do not exist in such mathematical precision because of their dependence on environmental conditions. Lönnberg (1905b: 4) further defined an original Antarctic Region on the basis of summer sea temperatures of below 0 °C from the surface to 1450 m (implying coastal Antarctica and the South Shetland Islands). Regan (1914b), on the basis of faunal changes with temperature, distinguished a Glacial District (coastal Antarctica, islands of the Scotia Ridge, and Bouvet Island) and a Kerguelen District (islands of the southern Indian Ocean bathed by the Antarctic Convergence), but was uncertain about the inclusion of Macquarie Island. Norman (1938) finally included it in a Kerguelen-Macquarie District. Nybelin (1947) argued for the removal of the Kerguelen-Macquarie District to a Subantarctic Zone equivalent to the Magellan (temperate South America) and Antipodes (south of New Zealand) Districts. Ekman (1953) held yet another opinion and included the Antarctic (with South Georgia as a subregion), the Kerguelen Plateau, and Magellan areas as equivalent Regions of the high Southern Ocean.

Although these biogeographic divisions from the earlier studies (1905–53) are more or less recognised today, they were based on a slow accumulation of regional data. It was not until the Soviet investigations of the vessel *Ob'* (1955–58) and International Geophysical Year (1957–58) and subsequent exploration, that more comprehensive analyses were attempted (Andriashev 1965; Hedgpeth 1970; DeWitt 1971). The current biogeographic divisions presented here (Fig. 2) follow these authors' appraisals, as do later works (Briggs 1974; Kock 1985). However, Permitin (1977) and Anderson (1988) suggested that many deeper living benthic fishes may have a more circumpolar distribution than samples known to them indicated. On the other hand, certain fishes may really have restricted ranges in coastal Antarctica (e.g. *Cryothenia peninsulae, Pseudochaenichthys georgianus, Psilodraco breviceps,* and *Lycodichthys dearborni*). Also, part of the problem of precision in biogeographic analysis lies with taxonomic treatment, and ichthyologists still need to resolve the status of populations of such genera as *Notothenia, Bathydraco,* and *Paraliparis.*

The Antarctic fossil record

The oldest vertebrate fossils known from Antarctica are Lower or Middle Devonian and were first reported by Woodward (1921). Earlier, Woodward (1908) identified vertebrae from Seymour Island,

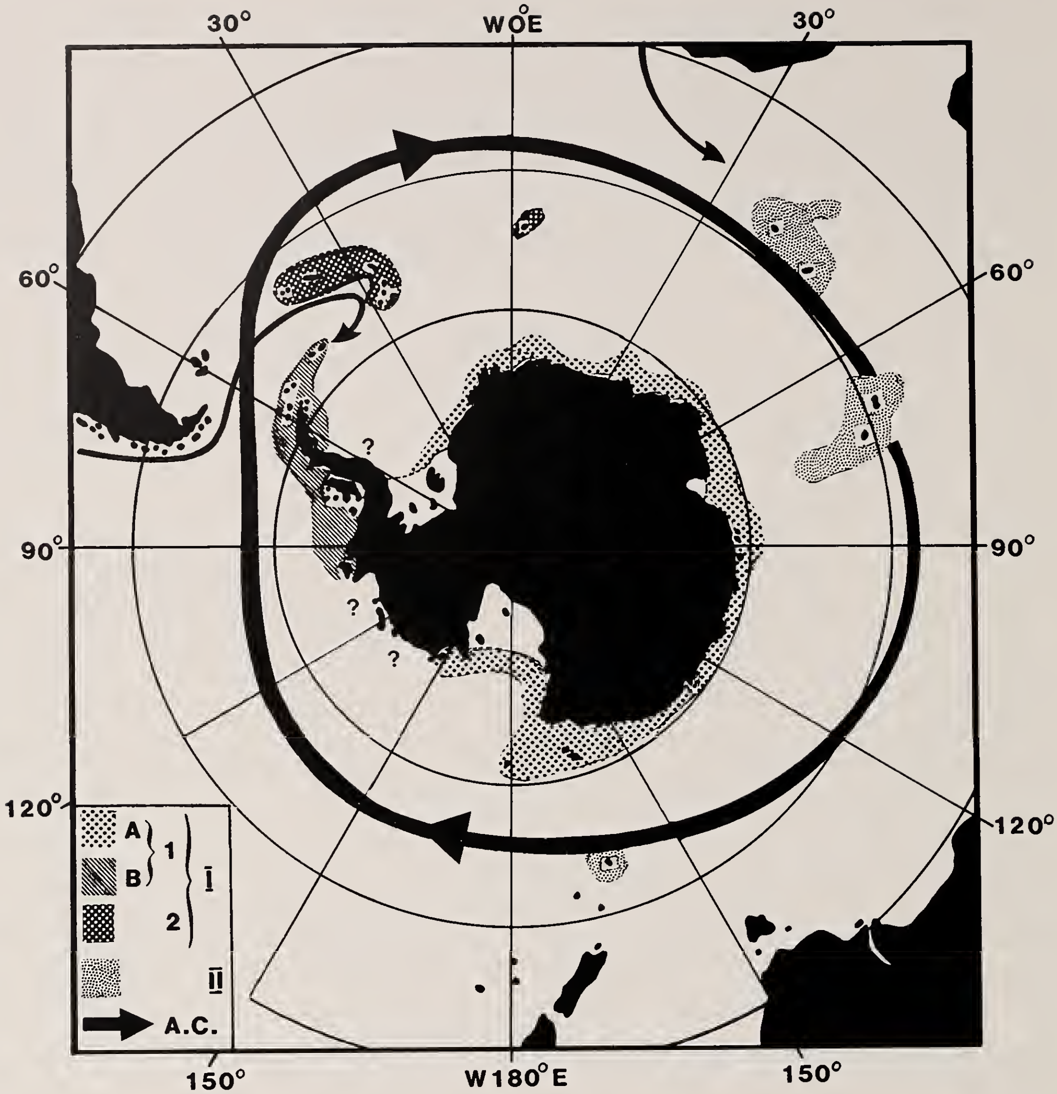


Fig. 2. Biogeographic divisions of the Antarctic and sub-Antarctic Regions based on the distributions of coastal shelf and upper slope fishes. Redrawn after Andriashev (1965) and Kock (1985). Terminology after Briggs (1974)
I—Antarctic Region; 1—South Polar Province; A—"East Antarctic District" of Andriashev (1965); B "West Antarctic District" of Andriashev (1965); 2—South Georgian Province.
II—sub-Antarctic Region, including Kerguelen and Macquarie Provinces.
Thick-arrowed line: axis of Antarctic Convergence. Thin-arrowed line: routes of dispersal into the Southern Ocean for ancestral species of boreal origin.

Antarctic Peninsula, as the mollusc-eating shark *Ptychodus* sp., but the specimens were re-evaluated by Welton & Zinsmeister (1980) and Grande & Eastman (1986) as presently undeterminable, even to order, and Cretaceous in age. At present, fossil fish remains are known from four sites in Antarctica. Two are Devonian in age (ca. 350–400 million years ago): the first is the Ohio Range near the head of the Ross Ice Shelf at about 85 °S, and the second is Victoria Land on the west coast of the Ross Sea. The third site is Jurassic in age in the Queen Alexandra Range, on the west side of the Ross Ice Shelf near the Ohio Range Devonian site. The fourth site is Cretaceous to Late Eocene or early Oligocene in age on Seymour Island off the tip of the Antarctic Peninsula in the Weddell Sea. Grande & Eastman (1986) gave a thorough review of the fish fossil record from these sites, adding several new records. This is summarized here.

The Devonian material spans the length of this period (Grande & Eastman 1986; Long 1989). It contains at least 35 species in 11+ families: one pteraspidomorph agnathan (the thelodont *Turinia* sp.), 17+ species of placoderms in five families, four species of acanthodians (spiny sharks), four species of extinct chondrichthyans, four species of osteolepidid, one rhizodontid, one porolepiform and one dipnoan sarcopterygian, and scales representing at least three species of paleoniscoid actinopterygians.

The Jurassic material consists of only the pholidophoroid holostean *Oreochima ellioti,* the only fossil fish from Antarctica known from nearly complete skeletons (Schaeffer 1972), and some unidentified actinopterygian fragments. *Oreochima* belongs in the family Archaeomaenidae, also known from three Australian genera, indicating an Australo-Antarctic biogeographic region during this time (Eastman & Grande 1989).

The Cretaceous material consists of a mako shark (*Isurus* sp.) tooth, apparently two teleost species (Grande & Eastman 1986), at least two hexanchiform sharks, and the beryciform *Antarctiberyx seymouri* (Grande & Chatterjee 1987). Despite the high latitude of the Cretaceous site at that time, the presence of the genus *Isurus* is indicative of the temperate climate of polar seas then. The cold, isolating Antarctic Convergence had not yet formed.

The Tertiary material is all from Late Eocene or Early Oligocene deposits on Seymour Island. It consists of nine species in eight families, plus vertebrae and jaw fragments of one or more large (over two metres) teleost species once thought to belong in Nototheniidae (Woodward 1908). Grande & Eastman (1986: 130) showed that this material is presently undeterminable. Families represented to date include four sharks (Odontaspidae, Lamnidae and Squalidae), one saw shark (Pristiophoridae), one angel shark (Squatinidae), one eagleray (Myliobatidae), one chimaera (Chimaeridae), and one (or two?) species of catfish (Siluriformes). However, D.J. Long (University of California, manuscript) has greatly increased the number of sharks, adding 10 species from eight families, including five families new to the region. Long reports that the elasmobranch fauna of Eocene Seymour Island was indicative of a cool-temperate marine climate with some incursions of tropical forms.

Composition of recent fauna

As stated above, the Recent Antarctic ichthyofauna is dominated by species of the five notothenioid families. Permitin (1977) summarized trawl data from the Scotia Sea and notothenioids represented 66.5% of the species (51.5% at South Georgia) captured. Prior to Permitin's work (Norman 1938; Andriashev 1965), notothenioids represented 82.4% of the species (69.7% at South Georgia) from the same region. DeWitt (1971) reported notothenioids represented 92.4% of the species trawled during one cruise in the Ross Sea. Notothenioids reach their greatest diversity in coastal Antarctic waters (inner shelf and pseudoabyssal basins; Andriashev 1977), and have evolved into benthic and pelagic habitats with several different life histories (Eastman & DeVries 1982). Dominant among the non-notothenioids are the primarily cold-adapted families Liparididae, Zoarcidae and Rajidae. These fishes of primarily boreal ancestry reach their greatest diversity in the Scotia Sea and adjacent areas (Antarctic Peninsula, Ross Sea, Weddell Sea). Because of the preponderance of groups whose members have diversified in the coldest marine habitats, the replacement of the temperate, early Cenozoic ichthyofauna with that of today has often been correlated with decreasing water temperatures. However, Eastman & Grande (1989) suggested that ecological constraints relating to food sources and habitat space had more importance in shaping the present Antarctic ichthyofauna, since low-temperature adaptation has occurred repeatedly in many unrelated animal groups. Clarke (1983) observed that most life history strategies of fishes and invertebrates living in cold water have evolved under ecological limiting factors.

The origin of the notothenioids is somewhat ambiguous. A detailed argumentation scheme for this is beyond the scope of this essay, however, and research on the question has begun through phylogenetic analysis. Most authors (e.g. Gosline 1968; Eakin 1981a) implicate the blennioid fishes as a likely sister group of Notothenioidei, but research has shown that Gosline's Blennioidei is paraphyletic and the group has been redefined (see below).

Woodward (1908) attributed Eocene vertebral centra found on Seymour Island to Nototheniidae. Stinton (1957) reported fossils of *Notothenia* sp. from Miocene deposits in New Zealand. Both these reports have since been re-evaluated (Fordyce 1982; Grande & Eastman 1986), thus positively identified notothenioid fossils are presently lacking. Gosline (1968, 1971) included the notothenioids in his suborder Blennioidei which has since been pared down considerably (see Nelson 1984: 273), but most authors have recognised the seemingly important anatomical resemblances between the notothenioids and other "blennioid" groups, most notably Zoarceoidea and Pinguipedidae) (= Cheimarrichthyidae + Mugiloididae (Parapercidae); see Rosa & Rosa 1987). All "blennioid" fishes were apparently derived from some percoid-like ancestor, at least by the Late Cretaceous or Early Palaeocene (Patterson 1964, reported Late Cretaceous perciforms from Europe). Anderson (1984a) postulated relationships between the notothenioids and the mostly northern hemisphere Zoarceoidea (= Stichaeoidea), pointing out anatomical similarities between Bathymasteridae and the advanced notothenioids. Both the notothenioids and zoarceoids are cold-adapted fishes that often share a general facies of meristic and morphometric features, have a single pair of nostrils, lack an orbitosphenoid and gas-bladder, have reduced or lost the basisphenoid bone (see Gosline 1968; Stevens *et al.* 1984) and have precocious, benthic larvae. These features (derived relative to the Pinguipedidae) would tend to place the notothenioids as a sister group of the zoarceoids. Although there have been a few osteological studies (Eakin 1981a; Andersen 1984; Anderson, 1984a; Iwami 1985; Voskoboynikova 1986) that could aid in phylogeny reconstruction of the "percoid derivative" groups outlined by recent classifications, this has not been attempted yet; and many of the similarities between groups are probably primitive at a perciform level of organization, or may be the result of convergence to benthic life. A thorough study of the above groups is now needed, concentrating on the primitive percoids and on ontogenetic osteology in all. With the absence of fossils, biogeographic and phylogenetic analyses are the best avenues for future testing of hypotheses about notothenioid evolution. In this regard, Miller (1987) suggested that the early evolution of notothenioids, the primitive bovichtids in particular, must have been influenced by plate tectonic activity in the Weddellian Province of the early Tertiary. Andersen (1984) and Miller (1987) both noted the sub-Antarctic distribution of the bovichtids and primarily Antarctic distribution of the nototheniids, however, the discovery of *Bovichtus elongatus* on the Antarctic Peninsula is an exception to the rule (Hureau & Tomo 1977). Ancestors of this species may have reached coastal Antarctica by ocean current dispersal as suggested by Miller (1987) for widely separated occurrences.

The origins of the non-notothenioid Southern Ocean fishes has been only briefly discussed by previous authors. Some species (or genera) seem to have evolved in situ in the Southern Ocean and have not reached Antarctica, e.g. *Zanclorhynchus spinifer*. The development of the Antarctic Convergence about 20 million years ago was probably an important vicariant event, creating high latitude disjunctions in pelagic populations. Indeed, Andriashev (1965: 517) distinguished the probable results of the development of this current with his Antarctic, mesopelagic "zone of *Electrona antarctica*" between the continent and the Convergence, and an austral "zone of *Electrona subaspera*" between the subtropical and Antarctic convergences. Other groups (e.g. achiropsettids and most gadiforms) probably have Atlantic origins, possibly excluding some Macrouridae (the north-eastern Pacific *Coryphaenoides (Nematonurus) yaquinae* is a sister species of the confined, Antarctic *C. ferrieri;* T. Iwamoto pers. comm.) One of the more interesting biogeographic problems of the Southern Ocean ichthyofauna concerns the origins of non-notothenioids of presumed boreal ancestry, especially Liparididae, Macrouridae, Rajidae, and Zoarcidae. Recent studies on the deep-sea bottom fishes of the Southern Ocean have revealed the Scotia Sea as a Southern Hemisphere equivalent of the Bering Sea with regard to radiation of the Liparididae and Zoarcidae (Andriashev 1986; Anderson 1988).

The number of endemic genera and species of the primarily boreal families in Antarctic waters implies geographical isolation for considerable periods (Regan 1914b; DeWitt 1971; Andriashev 1977; Anderson 1988). Earlier authors (Berg 1933; Hubbs 1952; Ekman 1953) suggested that present Southern Ocean distributions of these fishes were explained by deep-water dispersal ("tropical submergence") during the Pleistocene glaciations. This is probably the case for some Magellanic shelf species (*Sebastes* spp., *Agonopsis chiloensis,* etc.) which seem to be products of very recent evolution. Any lengthy duration in southern Chilean waters (or pre-Pleistocene dispersal) probably would have resulted in the evolution of far more species from these families (Scorpaenidae, Agonidae). The appearance of species with boreal ancestry in the Southern Hemisphere, however they arrived, has produced a type of distribution biogeographers have called "antitropicality" (bipolarity) (Hubbs 1952; Briggs 1974, 1987a). Antitropical distributions, first noted over a century ago, were originally discussed by workers who compared species of the polar regions, but as these became better known, the broadscale relationships were seen to be primarily at generic and higher taxonomic levels (Berg 1933; Briggs 1987a). Hubbs (1952) showed that most sister taxa found on either side of the tropics, but excluded from it, live in temperate regions, and he coined the term antitropical to describe this phenomenon.

Various theories have been advanced to explain antitropical distributions (reviewed by Briggs 1987a), but an analysis of this literature is beyond the scope of this essay. Suffice it to say that among the most recent, leading discussions, Briggs (1974, 1987a, b) discussed re-evaluated palaeoceanographic data strongly suggesting that sea temperatures in the tropics did not experience declines that would allow faunal transgressions during the Miocene by temperate species, as previously held by others. Briggs reintroduced the century-old "relict theory" which states that stable, tropical areas are centres of origin of new species that gradually move north or south across temperature barriers to higher latitudes in a process that produces disjunct distributions as a result of extinctions near the centre caused by increased competition from recently evolved sister species, predators, parasites, or disease organisms. Although this theory supports a mechanism that works over long periods of time, it does not explain antitropical patterns in which the primitive taxa are tropical, or patterns in which there are no tropical sister taxa (e.g. *Agonopsis, Sebastes,* some Cottidae). It also requires the *ad hoc* assumption that selected species move across temperature barriers.

Other models of evolution producing antitropical distributions are those of vicariance biogeography. The mechanism of these models involves allopatric speciation and global geophysical history. Nelson (1985) concluded that the best vicariance model for the antitropical pattern of anchovy distribution was that of an expanding Pacific basin fragmenting a hypothetical South Pacific continent (Pacifica). As this continent possibly split apart and drifted, a north-south expansion of the Pacific basin occurred, and the biota was thus drawn along. Like Briggs, Nelson's model focused on events in the Pacific, but contrary to Briggs' model, Nelson found his most derived taxa remote from the Indo-West Pacific "centre" in the Americas. However appealing Nelson's model may be, it requires the assumptions of a Pacifica continent and that the Pacific basin has expanded considerably.

Whatever the causes of antitropicality, the phenomenon is most clearly expressed among shallow water species of a large assemblage of temperate, marine taxa. Antarctic species of boreal ancestry, mainly occurring in the Scotia Sea, are not in this category, being representatives of deep-sea genera with worldwide distributions, or at least those with a North Atlantic-eastern Pacific-Antarctic pattern *(Myxine, Raja (Amblyraja), Bathyraja, Polyacanthonotus, Notolepis, Antimora, Coryphaenoides, Coelorinchus, Paraliparis, Careproctus, Melanostigma, Lycenchelys, Pachycara,* etc.). My own research on the phylogenetics of Zoarcidae indicates that the *Lycenchelys* and *Pachycara* species of the Antarctic have their origins in a Miocene, pan-American, tropical zoarcid fauna, primitive relicts of which now occur in the Gulf of Mexico and Caribbean Sea (Anderson 1984a, 1988). The enigmatic genus *Melanostigma,* however, was hypothesized to have originated in Southern Ocean waters in a speciation mechanism similar to that described by Andriashev *et al.* (1973) for the liparidid subgenus *Pseudoliparis*.

Absences of similar, broadly distributed, deep-sea genera in Southern Ocean habitats is harder to explain, but may relate to inabilities to transgress barriers that are not barriers to the above listed genera. Absences of some species may also be explained by historical factors, i.e. ancestors were never near Antarctic waters. Intolerably cold temperatures probably halt most species with broad distributions that approach the Antarctic Convergence but do not cross over, or rarely do, e.g. *Halargyreus johnsoni, Lamna nasus,* etc. Low food availability in tropical deep-sea areas seems to be a barrier to species with energetically expensive life histories (Anderson *et al.* 1986). Merrett (1987) documented a zone of abyssal fish faunal change in the north-eastern Atlantic that he tied to seasonality in productivity. Species on either side of the zone exhibited marked differences in their maximum size, gross morphology, feeding pattern and reproductive strategy. If these kinds of barriers are world-wide and have existed on continental slopes and in thalassobathyal regions, only the more eurythermic, mobile species, or those without specialized early life history regimes, food habits or reproductive strategies will be able to penetrate them and extend their ranges. Alternatively, at least the macrourids and morids in Antarctic waters may have life cycles tied to high latitude spawning and have penetrated far south for this, as have their boreal counterparts (Wenner & Musick 1977; Anderson *et al.* 1986). Finally, the absence of some taxonomic groups in Southern Ocean areas simply may be due to insufficient sampling and reporting. New species continue to be described by workers, most recently from the Indian Ocean sector of the sub-Antarctic.

The Biology and Physiological Ecology of Notothenioid Fishes

J. T. Eastman

Introduction

Until about a century ago most biologists thought that the sub-zero waters of much of the Southern Ocean were too cold to support a significant fish fauna. Today we recognise over 260 species of fishes comprising an interesting and important component of this unique marine ecosystem. The majority of the bottom fishes are notothenioids, a perciform group largely confined to the Antarctic region.

Notothenioids have provided a fascinating glimpse of the wide scope of adaptation and evolution at one extreme of the marine environment. During the course of their evolutionary history, notothenioids have undergone both diversification in general body form and specialization in the physiology of many body systems enabling life under Antarctic conditions. In this chapter I will consider the following aspects of the biology and physiological ecology of notothenioids: (1) general biology and diversification in the six notothenioid families; (2) morphological divergence in buoyancy, with emphasis on two neutrally buoyant nototheniids, and (3) qualitative overviews of some of the physiological specializations of notothenioids, especially those related to survival at low temperature. Since this book is focused on systematic ichthyology, coverage of physiological topics is brief and the historical development of physiological concepts is not considered. I have therefore referred the reader to recent reviews for detailed information. Paramount among these sources is the thorough treatment of notothenioid physiology by Macdonald *et al.* (1987).

The Antarctic continental shelf is 400–500 m deep at the edge and also contains inner-shelf depressions 1,000 m deep (Andriashev 1965). Unlike temperate fishes, with a maximum number of species at depths less than 200 m, the species diversity of notothenioids is greatest at depths of 300–600 m (Andriashev 1965, 1987; DeWitt 1971). This pattern of distribution, known as glacial submergence, may be attributable to destruction of bottom habitat by continental glaciers and ice shelves (Andriashev 1987). This habitat and faunal destruction may have caused the local extinction of most of the Tertiary fish fauna, leaving an ecological void which was filled by a notothenioid fauna tolerant of deep water conditions (Eastman & Grande 1989).

Most notothenioids are bottom fishes confined to waters less than 1,000 m deep, although the depth range of individual species may be considerable (DeWitt 1971). They lack swim-bladders, are usually denser than seawater and commonly feed and reproduce on the substrate. There is no reason to suspect that the ancestral notothenioid stock lived in deep water because closely related perciform groups like blennies are coastal fishes.

The Southern Ocean is under-utilized by fishes, in an ecological sense, and could theoretically support more species. The waters south of the Antarctic Convergence are productive during the summer, but contain relatively few non-notothenioid fishes. Thus, reduced competition and the isolation of Antarctica have provided the opportunity for speciation within this group. Notothenioids fill ecological roles normally occupied by taxonomically diverse fishes in temperate waters (Eastman 1990). The following sections contain introductions to the biology of the six notothenioid families, with emphasis on the Nototheniidae.

Ecology

Bovichtidae—thornfishes

Bovichtids have long been regarded as the most primitive notothenioid family (Regan 1914b). This view has been sustained by modern systematic (Eakin 1981a; Iwami 1985; Balushkin 1984) and karyological (Prirodina 1986) work. Bovichtids have a non-Antarctic distribution including south-eastern Australia, New Zealand and South America, although *Bovichtus elongatus* Hureau & Tomo, 1977, inhabits waters near the Antarctic Peninsula. Most species have heavy bodies with bony and spiny heads (Fig. 3A). As adults they are bottom dwellers in shallow coastal or intertidal habitats, however the young of *Bovichtus variegatus* Richardson, 1846, pass through a pelagic, distributive phase when they may be captured near the surface in offshore waters of New Zealand (Robertson & Mito 1979). This life history pattern may be common to other bovichtids, as it is for notothenioids in general. Pelagic larvae enhance the possibility of dispersal.

Pseudaphritis urvillii (Valenciennes, 1832) a catadromous species occuring in Australia (Tasmania and Victoria), is one of the few freshwater notothenioids. *P. urvillii* may be either a Gondwanian form that moved north in the freshwater of Australia, or a derivative of a marine dispersing bovichtid ancestor (McDowall 1981). In either case, it is certainly a relict species.

Nototheniidae—notothens

The nototheniids are the most diverse notothenioid family with respect to size, body form and distribution. Most are bottom fishes, however, there is evidence of a trend toward diversification, particularly of pelagic species (Nybelin 1947; Andriashev 1970; DeWitt 1970b; Voskoboynikova 1982; Eastman 1985a, 1988a; Hubold & Ekau 1987). This is discussed in more detail in the section on buoyancy. The following are some of the ecological types within the family:

1. Large, pelagic, midwater predators. Averaging 127 cm in total length and 28 kg in weight, *Dissostichus mawsoni* is about five times longer and 250 times heavier than other nototheniids in McMurdo Sound. *Dissostichus* are neutrally buoyant, permanent members of the midwater community (Eastman & DeVries 1981a); in McMurdo Sound they live at 300–500 m. Among the nototheniids examined to date, *D. mawsoni* is unique in having eyes with rod-dominated retinae, an adaptation for vision under dim conditions (Eastman 1988b). *Dissostichus eleginoides,* a sister species found largely north of the Antarctic Convergence, reaches a size equivalent to *D. mawsoni* and exhibits similar buoyancy adaptations (Oyarzún *et al.* 1988).

2. Shoaling midwater zooplanktivores. *Pleuragramma antarcticum* has a depth range of 0–900 m (Gerasimchuk 1986) and is found in both open water and beneath ice. They avoid intraspecific competition by vertical size segregation in the water column (Hubold & Ekau 1987). In waters west of the Antarctic Peninsula, *Pleuragramma* constitute 65–95% of the pelagic juvenile fish fauna (Kellermann 1986). A vital component of the food web in the Southern Ocean, *Pleuragramma* are an especially numerous and ecologically important nototheniid (Eastman 1985b).

Pleuragramma is a member of the Pleuragramminae, the most phyletically derived subfamily of nototheniids (Balushkin 1984). *Pleuragramma* and the other species in this subfamily possess buoyancy adaptations for life in the midwaters. *Aethotaxis mitopteryx,* originally described from McMurdo Sound (DeWitt, 1962b), is almost completely encircled by a subcutaneous layer of adipose tissue (Eastman & DeVries 1982). It has a circum-Antarctic distribution (Kotlyar 1978b; Gerasimchuk & Piotrovskiy 1980), although until recently few specimens have been collected. Ekau (1988) determined that *Aethotaxis* was the most pelagic species included in his ecomorphological study of 10 nototheniids from the Weddell Sea.

Balushkin (1989) recently described *Gvozdarus svetovidovi* from a 53 cm TL specimen collected at 550 m in the Ross Sea. The stomach of the holotype contained remains of *Pleuragramma.* A second specimen (65 cm TL) has been taken in the Co-operation Sea (A.V. Balushkin pers. comm.) If the size, habitat and diet of these two specimens are typical for the species, *Gvozdarus* is a medium to large midwater predator (see also this genus account in the family Nototheniidae below).

3. Cryopelagic species. *Pagothenia borchgrevinki* is specialized for life and zooplankton feeding near the undersurface of the sea ice (Eastman & DeVries 1985). Although they may not always feed in the immediate sub-ice habitat, *Pagothenia* are definitely planktivorous (Foster *et al.* 1987).

4. Epibenthic species. Although they live close to the bottom, their streamlined appearance and absence of contact adaptations indicate that they do not actually reside on the substrate. In McMurdo Sound *Trematomus loennbergii* inhabits depths of at least 450 m (Eastman & DeVries 1982).

5. Benthic species. Most nototheniids spend their lives on or near the substrate. There is a greater variety of food and micro-habitats available to bottom dwelling fishes than to midwater fishes, consequently bottom dwelling communities are generally more diverse (Roberts 1982).

Targett (1981) conducted a comprehensive study of five benthic communities dominated by nototheniids. He discovered that food resource partitioning was evident within communities and that dominant species were morphologically and behaviorally adapted to feed at different levels along a vertical prey distribution axis. For example, in a community at a depth of 123–150 m north-west of South Georgia, Targett found that *Lepidonotothen larseni* fed above the bottom on krill and mysids, *Gobionotothen gibberifrons* preyed on infauna and *Lepidonotothen nudifrons* consumed epifauna. Targett suggests that the evolution of niche differences within the Nototheniidae may have contributed to the success of this family, in terms of number of species, in most Antarctic bottom communities.

6. Species difficult to classify ecologically. *Cryothenia peninsulae* exhibits morphological characteristics of both pelagic and benthic species. It may be an ecological generalist living and feeding in the midwaters or on the bottom. This species belongs to the subfamily Pleuragramminae, and is therefore related to *Aethotaxis, Gvozdarus* and *Pleuragramma* (Balushkin 1984).

7. Species with an ontogentic change in habitat. Fingerlings of *Notothenia rossii* are pelagic, nearshore juveniles are demersal and offshore adults are both demersal and pelagic. These changes in habitat are accompanied by changes in colour, caudal fin shape, body shape and feeding habits (Burchett 1983b). Other nototheniids probably experience similar ontogenetic habitat shifts.

Harpagiferidae—spiny plunderfishes

With the elevation of the Artedidraconinae to familial status, the Harpagiferidae now contains only the genus *Harpagifer*. Harpagiferids are found at the Falkland Islands, off southern South America and at all of the sub-Antarctic islands (Andriashev 1965; Hureau this volume). Superficially resembling sculpins and some bovichtids, harpagiferids are small bottom fishes living in relatively shallow water or in tidepools. *Harpagifer antarcticus* is the only well studied species. This relatively long-lived, slow-growing species (Daniels 1983) exhibits nesting and possibly altruistic behaviour in guarding its eggs (Daniels 1978, 1979). *Harpagifer* species of the Scotia Sea islands are sit-and-wait feeders that consume primarily amphipods (Duarte & Moreno 1981; Wyanski & Targett 1981).

Artedidraconidae—plunderfishes

Artedidraconids are easily distinguished from harpagiferids by the presence of a mental barbel, which is usually specifically distinct, and by the blade-like and hooked opercular spines. Artedidraconids are considerably more diverse than harpagiferids, and many new species have recently been described (Eakin, 1987, 1988a,b; Balushkin 1988); little is known about their life history. Artedidraconids have a wider depth distribution than harpagiferids, and are largely confined to the Antarctic continental shelf and slope, although one species is found at South Georgia (Andriashev 1965).

Bathydraconidae—dragonfishes

Bathydraconids are elongate, slender fishes that are separated from all other notothenioids by the absence of the spiny first dorsal fin. *Gymnodraco* (Jakubowski 1975) and *Psilodraco* (H.H. DeWitt pers. comm.) have internal nares. With the exception of species at South Georgia, the South Orkneys and the Kerguelen-Heard area, bathydraconids are confined to waters near the Antarctic continent (Andriashev 1965). Most inhabit depths of 500–700 m, but *Bathydraco scotiae* has been collected at 2,000–3,000 m, deeper than any other notothenioid (DeWitt 1985). In McMurdo Sound *G. acuticeps* lives in relatively shallow water under cover of heavy sea ice, and may even live beneath the Ross Ice Shelf at 82° S (Bruchhausen *et al.* 1979).

Channichthyidae—icefishes

Channichthyids are the most phyletically derived notothenioids (Iwami 1985), and one of the most unusual groups of teleosts in the world. They are also commonly called "white-blooded" fishes as all species lack haemoglobin (see below). Channichthyids are fusiform fishes with large heads, elongate snouts and long pelvic fins. With the exception of one species (*Champsocephalus esox)* in the Patagonian-Falkland area, they have an Antarctic and sub-Antarctic distribution (Andriashev 1965). Most live at depths of 200–700 m (Andriashev 1965), however *Chionobathyscus dewitti* inhabits water 1,000–2,000 m deep (Andriashev 1987). While most channichthyids are bottom fishes, some are pelagic and a few alternate between these two modes of life. This probably facilitates feeding in the water column on krill when these crustaceans are abundant.

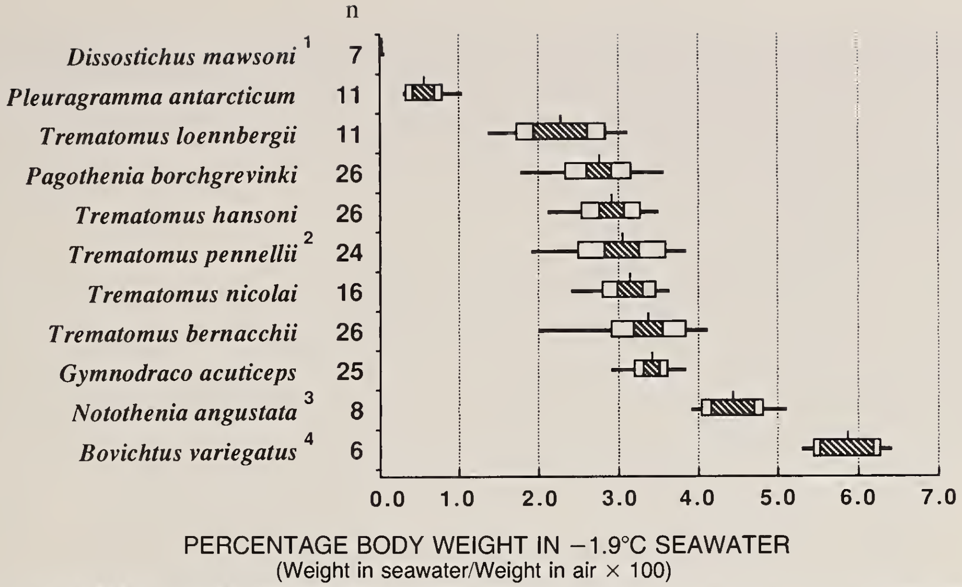
Buoyancy of Notothenioids

Neutral buoyancy conserves muscular energy and, as Alexander (1967) has indicated, evolution by natural selection offers a plausible explanation for adaptations resulting in small savings in energy. A neutrally buoyant fish has no weight to support in water and no component of the forward locomotion must be diverted to provide hydrodynamic lift.

Many marine fishes are made neutrally buoyant by a swim-bladder with a capacity of 5% of the body volume (Marshall 1966). Assuming that volume is roughly equal to weight, a marine fish without a swim-bladder and without buoyancy adaptations must support about 5% of its weight to keep from sinking to the bottom. Since notothenioids do not have swim-bladders, evolutionary alterations in buoyancy are associated with modifications in the structure and function of other body systems. Eastman & DeVries (1981a, 1982) described a method of determining buoyancy by weight in seawater. In a sample of nine species from McMurdo Sound (Fig. 1), those weighing less than 0.6% of their weight in air when in the water are considered neutrally buoyant. Most cryopelagic, epibenthic and benthic species are clustered in the 2.0–3.5% range, compared with values of 4.4% and 5.9% for *Notothenia angustata* and *Bovichtus variegatus,* two non-Antarctic notothenioids, which are relatively heavy bottom dwellers. These two non-Antarctic benthic species serve as the standard for comparison of buoyancy exhibited by Antarctic notothenioids.

Having established that several species are neutrally buoyant, permanent members of the midwater community, we are confronted with investigating the modern results of an historical process: the evolution of buoyancy alterations in fishes without swim-bladders. Work over the last ten years has revealed the morphological basis for buoyancy within the family Nototheniidae (DeVries & Eastman 1978, 1981; Eastman & DeVries 1981a, 1982, 1985, 1986a, 1989; Clarke *et al.* 1984). These studies indicate that evolutionary alterations in buoyancy are reflected as specializations in a variety of systems and organs including skeleton, integument, lipid storage, muscles and liver. Details and examples are considered below in discussions of the buoyancy of *Pleuragramma* and *Dissostichus.*

Pleuragramma has achieved neutral buoyancy through a combination of skeletal reduction and lipid deposition (DeVries & Eastman 1978; Eastman & DeVries 1982). The weight of the ashed skeleton is only 0.3% of the body weight, compared to 2.0–3.6% in other teleosts (Vinogradov 1953; Childress & Nygaard 1973). Since the vertebral column represents the largest component of the skeleton by weight,



1) Only 2 of 7 specimens had weight in seawater; mean for these 7 was 0.01. 2) Formerly *T. centronotus*. 3) New Zealand black cod, weighed in +4°C seawater. 4) New Zealand thornfish, weighed in +17°C seawater.

Fig. 1. Dice-Leraas diagram (modification of Hubbs & Hubbs 1953) comparing measurements of buoyancy among heavily anesthetized notothenioids from McMurdo Sound and New Zealand. Original data from Eastman & DeVries (1981a, 1982) and DeVries & Eastman (1981). Measurements for gravid females are not included. *Heavy horizontal line* is the range; *short vertical line* is the mean; *hatched rectangle* is 2 SEM on each side of the mean; *one-half of each hatched rectangle plus white rectangle* is 1 SD on each side of the mean. For sample sizes greater than 20, measurements of buoyancy approach statistical adequacy in terms of the ratio of dispersion (SD) to reliability (SEM) (Hubbs & Hubbs 1953). For sample sizes approaching 30, twice the SEM approximates the 95% confidence interval for the mean (Sokal & Rohlf 1981). Therefore when hatched rectangles overlap, differences among measurements of buoyancy are not significant

any reduction in the mineralization of this structure yields a substantial saving in weight. In *Pleuragramma* vertebrae are unconstricted (non-amphicelous), centra are thin collars of bone and vertebral processes are reduced. In addition, *Pleuragramma* has a persistent notochord and this gelatinous larval structure fills the hollow centra of adult vertebrae (Fig. 2A). That this is a derived condition in *Pleuragramma* is indicated by the fact that most other notothenioids have amphicelous vertebrae. These species, as typified by the generalized bovichtids, do not exhibit any reduction in the vertebral centra, vertebral processes or degree of mineralization (Fig. 3A).

The mechanism of lipid storage in *Pleuragramma* is unique among vertebrates. In other fishes lipid is stored in hepatocytes, or in small (120 μm) adipose cells within viscera, muscle, bone or skin (Bone & Roberts 1969; Malins & Barone 1970; Bone 1972; Lee *et al.* 1975). Lipid in *Pleuragramma* is stored in large subcutaneous lipid sacs (0.2 to 1.5 mm in diameter) along the sides of the body (Fig. 2A & B). A larger series of intermuscular lipid sacs (0.5 to 3.0 mm in diameter) is located deeper, adjacent to the midline vertical septum and proximal to the bases of the dorsal and anal fins (Fig. 2A). These intermuscular sacs are closed, segmental structures with one set of 4 large sacs (Fig. 2A) in each myomere (vertebral segment). Sacs are present in all 53 myomeres (range = 52–55; Eastman 1983), but are largest near the centre of mass of the body between vertebrae 5 through 30.

Recent ultrastructural studies of intermuscular lipid sacs indicate that the sac wall is composed of cells similar to white adipocytes (Eastman & DeVries 1989). Although the sac wall is only one cell thick, several adipocytes are arranged circumferentially around the perimeter of the large lipid droplet. The sac wall is therefore cellular, but the contained lipid is extracellular. Lipid sacs in *Pleuragramma* are complexes of several adipocytes differing primarily in their large size from the single adipocytes of other notothenioids and other vertebrates. The advantage of this arrangement is unknown. Like other white adipocytes, those of the sac wall are presumably under nervous and endocrine control. Although there is no information on turnover of lipid in the sacs, the cellular nature of the sac wall and the capillaries bordering the outer walls of the sacs indicate that both removal and addition of lipid are possible. While obviously functioning as a buoyancy agent, lipid in the sacs is theoretically available for metabolism. Studies of the cell junctions of adipocytes and of capillary endothelial cells might clarify this matter.

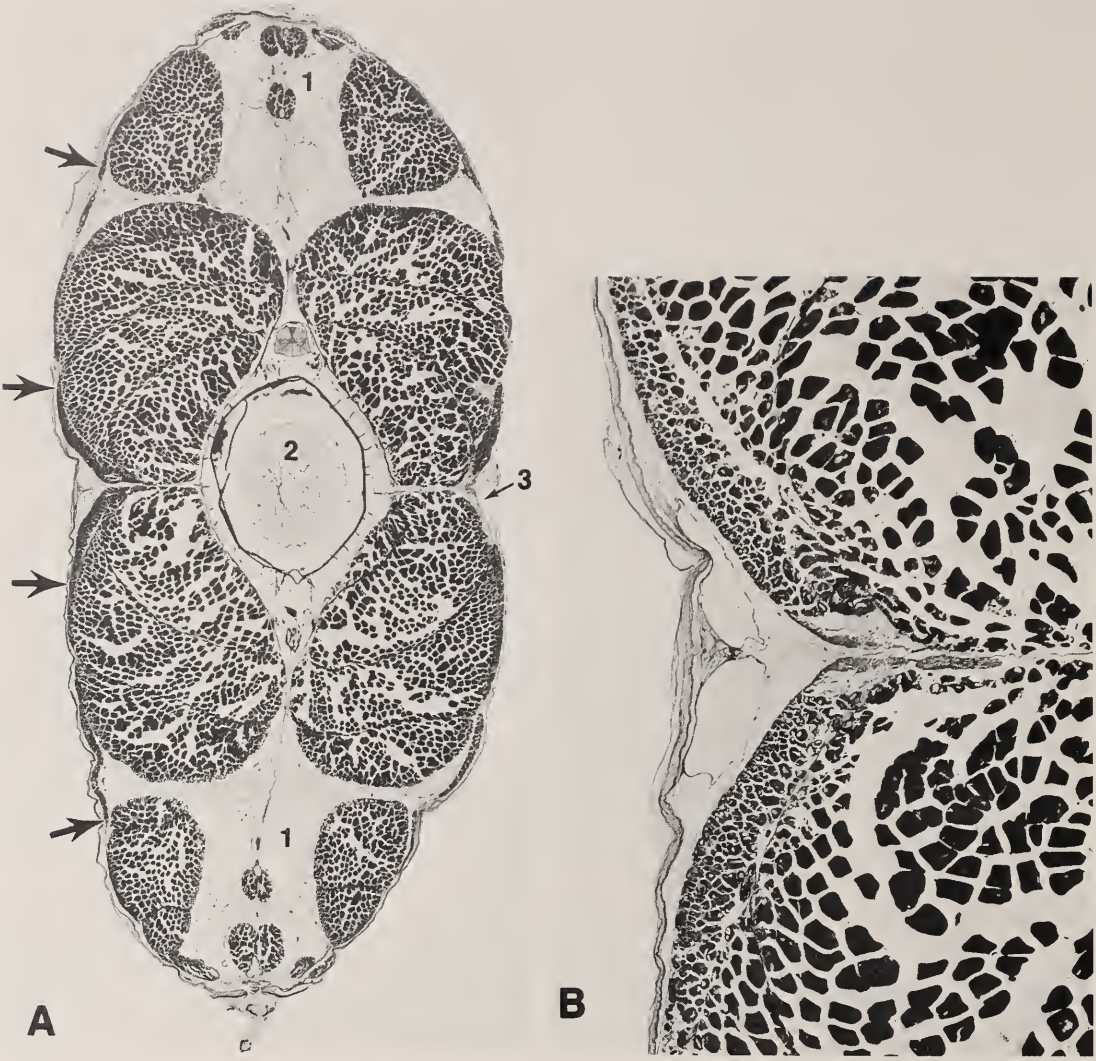


Fig. 2. These histological cross sections of *Pleuragramma antarcticum* show some of the adaptations for pelagic life mentioned in the text. Sections were taken from the posterior one-fifth of the body of a 17 cm TL specimen. (A) shows the large intermuscular lipid sacs (1), smaller subcutaneous lipid sacs (3) and the persistent notochord (2). The centra of the non-amphicelous vertebrae are thin collars of bone surrounding the notochord. Arrows on the left side indicate the lateralis superficialis (thin dark band just under the skin), a red muscle used for low speed caudal propulsion in *Pleuragramma*. Enlargement: ×9. (B) shows the left lateral line area of another section from the same specimen. Two subcutaneous lipid sacs and the lateralis superficialis are evident. Enlargement: ×40 (Photographs by William Winn.)

Lipid sacs are first evident in 45 mm SL *Pleuragramma* (DeVries & Eastman 1978), but it is not known if they are present in smaller specimens, or how they develop. With the exception of a small amount of intermuscular adipose tissue, *Pleuragramma* from McMurdo Sound do not have significant deposits of lipid elsewhere in the body.

Dissostichus mawsoni is also a neutrally buoyant member of the midwater fish community and provides another striking example of the evolutionary modification of various body systems for buoyancy (Eastman & DeVries 1981a, 1982; Eastman 1985a). With a specific gravity of 2.0 the skeleton is the densest body component, and diminished mineralization of this structure yields a considerable saving in weight for *Dissostichus* (Fig. 3B). The ash content of the skeleton is only 0.6% of the body weight. Cartilage (spec. grav. = 1.1) is substituted for some bone in the skull, pectoral girdle and caudal skeleton. Furthermore, the scales, which also contain heavy bone salts, have an unmineralized portion at their posterior margin.

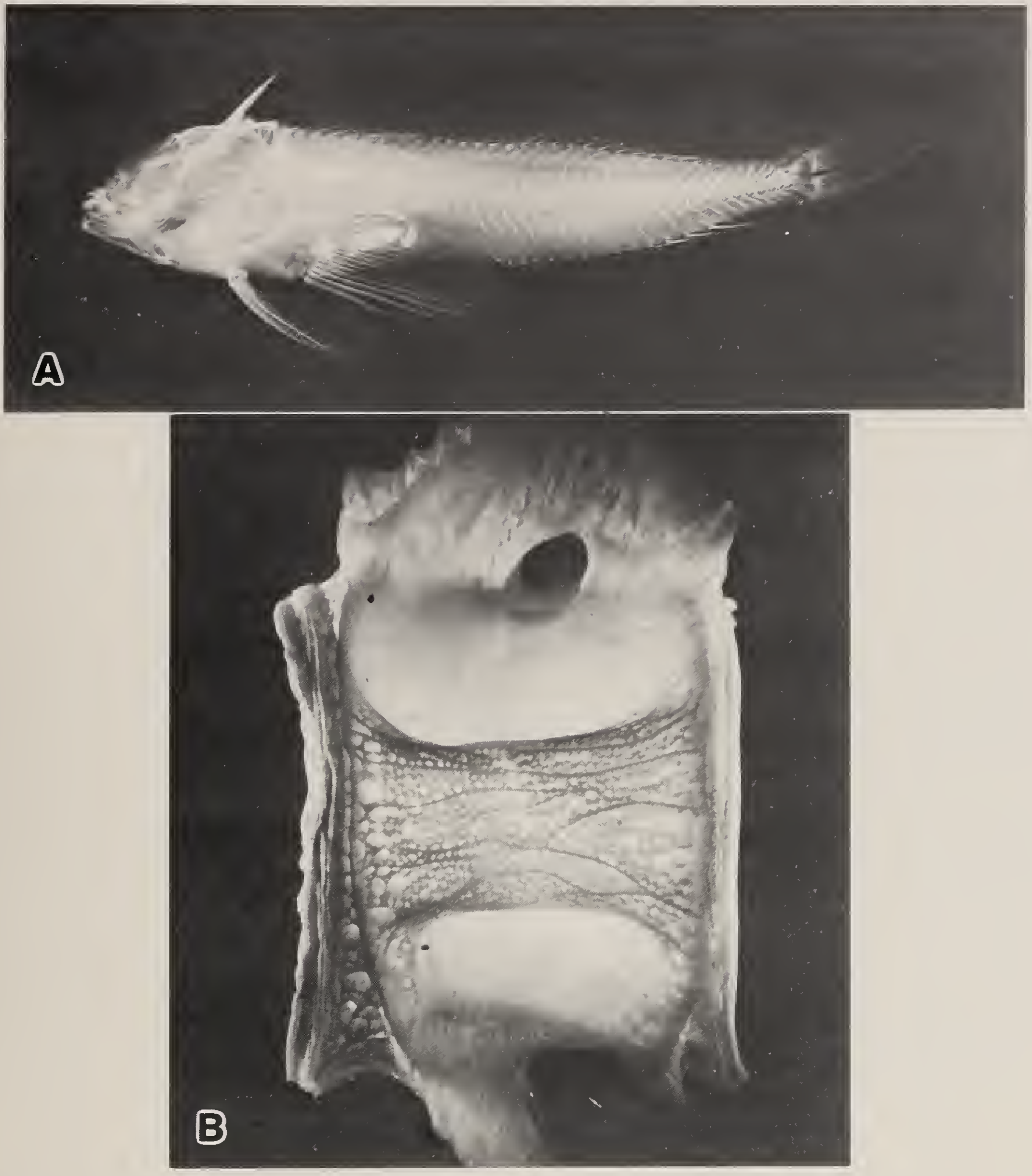


Fig. 3. (A) radiograph of a 44 mm TL specimen of *Bovichtus variegatus* (NMNZ P 16275). This non-Antarctic representative of the primitive notothenioid family Bovichtidae has a heavy well-ossified skeleton at an early stage in life. This is presumably the ancestral state for notothenioids, with skeletal reductions representing derived conditions. Enlargement: ×3. (B) left lateral view of the fifth caudal vertebra from an 88 cm SL *Dissostichus mawsoni*, one of the largest species of notothenioids. Transillumination reveals the cancellous nature of the vertebral centrum. Cavities are filled with lipid in life. Some notothenioids, especially the neutrally buoyant species, have reduced levels of skeletal mineralization compared to other teleosts. Enlargement: ×5.2 (Photographs by William Winn.)

Large deposits of lipid, predominantly triacylglycerols, also contribute to buoyancy in *Dissostichus* (Eastman & DeVries 1981a). With a specific gravity of 0.93, these components are less dense than McMurdo Sound seawater (spec. grav. = 1.028) and therefore provide static lift. *Dissostichus* has two primary lipid deposits. A 2–8 mm thick subcutaneous layer accounts for 4.7% of the body weight. The white axial musculature also contains considerable lipid: 23% on a dry weight basis, or 4.8% of the body weight. In addition to myoseptal lipid, this deposit includes lipid around muscle fasciculi. Red pectoral musculature has a similar deposit. Muscular lipid is most abundant in the anterior half of the body near the centers of mass and buoyancy. Unlike *Pleuragramma,* the lipid in both the subcutaneous and muscular sites is contained in typical adipose cells and is theoretically available for metabolism if necessary. A November sample of *Dissostichus* from McMurdo Sound did not have lipid deposits either around abdominal organs or in mesenteries (Eastman & DeVries 1981a). They did, however, have a transitory lipid store in the lamina propria of the pyloric caeca. Pyloric caeca, diverticula at the junction of the stomach and intestine, are usually the site of lipid absorption in fishes (Greene 1913; Patton & Benson 1975). Histological study of the caeca of *Dissostichus* also provides evidence of active lipid absorption (Eastman 1988a).

The liver in *Dissostichus* is not an organ of buoyancy in the sense that its large size and high lipid content provide static lift as in some elasmobranchs (Corner *et al.* 1969). In a November sample from McMurdo Sound, the liver averaged only 1.6% of the body weight (Eastman & DeVries 1981a). The liver of *Dissostichus* does present an interesting ultrastructural appearance. Hepatocytes contain numerous lipid droplets, and the liver is unique among vertebrates in possessing many perisinusoidal cells (Eastman & DeVries 1981b). These cells appear to be specialized for protein synthesis, and it is possible that their synthetic product transports lipid in the blood.

LIPID BIOCHEMISTRY AND BUOYANCY

It is unusual that those McMurdo Sound species studied to date do not contain significant amounts of wax esters. In *Dissostichus* lipid stores are primarily triacylglycerols (60%), with only traces of wax esters (0.6%) (Eastman & DeVries 1981a). The lipid in the sacs of *Pleuragramma* is 75% triacylglycerols (DeVries & Eastman 1978). In an analysis of *Dissostichus, Pagothenia borchgrevinki* and *Trematomus bernacchii,* Clarke *et al.* (1984) found that triacylglycerols were the major lipid class in all three species.

Wax esters are the major buoyancy agents in most deep and cold water teleosts (Nevenzel 1970; Nevenzel & Menon 1980; Nevenzel *et al.* 1969; Butler & Pearcy 1972; Sargent 1976; Neighbors & Nafpaktitis 1982; Falk-Petersen *et al.* 1986). Although some workers suspect that wax esters are transferred within the food web (Falk-Petersen *et al.* 1986), Kayama & Nevenzel (1974) found that myctophid and gonostomid fishes could synthesize wax esters in muscle, from either acetate or from fatty acids and alcohols.

It is unclear why McMurdo Sound notothenioids use triacylglycerols for buoyancy rather than wax esters. Low density wax esters provide more static lift, and significant amounts are available from mysids in the diet (Clarke *et al.* 1984). Patton *et al.* (1975) noted, however, that in fishes wax esters are hydrolyzed and re-esterified four times slower than triacylglycerols. Furthermore, the higher melting points of wax esters compared to triacylglycerols might impair membrane fluidity and general body flexibility at subzero water temperatures (Eastman & DeVries 1981a).

Triacylglycerols may also be accumulated in preference to wax esters because notothenioids must draw on their buoyancy lipids for energy during the austral winter. However this has never been tested experimentally, and it is not known how a single lipid deposit is regulated for a dual function. If wax esters and triacylglycerols were maintained in separate locations in the body, they could be removed independently with wax ester lipase or triacylglycerol lipase, respectively.

Nachman (1985) analyzed lipids in a three-level food chain in the Ross Sea and McMurdo Sound. Substantiating previous studies, he found that fishes in the chain (*Pleuragramma* and *Dissostichus)* contained large concentrations of triacylglycerols. The nature of the fatty acids and triacylglycerol fatty acid distributions was unremarkable. For example, primarily saturated fatty acids C_{14} to C_{20} predominated in the sac and muscle lipid of *Pleuragramma.* On a weight percentage basis, the major triacylglycerol fatty acids were oleic acid (18 : 1)—26%; myristic acid (14 : 0)—21%; palmitoleic acid (16 : 1)—20% and palmitic acid (16 : 0)—12%. The hydrocarbon distribution, however, displayed an unusual predominance of even-carbon *n*-alkane constituents. Nachman suggested that a different biochemical pathway to hydrocarbons was operating at the low temperatures experienced by members of this food chain.

Reinhardt & Van Vleet (1986b) examined lipid composition of fishes and zooplankton from the Antarctic Peninsula. Their analyses were in agreement with Nachman's results concerning the even-carbon predominance among straight chain hydrocarbons. Unlike those from McMurdo Sound, the *Pleuragramma* in their sample had major visceral lipid deposits. Triacylglycerols were the dominant lipid class in visceral deposits as well as in subcutaneous and muscular sacs, although muscular lipid sacs contained more wax ester (23%) than in McMurdo specimens (0%—DeVries & Eastman 1978). Lipid deposits from white muscle consisted of a mixture of wax esters (48%) and tricacylglycerols (45%). In *Pleuragramma* from McMurdo Sound, 75% of the lipid in white muscle was triacylglycerols with less than 1% wax ester (Nachman 1985). Reinhardt & Van Vleet (1986b) suggested that *Pleuragramma* from the Antarctic Peninsula had an abundant winter food supply allowing the level of triacylglycerols to be replenished so that they could be used for both energy and buoyancy.

It is not known whether notothenioids can use buoyancy lipids for metabolism, and there has been no experimental work with either lipid sacs or adipose cells. Also unknown are the advantages, if any, of lipid storage in one type of system compared to the other. The McMurdo Sound specimens used in buoyancy and dietary studies (Eastman 1985a,b) were captured in the early austral spring (November) before the annual plankton bloom. In November *Dissostichus* were eating primarly lipid-rich *Pleuragramma*. Both species emerged from winter with large lipid stores. These lipid stores probably persisted through the winter, and do not represent seasonal accumulations deposited only during summer when food is plentiful. Although McMurdo Sound is an extreme habitat, *Pleuragramma* and *Dissostichus* may not experience a period of food scarcity in the winter.

LIPIDS AND ENERGY METABOLISM IN NOTOTHENIIDS

While large stores of lipid obviously provide static lift, there has been no experimental work on the availability of lipids for metabolism. Also unstudied are the relative roles of lipids and carbohydrates as metabolic fuels in nototheniids. These questions have been examined by Sidell and colleagues.

Sidell & Crockett (1987) examined the activities of key enzymes of energy metabolism from muscle tissues of ecologically different nototheniids. Their studies compared *Gobionotothen gibberifrons,* a relatively inactive species feeding on benthic invertebrates, and *Trematomus newnesi,* an active semi-pelagic species that eats krill. When assayed at +1° C, they found that the overall capacity for aerobic metabolism, as measured by the enzymes cytochrome oxidase and citrate synthase, and anaerobic metabolism of carbohydrate (6-phosphofructokinase) was equivalent in homologous tissues of the two species. However, aerobic heart and red pectoral muscle of *T. newnesi* showed a consistently greater capacity for oxidation of fatty fuels (carnitine palmitoyltransferase activity) than those of *G. gibberifrons*. Finally, absolute levels of enzyme activities in the hearts of both species were similar to activities in temperate fishes at warmer temperatures.

The higher aerobic capacity in the muscle of *T. newnesi* compared to *G. gibberifrons* was reflected in the subcellular organization of the muscle. As revealed by stereological analyses of electron micrographs (Londraville 1988), *T. newnesi* had a significantly higher volume percentage of mitochondria, but the capillary density was lower than in *G. gibberifrons*. While these data seem to indicate a lower oxygen delivery per mitochondrion in *T. newnesi,* Londraville hypothesizes that the higher volume density of lipid droplets in the muscle of *T. newnesi* might compensate for the lower capillary density. Because oxygen is four times more soluble and more freely diffusable in lipid than in aqueous cytosol, Sidell (1988) and Londraville (1988) suggest that intracellular lipid may accelerate oxygen diffusion from capillaries to mitochondria deep within the muscle fibers, as well as serving as an oxygen store.

In studies of substrate selectivity in the muscles of *G. gibberifrons,* Crockett *et al.* (1988) found a distinct preference for unsaturated lipids. Based on calculations from enzyme activities in skeletal muscle measured at +1°C, their research indicated that oxidation of palmitoleic acid (16 carbons and one double bond) yielded three fold more ATP than oxidation of glucose. Furthermore, when assayed with substrates of different chain lengths and degrees of unsaturation, the rate limiting step of beta-oxidation showed highest activity with monoenoic palmitoleoyl CoA.

In conclusion, the work of Sidell and colleagues indicates that the muscles of nototheniids exhibit a preference for unsaturated lipids as fuel, that there is specialization in the quantitative representation of key organelles involved in energy metabolism and that absolute levels of enzyme activities in muscles of nototheniids at +1°C are similar to those of temperate teleosts assayed at significantly warmer temperatures. These findings support the concept of metabolic cold adaptation in some nototheniid fishes, and offer a possible explanation for elevated routine metabolic rates (see below).

Evolutionary Adaptation to Low Temperature

In addition to the well-known rate of depression of biochemical reactions at low temperature, other physico-chemical conditions of the Southern Ocean have biological implications that probably influenced the physiology of tissues and organs during notothenioid evolution.

ANTIFREEZE GLYCOPEPTIDES

The radiation of notothenioids under cold conditions was necessarily associated with a variety of specializations enabling normal physiological function at low temperature. Antifreeze compounds, for example, are absolutely essential for survival in certain habitats in the Southern Ocean. While antifreezes were not necessary for survival in the warmer waters of the late Cretaceous/early Tertiary, the acquisition of antifreezes allowed the radiation of some notothenioids into ice laden habitats later in the Tertiary. Surface mucus may have initially prevented propagation of ice across the epithelial surfaces of gills and skin. This may have provided adequate protection before waters reached temperatures below the body's freezing point. As climatic cooling continued gradually over millions of years, more effective internally synthesized and systemically distributed antifreezes may have become necessary. Over the past 20 years DeVries and colleagues have elucidated the structure, mode of action and distribution of antifreezes in notothenioids. The following brief synopsis is drawn from two of his recent papers (DeVries 1988a; Ahlgren *et al.* 1988). DeVries worked primarily at McMurdo Sound where water temperatures remain at about the freezing point of seawater (−1.9 °C) throughout the year. The freezing point of the blood of fishes from this environment, calculated from blood osmolality, is −1.2 °C but antifreezes further depress the freezing point of blood to about −2.2 °C and thus prevent these fishes from freezing. Antifreezes must obviously be present in the blood of McMurdo fishes throughout the year.

DeVries discovered that notothenioid antifreeze consists of eight distinct glycopeptides ranging in molecular weight from 2,600 to 33,700. These antifreeze glycopeptides (AFGPs) are composed of repeating units of the tripeptide alanyl-alanyl-threonine with a disaccharide linked to the threonine residues. Antifreezes are synthesized in the liver, secreted into the circulatory system and passively distributed into various fluid compartments of the body. All eight AFGPs are found in blood, peritoneal, pericardial and extradural fluid. Secreted fluids like urine, endolymph and aqueous and vitreous humor either lack AFGPs or have small amounts of the low molecular weight forms. AFGPs are not contained in the cytoplasm of cells but are present in all interstitial fluid except that of nervous tissue.

The antifreeze glycopeptides of notothenioids lower the freezing point in a non-colligative manner, but they also show the expected colligative effect on the melting point of ice. This, by definition, is the "antifreeze effect" (DeVries 1988a: 612). DeVries and colleagues found that AFGPs work by a mechanism known as adsorption-inhibition, briefly summarized below.

Minute ice crystals presumably enter the bodies of notothenioids, but AFGPs prevent further growth of the ice crystals so that tissues of the fish are not damaged by the ice. The crystals may be swallowed with seawater and reside in the intestinal fluid (DeVries *et al.* 1987). Chemists have long known that adsorbed impurities can inhibit the growth of small crystals and that impurities consisting of a large number of repeating molecular subunits are particularly effective in this regard. DeVries hypothesized that AFGPs are adsorbed to ice crystals and that since ice cannot propagate over adsorbed AFGP molecules, it is forced to grow in the small spaces between them. The long straight fronts in the growing ice crystal are divided into many small fronts by adsorbed antifreeze molecules. These small fronts become highly curved and cause an increase in the free surface energy of the ice crystal. The growth of the crystal is therefore halted. Since additional water molecules cannot be added without decreasing the temperature of the solution, the AFGPs have effectively lowered the freezing point of the solution (i.e., they have exerted an "antifreeze effect").

DeVries also determined that the hydroxyl groups of the carbohydrate portion of the AFGP molecules are necessary for proper adsorption to the ice lattice. Experimental alteration of the hydroxyl groups leads to loss of antifreeze activity. Hydrogen bonding is therefore probably important in the adsorption of AFGPs to ice. The hydroxyl, carboxyl and amino groups of the AFGPs can form hydrogen bonds with the oxygen and hydrogen atoms in the ice lattice.

Antifreezes have been isolated in 15 species of notothenioids (Ahlgren & DeVries 1984; Eastman & DeVries 1986b). Not all species require antifreezes, only those living in subzero portions of the water column where ice is present, or species liable to encounter ice during latitudinal or vertical migrations. For example, the cryopelagic *Pagothenia borchgrevinki* lives near the platelet ice and is therefore in danger of contacting ice. Its blood exhibits the greatest freezing point depression and therefore contains the highest concentration of AFGPs of any of the McMurdo Sound species. Near the Balleny Islands, 1,200 km north of McMurdo, *Lepidonotothen kempi* inhabits a +1 °C layer of water and does not possess antifreezes (DeVries & Lin 1977). The New Zealand black cod (*Notothenia angustata)* does not have antifreeze translation products and does not synthesize antifreezes (DeVries *et al.* 1982). Thus while cold resistance is ancestral for the suborder (Andriashev 1987), the possession of definitive antifreeze glycopeptides is a derived condition and may be a relatively recent evolutionary acquisition.

AGLOMERULARISM AND THE PRESENCE OF ANTIFREEZE IN NOTOTHENIOIDS

The nephron is the structural and functional unit in the kidneys of all vertebrates. The evolution of the aglomerular nephron (Fig. 4A) in a few species of teleost fishes is probably the most striking departure from the basic renal pattern. The adaptive significance of aglomerularism, however, is difficult to assess as the 23 species known to be aglomerular (Hickman & Trump 1969) represent seven unrelated families, both freshwater and marine.

Subsequent to Hickman & Trump's (1969) compilation, Dobbs *et al.* (1974) and Dobbs & DeVries (1975a,b) identified 10 aglomerular species of Antarctic notothenioids from two families. They related aglomerularism to the urinary conservation of small molecular weight antifreeze glycopeptides that are necessary for survival in subzero seawater. Dobbs & DeVries (1975a) noted that the Southern Ocean contains a disproportionately high percentage of aglomerular species. Eastman & DeVries (1986b) recently studied renal histology in an additional 10 notothenioid species including representatives of three families not examined by Dobbs & DeVries (1975a). With documentation for roughly 20% of the notothenioid fauna (Table 1) including five families, it is now possible to draw conclusions about the evolution of aglomerularism in these fishes.

Trachinids and blenniids have glomerular kidneys (Hickman & Trump 1969) as does the mugiloidid *Parapercis colias* (Bloch & Schneider, 1801) (Eastman unpubl. data). Members of the most primitive

Table 1. Habitat, antifreezes and glomerular development in notothenioids (from Dobbs *et al.* 1974; Dobbs & DeVries 1975a; Eastman & DeVries 1986b; and Eastman unpubl. data).

Species	Location & latitude	Water temp. (°C)	Antifreeze glycopeptides[1]	Degree of glomerular development[2]
Nototheniidae				
Pagothenia borchgrevinki	McMurdo (78°S)	−1.9	+	−
Pleuragramma antarcticum	„	−1.9	?	−
Trematomus				
bernacchii	„	−1.9	+	−
hansoni	„	−1.9	+	−
lepidorhinus	„	−1.9	+	−
loennbergii	„	−1.9	+	−
newnesi	„	−1.9	+	−
nicolai	„	−1.9	+	−
pennellii[3]	„	−1.9	+	−
Dissostichus				
mawsoni	„	−1.9	+	−
eleginoides	Chile (25°S)	>+5	−	+
Lepidonotothen				
larseni	Balleny Islands (67°S)	−1 to +1	+	−
kempi[4]	„	−1 to +1	−	−
Notothenia				
coriiceps	„	−1 to +1	+	−
angustata	New Zealand (46°S)	+5 to 19	−	+
microlepidota	„	+5 to 19	−	+
Artedidraconidae				
Pogonophryne scotti	McMurdo (78°S)	−1.9	?	−
Bathydraconidae				
Gymnodraco acuticeps	„	−1.9	+	−
Channichthyidae				
Pagetopsis macropterus	„	−1.9	?	−
Bovichtidae				
Cottoperca gobio	Burwood Bank (54°S)	+1 to 6	?	+++
Bovichtus variegatus	New Zealand (46°S)	+5 to 19	−	++
Pseudaphritis urvillii	Australia (37°S)	+5 to 26	−	+++

1. Antifreezes: + = present; − = absent; ? = uncertain or not studied
2. Glomeruli: +++ = many; ++ = moderate; + = few; − = aglomerular
3. Formerly *Trematomus centronotus*
4. Near the Balleny Islands *L. kempi* lives at a depth of 100 m where the water temperature remains above 0°C throughout the year.

notothenioid family (e.g. *Bovichtus variegatus* and *Cottoperca gobio)* also have glomeruli. Another bovichtid, *Pseudaphritis urvillii,* enters rivers well above the tidal influence and can be transferred directly from seawater to freshwater without adverse effects (Scott 1962). Glomeruli are well-developed in this species (Eastman unpubl. data). Thus the pattern of glomerular development in both extant primitive notothenioids and possible sister groups suggests that the ancestral kidney was glomerular and that there has been an evolutionary loss of glomeruli in some notothenioids. Sixteen of 22 notothenioid species examined to date are aglomerular, and 13 of those 16 species are from McMurdo Sound, one of the coldest bodies of water in the world with a mean annual water temperature of −1.9 °C.

Most notothenioids living north of the Antarctic Convergence or in the temperate waters around New Zealand have few glomeruli, which are probably vestigial (Fig. 4B), reflecting the ancestral condition rather than the functional necessity of these structures. This idea is substantiated by renal clearance experiments on *Notothenia angustata*, a New Zealand species that does not produce significant filtrate at the glomeruli (Eastman & DeVries 1986b).

Hickman & Trump (1969) regard loss of glomeruli in marine teleosts as an energy conserving mechanism. They note that when there is a reduction in the number of ions and molecules escaping from the plasma at the glomeruli, energy need not be expended in reabsorbing these components from the filtrate. The aglomerular kidneys of notothenioids have the additional advantage of preventing urinary loss of small glycopeptides with antifreeze properties (Dobbs *et al.* 1974). If filtered into the urine at the glomeruli, recovery of antifreezes would involve degradation into amino acids in the lysosomes of the kidney tubules. Resynthesis of antifreezes would then require metabolic energy. For example, during the activation of each amino acid in protein synthesis, one ATP molecule is hydrolyzed to AMP and two high-energy phosphate bonds are consumed (Stryer 1981). By eliminating glomeruli

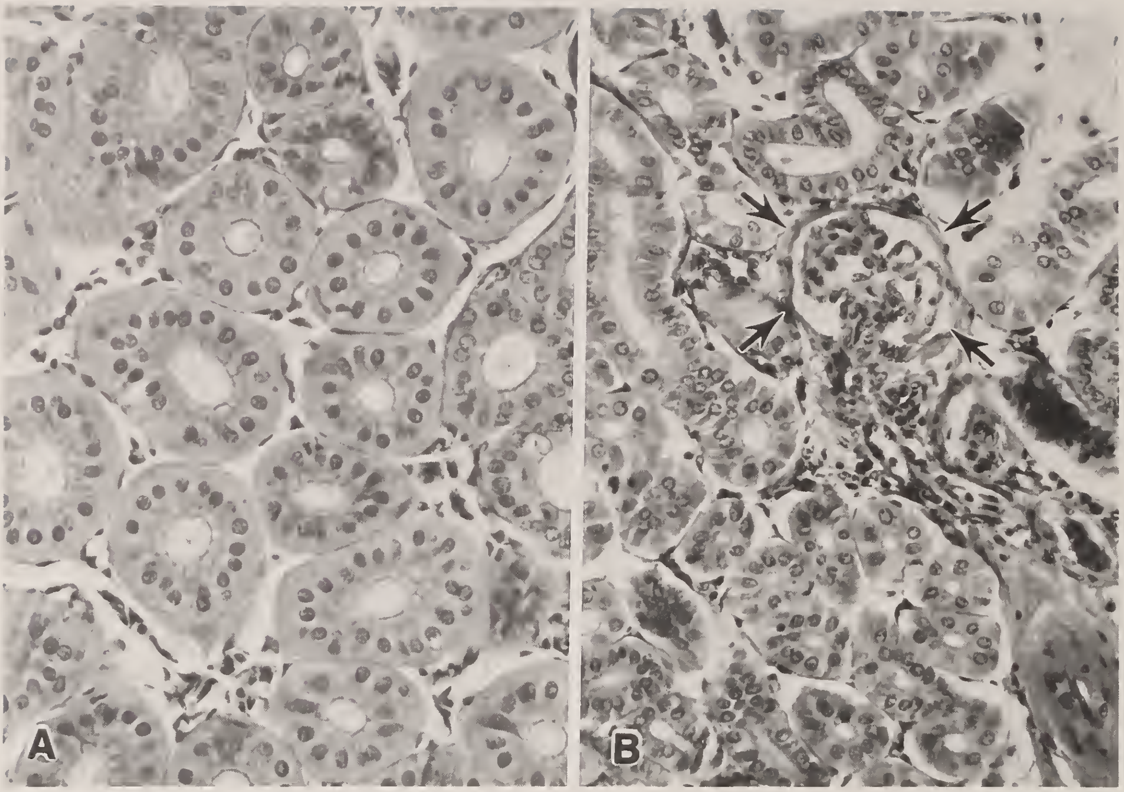


Fig. 4. Light micrographs of the kidneys of the aglomerular *Gymnodraco acuticeps* (A) and the pauciglomerular *Notothenia angustata* (B). Aglomerular species produce urine by a process known as tubular secretion rather than by ultrafiltration. Cross sections of many of these tubules are seen in the kidney of *Gymnodraco*. There are few glomeruli in the kidney of *N. angustata* and experimental studies indicate that the glomerular filtration rate is low in this species (Eastman & DeVries 1986b). A glomerulus measuring 80 μm in diameter is indicated by the arrows. Enlargement: ×380

during the course of their evolution, many notothenioids may save energy by not having to degrade and reabsorb compounds necessary for the resynthesis of antifreezes.

All 13 McMurdo Sound species examined to date are aglomerular (Fig. 4A). Ten of those 13 species have antifreezes (DeVries & Lin 1977; Ahlgren & DeVries 1984; DeVries unpubl. data). Most notothenioids inhabiting sub-Antarctic and temperate waters do not have antifreezes because the water never drops below zero and they therefore have no need for protection. There are no pauciglomerular species that are known to have antifreezes. Selection pressure for evolutionary loss of glomeruli may not have been as great in these pauciglomerular species. A similar pattern of glomerular development is evident in the two closely-related allopatric species of *Dissostichus*: *D. eleginoides* lives north of 55 °S (water temp. 2–11 °C), lacks antifreeze and is pauciglomerular; *D. mawsoni*, on the other hand, lives south of 55 °S, in waters of 2.3 °C or colder, has antifreeze and is aglomerular.

While it cannot be definitively proven that aglomerularism in notothenioids is causally related to the presence of antifreezes, the correlative evidence is consistent with this hypothesis. Energetic efficiency confers an adaptive advantage to an organism and is therefore an important feature in the evolutionary design and modification of all body systems.

ENZYME ADAPTATIONS

Notothenioids are among the most stenothermal fishes in the world, with some species from McMurdo Sound having upper lethal temperatures of +6 °C (DeVries 1977). Since upper and lower lethal temperatures cannot be raised or lowered by warm or cold acclimation, notothenioid enzyme systems are obviously specialized for function under constantly cold conditions. While far from complete, research on notothenioids to date suggests that only one set of isozymes is necessary for an unchanging thermal environment like McMurdo Sound (Clarke 1987). Clarke also indicates that notothenioid enzyme systems function at constantly low temperatures through genetic expression of enzyme variants with lower free energies of activation and by fine control of the enzyme microenvironment.

MEMBRANE ADAPTATIONS

Normal function of plasma and organelle membranes is necessary for survival of notothenioids at low temperatures. That vital functions like ionic transport and synaptic transmission occur is evidence that there has been adaptation in the membrane systems of these fishes.

Conservation of the physical state of membrane lipids and proteins in poikilotherms is known as homeoviscous adaptation (Hochachka & Somero 1984). The fluidity of membranes is influenced by the ratio of saturated/unsaturated fatty acids in membrane phospholipids (Prosser 1986). Increased unsaturation of fatty acids ensures membrane fluidity at low temperatures. Work on notothenioids indicates that both sensory and motor nerves are resistant to blockade at low temperatures, and show compensatory increases in excitability and conduction velocity compared with values extrapolated from temperate fishes (Macdonald 1981; Montgomery & Macdonald 1984). Macdonald *et al.* (1987, 1988) summarize extensive additional work on notothenioid neurobiology by the New Zealand group of Antarctic fish physiologists.

BLOOD AND HAEMOGLOBIN

The solubility of gas in water is inversely related to temperature; consequently, in the subzero seawater of much of the Southern Ocean, notothenioids are unlikely to encounter hypoxic conditions. At McMurdo Sound the oxygen saturation of the −1.9 °C water ranges from 74 to 105% (Littlepage 1965), which is about 1.6 times as much oxygen as seawater contains at 20 °C (Clarke 1983).

Because water has a high kinematic viscosity at low temperature (Vogel 1981), some processes requiring the movement of fluid have been modified from the condition we view as normal in temperate fishes. Two examples are the circulation of blood and gill ventilation (see below). Although the energetic cost of these actions is probably greater in cold seawater, there has been no experimental study of the fluid dynamics of these processes in notothenioids.

In a study of ten notothenioids (mostly nototheniids) from McMurdo Sound, Wells *et al.* (1980) found reduced erythrocyte numbers, hematocrits and haemoglobin concentrations compared to temperate species. Reduction in the number of cellular elements probably serves to reduce the viscosity of notothenioid blood. With resistance to flow minimized at low temperature, less energy is required to move blood through the vessels. Although the viscosity of notothenioid blood has not been measured, the blood of Arctic fishes is significantly less viscous than that of temperate species (Graham *et al.* 1985).

Using many of the same species as Wells *et al.* (1980), D'Avino & di Prisco (1988) and di Prisco (1988) performed cellulose acetate electrophoresis on the haemoglobins of 13 nototheniids, one harpagiferid, one artedidraconid and one bathydraconid. All nototheniids had two haemoglobin components. The major component comprised 80–90% of the total haemoglobin while the second component accounted for 5–15%. Members of the other three phyletically derived notothenioid families had a single component. Most temperate fishes have multiple haemoglobins that often exhibit differences in oxygen binding (D'Avino & di Prisco 1988). The relatively constant physico-chemical conditions in the Southern Ocean have probably reduced the selective advantage of multiple haemoglobins in notothenioids.

The evolutionary trend toward reduction in erythrocytes and haemoglobin culminates in the "white blooded" icefishes of the family Channichthydae. All 15 species lack haemoglobin, although a few pale, fragile erythrocytes are present (Barber *et al.* 1981). Oxygen is therefore carried in physical solution in the blood plasma. In addition, the muscles of these fishes do not contain myoglobin (Hamoir 1988). This highly specialized condition involving evolutionary loss of the respiratory pigments is compatible with life only under Antarctic conditions where waters always have a high oxygen content. A variety of cardiovascular, branchial and metabolic adaptations appear to compensate for the lack of respiratory pigments. The reviews of Everson (1984) and Macdonald *et al.* (1987) contain details of the physiology of these interesting fishes.

RESPIRATION

In research encompassing seven nototheniids and one bathydraconid, Wells (1987) found that both the resting rates of oxygen uptake and ventilation frequencies were reasonably well correlated with activity levels. Cryopelagic and active benthic species had the highest rates. By suturing the opercula closed and administering a neuromuscular blocking agent, Wells also obtained measurements of cutaneous oxygen uptake in two species with scales. The skin contributes 9% of the total oxygen transfer in the benthic *Trematomus bernacchii* and 17% in the cryopelagic *Pagothenia borchgrevinki*. Cutaneous exchange obviously did not compensate for occluded branchial exchange, nor did it approach the 40% of total oxygen uptake reported for some channichthyids (Wells 1987).

Cutaneous oxygen exchange may nevertheless be more important in polar fishes than in temperate fishes (Macdonald *et al.* 1987; Wells 1987). Diffusion gradients for oxygen are always favourable and energy may be saved by reduced branchial irrigation with high viscosity seawater. In some notothenioids gill surface area and metabolic rate are low while the skin is scaleless. For example, the surface area of cutaneous capillaries is reported to exceed that of the gills by 15–20% in the scaleless *Gymnodraco acuticeps* (Jakubowski & Rembiszewski 1974). However, measurements indicating abundant skin vascularization in *G. acuticeps* and in *Chaenocephalus aceratus* (Jakubowski 1982) were performed on specimens injected with India ink under non-physiological conditions. Furthermore, these observations are without permanent photographic documentation. Modern vascular casting (Eastman 1988b) and image analysis techniques could contribute greatly to an understanding of the potential of the skin as a respiratory surface in notothenioids. Figures 5 and 6 indicate that microvascular filling agents like Microfil can effectively display cutaneous blood vessels in *Gymnodraco acuticeps,* and that this common bathydraconid is a worthwhile subject for future research in this area.

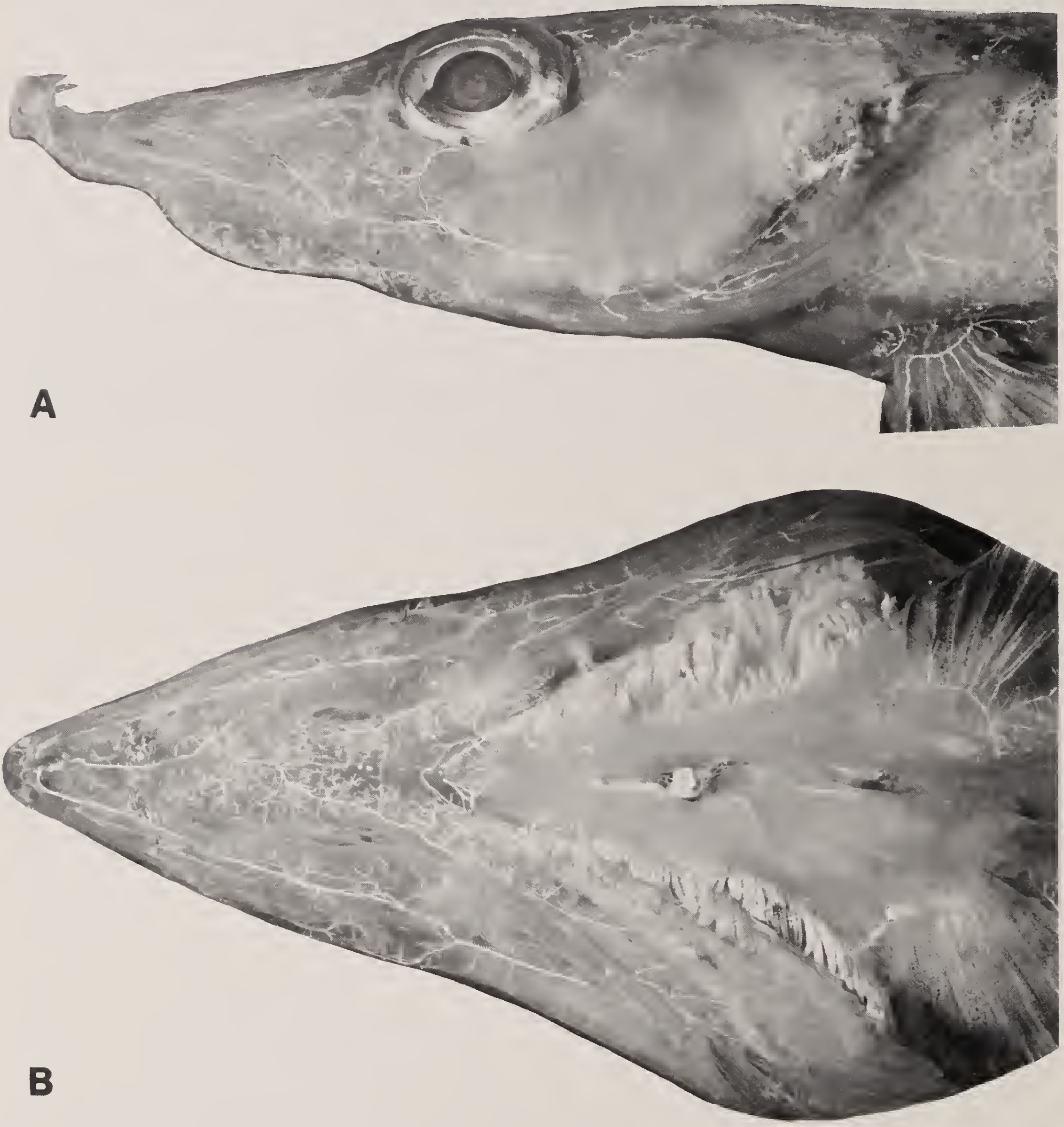


Fig. 5. Head of *Gymnodraco acuticeps* demonstrates the extent of cutaneous blood vessels and potential for cutaneous respiration in this scaleless bathydraconid. The 17 cm SL specimen was perfused through the ventral aorta with Microfil, fixed, bleached, dehydrated and cleared with methyl salicylate. The skin, which is 300–500 μm thick over most of the body, has not been removed. Left lateral (A) and ventral (B) views show vessels in the head region and in the membrane between pelvic fin rays. Differences in the vascularization of red (pectoral) and white (adductor mandibulae) muscle are also seen in (A). Enlargement: ×2 (Photographs by William Winn.)

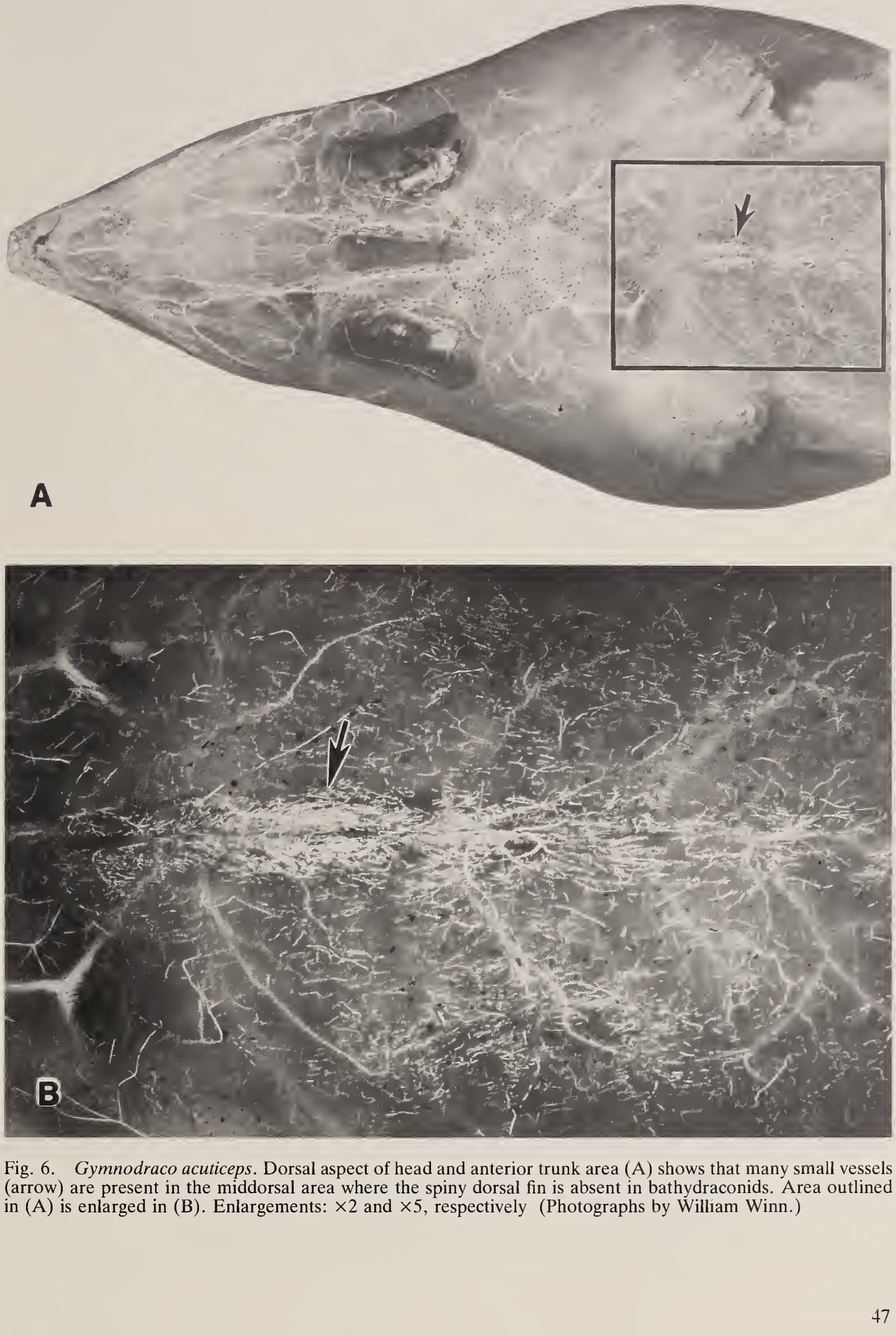


Fig. 6. *Gymnodraco acuticeps*. Dorsal aspect of head and anterior trunk area (A) shows that many small vessels (arrow) are present in the middorsal area where the spiny dorsal fin is absent in bathydraconids. Area outlined in (A) is enlarged in (B). Enlargements: ×2 and ×5, respectively (Photographs by William Winn.)

Metabolic cold adaptation

When oxygen uptake is taken as a measure of the routine metabolic rate, notothenioids of the family Nototheniidae have higher rates than those in temperate fishes extrapolated downward to subzero temperatures (Fig. 7). In other words the routine metabolic rates of some nototheniids are elevated to a level several times higher than would be predicted for temperate species at the equivalent low temperature. The history of this "contentious concept" (Wells 1987) known as metabolic cold adaptation has been reviewed and re-examined in the light of new experimental data (Wells 1987; Macdonald *et al.* 1987, 1988). These references should be consulted for the full perspective on this issue.

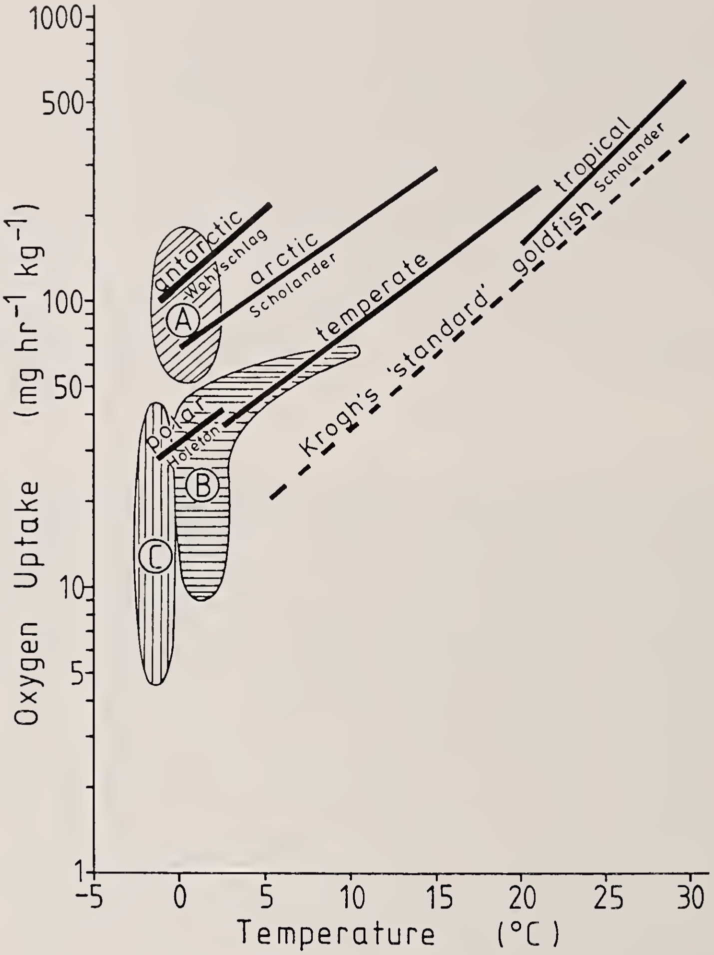


Fig 7. Metabolic cold adaptation—some polar fishes have higher than expected metabolic rates at low temperatures (from Macdonald *et al.* 1987 which may be consulted for references to the original data). The physiological basis of this concept rests upon comparisons of rates of resting oxygen consumption as a function of temperature among polar, temperate and tropical fishes. These comparisons are represented by the heavy lines indicating median rates of oxygen consumption. The variability of these data is not shown. Cold water fishes have higher rates of metabolism at lower temperatures. Hatched areas depict the scatter of data for a variety of Antarctic fishes. (A) the nototheniid *Trematomus bernacchii* from McMurdo Sound, a clear example of metabolic cold adaptation; (B) various channichthyids; and (C) the zoarcid *Lycodichthys dearborni* from McMurdo Sound. The metabolic rates of the channichthyids and *Lycodichthys* are not elevated above expected rates, therefore these fishes do not exhibit metabolic cold adaptation. (Reproduced with the permission of the authors and Academic Press)

Metabolic cold adaptation is not an artefact of experimental procedure as claimed by some critics. Wells (1987) repeated Wohlschlag's original experiments on nototheniids from McMurdo Sound. Using modern flow-through respirometers that reduce handling stress and hypoxia, he found that oxygen consumption was still higher than expected and that data from *Trematomus* and *Pagothenia* support the concept of metabolic cold adaptation. There is, however, considerable interspecific variation in routine metabolic rates (Macdonald *et al.* 1987). Furthermore, when analyzing metabolic rates in fishes from different latitudes, it is important that the comparison involve fishes that are ecologically similar (DeVries & Eastman 1981). There is no obvious adaptive advantage to an elevated routine metabolic rate given the energy limiting conditions of the polar environment. Macdonald *et al.* (1987) speculate that an elevated rate may reflect the energy required by other adaptive changes such as antifreeze synthesis and tubular secretion in the kidneys.

Muscles and swimming

Although they occupy a variety of ecological niches in the Southern Ocean, most notothenioids use their large fan-shaped pectoral fins as the primary means of propulsion. With this labriform mode of swimming, *Pagothenia borchgrevinki* attain speeds of up to 38 cm/sec (1.8 body lengths/sec) (Montgomery & Macdonald 1984). Undulation of the posterior one-half of the body, the subcarangiform mode of swimming, is employed for the quick bursts of speed necessary to capture prey or to escape from predators. *Pagothenia* reach maximum speeds of 110 cm/sec (4.9 body lengths/sec) when swimming in this fashion. Furthermore, they show no temperature compensation in swimming speed as values are close to speeds predicted for temperate species when extrapolated to subzero temperatures (Montgomery & Macdonald 1984).

The muscles of notothenioids consist of various proportions of three fibre types (Davison & Macdonald 1985) with red and white fibres as the most prominent. Red fibres are small diameter, oxidative fibres with a rich blood supply (Fig. 8). They are energy efficient and employed in sustained activities like low-speed swimming. White fibres, on the other hand, are large diameter fibres with a sparse blood supply. They mediate quick movements of short duration. In *Dissostichus mawsoni* the

Fig. 8. Radiograph of right pectoral fin of *Dissostichus mawsoni*. The subclavian artery was cannulated and perfused with radiopaque Microfil, a silicone rubber compound designed to fill microvascular spaces. This preparation demonstrates the extensive blood supply to the red pectoral muscle fibers of *Dissostichus*. These oxidative fibers provide the primary means of propulsion in most notothenioids. Enlargement: ×1.4. (Photograph by William Winn.)

red pectoral muscle comprises only 1.6% of the total body weight and is used for the slow labriform swimming characteristic of this species (Eastman & DeVries 1981a). The white axial musculature of *Dissostichus* is 50.6% of the body weight and is used for infrequent bursts of subcarangiform locomotion.

Little is known about the swimming behaviour and muscle fibre composition of *Pleuragramma antarcticum,* a pelagic species that is atypical in having small pectoral fins. This species does possess an extensive red lateralis superficialis muscle (Fig. 2) along the sides of the trunk (Eastman & DeVries 1982). Observations on a captive specimen at McMurdo Sound indicate that, unlike other notothenioids, subcarangiform locomotion is the primary means of propulsion in *Pleuragramma*. When this specimen was held out of the water, the lateralis superficialis was seen contracting beneath the skin when the caudal fin moved from side to side (J.T. Eastman & A.L. DeVries, unpubl. data). Dissection revealed that this muscle in *Pleuragramma,* as in other teleosts, is inserted on the bases of the caudal-fin rays via tendons separate from those of the white axial musculature. It is therefore capable of providing an efficient means of caudal propulsion not involving the large mass of white muscle.

The physiology and biochemistry of notothenioid muscle is an area of active research beyond the scope of this chapter. The works of Davison & Macdonald (1985), Dunn (1988) and Johnston & Altringham (1988) may be consulted for access to this field.

Feeding and growth rates

Information on the diets of notothenioids is contained in the accounts of the various species. Nearly all of these data are based on collections taken during spring, summer and autumn. Targett *et al.* (1987) recently reported that five nototheniids and one harpagiferid living near the Antarctic Peninsula also feed during late winter (August and September). To determine relative rates of seasonal feeding, Targett *et al.* transferred a group of *Harpagifer antarcticus* to a controlled aquarium facility at the University of Delaware. Spring and autumn conditions were simulated by a water temperature of 0 °C and a 12 hour light/12 hour dark photoperiod. After seven days these fish were subjected to a simulated winter temperature of −1.7 °C and a 5 hour light/19 hour dark photoperiod. Daily feeding rate under winter conditions was 1.46% of wet body weight/day, significantly less than the 2.33% consumed at 0 °C. Targett *et al.* concluded that feeding rate in this species was sensitive to slight changes in temperature and also to photoperiod, although the precise role of these two variables in controlling the process is unknown.

Available data suggest that notothenioids grow slowly compared to temperate species (Kock 1985). Recent work on otoliths indicates that these structures provide useful information about the life history of notothenioids (Radtke & Targett 1984; Radtke 1987a). By analyzing daily growth rings detected with scanning electron microscopy, Radtke (1987b) determined that both *Lepidonotothen nudifrons* and *Trematomus newnesi* grew slowly. *L. nudifrons* reached sexual maturity at 4–5 years, with the largest fish attaining an age of 8 years. Radtke & Targett (1984) also discovered that variations of the strontium/calcium ratios in otoliths of *Lepidonotothen larseni* probably reflect the thermal conditions experienced during the life of an individual fish.

In an ambitious, ongoing project at McMurdo Sound, DeVries (1988b) has captured, tagged and released 5,000 *Dissostichus mawsoni* since 1972. This is one of the largest notothenioids, and little is known about its growth. During the study period DeVries had 12 recaptures with away times of 1 to 7 years. Growth was slow with recaptured fish increasing an average of 2 cm and 0.9 kg per year. Previous work on the otoliths of this population (Burchett *et al.* 1984) indicates that *D. mawsoni* becomes sexually mature at 8 years and that the largest specimens (1620 mm TL) in McMurdo Sound are about 30 years old.

Final remarks

Notothenioids do not outwardly display any unusual features that are obviously associated with environmental conditions in the Southern Ocean. As mentioned in this chapter, there has been morphological diversification allowing them to fill ecological niches occupied by taxonomically diverse fishes in temperate waters. In this sense the neutrally buoyant notothenioids like *Pleuragramma* represent the most extreme departure from the presumably benthic ancestral condition. Many of the key evolutionary adaptations for life in the Southern Ocean involve refinements of physiological and biochemical processes. Some of these have been briefly considered in this chapter. Especially prominent are mechanisms that prevent freezing and allow normal cellular, tissue and organ function at subzero water temperatures.

Recent descriptions of new species indicate that our knowledge of notothenioid diversity is incomplete. Consequently it is difficult to formulate accurate hypotheses concerning the role of notothenioids in the ecosystem of the Southern Ocean. It is essential that collecting and systematic work continue, and that studies of notothenioids persist at levels of biological organization from the organismal to the molecular. The acquisition and analysis of molecular data should provide additional information useful in understanding the origin of adaptations like antifreeze as well as in elucidating the phylogenetic relationships of notothenioids.

Exploitation and Conservation of Antarctic Fishes and Recent Ichthyological Research in the Southern Ocean

J.-C. Hureau & W. Slosarczyk

Early fishing activities

Attempts to exploit Antarctic fish stocks date back to the beginning of this century. Since whaling commenced at the Grytviken, South Georgia in 1904, whalers had noted the occurrence of large quantities of the "South Georgian cod" (a former name of *Notothenia rossii)* off the northern coast of the island, and they also learnt to appreciate this fish as excellent food. Members of the Swedish expedition in 1902 report (Lönnberg 1906) that *N. rossii* was the most common fish at South Georgia, or at least the one most commonly caught in Cumberland Bay and offshore. As fishing gear the "pilk", a kind of squid-hook, and hand line were used with pieces of fish, penguins or seals as bait. Offshore ("on the bank") large specimens of *N. rossii* were extremely abundant. During pauses in the whale hunt, when a whale had been killed and was waiting to be hauled in and secured to the steamer, it was a much enjoyed sport to fish *N. rossii* reported the Swede Sörling (in Lönnberg 1906). The lifeboats of the steamer were used for storing the fish, and two men with pilks, could sometimes fill both lifeboats with fish in less than an hour. Lönnberg, (1906), in his contribution on the fauna of South Georgia said that *Champsocephalus gunnari* was so common that it might become of economic value. Because this fish lives a little deeper than *N. rossii,* it was not observed as often, and consequently was not the object of fishing on any great scale.

The idea of utilizing fishes as an exportable resource of South Georgia is as old as the whaling station. Sörling (in Lönnberg 1906) reports that in 1905 many barrels of salted fish, caught by the method described above, were sent to Buenos Aires where they found a ready market. There was then no doubt that important fisheries could be established at South Georgia, but after 1905, there were no further shipments of fishes.

At that time the markets of South America were known to absorb large quantities of imported fish. Argentina, in some respects the most convenient market to enter, took over 9,000 metric tons of fish in 1914, while Brazil imported about 50,000 tons. The First World War produced a great shortage of fish with a corresponding rise in prices. Fish imports for the countries bordering the South Atlantic were furnished mainly by European countries exporting North Atlantic fishes, Norway being the largest contributor. Newfoundland and Canada were also very large exporters. In those circumstances the British Government considered the development of fisheries in the home waters of the Falkland Islands Dependencies, taking into account the advantage of shorter fish transport through cooler waters to South America. A comprehensive study of the question examined the problems of fuel supply for fishing vessels, the location of marketable quantities of fish and the best methods for their preservation, including canning and refrigeration. However, the idea remained only in the reports of the Interdepartmental Committee on Research and Development in the Dependencies of the Falkland Islands, presented to the British Parliament in 1920.

In the 1928–29 season, Mr Heyerdahl, a Norwegian chemist, made some analyses and experiments with a view to the production of fish oil and fish meal, as Olsen (1954) reports. He found 12,5% fat in the fish and obtained 19,5% meal. The possibilities for an economically remunerative fishery were therefore good, provided that the problem of catching the fish was solved in a satisfactory manner. In the middle of the 1930's, Compania Argentina de Pesca tried fishing with purse seines, but the attempt was not successful.

The exploratory fishery surveys

Expeditions to the Southern Ocean, devoted wholly to research and development of the fisheries, as distinct from early scientific expeditions, commenced in the 1950s. In the late 1940s, A.S. Tønsberg Hvalfangeri entertained the idea of using fish for oil and meal production, because it seemed that the stocks of whales were diminishing at South Georgia (Olsen 1954). During the season 1950–51, the idea was put into effect. The first priority was to carry out scientific investigations of the fish stocks and procure a small sample collection of the products the fish could furnish. *Busen 6,* an old whale catcher from 1926, was equipped with an echo sounder and a Swedish floating trawl. Fisherman Lars Nilssen of Kjøllefjord, and the Norwegian ichthyologist Steinar Olsen were engaged to take charge of the investigations and the experimental fishing operations. Neither the vessel nor the floating trawl proved very suitable for the purpose. Relatively large quantities of fish, however, were found to be present, and by means of vertical line and tinbait a sufficient quantity was obtained for a small trial production of oil and meal. In other respects the conditions appeared so promising that in the following season the company sent down two Norwegian 70-foot fishing cutters. These were equipped with purse seines and manned by experienced North Sea Norwegian fishermen. Unfortunately this attempt with purse seines was also unsuccessful. The operations started too late, and from the New Year 1952 the weather conditions were difficult and there was little fish to be seen. The amount fished was therefore much less than had been expected. This, in conjunction with the depression in the whale oil market, led to suspension of further Norwegian attempts. Repeated Japanese fishing trials in the early 1960s also failed (Inoue & Kido 1964).

Contrary to these early unsuccessful attempts, the exploratory fishing by the Soviet Union in the Scotia Sea during the mid-'60s quickly developed into large-scale commercial fishing in the vicinity of South Georgia. In the Indian Ocean sector of the Southern Ocean, Soviet fishery exploration had already begun by the late 1950s with several fish survey cruises in 1956–60 and 1961 (Hureau 1979; Kock *et al.* 1985). During the 1967–68 season, a French commercial trawler (*Sapmer II*) surveyed the inshore waters of the Kerguelen Islands, and the first Soviet trawler (*Aelita*) arrived in the area, followed by four scouting trawlers (*Skif, Kara-dag, Chatyr-Dag* and *Mys-Ostrovskogo*). A Soviet fishing fleet was operating at the Kerguelen Islands in 1970 (Kock *et al.* 1985).

It is difficult now to estimate correctly the amount of fish taken in the period of Soviet exploratory fishing. The catch reporting system was inadequate for two reasons: firstly, two major fishing areas (South Georgia and the Kerguelen Islands) were not yet included within the present Antarctic statistical Areas 48 and 58; secondly, the reported catch was not broken down into species. Everson (1977), in his extensive report for the FAO on the living resources of the Southern Ocean, concluded that Nototheniiform fishes in catch statistics were probably classified as unspecified demersal percomorphs, mainly in FAO statistical Areas 41 and 51. The catches in this category in Area 41, reported by USSR in the '60s, are as follows: 1966—1,100 tonnes; 1967—12,900; 1968—5,400; and 1969—89,100. The same category of catches in Area 51 is: 11,400; 5,300; 1,300; and 900 tonnes respectively (FAO 1976). The main species caught at that time was most probably *Notothenia rossii*.

In the mid '70s a number of countries undertook exploratory fishing surveys in the Antarctic. For three seasons since 1973–74 France sent the research vessel *Marion-Dufresne* to the Indian Ocean sector on exploratory voyages (Hureau 1976; Guille 1977; Arnaud & Hureau 1979). In 1979–80, the French trawler *Jutland* explored fishing grounds in the vicinity of the Kerguelen Islands and Crozet Islands (Duhamel & Hureau 1981). One year later (September 1980) the *Marion-Dufresne* surveyed Marion Island and Bouvet Islands as well as the Ob and Lena seamounts (Hureau 1986). In 1981 three French trawlers (*Zelande, Austral* and *Sydero)* began commercial fishing around the Kerguelen Islands. The general result of these cruises was that the French fishing companies estimated that it was not economically remunerative to send several fishing vessels to these relatively small fishing grounds, until a market could be developed for the products. Since that period only one French trawler (*Austral)* is allowed to do one fishing cruise each year.

Poland entered the exploratory programme in the 1974–75 season. The research vessel *Professor Siedlecki* operated at the Kerguelen Islands and Heard Island. High catch rates were achieved on the Skif Bank (Slosarczyk & Wysokinski 1980). In the 1975–76 season the R/V *Professor Siedlecki* and the chartered trawler *Tazar* surveyed the Scotia Sea area. On the basis of fisheries observations from the South Georgia Shelf (Linkowski & Rembiszewski 1978), Poland sent the R/V *Professor Siedlecki* and four chartered commercial trawlers (*Gemini, Manta, Rekin* and *Tazar)* to the West Antarctic in the 1976–77 season. With that expedition, Poland entered the commercial phase of the Antarctic fishery. In the Indian Ocean sector, the Polish scouting trawler *Manta,* working in 1977–78 was followed in 1979 by the commercial trawler *Lacerta* fishing in the vicinity of the Kerguelen Islands.

The Federal Republic of Germany (FRG) sent the research vessel *Walther Herwig* and the commercial trawler *Weser* to the Scotia Sea and the Drake Passage in the 1975–76 season. Besides exploratory krill catches, a finfish study was also carried out (Kock 1976, 1978). West German fishery research was continued in 1977–78 (Kock 1979), but that country did not undertake any further commercial exploitation of Antarctic fishes.

Intensive experimental finfish fishing was conducted by Japan in the vicinity of the Kerguelen and Crozet islands and seamounts in the Enderby-Wilkes Division 58.4.4. In the 1976–77 and 1978–79 seasons, about 5,000 tonnes of fish were taken from those fishing grounds (Endo, pers. comm.; internal report of Nippon Suisan Kaisai 1976 in Everson 1978). From 1978–79 onwards, exploratory fishing in the Scotia Sea area was extended by the German Democratic Republic (GDR), Poland and USSR to the South Shetland Islands and west coast of the Antarctic Peninsula, down to Adelaide and Peter I islands. The shelf areas of the South Sandwich Islands and Bouvet Island were also surveyed at that time (Gubsch & Hoffmann 1981; Gubsch 1982; Sosinski 1982). Finally, only recently the Spanish commercial trawler *Nuevo Alcocero* carried out exploratory fishing in the Scotia Sea area (Sabrino *et al.* 1987).

The commercial fishery phase

The period of intensive commercial fishing in the Southern Ocean began at the end of the 1960s. The most important fishing areas (South Georgia, South Orkney Islands and the Kerguelen Islands) are shown in Fig. 1. A summary of the commercial phase in the Antarctic fishery is in Fig. 2. Catch data are the only source here because complete effort data for the most interesting period up to 1982 are not available. The beginnings were very promising: nearly 400,000 tonnes of *Notothenia rossii* were caught

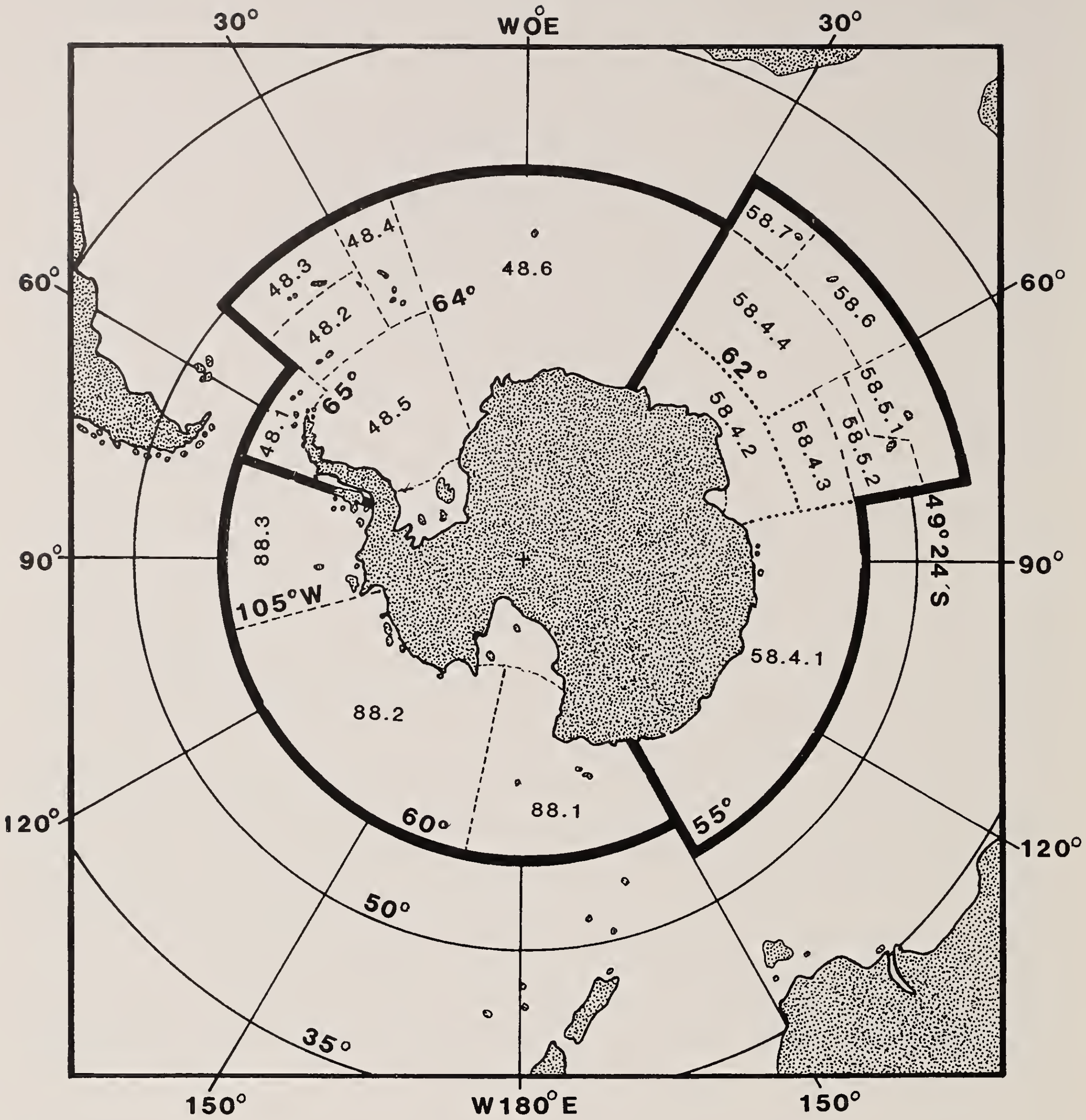


Fig. 1. Areas, Sub-areas and Divisions of the CCAMLR Area:

Area 48: Atlantic Ocean Antarctic Area: 48.1 Peninsula Sub-area; 48.2 South Orkneys Sub-area; 48.3 South Georgia Sub-area; 48.4 South Sandwich Sub-area; 48.5 Weddell Sea Sub-area; 48.6 Bouvet Sub-area

Area 58: Indian Ocean Antarctic Area: 58.4 Enderby-Wilkes Sub-area; 58.4.1 Enderby-Wilkes Division 1; 58.4.2 Enderby-Wilkes Division 2; 58.4.3 Enderby-Wilkes Division 3; 58.4.4 Enderby-Wilkes Division 4; 58.5 Kerguelen Sub-area; 58.5.1 Kerguelen Division; 58.5.2 McDonald-Heard Division; 58.6 Crozet Sub-area; 58.7 Prince Edward and Marion Sub-area

Area 88: Pacific Ocean Antarctic Area: 88.1 Eastern Ross Sea Sub-area; 88.2 Western Ross Sea Sub-area; 88.3 Amundsen Sea Sub-area

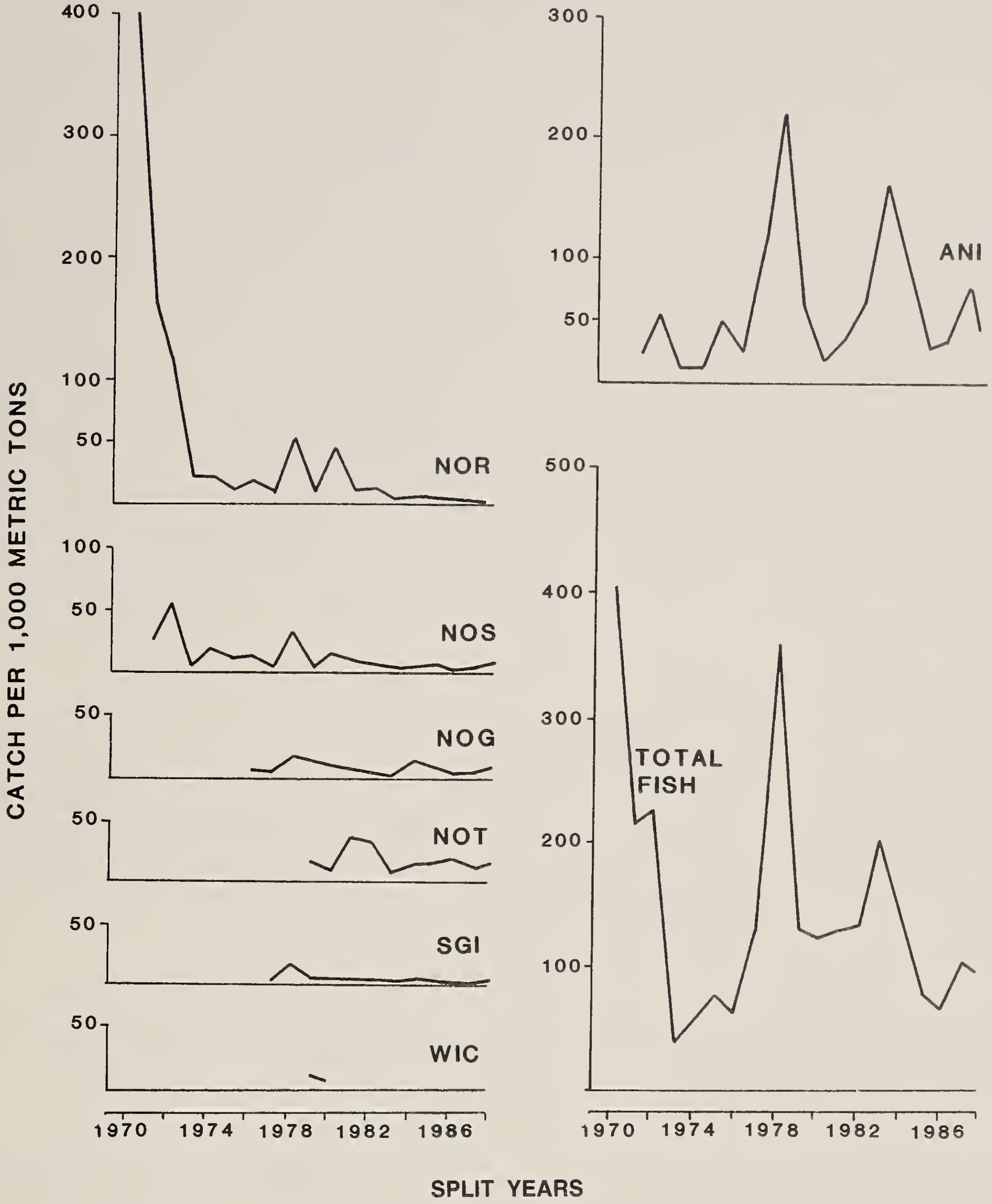


Fig. 2. Total commercial catch of selected species (max. annual catch over 10,000 tonnes) in the Southern Ocean: ANI = *Champsocephalus gunnari*; SGI = *Pseudochaenichthys georgianus*; WIC = *Chaenodraco wilsoni*; NOR = *Notothenia rossii*; NOS = *Lepidonotothen squamifrons*; NOG = *Gobionotothen gibberifrons*; and NOT = *Patagonotothen guntheri*

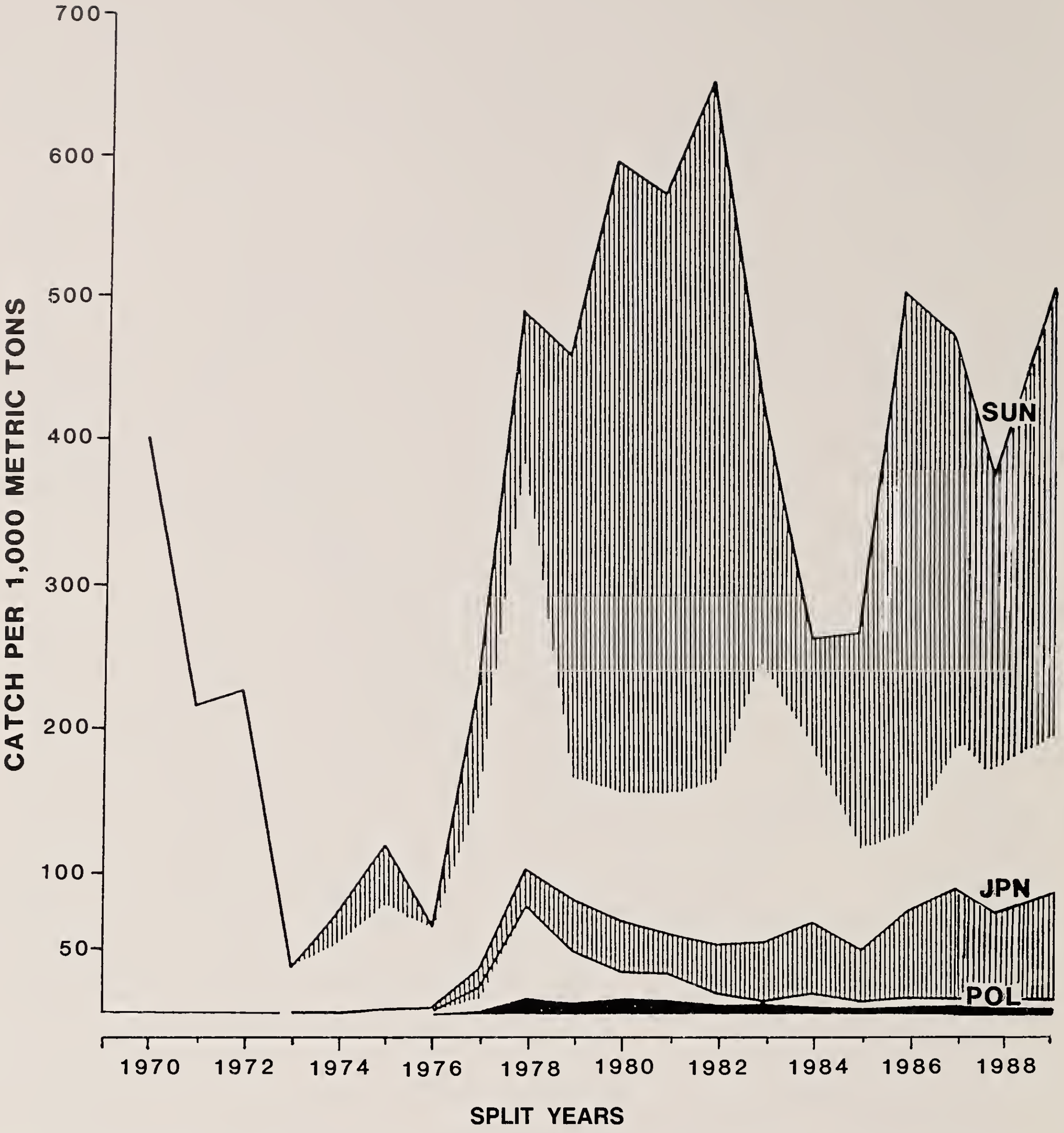


Fig. 3. Total commercial catch of fish (white area) and krill (hatched area) in the Southern Ocean, by country: Japan (JPN), Poland (POL), Union of Soviet Socialist Republics (SUN); and other states (black area; including Bulgaria, Chile, Democratic Republic of Germany, France, Korea and Spain)

off South Georgia in the 1969–70 season. What followed was a decline, but catches for the next two seasons remained at a high level of about 210–220,000 tonnes, maintained by commercial exploitation of *N. rossii* at the Kerguelen Islands area. The following season (1971–72) brought a drop in the catch down to 35,000 tonnes, and for the subsequent three seasons (1972–75) total fish catches fluctuated between 51,000 and 73,000 tonnes. By then, commercial exploitation of fish in the Antarctic was carried out by only one country, the Soviet Union (Fig. 3).

A subsequent increase in the fishing effort, from 1976–77 onwards, accompanied the entry of Poland, the German Democratic Republic and Bulgaria into the fishery. This, together with an increase in catch rates in the already exploited fishing grounds off South Georgia and Kerguelen Islands (Slosarczyk *et al.* 1985; Hureau & Duhamel 1980) and extension of the fishery to the South Orkney Islands, led to the rapid build-up of catches to 355,000 tonnes in 1977–78. As distinct from the 1969–70 season, the target species was *Champsocephalus gunnari* at all main fishing areas: the South Orkney Islands and the

Kerguelen Islands (Fig. 4). Substantial catches were also made of four other species: *N. rossii* and *Lepidonototothen squamifrons* in the vicinity of Kerguelen Islands, and *Gobionotothen gibberifrons* and *Pseudochaenichthys georgianus* off South Georgia.

In the years 1971 and 1974–78, numerous Soviet trawlers were fishing at the Kerguelen Islands area (Hureau 1979; Hureau & Duhamel 1980), and by the end of 1978 an Exclusive Economic Zone (EEZ) was established at the French sub-Antarctic islands. After 1978, no more than seven foreign trawlers were allowed to fish simultaneously at the Kerguelen Islands.

As in the early 1970s, the peak year 1977–78 was followed by four seasons of fairly low catches at a level of 120,000 tonnes. From 1978–79 onwards, fishing was extended to the South Shetland Islands and Joinville Island (Sosinski & Skora 1979; Bech 1982). Catches consisted of a number of species: *N. rossii, G. gibberifrons, C. gunnari, Chaenodraco wilsoni* and *Patagonotothen guntheri,* the two last being new to the fishery (Fig. 2). In the 1979–80 season, Bulgaria terminated fishing, and the GDR suspended fishing one year later, until 1984–85. The subsequent rise in the total fish catch in the 1982–83 season was related again to *C. gunnari*. By-catch of other species was rather low (Fig. 2). In the 1982–83 season, high catch rates and a larger fishing fleet were noted mainly off South Georgia, and to a lesser degree off the Kerguelen Islands. With the exception of a couple of thousand tonnes taken by France and Poland, fishing was conducted by one country only, the Soviet Union (Fig. 3). Once again total catch decreased, but this time down to the level of the 1973–74—1975–76 seasons, i.e. 58–72,000 tonnes, maintained by two species: *C. gunnari* and *P. guntheri* (Fig. 2). In the 1987–88 season, the total catch of finfish in the Southern Ocean attained a level of 88,000 tonnes with the addition of a new group of fishes: the pelagic myctophids accounting for 15,172 tonnes. The Soviet Union caught 83,000 tonnes and 5,000 tonnes were caught by five other countries (Poland, GDR, France, UK and USA).

Some of the peak landings in the history of commercial fishing in the Southern Ocean (for example in 1977–78), resulted partially from increased fishing effort, and some of them were based on abundant year-class recruitment to the exploited stock, like that of *C. gunnari* in the South Georgia area and in the Kerguelen Islands in 1982–83. However, most of the peak catches were the result of the exploitation of new fishing grounds or new fish stocks (Fig. 4).

Exceptional landings of about 400,000 tonnes of accumulated stock of *N. rossii,* caught in 1969–70 off South Georgia, were followed the next season by over 100,000 tonnes of that fish from the same

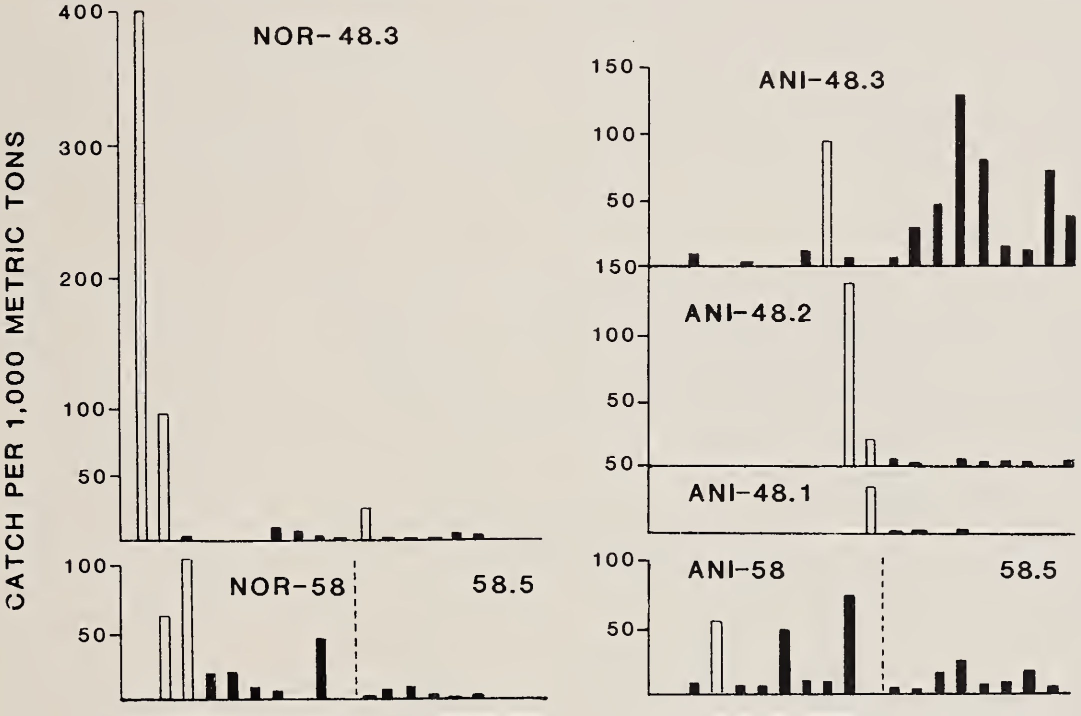


Fig. 4. Total commercial catch of selected fish species in main fishing areas: NOR = *Notothenia rossii* and ANI = *Champsocephalus gunnari* (white columns indicate fishing on accumulated stocks). Fishing areas: 48 = Atlantic Ocean Antarctic Area; 48.1 = Peninsula Sub-area; 48.2 = South Orkneys Sub-area; 48.3 = South Georgia Sub-area; 58 = Indian Ocean Antarctic Area; 58.4 = Enderby-Wilkes Sub-area; and 58.5 = Kerguelen Sub-area

area and about 64,000 tonnes of *N. rossii* from the Kerguelen Islands in the same season. A further 105,000 tonnes of *N. rossii* were caught at the Kerguelen Islands in 1971–72.

As regards *C. gunnari,* the first peak consisted of 54,000 tonnes from the Kerguelen Islands in 1971–72, followed by two other peaks in 1974–75 (48,000 tonnes) and 1977–78 (73,000 tonnes). In the Atlantic sector, there were three subsequent years of fishing on accumulated stocks or on new fishing grounds: 1976–77, 93,000 tonnes off South Georgia and Shag Rocks; 1977–78 and 1978–79, 160,000 tonnes on the South Orkney Islands shelf, and finally about 36,000 tonnes at the South Shetland Islands area. The case of the 1977–78 season near the South Orkney Islands is not yet thoroughly explained: catches comprised mostly 3-year-old recruits (Sosinski 1981) and no landings of *C. gunnari* were reported from the area before.

Further peak catches achieved partially or wholly on accumulated stocks of several other fish species are shown on the map of the Southern Ocean in Fig. 5, together with peak landings of *N. rossii* and *C. gunnari,* extracted from Fig. 4. It is worth pointing out a peak catch of 53,000 tonnes taken from the accumulated stock of *Lepidonotothen squamifrons* in 1971–72 near the Kerguelen Islands, as well as small landings of about 10,000 tonnes of *Chaenodraco wilsoni* in 1978–79, followed then by a catch of 4,300 tonnes in 1979–80. The latter species has never been recorded in the catches of subsequent years. Interesting is a series of increased landings of *Pseudochaenichthys georgianus, Gobionotothen gibberifrons* and *N. rossii* from the South Georgia Shelf, after the peak year of *C. gunnari* landings in 1976–77. Those little peaks of about 13, 12 and 25 thousand tonnes respectively, resulted from increased fishing effort, but presumably came (at least partially) from local accumulated stocks that had not been fished before.

In the early 1980s, the fishing near Shag Rocks (South Georgia) was probably on accumulated stock of *P. guntheri*. Kock *et al.* (1985) assumed that about 50% of fish captured in the Southern Ocean before the 1982–83 season came from accumulated stocks. Peak landings shown in Fig. 5 represent about 1.1 million tonnes of fish removed mostly from accumulated stocks, out of 2.5 million tonnes caught during 18 years of commercial exploitation (until 1986–87 season only).

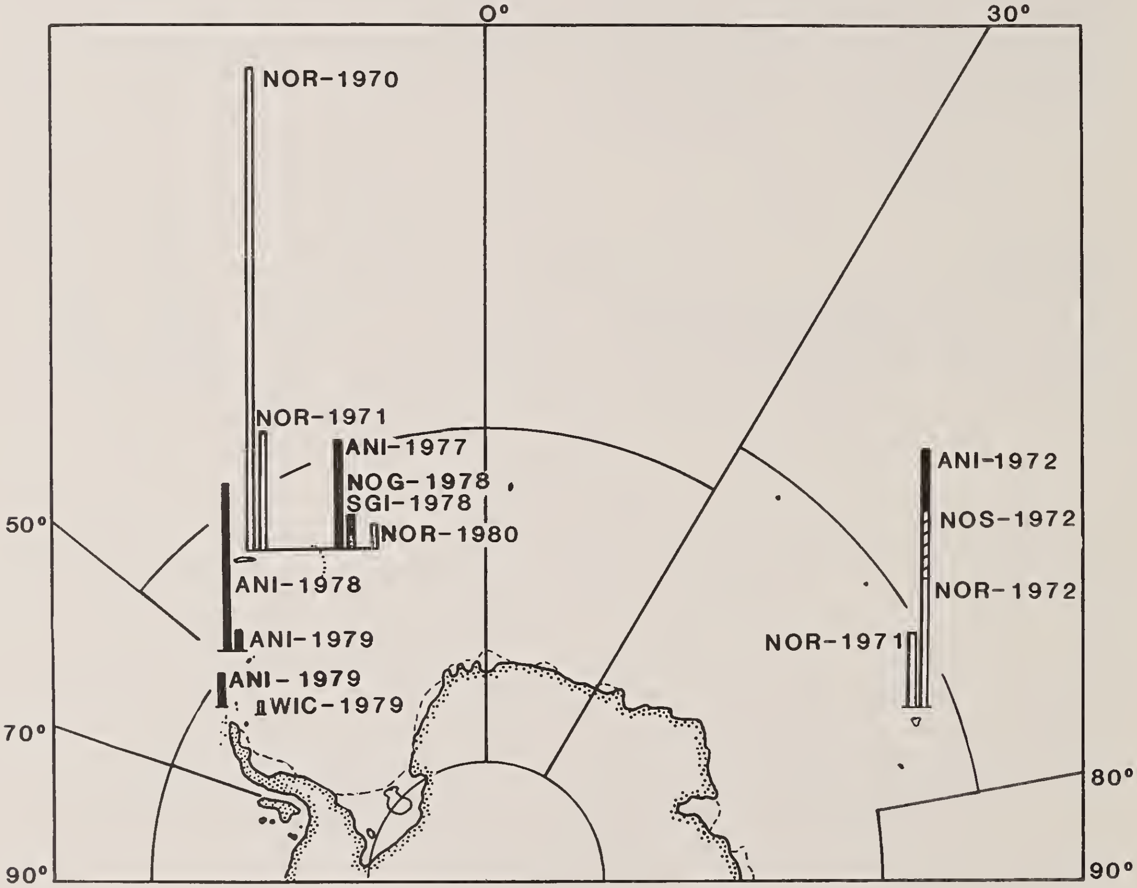


Fig. 5. Peak landings from accumulated fish stocks: NOR = *Notothenia rossii*; NOS = *Lepidonotothen squamifrons*; NOG = *Gobionotothen gibberifrons*; ANI = *Champsocephalus gunnari*; SGI = *Pseudochaenichthys georgianus*; and WIC = *Chaenodraco wilsoni*

Analysing the commercial phase in the Antarctic fishery, it is worth considering some relationships between fish and krill catches. For most of the fishing countries, fishes were a more attractive organism for harvesting. Catching and processing of fish did not create any difficulties; moreover, the market value of fish—until peeled krill meat was produced—exceeded that of krill. However, with substantial decreases in catch rates of fish, fishing companies tried to utilise other harvestable resources in the same or neighbouring area. Antarctic krill, which was usually available in the vicinity of finfish grounds, became in this way a substitute organism for fishing, although satisfactory technology for krill processing had not yet been developed.

After the peak catches of *C. gunnari* on the fishing grounds of South Georgia in 1977 and the peak in its catch at the South Orkney Islands area one year later, the large fishing fleet was faced with a sudden drop in catch rates of that species. Polish fishing companies began to transfer some of their vessels from the Antarctic grounds to the Falkland Islands, while the remaining Polish, GDR and Bulgarian trawlers started a mixed fishery in the whole Scotia Sea area. The Soviet fishing fleet turned its attention to krill, gradually increasing the annual catch from all fishing grounds in the Antarctic to 490,000 tonnes in the 1981–82 season (Fig. 3). Peak Soviet landings of *C. gunnari* (137,000 tonnes) in the Atlantic sector in 1982–83 reduced their krill catches by 300,000 tonnes. Krill catches remained at this low level for the following two years, due to technological difficulties with krill processing in the USSR (Anon. 1985a, b). The 1985–86 season brought an increase in the krill harvest, to compensate for the low fish landings of about 50,000 tonnes, followed once more by a slight decrease, due to increased catches of *C. gunnari* in the season 1986–87. The most recent seasons (1987–88 and 1988–89) in the available fish catch records are similar to the previous year's catch of about 100,000 tonnes (Fig. 3).

Recent ichthyological investigations

In a previous chapter, R. Headland has reviewed the history of Antarctic Ichthyology until the early 1960s. Here, we would like to discuss recent developments in fish research, which are particularly important for implementing a system of conservation of the Antarctic fish populations.

International co-operation in polar and, more specifically, Antarctic research culminated in the International Geophysical Year (IGY) (1957–58). This resulted in the establishment of the Antarctic Treaty, signed in 1959 and entered in force in 1961, and the Scientific Committee on Antarctic Research (SCAR), created in 1958 by the International Council of Scientific Unions (ICSU). The creation of SCAR was recommended to ICSU in 1957 by the Fourth Antarctic Conference of the Comité Spécial pour l'Année Géophysique Internationale (CSAGI). The President of that Committee, G.R. Laclavère, emphasized that the overall aims of the conference were exclusively scientific, and that it was not concerned with political questions. This statement has ever since consistently distinguished international scientific activities in the Antarctic, organized under the auspices of ICSU and SCAR. The continuation of scientific activity in Antarctic research was not to be regarded as an extension of the IGY, as it would also include scientific disciplines that had not been studied in the IGY, in particular all the fields of terrestrial and marine biology.

Post-IGY Period (1960s)

The post-IGY period saw the burgeoning of intensive ichthyological investigations in the Antarctic. In 1960, the first shore-based fish research was carried out by several countries already engaged in Antarctic research: Argentina, Belgium, France, Japan, Norway, UK, USA and the USSR. The main areas of investigation were the Ross Sea, the Adélie and Enderby coasts, the Antarctic Peninsula, and several sub-Antarctic islands, mainly South Georgia and Kerguelen Islands (Olsen 1954, 1955; Barsukov & Permitin 1960; DeWitt & Tyler 1960; Wohlschlag 1960, 1961; Blanc 1961; Miller 1961; DeWitt 1962a, b, 1966; Hureau 1962, 1964, 1966a, 1970; Bellisio 1964; Andriashev 1965; Holloway 1969; Everson 1970a, b).

During this post-IGY period, Antarctic ichthyological research focussed on fish systematics, zoogeography and general biology (life cycles, spawning periods, age and growth, and diets). Some physiological studies were also carried out, especially on the white-blooded fishes (Channichthyidae) and on the freezing resistance of nototheniids (Walvig 1958, 1960; Wohlschlag 1962, 1964a, b; Hureau 1966b; Spillmann & Hureau 1967; Holeton 1970; Ruud 1971; DeVries 1971; Jakubowski 1971).

Pre-BIOMASS Period (1970s)

During the 1970s, ichthyological investigations were carried out largely in conjunction with cruises conducted by several countries. For a little more than 10 years (until December 1972), the USA carried out extensive research with the R/V *Eltanin,* which made large collections of fishes during 55 cruises over most of the Southern Ocean (Capurro 1973). As early as 1964, the Soviet Union made several research cruises with ships of the Academy of Sciences and the All-Union Research Institute of Marine Oceanography and Fisheries (VNIRO). Since 1965, the British research vessel *John Biscoe,* carried out a series of cruise surveys. The UK also developed an Offshore Biological Programme, for which large collections of ichthyoplankton were made in the vicinity of South Georgia and in the Scotia Sea. As mentioned above, some other countries (France, Poland, Federal Republic of Germany, Japan) sent several research and scouting ships both to the Indian Ocean sector and to the Atlantic Ocean sector of the Southern Ocean. Those ships, in addition to a fishery survey programme, have proceeded with important fish research in both of these areas.

The increase in ichthyological research in the pre-BIOMASS period was unknown since the British *Discovery* investigations in the years 1925 to 1951. These cruises and ancillary long-term programmes provided the opportunity to develop previous research. Apart from the fundamental problems of fish systematics and zoogeography—which still remain important—other scientific fields were studied, such as (1) ecology and physiology, (2) fishery biology and conservation of Antarctic fishes as harvestable resources. The first item requires information on the distribution of the species, their abundance and migrations. In terms of production within the ecosystem, information on feeding, metabolism with respect to feeding, and on growth is also required. The second item requires information on changes in abundance, stock separation, growth rate, mortality and reproduction. Most of these topics were studied between 1965 and 1975 (Permitin 1969, 1973, 1977; DeWitt 1971; Tarverdiyeva 1972; Hureau 1973, 1974; Crisp & Carrick 1975; Zacharov & Frolkina 1976; Everson 1977; Meisner & Kratkii 1978; Shust & Pinskaya 1978; Linkowski & Rembiszewski 1978; Hoshiai 1979; Lisovenko & Sil'yanova 1979; Linkowski & Żukowski 1980; Kock 1981).

The BIOMASS Programme

At the beginning of the 1970s, several international bodies expressed their interest in the living resources of the Southern Ocean and especially in krill and fishes: the Antarctic Treaty Consultative Meeting (ATCM), the Intergovernmental Oceanographic Commission (IOC) through its International Co-ordination Group for the Southern Ocean (ICG/SOC), the Food and Agriculture Organisation of the United Nations (FAO), the International Whaling Commission (IWC) and the SCAR which played a key role. In August 1972, a sub-committee on the Marine Living Resources of the Southern Ocean was established within the Biology Working Group of SCAR. That sub-committee met for the first time in May 1974 in Montreal, in conjunction with the SCOR/SCAR Polar Oceans Conference. At this meeting, the sub-committee emphasized the role played by krill in the Antarctic marine ecosystem. "In view of the enormous gaps in the knowledge of the stocks of potentially important and presently under-exploited fisheries resources such as the pelagic and demersal fishes", the sub-committee also recommended that "in-depth studies of the biology, distribution, biomass and population dynamics of these resources be undertaken".

These recommendations were later approved by the ICG/SOC (Buenos Aires) and by the 13th meeting of SCAR (Jackson Hole, USA), in July and September 1974, respectively. The 8th ATCM (Oslo, June 1975) and the Executive Council of IOC (Paris, March 1975) invited SCAR to continue its scientific work on these matters and to organise multiship studies. In recognition of these responsibilities, SCAR upgraded the status of the marine living resources sub-committee to a Group of Specialists, co-sponsored by SCAR and SCOR (Scientific Committee for Oceanographic Research), under the convenership of S.Z. El-Sayed (USA). The new Group of Specialists met in Cambridge (England) in October 1975 and undertook the preparation of practical proposals for long-term co-operative investigations of the Southern Ocean. The Group also made plans for an international conference of experts (Woods Hole, USA), held in August 1976, and was followed by another meeting of the Group (in Woods Hole). The objective of both meetings was to review the present knowledge of the living resources of the Southern Ocean and to develop a proposal for future co-operative studies. The meetings also marked the beginning of the 10-year BIOMASS (Biological Investigations of Marine Antarctic Systems and Stocks) Programme.

The principal objective of the BIOMASS Programme was "to gain a deeper understanding of the structure and dynamic functioning of the Antarctic marine ecosystem as a basis for the future management of potential living resources" (BIOMASS Scientific Series no. 1, 1977). In order to implement the overall programme prepared during the Woods Hole Conference, the SCAR/SCOR Group of Specialists on Living Resources of the Southern Ocean established an organisational structure with three Technical Groups, five Working Parties and three *Ad-hoc* Groups, each being specialised in a certain scientific or technical area. One of the five Working Parties dealt with fish biology and ecology and was chaired by D. Sahrhage (FRG).

The Working Party on Fish Biology (later renamed Working Party on Fish Ecology) was very active for several years, and through its impetus ichthyological investigations in the Southern Ocean developed quickly during the BIOMASS Programme. Three field operations were organised during the life of the BIOMASS Programme: FIBEX (First International BIOMASS Experiment, in 1980–81) has certainly been the most important event in biological oceanography for a long time as 13 ships from 10 countries worked together in February 1981. But the international co-operation among Antarctic ichthyologists was particularly strong in the Second International BIOMASS Experiment (SIBEX I in 1983–1984 and SIBEX II, in 1984–85) which involved 15 ships from 12 countries. A number of fish workshops have been organised since 1979, gathering together the worldwide representation of ichthyologists: workshops on fish ageing in 1979 (Cambridge, UK) and 1982 (Orono, USA); workshop on early life history stages of Antarctic fishes in 1981 (Paris, France); Antarctic fish workshops organised during the European Congresses of Ichthyology in 1985 (Stockholm, Sweden) and 1988 (Budapest, Hungary); and the Post-SIBEX workshops in 1986 and 1987 (Cambridge, UK). The Working Party on Fish Ecology recommended in August 1984 to hold a third workshop on ageing of Antarctic fishes, which was later organised by CCAMLR (see section on conservation below) in Moscow (1986). Such international and fruitful co-operation resulted in a large number of scientific papers published in the publication series of SCAR/BIOMASS, FAO and CCAMLR, as well as in many specialised scientific journals (Hureau 1979; Everson 1980, 1984; North & White 1982; Efremenko 1983; Kellerman & Slosarczyk 1984; Kock *et al.* 1985; Slosarczyk *et al.* 1985; Fischer & Hureau 1985, 1987, 1988; Kock 1986; Gon 1987, 1988; Hecht 1987; and others).

The Working Party on Fish Ecology met four times (Hamburg, FRG, 1979; Dammarie-les-Lys, France, 1980; Hamburg, 1982; Dammarie-les-Lys, 1984). At each meeting, it reviewed the past and present work on Antarctic fish biology and ecology, and identified gaps in knowledge of these fields, in order to propose further developments in Antarctic fish research. The main proposals recommended studies on distribution and abundance, migration, age and growth, reproduction, early life history stages, food and feeding, mortality, metabolism, and stock separation. Antarctic fish species were classified in four categories in order to give some kind of priority based on their ecological and/or commercial significance: (1) abundant and commercially fished, (2) commercially important but not abundant, (3) ecologically important but without any present commercial interest, and (4) other species.

The period following 1976, has seen a great increase in ichthyological investigations and the BIOMASS Programme was an efficient catalyst for many national programmes. BIOMASS initiated the publication of several papers on the life cycle, the age and growth and other basic biological parameters of commercially-fished species in the Southern Ocean (Andriashev 1986; Balushkin 1986; Faleyeva & Shandikov 1986; Prirodina 1986; Voskoboynikova 1986; Duhamel 1987a, b, 1988, 1989; Macdonald *et al.* 1987; Ekau 1988; Gabriel 1988; Hennemuth *et al.* 1988; Mucha & Slosarczyk 1988; North 1988; Schwarzbach 1988; Kellermann 1989, 1990). All these data constitute a fundamental input for understanding the population dynamics of Antarctic fishes and are now being used by the Scientific Committee of CCAMLR (see section on conservation below).

Post-BIOMASS period

In 1984, before the end of the BIOMASS Programme, the SCAR Executive decided to disband the Group of Specialists on Southern Ocean Ecosystems and their Living Resources, for reasons which still remain unclear. The group and its overall structure (Technical Groups, Working Parties and *ad-hoc* Groups) were disbanded. At the same time the BIOMASS Executive was established to manage the BIOMASS Data Centre (set up in Cambridge at the British Antarctic Survey), to support the various workshops which were organised for the validation and evaluation of the FIBEX and SIBEX data, and to prepare the 1991 BIOMASS Colloquium. That meeting will mark the end of the BIOMASS Programme.

A direct consequence of the decision of the 1984 SCAR Executive meeting has been the disbanding of the Working Party on Fish Ecology. During the following years, Antarctic ichthyologists continued to meet informally at various occasions and to work together. Nevertheless, in 1986, strong pressure coming from the marine scientists within SCAR resulted in the establishment of a new Group of Specialists on Southern Ocean Ecology, under the convenership of J.-C. Hureau (France), who was replaced by G. Hubold (FRG) in 1990. The XXth SCAR meeting (Hobart 1988) accepted the establishment of a small sub-group on Fish Biology and Physiology, under the co-chairmanship of J.-C. Hureau and M. White (UK). The sub-group will only deal with fundamental aspects of fish research like physiology, experimental studies, behaviour, etc., excluding fishery-related studies. In June 1990, the Group proposed to SCAR a new co-operative programme, the overall objective of which being to determine the role of the Antarctic sea-ice zone in Antarctic marine systems and in the control of global biogeochemical and energy exchanges.

Conservation of fish stocks

The Antarctic Treaty Consultative Parties met in London in 1977 to discuss for the first time the possibility of the establishment of a convention for the conservation of marine living resources in the Antarctic. They decided to seek agreement for a wide-ranging conservation convention, which would deal not only with the direct effects of harvesting specific organisms, but also with the indirect effects of exploitation on other species. Several diplomatic and scientific meetings were held until the final signature of the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) in Canberra on 20 May 1980 by 15 states (Argentina, Australia, Belgium, Chile, France, GDR, FRG, Japan, New Zealand, Norway, Poland, Republic of South Africa, USSR, UK, and USA.)

The Contracting Parties established the Commission of the CCAMLR with its headquarters in Hobart, Australia, with a key role to acquire and study data to regulate fishing and decide on necessary conservation measures. They also established a Scientific Committee to give expert advice to the

Commission and to provide a forum for consultation and co-operation with respect to Antarctic marine living resources. A close working relationship between the Commission and specialised international agencies such as SCAR and FAO is provided by the Commission.

In 1984, CCAMLR established an *ad-hoc* Working Group on Fish Stock Assessment, and in 1987 raised it to a standing Working Group under the convenership of K.-H. Kock (FRG). The objectives of the working group are exclusively related to fishery problems: developing methodologies for fish stock assessment, reviewing and conducting assessments of the status and potential yield of fish stocks in the Southern Ocean and evaluating the actual and potential impact on fish stocks of past, present and possible future management actions. It is envisaged that in the future the CCAMLR Working Group on Fish Stock Assessment and the SCAR Sub-group on Fish Biology and Physiology will complement each other's work and will co-operate very closely.

In 1978, considering the intensive fishing in the vicinity of the Kerguelen Islands and assuming its responsibility to regulate the fisheries in that area, the French Government decided to create an Exclusive Economic Zone around the French sub-Antarctic islands (Kerguelen Islands and Crozet Islands). Since then, regulations have been imposed on any fishing activity in the Kerguelen Islands area and the Crozet Islands have been closed to commercial fishing. In 1985, Australia established an Exclusive Fishing Zone around Heard Island and closed the area to fishing. All the other fishing grounds of the Southern Ocean, except the Prince Edward Islands (twelve nautical mile territorial zone of South Africa), are in international waters and regulations adopted by the CCAMLR are applied there.

Around the Kerguelen Islands, the main regulations and fishery controls, set up by the French Government, are:

☐ Fishing forbidden within the 12-mile zone around the islands,

☐ Complete or partial closure of the fishing grounds during some periods of the year for protection of the spawning seasons and the spawning grounds of various species,

☐ Total allowed catches (TAC) per species,

☐ Minimum size of 25 cm for *Champsocephalus gunnari*,

☐ Minimum mesh size of 80 and 120 mm (according to CCAMLR conservation measure 2/III (1984)),

☐ Fishing licences provided by the French authorities to a limited number of trawlers,

☐ Requirements of standard logbooks (information on each haul and weekly reporting procedures of fisheries statistics),

☐ French fishery inspectors on board the trawlers,

☐ Controlled transfers of catches from trawlers to cargo vessels,

☐ Presence of the fisheries protection vessel *L'Albatross* and of the research ship *La Curieuse,* permanently based at Kerguelen Islands.

The Kerguelen and Crozet islands (Sub-areas 58.5.1 and 58.6) are included in the CCAMLR area of application. France is bound by any conservation measure adopted by consensus with its participation in the CCAMLR meetings, but may promulgate national measures that would be more strict than the Commission's measures, which is now the case.

With the ratification of the required eight signatory countries, the Convention became effective on 8 March 1982. Since 1982, in addition to the 15 original signatory states, Brazil, the European Economic Community, India, Republic of Korea and Spain also became Members of the Commission. Moreover, seven states acceded to the Convention but are not yet members: Canada, Finland, Greece, Italy, Peru, Sweden and Uruguay. The first two meetings (1982 and 1983) of CCAMLR had to solve many procedural difficulties and did not produce any conservation measures. When the Scientific Committee was able to analyse the catch statistics submitted by member countries, the Commission adopted several conservation measures:

☐ 1984: Fishing prohibited in waters within 12 nautical miles of South Georgia (Sub-area 48.3); mesh size regulations were imposed in all the CCAMLR areas of application (120 mm for *Notothenia rossii* and *Dissostichus eleginoides,* 80 mm for other species) (Anon. 1984),

☐ 1985: Directed fishing on *N. rossii* around South Georgia prohibited (Anon. 1985a, b),

☐ 1986: General regulations on mesh size measurement applicable to all CCAMLR areas; prohibition of directed fishing on *N. rossii* extended to the Peninsula area (Sub-area 48.1), and to the South Orkneys area (Sub-area 48.2); limitations on catch around South Georgia should be adopted in 1987 (Anon. 1986),

☐ 1987: Total catch of *C. gunnari* around South Georgia limited to 35,000 tonnes for the 1987–88 season and a 10-day catch reporting system for that species was established; when the total catch of *C. gunnari* has been reached, the other species (*N. rossii, Gobionotothen gibberifrons, Chaenocephalus aceratus* and *Pseudochaenichthys georgianus)* should not be taken; directed fishing on these five species was prohibited from 1 April until 1 October 1988 (Anon. 1987),

☐ 1988: Directed fishing on all species prohibited, except on *Patagonotothen guntheri,* in the Sub-area 48.3 from 4 November 1988 until 20 November 1989, and the total allowed catch for *P. guntheri* is limited to 13,000 tonnes for the 1988–89 season (12,000 tonnes for the 1989–90 season) with the application of the system of declaration established in 1987, and a provisional system of observation and inspection was established (Anon. 1988a, b).

☐ 1989: Total catch of *C. gunnari* around South Georgia limited to 8,000 tonnes for the 1989–90 season. Limitation to 300 tonnes for the other species in the same area. Directed fishing on *G. gibberifrons, C. aceratus, P. georgianus* and *Lepidonotothen squamifrons* around South Georgia prohibited. Closed seasons around South Georgia from 20 November 1989 until 15 January 1990 and from 1st April until 4 November 1990. Establishment of a 5-day catch reporting system for all species around South Georgia (Anon. 1989).

The CCAMLR philosophy and operating procedure

CCAMLR adopted a unique ecosystem approach in conservation. It provides that the marine living resources found south of the Antarctic Convergence are to be treated as a single system. In this respect, it is essential to detect and record significant changes in critical components of the ecosystem, to serve as the basis for the conservation of Antarctic marine living resources. A monitoring programme has been designed by the Scientific Committee of CCAMLR to distinguish between changes due to the harvesting of commercial species and changes due to environmental variability, both physical and biological. The conservation measures adopted by the Commission may include the designation of quantities of any species that may be harvested, regions or sub-regions in which it may be harvested, the designation of open and closed seasons, regulation of methods of harvesting, and if necessary, the designation of protected species.

In order to implement all the already adopted measures and those to be elaborated in the future, and with respect to Article XXIV of the Convention, the Commission set up a preliminary system of observation and inspection, which should be completed in the future, in order to collect scientific data on board the trawlers and scouting vessels for the work of the Scientific Committee.

Final remarks

Commercial fishing in the Southern Ocean was usually underway before studies of the exploited fishes were done to assess the impact of fishing on these populations; this frequently resulted in over-exploitation of some fish stocks. The history of the Antarctic finfish fishery in its commercial phase followed in the footsteps of many other regional fisheries, showing how rapidly a newly-developed fishery can reach the level of over-exploitation. Any rise in catches was then achieved by discovery of new fishing grounds or fish stocks, or fishing on recruits coming into the exploited stock from abundant year classes. The only exception to this rule is the fishery for the Antarctic icefish *C. gunnari,* which reaches sexual maturity approximately two years earlier than other fish species harvested in the Southern Ocean (Kock *et al.* 1985; Duhamel 1987b). This species has periodically produced good year classes recruited to the exploited stock, and has so far withstood intensive fisheries exploitation. However, the structure of its stocks, consisting now mainly of 3-year old recruits, is far from ideal.

A simulation of recovery rates of some fish stocks in the Antarctic, presented during the 1987 SC-CAMLR meeting (Hennemuth *et al.* 1988), may serve as an example of that process. In the case of *N. rossii* in the South Georgia and Kerguelen islands areas, an early recovery of the stocks in the future is only possible with relatively low levels of fishing mortality. For *C. gunnari,* the future stock size and yield will depend mostly on the current recruitment; however, lower fishing mortality will help to rebuild former stock biomass and structure.

The future of the finfish fishery in the Southern Ocean depends at present on recovery of those already over-exploited fish stocks and the only way to restore them is through further restrictions on catches and rigorous fishery management. Conservation measures, already adopted, include: designation of protected species, mesh size regulations, designation of closed areas and seasons, prohibition of directed fishing on some species and total allowable catches for harvested species. During the 1988 meeting of CCAMLR, a system of inspection and observation was finally elaborated to ensure the enforcement of those conservation measures.

The ichthyological investigations of the past ten years have been greatly facilitated by international or multi-national co-operation through the SCAR/BIOMASS Programme and the programmes initiated by the Scientific Committee of CCAMLR and by SCAR. More recently (since 1988) a wide European co-operation has led to a multinational experiment, the EPOS Programme (European Polarstern Study) in which the ichthyological investigations are particularly active (Hureau *et al.* 1990). Several fields of research are now developing in the Antarctic: e.g., population dynamics of exploited stocks including continuous stock assessment, exploration of unknown or little known regions, fish physiology, study of the role of environmental factors on fish metabolism and behaviour, and investigation of the role of finfish in the Antarctic foodweb.

Fishery management is a function of the results obtained by scientists when they are studying fish and fish stocks. The Scientific Committee of CCAMLR and its subsidiary groups and the Scientific Committee on Antarctic Research and its groups of specialists are responsible for such studies and scientific investigations.

Otoliths: An Introduction to Their Morphology and Use in the Identification of Southern Ocean Fishes

T. Hecht

Introduction

Aristotle in the third century BC first observed and noted the uniqueness of fish otoliths (Stinton 1975). The taxonomic value of otoliths, in the modern sense, was recognised by Cuvier (1828) and their value to palaeo-ichthyology was first acknowledged by Koken (1884). Koken, a palaeontologist, published several classic papers on the value of fossil otoliths for faunal reconstructions. It is not surprising therefore, that palaeontologists were the first proponents of the study of these structures. The value of otoliths to extant ichthyology has only been realized since the early 1940s (Weiler 1942). Since then, however, the use of otoliths as a taxonomic character has proliferated greatly, evidenced by the number of publications on otoliths of extant species (Weiler 1968a; Huygebaert & Nolf 1979; Gaemers 1980, 1982). The latter four papers provide a nearly complete bibliography of otolith literature (fossil and extant) for the period before 1968 up to and including 1982.

Studies on the otoliths of Southern Ocean fishes, apart from isolated descriptions (Hureau 1962; Yukhov 1971c; North *et al.* 1984), have until recently been non-existent (Hecht 1987). Considering the overall objectives of this volume on the fishes of the Southern Ocean it was decided to incorporate brief descriptions of the available otolith material. The representative otoliths illustrated in this volume have been carefully chosen to depict as far as possible, a "generalized" otolith for each species. The descriptions presented here include only the most important diagnostic features, with comments on intraspecific variation and, where possible, some notes on their ontogeny. Reference samples of otoliths of each species are housed in the otolith collection of the J. L. B. Smith Institute of Ichthyology, Grahamstown, South Africa. Detailed descriptions of most of the otoliths illustrated in this volume are provided in Hecht's (1987) *Guide to the Otoliths of Southern Ocean Fishes.*

Composition, structure and function of otoliths

Otoliths are calcareous extra-skeletal structures, associated with the acoustico-lateralis system. Three otoliths are found in the membranous labyrinth of the *capsula auditiva,* on either side of the neurocranium. They are known as the saccular (sagitta), the utricular (lapillus) and the lagenar (astericus) otoliths. Except in ostariophysean fishes the saccular otolith is the largest of the three. Otoliths are secreted by the walls of the labyrinth and increase in size by the regular (often seasonal) deposition of calcium carbonate and organic proteinaceous material (Norman & Greenwood 1975). In fact, the otoliths of all actinopterygean fishes are composed primarily of calcium carbonate, in the aragonite form, and a proteinaceous material (otoline) (Degens *et al.* 1969). The aragonite crystals are orientated with their long axes radiating outwards from the nucleus (Irie 1955; Morales-Nin 1986). Occasionally one finds otoliths that are completely transparent or have irregular extraneous growths on their surfaces. These, according to Nolf (1985), are pathological conditions. The growths are composed of calcium carbonate in the vaterite form.

It would appear that the three pairs of otoliths in either side of the neurocranium have different but interrelated functions. However, precise knowledge of their physiology and the way they operate is lacking. According to Cordier & Dalq (1954) and Lowenstein (1957), the labyrinth, together with the associated otoliths, have the following functions: sound reception, maintenance of equilibrium, maintenance and regulation of muscle tone and the reception of angular accelerations; and because of their piezo-electric properties (Morris & Kittelman 1967) they may theoretically have some function in frequency analysis and depth perception.

Of the three otoliths, the sagitta is the most uniform in shape and size and shows much species specificity. The medial face of the otolith is usually well sculptured, whereas the lateral side is devoid of any diagnostic features. The terminology that has been established for the description of otoliths is therefore based solely on the sculpture of the medial face of the sagitta.

The value of otoliths in the systematics of fossil and recent fishes

Nolf (1985) in his excellent monograph *Otolithi Piscium* pointed out that Koken (1884) was the first to insist upon the fact that nearly every osteichthyean species is characterized by features of its saccular otoliths. Considering the chemical composition and the crystalline structure of otoliths (Irie 1955; Degens *et al.* 1969; Morales-Nin 1986), they are to a large extent resistant to erosion and digestion. It is not surprising therefore that otoliths are common fossils in different geographic areas and in successive strata from the late Cenozoic to the present. Since Koken's (1884) paper they have thus been widely used for biostratigraphic studies and for faunal reconstructions. Otoliths are conservative structures which show distinct plesiomorphic and apomorphic characters (Fitch & Craig 1964; Weiler 1968b; Greenwood 1970; Karrer 1971; Fitch & Barker 1972; Schwarzhans 1972, 1978, 1981; Gaemers 1976; Nolf 1978, 1979, 1985; Nolf & Tavern 1978; Hecht 1982; Heemstra & Hecht 1986). Evolutionary trends, below the species level, on the species level and at the fauna and biota level can thus sometimes be demonstrated or at least hypothesized (Schwarzhans 1978; Gaemers 1976; Nolf 1985). Obviously factors such as attrition, erosion and intraspecific variability (briefly discussed below) have to be acknowledged and great care should be taken when otoliths are used for evolutionary or phylogenetic purposes. Otoliths have also been used to distinguish between closely related species (Schmidt 1969; Botha 1971; Casteel 1974; Post & Hecht 1977; Post & Quero 1981), and to separate stocks of commercially important species (Parrish & Sharman 1958; Kotthaus 1961; Messieh 1972; Price 1978; Payne 1985).

The value of otoliths for age and growth studies is well documented in the general fisheries biology literature. One opaque and one hyaline ring is usually deposited on the otolith each year, thus forming an annulus. Since the early 1970s micro-ridges or daily rings have also been used for ageing studies of fishes (Pannela 1971; Radtke & Targett 1984; Radtke *et al.* 1989).

Oxygen and carbon stable isotope values of otoliths approximate those of seawater and hence can also be used for palaeotemperature and palaeoecological studies (Devereux 1967; Degens *et al.* 1969; Nolf 1985) as well as for the study of migrations.

Apart from their use in systematic ichthyology and in palaeoichthyology, otoliths have also been used to interpret the feeding biology of various marine predators including cetaceans, seabirds and fish. As mentioned previously, the chemical composition and crystalline structure of otoliths make them remarkably more resistant to attrition by digestive fluids than fish bone; hence they are often the only identifiable remains of fishes found in the stomachs or faeces of their predators (Esiuzo 1963; Martini 1964; Fitch & Brownell 1968, Pinkas *et al.* 1971; Perrin *et al.* 1973; Talent 1976; Cooper *et al.* 1984; La Cock *et al.* 1984; Smale & Bruton 1985; Hecht 1987).

During the 1970s research on the feeding biology of various predators in the Southern Ocean had advanced to a stage where it became more important to look at the entire food web of the region, in order to gain a better understanding of the underlying ecological processes. In September 1981 the BIOMASS Working Party on Bird Ecology passed a recommendation to the Group of Specialists on Southern Ocean Ecosystems and their Living Resources that "the BIOMASS Working Party on Fish Ecology be asked to arrange for the production of a handbook for the identification of remains of Antarctic and sub-Antarctic fish". It was stressed that such a handbook should include a guide to the identification of otoliths. The rationale behind this request was "to improve the understanding of the role of Antarctic and sub-Antarctic seabirds, marine mammals and fish as predators on fish in these regions" (Anon. 1981). At the September 1982 meeting of the BIOMASS Working Party on Fish Ecology in Hamburg, during the IV Congress of European Ichthyologists, it was decided to initiate this project. The results of the investigation have since been published (Hecht 1987) and include a dichotomous key for the identification of the otoliths of Southern Ocean fishes.

An understanding of the predator/prey interrelationships could provide valuable information not only for the understanding of the Antarctic marine ecosystem as a whole, but could also be of great value for the management of this system. Recent investigations have indicated that the foodweb of the Southern Ocean appears to be more complex than originally surmised (S.Z. El Sayed, pers. comm.). The size of otoliths is usually proportional to the size of the fish from which they have been removed. Therefore, the size of a prey species can be calculated from the size of their otoliths. This has obvious advantages for detailed feeding studies, particularly as regards more detailed investigations on energy transfer between trophic levels.

The stomach contents of predators should preferably be examined in a fresh state. Fixation of the material in formalin, particularly unbuffered formalin, results in further corrosion of the otoliths (McMahon & Tash 1979) which effectively negates any possibility of their being identified. Because otoliths have been subjected to a greater or lesser degree of attrition by digestive fluids, it is recommended that, prior to any attempt at identification, they be coated with a layer of ammonium chloride (Hecht 1977) to highlight the relief on the medial side.

The identification of the prey of piscivorous predators should, however, be viewed only as a first step in the quantitative assessment of the role played by predators in the ecosystem. Hecht (1987) pointed out that a second and ultimately more important step would be to quantify the transfer of energy between trophic levels. For this purpose the calorific content of prey species is of paramount importance (Hecht & Cooper 1986), and greater emphasis will have to be given to such investigations in future.

Otolith morphology and terminology

There is already a fairly standardized terminology to describe saccular otoliths (Schwarzhans 1978; Hecht 1978, 1987; Gaemers 1984; Nolf 1985). No new terms have been introduced into this text, although some are used in a slightly different connotation than originally conceived. For this reason all the terms are defined below and are illustrated in Fig. 1. Three features were not included in this figure. These are the pseudo-rostrum, the pseudo-antirostrum and the pseudo-excisura ostii. These structures, if present, are essentially the same as the rostrum, antirostrum and excisura ostii except that they are found on the posterior end of the otolith.

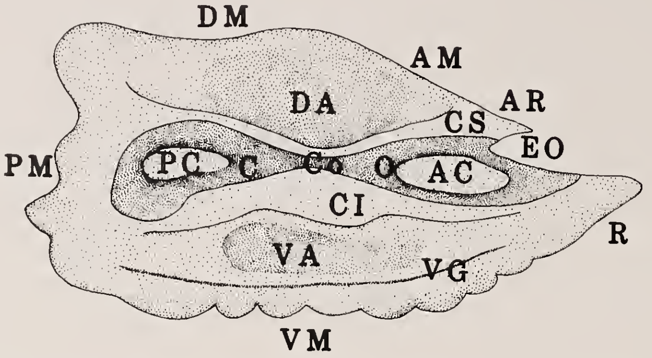


Fig. 1. Schematic diagram of the medial side of a left sagittal otolith showing the main diagnostic features: The sulcus acusticus, comprising the ostium (O) and the cauda (C), the anterior colliculum (AC), the posterior colliculum (PC), the collum (Co), the crista superior (CS), the crista inferior (CI), the rostrum (R), the antirostrum (AR), the excisura ostii (EO), the dorsal area (DA), the ventral area (VA), the ventral groove (VG), the dorsal margin (DM), the posterior margin (PM), the ventral margin (VM) and the anterior margin (AM).

Sulcus acusticus—a distinct, generally horizontal, groove or depression on the medial face.
Ostium—the anterior portion of the sulcus acusticus.
Cauda—the posterior half of the sulcus acusticus, separated from the ostium by the collum.
Anterior colliculum—a raised area within the ostium.
Posterior colliculum—a raised area within the cauda.
Collum—a constriction between the ostium and the cauda.
Crista superior—the ridge-like dorsal border of the sulcus acusticus.
Crista inferior—the ridge-like ventral border of the sulcus acusticus.
Rostrum—the anterior projection of the otolith on the ventral side.
Antirostrum—the anterior projection of the otolith on the dorsal side. The antirostrum is usually smaller than the rostrum.
Excisura ostii—the notch in the anterior margin between the rostrum and the antirostrum.
Dorsal area—a depression in the dorsal field of the medial face above the crista superior.
Ventral area—a depression in the ventral field of the medial face below the crista inferior.
Ventral groove—a distinct groove in the ventral field of the medial face.
Dorsal margin—between the proximal end of the antirostrum and the posterodorsal corner.
Ventral margin—between the posteroventral corner and the proximal end of the rostrum.
Posterior margin—between the posterodorsal corner and the posteroventral corner of the otolith.
Anterior margin—comprising the margin of the rostrum, the antirostrum and the excisura ostii.

Fig. 2 illustrates the various types of otolith shape. Fig. 3 illustrates the various types of sulcus acusticus openings. Fig. 4 illustrates the various sulcus acusticus and colliculi types. Fig. 5 illustrates the different types of marginal sculpture. It is not uncommon that parts of the margin are sculptured in different ways, which necessitates the division of the margin into several distinctly circumscribed regions.

As mentioned previously, the medial or inner surface of the sagitta is well sculptured in relation to the lateral side. The latter is generally devoid of any relief and hence is of little diagnostic value. In general, the variation in the definition of the sculptures on the medial side are of particular diagnostic value at the genus and species level, while the geometric shape of the otolith is of greater importance at the family and order level.

Two additional aspects of otoliths need to be discussed here. These are intraspecific variation and ontogeny. While intraspecific variation is very marked in some species, and must for obvious reasons be taken into consideration, it is generally moderate to insignificant in most species. In fact, Nolf (1985) states that "fortunately for palaeontology such moderate variability is the rule in otoliths of many species". Had it been the exception rather than the rule their value for palaeoichthyology and extant ichthyology would have been much reduced, if not entirely worthless. The fact that intraspecific variation is the exception rather than the rule also holds true for Southern Ocean fishes. Of those otoliths of Southern Ocean fishes described by Hecht (1987) which include comments on intraspecific variation, 80% of the otoliths showed negligible, 17% marginal and only 3% showed a relatively high level of intraspecific variation. Consequently it was possible to construct a key for their identification. Nolf (1985) further discusses in detail the question as to which differences are attributed to variability and which truly delimit a species.

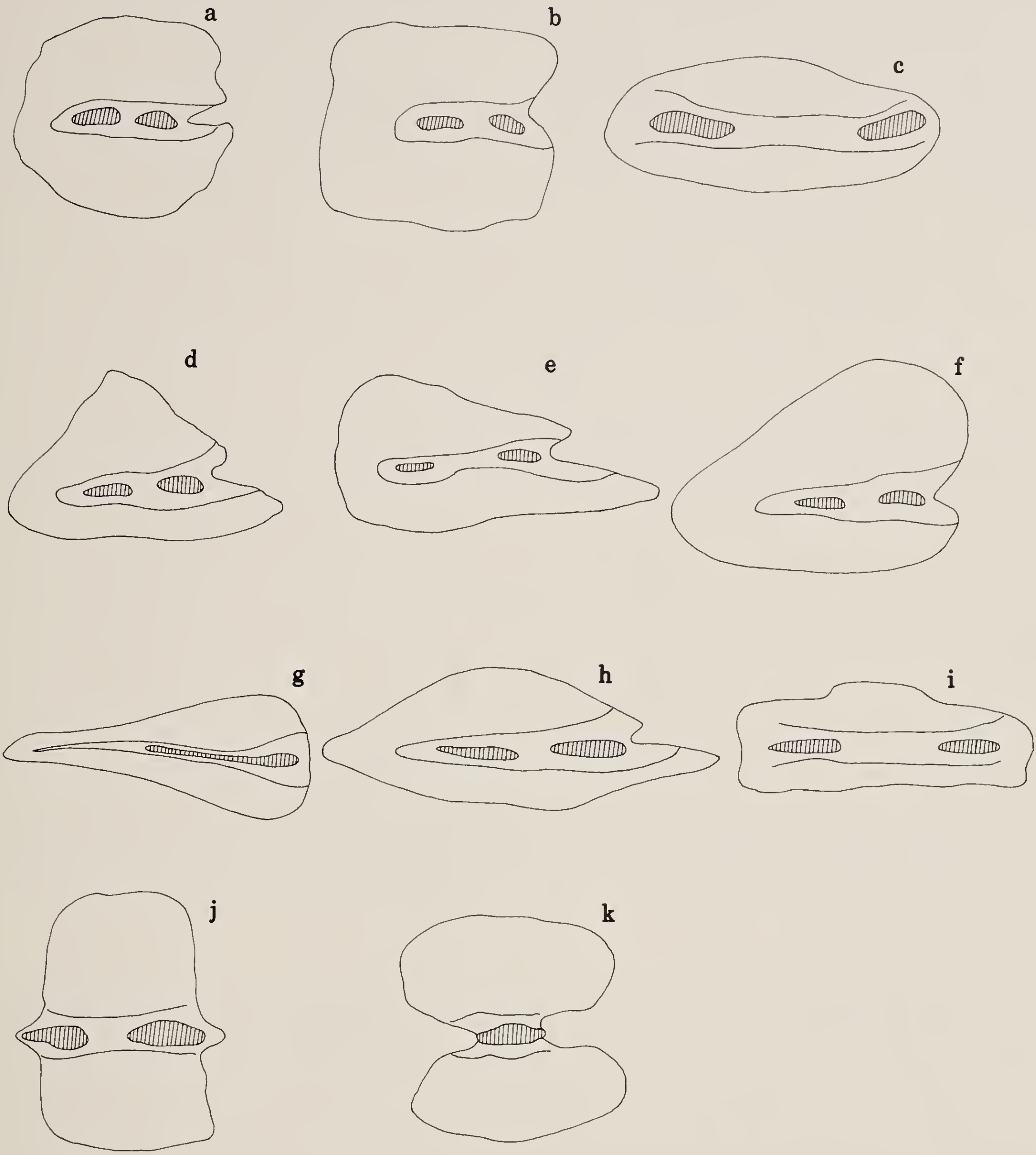


Fig. 2. Schematic diagrams of the various types of otolith shape. a—discoid, b—square, c—oval, d—triangular, e—ovate, f—obovate, g—pyriform, h—fusiform, i—rectangular, j—greater in height than in length, k—hour-glass shape. The sulcus acusticus is outlined and the colliculi are hatched for orientation purposes

Ontogenetic changes within the otoliths of most species follow a constant pattern. The otoliths of all larval fishes are virtually identical. With an increase in size the otoliths can be identified as belonging to a particular order of fishes, followed by their being recognisable as belonging to a particular family within an order and so on, until they take on the characteristic features of a particular species. It is essential that these changes are taken into consideration when using otoliths for taxonomic purposes and also in their use in feeding studies. A good example of the similarity of early juvenile otoliths and their ultimate differentiation at the species level is found in the families Nototheniidae (see Hecht 1987) and Myctophidae (Nolf 1985).

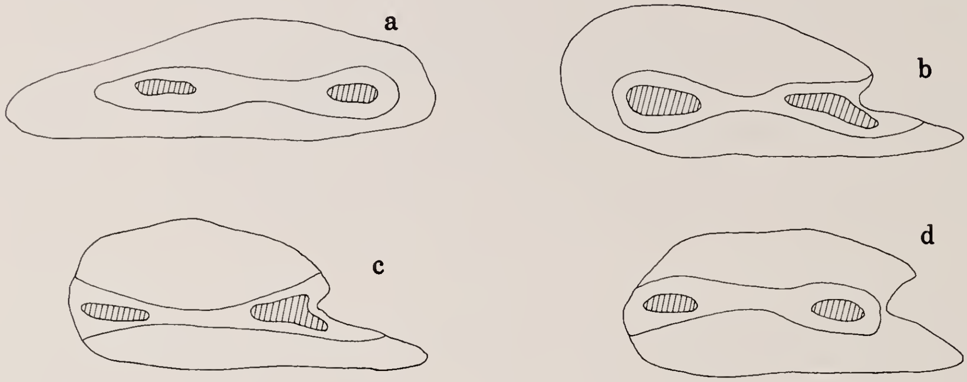


Fig. 3. Schematic diagrams of the different types of sulcus acusticus openings. a—medial (sulcus acusticus does not open onto anterior and posterior margin), b—ostial (sulcus acusticus opens only onto anterior margin), c—ostio-caudal (sulcus acusticus opens onto anterior and posterior margins), d—caudal (sulcus acusticus opens only onto posterior margin). The sulcus acusticus is outlined and the colliculi are hatched for orientation purposes

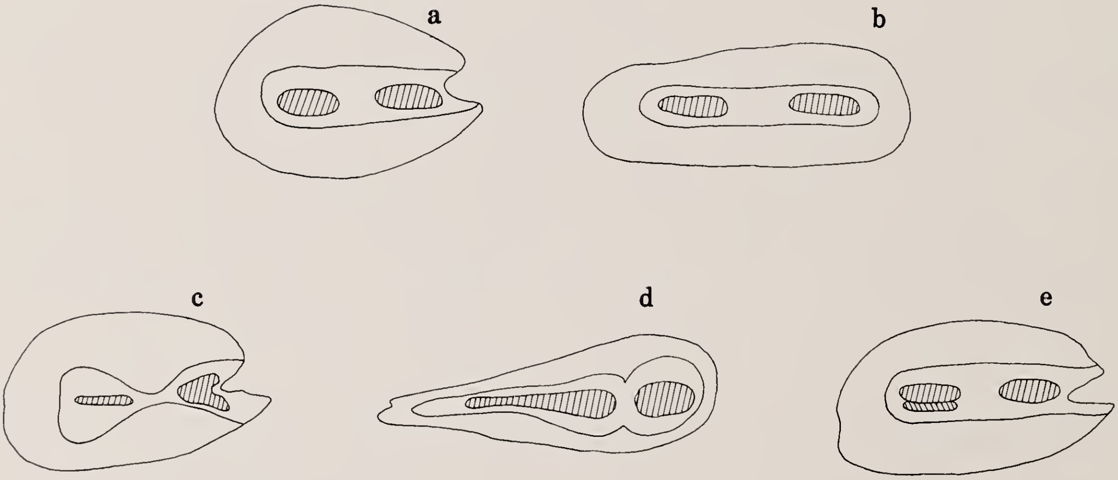


Fig. 4. Schematic diagrams of the different sulcus acusticus and colliculi (hatched) types. a & b—homosulcoid sulcus acusticus (not differentiated into ostium and cauda) and homomorph colliculi (equal in size and shape), c & d—heterosulcoid sulcus acusticus (distinctly recognizable ostium and cauda) and heteromorph colliculi (different in size and shape), e—homosulcoid sulcus acusticus, homomorph colliculi with pseudo-colliculum

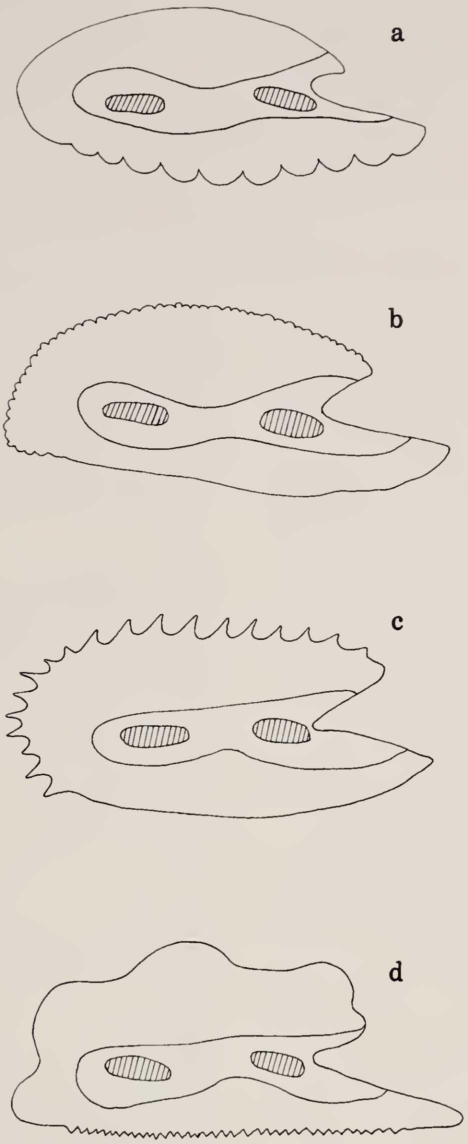


Fig. 5. Schematic diagrams of otoliths showing the different types of marginal sculpture. a—dorsal and posterior margins entire and ventral margin sinuate, b—dorsal and posterior margins crenate and ventral margin entire, c—dorsal and posterior margins dentate and ventral margin entire, d—dorsal and posterior margins lobed and ventral margin serrate. The sulcus acusticus and the colliculi (hatched) are included for orientation

Sexual dimorphism in otoliths has not yet been observed, although it may occur in the reduced males of certain angler fishes. Otolith dissymmetry occurs in most pleuronectiform fishes to some extent or other (Schwarzhans 1980; Nolf 1985).

The otolith descriptions in this book are based on the full descriptions given in Hecht (1987). The otoliths illustrated in the species accounts below represent the most common forms the reader is likely to encounter.

INTRODUCTION TO THE SYSTEMATIC SECTION

by THE EDITORS

Scope

This section of the book deals with the taxonomy of all the fish species reported from the Southern Ocean as well as a small number of species that are regarded as incidental visitors and/or known to occur on the border of this ocean area.

For the purpose of this book, the Southern Ocean is defined as the ocean area south of the mean position of the Antarctic Polar Front with an extension to include the sub-Antarctic islands of the Indian Ocean sector. This is in agreement with the definition proposed in CCAMLR Article 1: the Antarctic Convergence shall be deemed to be a line joining the following points along parallels of latitude and meridians of longitudes: 50°S, 0°; 50°S, 30°E; 45°S, 30°E; 45°S, 80°E; 55°S, 80°E; 55°S, 150°E; 60°S, 150°E; 60°S, 50°W; 50°S, 50°W; 50°S, 0°. This boundary is depicted in the distribution maps included in this section, as well as in many maps of the previous section, by the thick black line surrounding the Antarctic continent.

The inclusion of the sub-Antarctic islands of the Indian Ocean sector is justified by (1) their proximity to the APF, which reaches its northernmost extension in this area; (2) the great ocean expanse separating them from the shelves of the continents; and (3) their relatively young geological age. As a result of these factors, the fish fauna of these islands is composed mainly of species that either occur south of the APF or originated from taxa endemic to the latter area. This has recently been demonstrated by Hureau (1979), Duhamel (1987b), Duhamel *et al.* (1983), and Gon & Klages (1988).

Organization

The systematic section of this book begins with a key to the families of fishes present in the Southern Ocean. The key is followed by family accounts arranged in a phylogenetic order. Within the family, the genera and species are presented in alphabetical order.

Each family account is regarded as a separate chapter and its illustrations are numbered independently. All the illustrations except the distribution maps are numbered and accompanied by a figure caption.

The various abbreviations and special terms used throughout the book are explained in the appendices *Abbreviations* and *Glossary*, respectively.

Classification

We generally follow the classification proposed by Nelson (1984) with adjustments resulting from more recent studies. These modifications include combining the families Astronesthidae, Chauliodontidae, Stomiidae, Melanostomiidae, and Idiacanthidae into 1 family, Stomiidae (Fink 1985); dividing the Harpagiferidae of Norman (1938) into 2 families (Fischer & Hureau 1985): Artedidraconidae (containing the genera *Artedidraco, Dolloidraco, Histiodraco,* and *Pogonophryne)* and Harpagiferidae (with the single genus, *Harpagifer*); and grouping the previously bothid genera *Achiropsetta, Mancopsetta,* and *Pseudomancopsetta,* which lack pectoral fins, in the family Achiropsettidae (Evseenko 1984).

Keys

The keys are the standard dichotomous biological keys that lead to the identification of a taxon by way of a series of alternate choices of characters.

The keys were compiled for the taxa of the Southern Ocean as defined above, and may not work elsewhere. The key to families is accompanied by line drawings depicting the general form of each family to facilitate quick identification. However, users are advised not to rely on the drawing alone as exceptions almost always exist; compare your specimens with the family diagnosis.

Special characters used in the keys are immediately followed by an explanation or include a reference to an illustration, or are explained in a *Methods* section following the diagnoses of the relevant families or genera.

Family accounts

These provide the framework within which species accounts are organised and presented. Each family account includes diagnoses of the family and its genera in the Southern Ocean, keys for genera and species, and species accounts.

The diagnosis of some families and genera is followed by a *Remarks* section in which various problems such as taxonomy and nomenclature are discussed.

Species accounts

These comprise the main part of the systematic section. The species account is headed by the valid species name, the author and the date, and a vernacular name (see below). A list of primary synonyms follows. Subsequent uses such as misidentifications are included when deemed important to minimise confusion. In such cases, the species name is separated by a colon from the subsequent user's name.

The *Diagnosis* is a short description of the species using a set of diagnostic morphometric and/or anatomical characters. The standard method is that of Hubbs & Lagler (1958). Special characters are defined in conjunction with the use of the character or, if pertaining to other species in the same genus or family, in a special *Methods* section following the genus or family diagnosis. The *Diagnosis* ends with a colour description of the species in life and/or in preservative.

If available, a representative otolith of the species is illustrated and its diagnostic morphological features, intraspecific variation, and ontogenetic variation are described.

The distribution of the species is described. A distribution map shows the localities at which the species was collected in the Southern Ocean (see also *Maps*).

The species account ends in a general *Remarks* section in which the author(s) comment on the taxonomy of the species, provide a summary of available information on the biology, and list the maximum size known for the species. When applicable, the maximum sizes of males and females are given separately.

Common names

The subject of "common" (vernacular) names for fishes is inevitably a contentious one. In this book, we have generally used the names given in the *FAO Species Identification Sheets for Fishery Purposes* (Fischer & Hureau 1985). For some fishes however, (especially the nototheniids) the FAO names seemed particularly unsuited to the species in question or likely to lead to confusion with other (unrelated) species with similar names. In these cases, we have adopted new common names, in place of the FAO names.

We have not used common names for most deep-sea fishes, nor for most fishes that are of no interest to commercial fisheries.

Maps

General reference map: A map showing the islands of the Southern Ocean and localities on Antarctica is printed on the endpapers. Locality names mentioned in this book are those given on (1) the fifth edition of map no. 5–18 (polar stereographic projection—scale 1:6,000,000 at 75°S) of the *General Bathymetric Chart of the Oceans,* of the International Hydrographic Organization, published by the Canadian Hydrographic Service, Ottawa (August 1980); and (2) the map of Antarctica published by the National Geographic Society, Washington D.C. (April 1987).

Distribution maps: Two types of symbols are employed. A black dot indicates a single record in a given locality. A shaded zone indicates an area in which more than two separate captures of a given species are known. Distributional records indicated only by general names (e.g. East Antarctica; Wilkes Land; Weddell Sea) are not included. The coverage of species distribution within CCAMLR area is as complete as we could possibly make it. The distribution of species north of CCAMLR area may not be complete.

Illustrations

Most drawings were prepared from specimens and with instructions of the author(s) of a given family. In some cases, however, specimens were not available and the fish were redrawn from photographs or published illustrations. For some widely distributed species, if specimens suitable for illustration were not available from the Southern Ocean, fish from localities outside the Southern Ocean were used. Otolith scale bars = 1 mm.

The colour paintings for the plates at the end of the book were prepared using colour slides, with reference to specimens, and with the author's or editors' supervision.

KEY TO FAMILIES

1a Jaws and paired fins absent; gill chambers opening to surface through pores; a single, median nostril; body eel-like and naked 2

1b Jaws and (usually) 1 set of paired fins present; gill chambers opening to surface through slits or bony opercles; 1 or 2 pairs of nostrils; body elongate, compressed or depressed; scales or dermal denticles present or absent 3

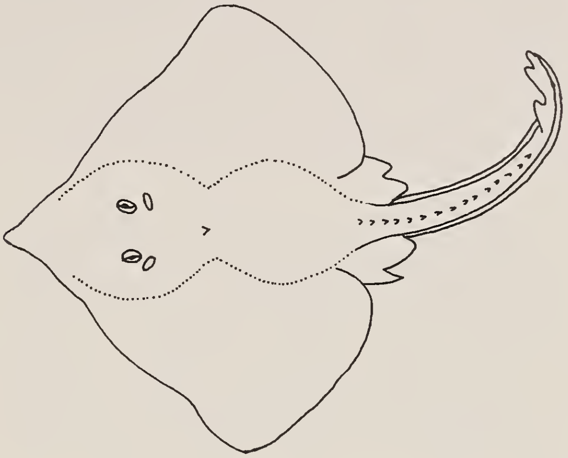
2a A single continuous median fin originating dorsally on rear quarter of body and extending forward ventrally about 2/3 of body length; head with barbels around nostril and mouth; a ventrolateral series of mucus pores .... MYXINIDAE

2b Two distinct dorsal fins and a separate caudal fin; no fin on ventral midline; no barbels on head; no lateral series of mucus pores .... PETROMYZONTIDAE

3a Five pairs of gill slits; skeleton cartilaginous, sometimes calcified but never ossified; skin with dermal denticles or prickles but not bony scales 4

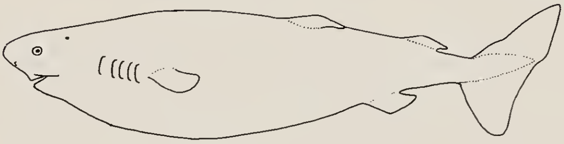
3b A single gill opening covered by a bony opercle; skeleton ossified; scales present or absent 6

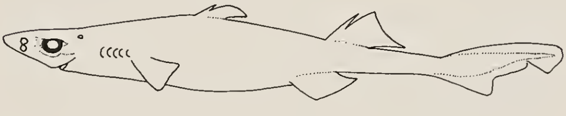
4a Body flat and disc-like, with a long and slender tail; gill slits on ventral surface of body; both dorsal fins near posterior end of tail .... RAJIDAE



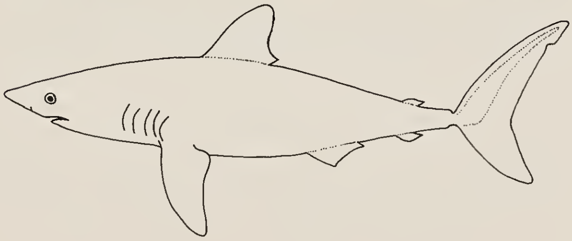
4b Body long, subcylindrical to somewhat compressed; gill slits lateral, in front of pectoral fins; first dorsal fin above or behind pectoral fins 5

5a Anal fin absent; large spiracle behind eye; dorsal fins equal or first dorsal fin somewhat smaller; spines in front of dorsal fins present or absent .... SQUALIDAE

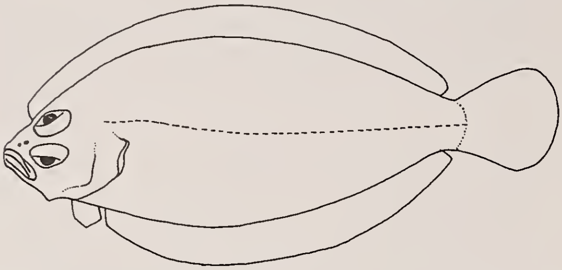




5b Anal fin present; spiracle greatly reduced or absent; first dorsal fin much larger than second fin; no spines in front of dorsal fins.................................. LAMNIDAE



6a Head and body greatly compressed and not bilaterally symmetrical; both eyes on left side; no pectoral fins; dorsal and anal fins long but not confluent with caudal fin; blind side not pigmented..........................ACHIROPSETTIDAE

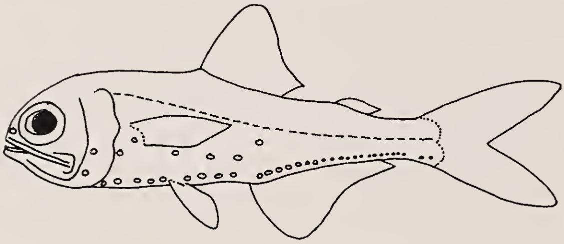


6b Head and body bilaterally symmetrical (both sides equally pigmented; eyes normal) pectoral fins usually present.....7

7a Photophores present and organized in distinct groups (serial photophores or compound organs).....................8

7b Photophores absent; if present, they are not organized in distinct groups.....................................11

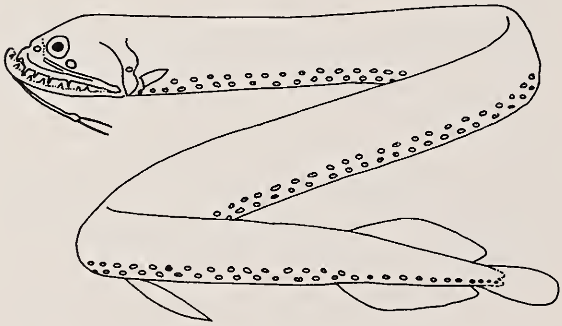
8a Rudimentary spine at dorsal and anal fin origin, upper pectoral- fin base and at base of outermost pelvic ray; adipose fin present; luminous organs, other than photophores, present on caudal peduncle; scales present; barbel absent; eye diameter larger than snout length..........MYCTOPHIDAE

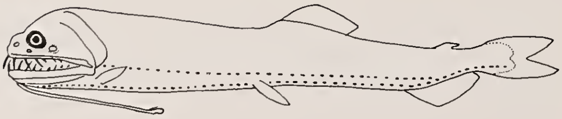


8b No rudimentary spines as above, but dorsal bony blade may be present in front of dorsal fin; adipose fin present or absent; no luminous organs other than photophores on caudal peduncle; scales present or absent; barbel present or absent; eye diameter equal to or smaller than snout length 9

9a Scales present (but deciduous) or absent; barbel absent; large canines absent, dorsal and anal fins more or less opposite each other.................................10

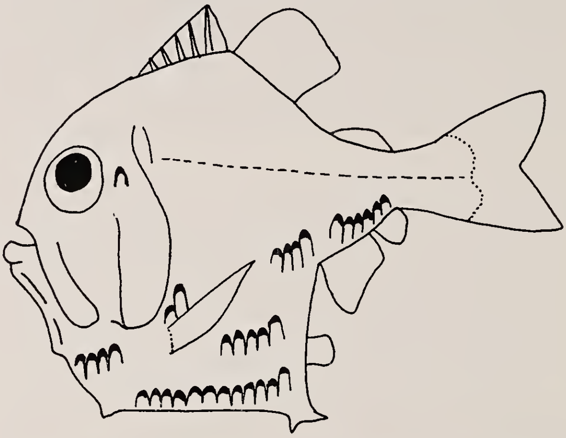
9b Scales absent; barbel present; large canines present ....STOMIIDAE





10a Body elongate and slender; branchiostegal rays 12–16; BR photophores 7–16; no spine or keel on ventral profile of body; AC photophores not grouped into compound light organs ...........................GONONSTOMATIDAE

10b Body relatively short and highly compressed; branchiostegal rays 6–10; BR photophores 3–7; abdominal spines and keel present; AC photophores sometimes grouped to form compound light organs ....
...............STERNOPTYCHIDAE (STERNOPTYCHINI)



11a Gill openings small, ventrolateral or ventral or entirely confluent on throat....................SYNAPHOBRANCHIDAE

11b Gill opening not as above.............................12

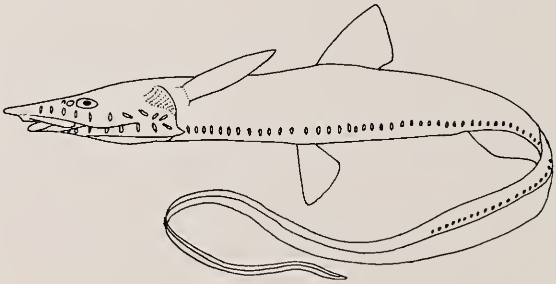
12a Pelvic fins abdominal.................................13

12b Pelvic fins jugular, thoracic or absent...................22

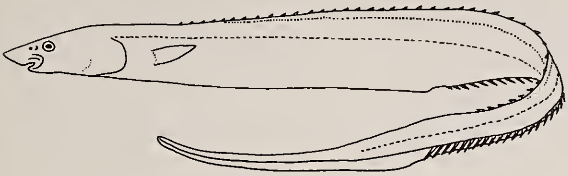
13a Anal-fin base very long, usually more than half body length; adipose fin absent; caudal fin absent or minute..........14

13b Anal-fin base less than half body length; adipose fin present or absent; distinct caudal fin present 15

14a No spines in dorsal and anal fins; dorsal fin short-based, placed entirely in front of anal-fin origin; lateral line ventrolateral, its origin well below pectoral-fin base; caudal fin absent ................................HALOSAURIDAE

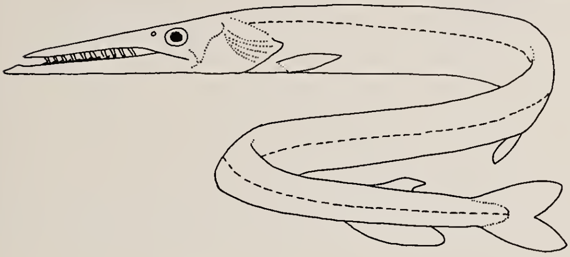


14b Dorsal and anal fins with spines; dorsal fin comprised only of well spaced spines extending beyond level of anal-fin origin; lateral line dorsolateral, its origin above pectoral-fin base; minute caudal fin present .............NOTACANTHIDAE

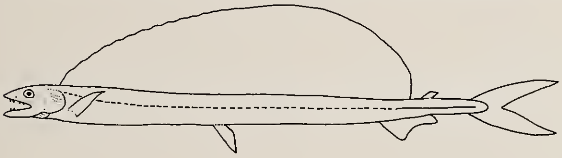


15a Dorsal fin present; adipose-fin base, if present, shorter than anal-fin base 16

15b Dorsal fin absent; adipose-fin base about as long as anal-fin base; mouth large, with large fang-like teeth; lower jaw with a fleshy chin nub ......................ANOTOPTERIDAE



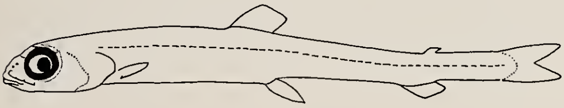
16a Adipose fin present; dorsal fin long and high, its origin over head and its end over anal fin; mouth large, with large teeth .....................................ALEPISAURIDAE



16b Adipose fin present; dorsal fin shorter and lower, entirely in front of anal fin and well behind head 17

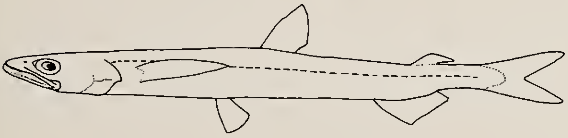
16c Adipose fin absent; dorsal fin opposite anal fin and of more or less the same height and length 21

17a Anal-fin base shorter than caudal peduncle length; eye diameter larger than snout length; mouth small, maxilla reaching slightly beyond anterior edge of eye . .MICROSTOMATIDAE



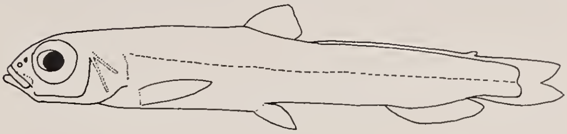
17b Anal-fin base longer than caudal peduncle length........18

18a Pelvic fins well in front of dorsal-fin origin; dorsal fin at about middle of SL; body long and slender.......NOTOSUDIDAE



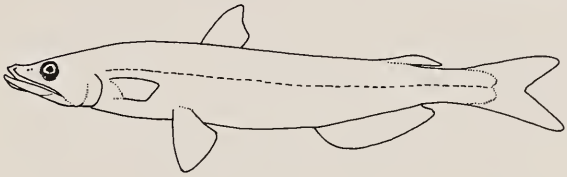
18b Pelvic fins under or slightly in front of dorsal-fin origin....19

19a Mouth small; no teeth on upper jaw; gill rakers well developed .................................BATHYLAGIDAE

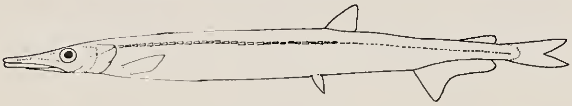


19b Mouth large; teeth present on both jaws; gill rakers reduced to small gill teeth......................................20

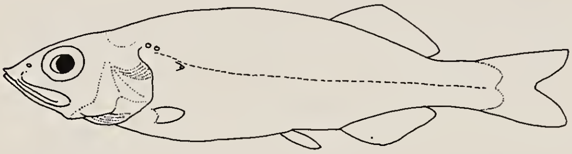
20a Eyes large and tubular, directed upward; median fins without spines; dorsal fin well in front of middle of SL ....SCOPELARCHIDAE



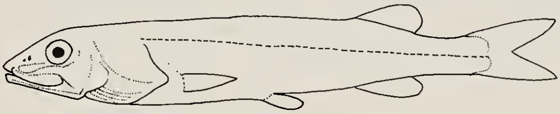
20b Eyes moderate, normal and laterally directed; dorsal fin behind middle of SL ....................PARALEPIDIDAE



21a A small tube, supported by a modified scale, close behind rear edge of opercle just below lateral line. . .PLATYTROCTIDAE



21b No tube as above..................ALEPOCEPHALIDAE



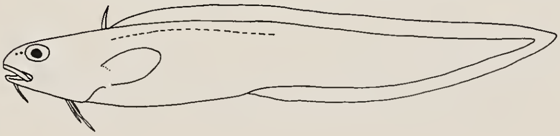
22a Dorsal and anal fins joined with caudal fin, or caudal fin absent..23

22b Dorsal and anal fins separate from caudal fin 28

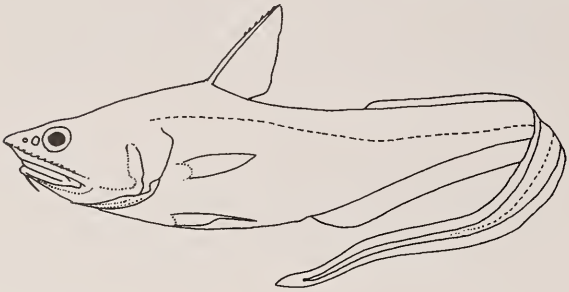
23a Chin barbel present; 2 dorsal fins (first may be only 1 ray) 24

23b Chin barbel absent; a single dorsal fin present 25

24a First dorsal fin consists of a single ray; gill opening restricted below pectoral fin; scales non-imbricate and embedded in skin; surface of body smooth .......MURAENOLEPIDIDAE



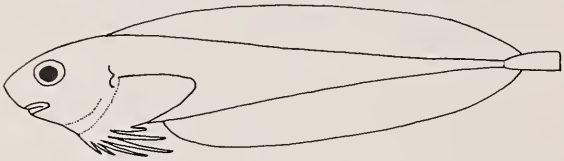
24b First dorsal fin with several rays, gill opening not restricted; scales imbricate, not completely embedded in skin and usually covered with minute spinules which make body surface rough .... MACROURIDAE



25a A single nostril on each side of head 26

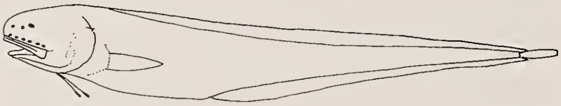
25b Two nostrils on each side of head 27

26a Pectoral fin large and may be notched or divided into 2 lobes; rays of lower pectoral-fin lobe (may appear as pelvic fin) free; pelvic fins, if present, united to form a sucking disc; anus on anterior part of body cavity, far in front of anal-fin origin; scales absent.................................. LIPARIDIDAE

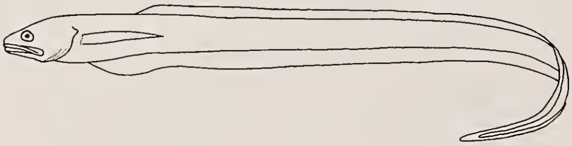


26b Pectoral fin not notched or divided into lobes; pelvic fins, if present, rudimentary; anus immediately in front of anal-fin origin .... ZOARCIDAE

27a Small scales present; pelvic fins usually present (1–2 rays); teeth small; supramaxilla present............ OPHIDIIDAE



27b Scales absent; pelvic fins usually absent; large canines and fang-like teeth may be present; supramaxilla absent........ .... CARAPIDAE

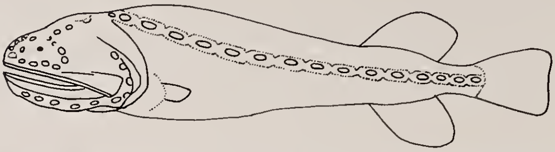


28a Pelvic fins absent 29

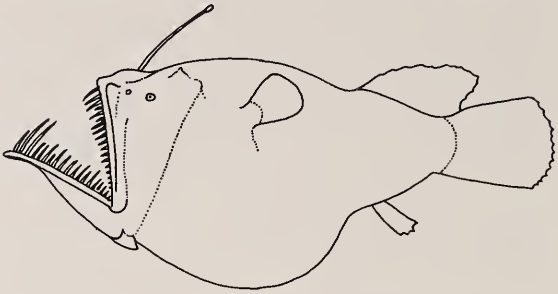
28b Pelvic fins present 32

29a Body short, relatively deep and wide; first dorsal spine modified to form an angling apparatus (illicium); lateral line absent; gill opening restricted to a small opening near pectoral-fin base 30

29b Body elongate and moderately deep; no modified dorsal spines or rays; lateral line on body a broad canal with large pores; gill opening normal................ CETOMIMIDAE

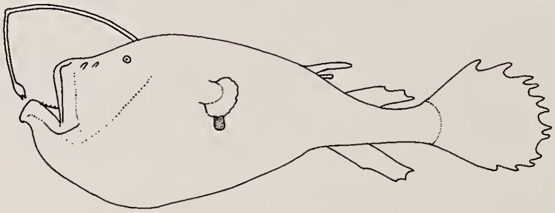


30a Soft dorsal-fin rays 12–17; mouth with large, fang-like teeth .... MELANOCETIDAE

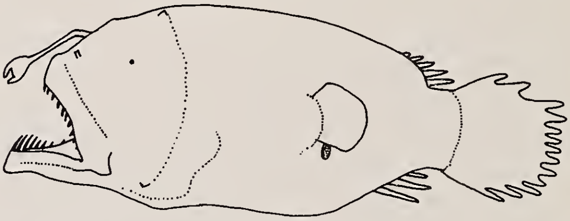


30b Soft dorsal-fin rays 3–8; teeth (absent in males) short or moderate and not fang-like........................... 31

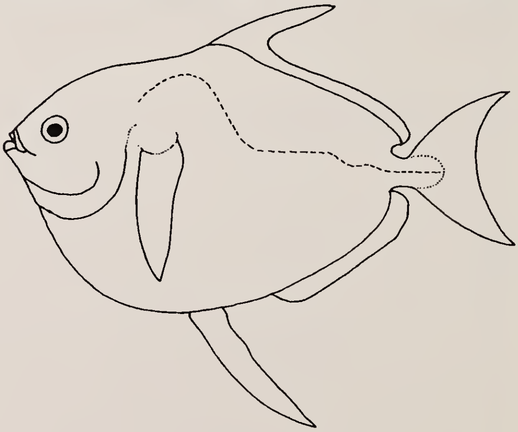
31a Two or 3 "caruncles" on dorsal midline just in front of soft dorsal fin; mouth strongly oblique to vertical, not extending past eye .... CERATIIDAE



31b No "caruncles" on dorsal midline; mouth horizontal or slightly oblique and may extend behind eye........ ONEIRODIDAE



32a Body depth less than 2.5 in SL; pectoral-fin base horizontal; fins and jaws typically bright orange .... LAMPRIDAE

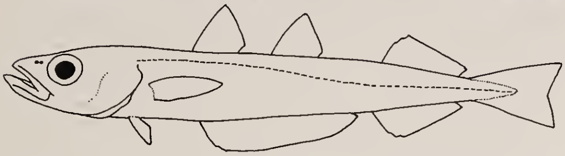


32b Body depth more than 2.5 in SL (less than 2.0 in Oreosomatidae); pectoral-fin base normal........................33

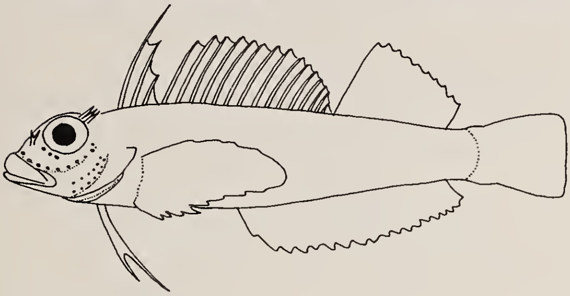
33a Three dorsal fins....................................34

33b One or 2 dorsal fins..................................35

34a Two anal fins; chin barbel present or absent; no supraorbital tentacle; pelvic fins thoracic....................GADIDAE



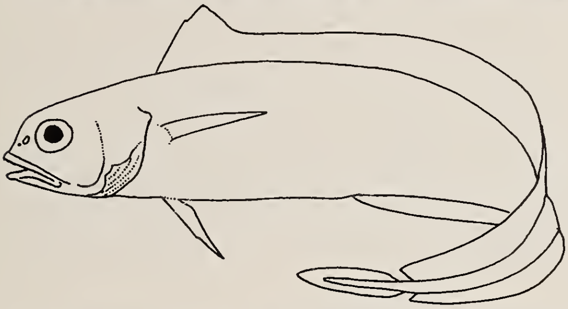
34b One anal fin; chin barbel absent; supraorbital tentacle present; pelvic fins jugular.............TRIPTERYGIIDAE



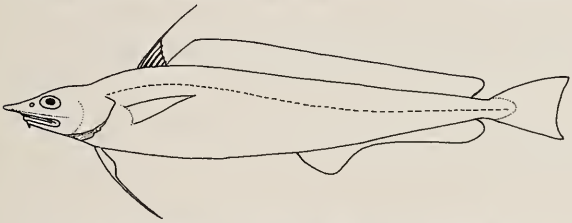
35a Fin spines absent...................................36

35b Fin spines present but may be weak (only pelvic spine in Bathydraconidae)...................................37

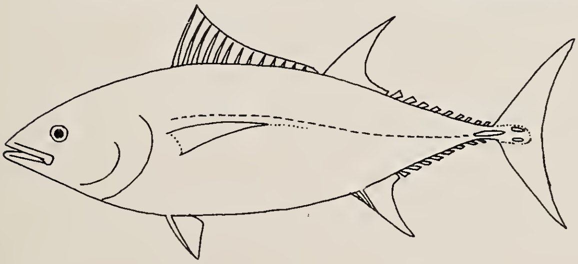
36a Pelvic fins thoracic, their anterior rays not elongate; chin barbel absent; a single, long dorsal fin.....MELANONIDAE



36b Pelvic fins jugular, their anteriormost 1 or 2 rays elongate; chin barbel present; 2 dorsal fins..............MORIDAE



37a Two small keels and a larger median keel between them on each side of caudal peduncle; finlets present behind dorsal and anal fins............................SCOMBRIDAE



37b Keels and finlets absent..............................38

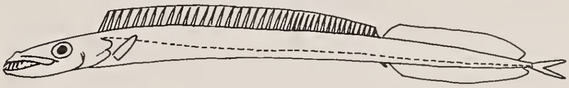
38a Anal fin spines present, but may be weak(*Zanclorhynchus*; *Pseudoicichthys*).....................................39

38b Anal fin spines absent................................43

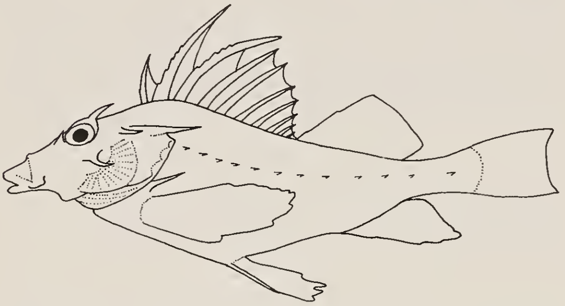
39a Spinous portion of dorsal fin longer than soft-rayed portion 40

39b Spinous portion of dorsal fin shorter than soft-rayed portion 41

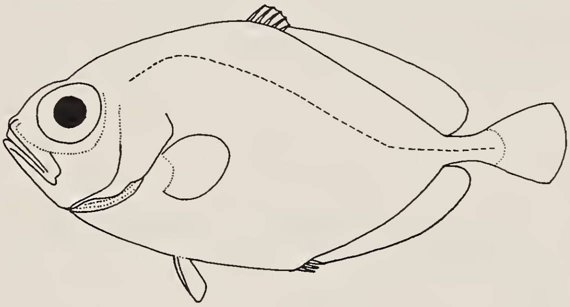
40a Pelvic fins reduced to a short spine (sometimes absent); head without spines; mouth large, non-protractile with fang-like teeth..................................GEMPYLIDAE



40b Pelvic fins with well developed spine and rays; head with strong spines; mouth small, protractile; teeth small.........
....................................CONGIOPODIDAE

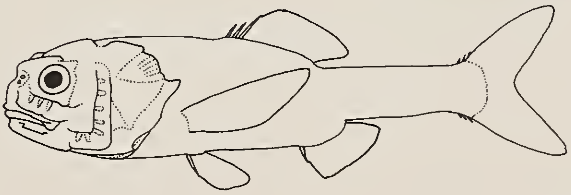


41a Eye very large its diameter less than 3 in head length; dorsal and anal spines strong and longitudinally grooved; body depth 1.3–1.8 in SL.......................OREOSOMATIDAE

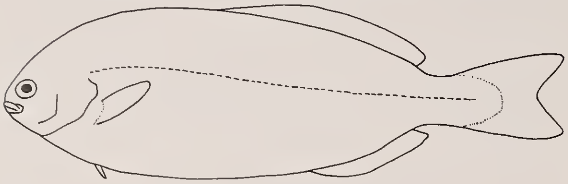


41b Eye diameter 3 or more in head; dorsal and anal spines feeble and not grooved; body depth 2.9–4.0 in SL............42

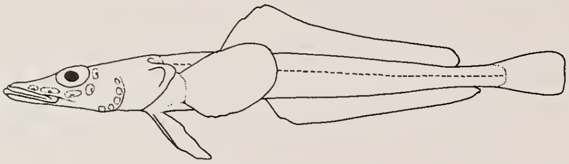
42a Caudal fin with 3–4 small, spiny procurrent rays; head with irregular ridges and small spines; pelvic fin I,6–8, well developed; dorsal and anal fins short-based ....
....................................MELAMPHAIDAE



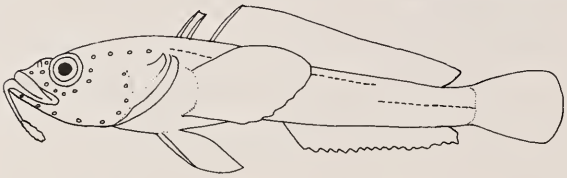
42b No procurrent rays on caudal fin; head smooth, pelvic fins I,5, rudimentary; dorsal and anal fin long-based ....CENTROLOPHIDAE



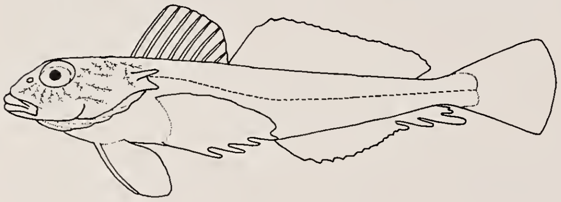
43a A single dorsal fin without spines; snout produced and flattened; chin barbel absent ...........BATHYDRACONIDAE



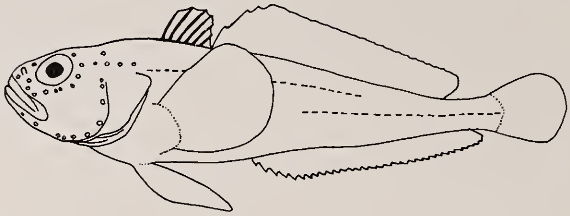
43b Two dorsal fins, the first spinous; snout normal or produced and flattened; chin barbel present or absent.............44
44a Barbel present; opercular spine flat and medially curved ................................ARTEDIDRACONIDAE



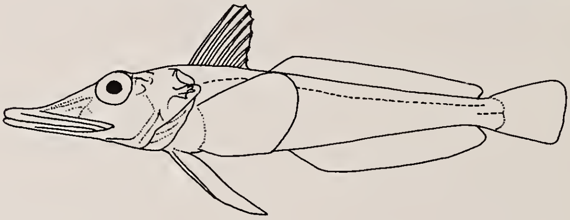
44b Barbel absent 45
45a Posterior anal-fin rays elongate and thickened; a single strong spine on opercle.........................BOVICHTIDAE



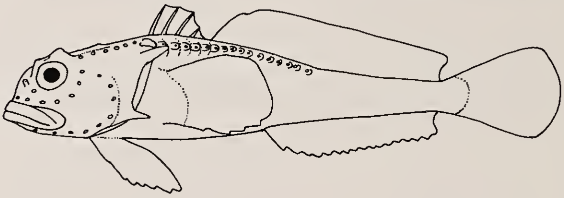
45b Posterior anal-fin rays normal; spines on opercular bones present or absent 46
46a Body scaled; spines on opercular bones absent; 2 or 3 lateral lines ................................NOTOTHENIIDAE



46b Body naked; spines on opercular bones usually present; 1 or 2 lateral lines.......................................47
47a Snout produced and flattened; upper jaw not protrusile; upper opercular spine flat and multifid.......CHANNICHTHYIDAE



47b Snout normal; upper jaw protrusile; opercle with strong and simple spines ........................HARPAGIFERIDAE



MYXINIDAE

Hagfishes

by B. FERNHOLM

Eel-like body-shape. Cartilaginous skeleton. Jaws absent; laterally biting horny teeth in 2 rows on each side of tongue (Fig. 1) and a single median palatine tooth. Snout pointed, with 1 median nasal opening surrounded by prominent barbels. No scales. Lateral and dorsal fins absent. Eyes rudimentary under the skin. Slime glands opening in 2 ventrolateral rows of mucus pores producing large amounts of slime used for defence and perhaps feeding (Fernholm 1975, 1981). Sexes separate. Eggs oval, large and yolky, with horny protrusions on the ends for attachment. Young adults several centimetres long when hatching; no metamorphosis.

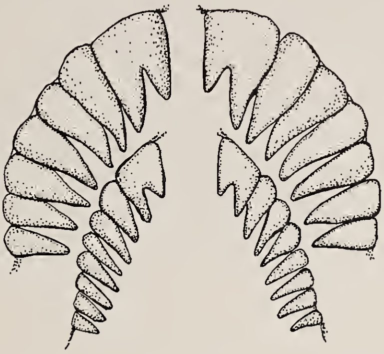


Fig. 1. Anterior view of teeth rows in the mouth of *Myxine*.

Two subfamilies, Myxininae and Eptatretinae; 6 genera with about 35 extant species, confined to marine environment. Scavengers eating dead or dying fish, prawns and other invertebrates. Species of hagfish occur in all oceans from shallow water to depths of 2,000 m; in tropical or subtropical areas, the distribution is limited to cooler deep waters.

Genus ***Myxine*** Linnaeus, 1758

Efferent branchial ducts from 5 to 7 pairs of gill pouches open by a common ventral aperture on each side. No ventrolateral finfolds. Anal fin originates posterior to branchial apertures and is continuous with dorsal fin; dorsal-fin origin on posterior quarter of body. Pharyngocutaneous duct usually opening in common with enlarged left branchial aperture.

Remarks: The systematics of the Atlantic species of *Myxine* is complicated and in great need of a thorough revision (Fernholm 1981). At least 6 different species have been described but 5 of these have at times been synonymised within the *Myxine glutinosa* complex. *Myxine australis* Jenyns, 1842, is one of the species synonymised with *M. glutinosa* by Adam & Strahan (1963). It has also been synonymised with *Notomyxine tridentiger* Nani & Gneri, 1951. I choose to recognise *Myxine australis* even though at present there is no convincing evidence that it is distinct from *M. glutinosa* Linnaeus, 1758.

Myxine australis Jenyns, 1842

Fig. 2

Myxine australis Jenyns, 1842: 159, Tierra del Fuego. Holotype: Zoological Museum, University of Cambridge, 290 mm TL.

Diagnosis: Six pairs of gill pouches; gill apertures immediately in front of anal-fin origin. Mucus pores 26 in front of gill apertures. Four barbels around nostril; one barbel on each side of mouth.

COLOUR: In life, dorsum like an earthworm, but more leaden; beneath yellowish, head purplish (Darwin, in Jenyns 1842).

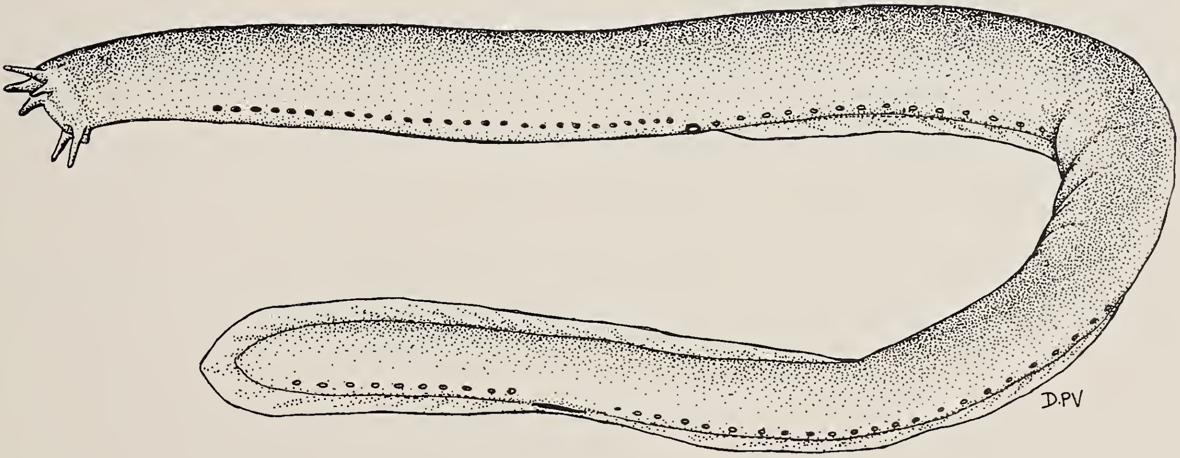
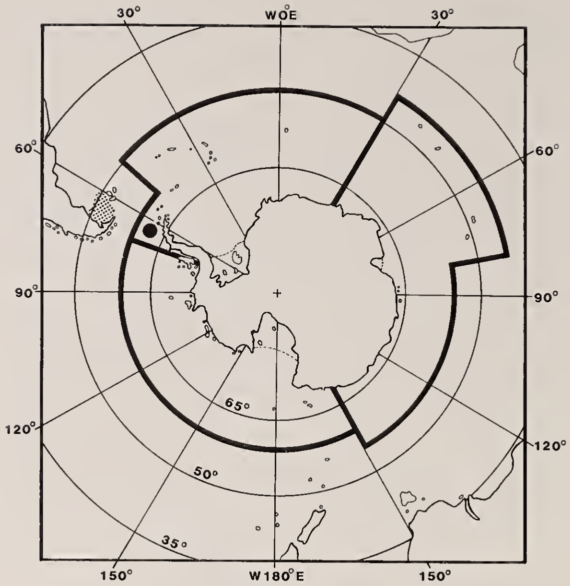


Fig. 2. *Myxine australis* (adapted from Fischer & Hureau 1985)

Distribution: Within the Southern Ocean, a single 230 mm TL specimen was collected in the South Shetlands Islands in 1924 (Norman 1938). More frequent in Tierra del Fuego (Jenyns 1842; Smitt 1898). Depth range probably 10-100 m.

Remarks: The taxonomic status of *M. australis*, as well as some other members of the *Myxine glutinosa* complex, remains to be determined.

Biology unknown. Attains 60 cm TL.



Distribution of *M. australis*

PETROMYZONTIDAE

Lampreys

by B. FERNHOLM

Eel-like body. Cartilaginous skeleton. No jaws, scales or lateral fins. One or 2 dorsal fins. Eyes well developed in adults. Horny teeth on oral disc and tongue. Sexes separate, eggs numerous, small and not yolky. Larval stage (ammocoetes) lives several years in fresh water before undergoing radical metamorphosis.

Three subfamilies (or families, Hubbs & Potter 1971; Potter 1986), Petromyzontinae, Geotriinae and Mordaciinae. Six genera with 41 extant species (Nelson 1984). Most species are confined to fresh water and 18 are parasitic; the rest probably do not feed as adults. Parasitic species are generally active predators attaching themselves to fishes and extracting blood and other tissues. Occasionally, they may feed on whales (Pike 1951; Nemoto 1955), various invertebrates and carrion (Hardisty & Potter 1971).

Circum-polar distribution with Petromyzontinae occurring only in the Northern Hemisphere; Geotriinae (with a single species) on the coasts of Australia, New Zealand, the Falkland/Malvinas Islands, Argentina, Chile and South Georgia; Mordaciinae on the coasts of south-east Australia, Tasmania and the west coast of South America (Potter & Strahan 1968).

Genus *Geotria* Gray, 1851

Monotypic; restricted to the Southern Hemisphere.

Geotria australis Gray, 1851

Fig. 1

Geotria australis Gray, 1851: 142, pl. 1, fig. 3, pl. 2, Inkar Pinki River, South Australia. Holotype: BMNH 1851.7.11.1.

Velasia chilensis Gray, 1851: 143, pl. 1, fig. 4, Chile.

Thysanochilus valdivianus Troschel in Philippi, 1857: 268, Valdivia, Chile.

Petromyzon fonki Philippi, 1865: 109, Chile.

Petromyzon macrostomus Burmeister, 1868: xxxvi, Buenos Aires.

Geotria allporti Günther, 1871: 675, pl. LXX, Tasmania.

Yarra singularis Castelnau, 1872: 231, lower Yarra River, Victoria.

Neomordacia howittii Castelnau, 1872: 232, Cape Shanck, Southern Australia.

Velasia stenostomus Ogilby, 1896: 409 (new name).

Macrophthalmia chilensis Plate, 1897: 137, mouth of Maullin River, Southern Chile.

Geotria saccifera Regan, 1911: 197, New Zealand.

Dionisia patagonica Lahille, 1915: 374, 380, Argentina.

Diagnosis: Posterior dorsal fin separate from caudal fin. Teeth of spatulate shape (Fig. 2). Anadromous and parasitic undergoing marked changes in dentition and snout morphology during spawning run.

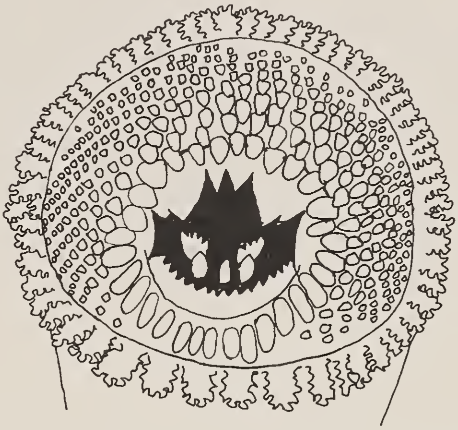


Fig. 2. The configuration of the teeth in the mouth of *Geotria australis* (from Potter 1986)

Colour: In life, at the completion of metamorphosis *G. australis* has a dark dorsal, and silver ventral surface, with a blue-green band running down each side of the body in a dorsolateral position. The individuals returning from the sea on their spawning run are dark blue dorsally and light blue on their ventral surface, and retain, for a time, traces of the blue-green bands (Potter 1986).

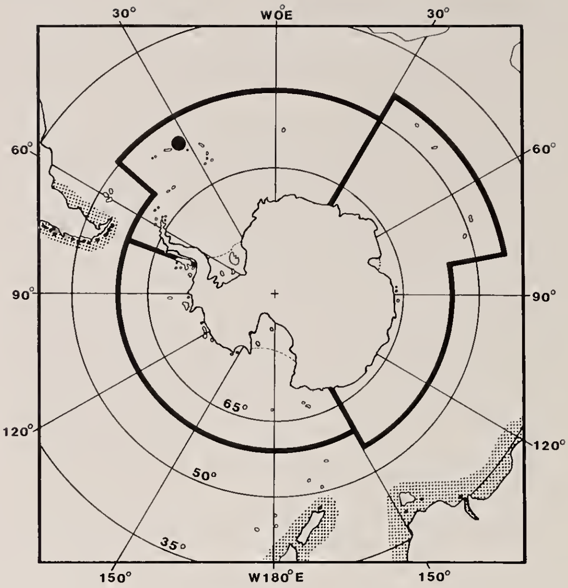
Distribution: Within the Southern Ocean in South Georgia, extending north along the coasts of all southern continents.

Remarks: *Geotria australis* is an important component in the diet of breeding populations of the black browed- (*Diomedea melanophrys)* and grey-headed (*D. chrysostoma)* albatrosses in South Georgia (Tickell 1964; Potter *et al.* 1979). Potter *et al.* (1979) demonstrated that a large number of adult *G. australis* are present in the sea around South Georgia during the summer, but noted that there was no indication of the lampreys entering the few freshwater rivers of the island to spawn. Potter *et al.* (1979) postulated that the lampreys migrated to South

Fig. 1. *Geotria australis* adult male with a gular pouch. The pouch develops only after the animal has left the sea and been in fresh water for a number of months (from Potter 1986)

Georgia from their natal rivers in South America, probably following migratory routes of their marine hosts. They suggested that the gadid *Micromesistius australis* and the nototheniid *Dissostichus eleginoides* are the likely hosts for the lampreys. Comparing the length distribution of the South Georgia fishes with that of *G. australis* from Western Australia and Tasmania, Potter *et al.* (1979) estimated that having a mean length of 45.9 cm, the South Georgia population had already been to sea for more than 1 year.

Attains 62 cm TL.



Distribution of *G. australis*

SHARKS

by L.J.V. COMPAGNO

Jawed (gnathostome) fishes with a cartilaginous skeleton, lacking bony elements. Braincase at all growth stages consisting of an unsutured chondroneurocranium that is not replaced by jointed bony plates. Body cylindrical in most sharks, somewhat compressed or depressed in some species. Five to 7 pairs of separate gill slits or openings on sides of head; no single gill cover or hyoid operculum concealing gill openings. Nostrils on ventral surface of head. Snout produced anterior to mouth, which is inferior or subterminal in all but a few sharks. Primary jaws (palatoquadrates and Meckel's cartilages) are the only functional jaws at all stages. Teeth attached by membrane to jaws, formed in rows or tooth families of functional and replacement teeth that run transverse to jaw axis.

Body and fins covered by small, toothlike placoid scales or dermal denticles. Usually 2 dorsal fins (1 in hexanchoid sharks, and a single species of catshark, family Scyliorhinidae) with or without fixed anterior spines; paired pectoral and pelvic fins; an anal fin (absent in some species); and a caudal fin, usually heterocercal but sometimes diphycercal or even hypocercal. Propulsion primarily by tail and caudal fin.

Fertilisation internal; males with paired copulatory organs, the myxopterygia or "claspers", on their pelvic fins. Development oviparous, ovoviviparous, or viviparous.

Sharks differ from their close relatives, the rays or batoids, by having lateral gill openings and pectoral fins free from the head; most sharks are less dorsoventrally flattened than batoids.

Eight orders, about 30 families, and over 370 valid species of living sharks are known at present (Compagno 1984 and unpubl.), with 1 or more new species being described each year. Sharks are most diverse in tropical and warm-temperate continental marine waters, from close inshore to the upper slopes above 2,000 m, and least diverse in fresh water, on the abyssal plains, in deep trenches, and in the Antarctic and Arctic oceans. Only 2 families (Lamnidae and Squalidae), and 3 species, none of which are endemics, are known from the Southern Ocean. Two of the species are an incidental minor bycatch of trawl fisheries for bony fish species.

LAMNIDAE

Mackerel sharks

Body massive, slender to stout, and spindle-shaped. Caudal peduncle flattened, lenticular in cross-section, with strong lateral keels and upper and lower precaudal pits. Caudal fin crescentic, with lower lobe nearly as long as upper. Pectoral fins large and falcate, anterior margins over 3 times length of pelvic fin anterior margins. Dorsal fins without spines; first dorsal fin large, between pectoral- and pelvic-fin bases; second dorsal and anal fins small, with narrow pivoting bases. Head and snout conical; spiracles minute or absent; 5 large gill openings on each side of head. No gill rakers on internal gill openings. No nictitating eyelids. Teeth large and few in number, blade-like or awl-shaped; upper jaw with large anterior teeth, separated from lateral teeth on each side by a row of small intermediate teeth. Intestine with a ring valve.

Three genera and 5 species (Compagno 1984) of large, active, warm-blooded sharks. Included in the family is the great white shark, *Carcharodon carcharias* (Linnaeus, 1758), the most notorious and formidable living shark. Lamnids occur in all temperate and tropical seas, but only members of the genus *Lamna* penetrate polar seas. One *Lamna* species occurs around sub-Antarctic islands. All species are of some commercial importance (Compagno 1984), particularly members of the genera *Isurus* and *Lamna*.

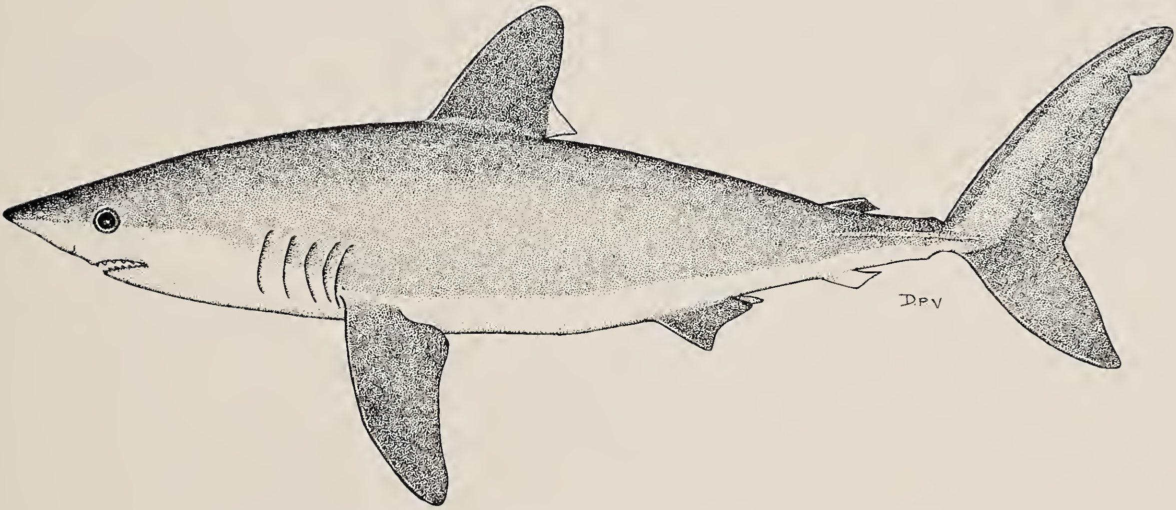


Fig. 1. *Lamna nasus* uncatalogued, 94 cm TL, False Bay, South Africa

Genus *Lamna* Cuvier, 1816

Body stout; first dorsal-fin origin over or just behind the pectoral-fin bases. Anal-fin origin beneath second dorsal-fin origin. Small secondary keels present on base of caudal fin just below primary keels. Mouth broadly parabolic; teeth small, with short, narrow, awl-shaped, smooth-edged cusps and small cusplets; intermediate teeth less than half height of upper anterior teeth.

Two species, the salmon shark, *Lamna ditropis* Hubbs & Follett, 1947, in the eastern North Pacific and Bering Sea, and the wide-ranging porbeagle shark, *Lamna nasus* (Bonnaterre, 1788).

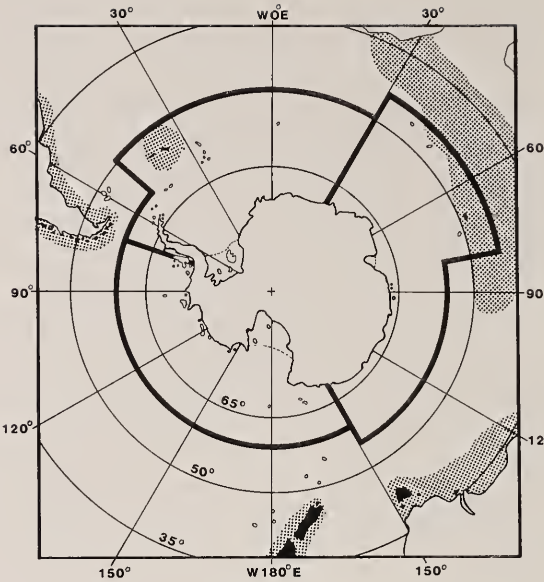
Lamna nasus (Bonnaterre, 1788)
Porbeagle
Fig. 1

Squalus nasus Bonnaterre, 1788: 10. Type locality uncertain, probably British waters. Holotype: None.

Diagnosis: Snout length 2 times or less in distance from eye to first gill opening. First row of upper lateral teeth on each side with cusp erect or nearly so.

Colour: In life, blue-grey above, immaculate white on sides, ventral surface, and extending over bases of pectoral fins. Dorsal surface of pectoral fins dusky. No black spot on pectoral-fin axils. Rear tip of first dorsal fin abruptly white.

Distribution: This species is found in the North Atlantic and Mediterranean, also southern Pacific and sub-Antarctic seas, but is not known from the tropics. At least 2 populations: North Atlantic and Southern Hemisphere. In the North Atlantic, from the east coast of the USA (New Jersey and possibly South Carolina) north to Newfoundland and east to Greenland, Iceland, Norway, and the USSR, thence south to the Baltic and North seas, the United Kingdom, Spain, the Mediterranean Sea, Morocco, and Madeira. In the South Atlantic, from off southern Brazil to Argentina, and off the western Cape Province, South Africa. In the southern Indian Ocean and western Pacific Ocean, probably in a wide area between South Africa and Western Australia, continuing off South Australia and Tasmania to New Zealand. In the eastern Pacific, off southern Chile south to Cape Horn. In the Southern Ocean known from off South Georgia and the Kerguelen Islands, and in the open sea north of the Kerguelen Islands (Svetlov 1978b; Duhamel & Hureau 1982; Duhamel & Ozouf-Costaz 1982; Compagno 1984; and Duhamel & Compagno 1985).



Distribution of *L. nasus*

Remarks: The porbeagle is a coastal and oceanic shark, littoral from the intertidal to the outer shelf and epipelagic over the ocean basins, and occurring from the surface down to at least 366 m. This shark is regularly caught in bottom trawls in commercial fisheries off the Kerguelen Islands and South Georgia at depths of 200–350 m and at water temperatures of 1.7 to 3.2 °C. Porbeagles feed primarily on small pelagic schooling fish and cephalopods, and off the Kerguelen Islands they prey mainly on *Champsocephalus gunnari* (Duhamel & Compagno 1985). Little is known of the biology of porbeagles in the Southern Hemisphere, but from the discontinuous distribution of the species it is assumed that a discrete breeding population (or populations) exists there. The porbeagle is ovoviviparous, with 1–5 young per litter; a 201 cm female from off the Kerguelen Islands had 4 young. Foetuses resorb their yolk-sacs early in their development and thenceforth practise uterine cannibalism, feeding on fertilised eggs until birth. In European porbeagles the gestation period is estimated at 8 months.

Porbeagles reach a maximum total length of at least 3 m and possibly 3.7 m, though most adults are below 3 m.

SQUALIDAE
Spiny dogfishes

Body slender to stout, cylindrical or somewhat compressed. Caudal peduncle cylindrical, nearly circular in cross section, with low lateral keels or no keels; precaudal pits usually absent. Caudal fin usually asymmetrical, with lower lobe much shorter than upper, although nearly symmetrical in some small oceanic species. Pectoral fins small and generally paddle-shaped or triangular; anterior margins less than twice length of pelvic anterior margins. Dorsal fins with or without spines; first dorsal fin small to moderately large, usually on midback between pectoral- and pelvic-fin bases; second dorsal fin not much smaller than first, with a long, non-pivoting base. No anal fin. Head and snout flattened or bluntly conical; spiracles well-developed; 5 small to moderate-sized gill openings on each side of head. Short dermal gill rakers usually present on internal gill openings. No nictitating eyelids. Teeth small to large and few in number, small and cuspidate or large, blade-like, and forming a saw-like cutting edge in the lower jaw or both jaws; no small intermediate teeth in upper jaw. Intestine with a spiral valve.

This large, complex family includes at least 19 genera and 80 or more species (Compagno 1984 and unpubl.) of small to large sharks, found in all temperate and tropical seas. Only species of the genera *Etmopterus* and *Somniosus* are known from the Southern Ocean. A number of species are of commercial importance elsewhere, particularly members of the genera *Centrophorus*, *Centroscymnus*, *Deania*, *Dalatias*, *Somniosus* and *Squalus*.

KEY TO GENERA

1a Fin spines present on both dorsal fins .... *Etmopterus*
1b No dorsal fin spines .... *Somniosus*

Genus ***Etmopterus*** Rafinesque, 1810

Grooved spines present on both dorsal fins, the first short and straight, the second long and curved; first dorsal-fin origin over or behind pectoral-fin bases, first dorsal-fin base well in front of pelvic-fin origins; second dorsal fin larger than first. Pectoral fins small, with rounded free rear tips. No precaudal pits. Caudal fin asymmetrical, with short ventral lobe and strong subterminal notch. Body subcylindrical. Snout length half of head length or less; anterior nasal flaps not expanded as barbels. Gill openings about equally wide. Lips thin, without folds, not capable of suction. Teeth differing in upper and lower jaws; upper teeth with narrow, erect cusps and 1 or more pairs of cusplets; lower teeth larger, blade-like, with oblique cusps and distal blades, forming a saw-like cutting edge; tooth rows 18–38/24–52. Dermal denticles varying from low and block-shaped to slender and thorn-like. Colour varying from blackish to light brown, often with prominent dark markings (luminous areas) on underside of body. Cloaca without a luminous gland. Size small, maximum less than 1 m.

This large, complex, poorly known genus of at least 21 nominal species, termed "lanternsharks" because of their luminous organs, has a wide range in deep water. Identification of the single species, *Etmopterus lucifer* Jordan & Snyder, 1902, reported from our area is highly provisional.

?*Etmopterus lucifer* Jordan & Snyder, 1902
Fig. 1

Etmopterus lucifer Jordan & Snyder, 1902: 79, off Misaki, Japan. Holotype: SU 6863, 282 mm adult male.

Diagnosis: Body stout; tail moderately long, distance from pelvic-fin bases to ventral caudal-fin origin about as long as prebranchial space, slightly less than 1.5 times in pectoral-pelvic space, and slightly less than interdorsal space. Prespiracular length about 1.8 times distance from spiracles to pectoral-fin origins. Predorsal length about equal to distance from first dorsal spine to second dorsal rear tip. Pectoral-pelvic space about equal to head length. Interdorsal space about equal to head length. Head width about equal to preoral snout length. Dorsal-caudal space about 1.5 in interdorsal space. Gill openings considerably wider than spiracle, 0.33 eye length or less. Upper teeth generally with fewer than 3 pairs of cusplets. Lateral trunk denticles with slender, hooked, conical crowns, arranged in regular longitudinal rows on entire dorsolateral surface from snout tip to sides of caudal fin; no denticles on anterolateral surface of snout; no rows of enlarged denticles on antrolateral surface of snout; no rows of enlarged denticles on flanks above pectoral fins; no denticles on distal margins of fins. Fins not distinctly fringed with naked ceratotrichia. First dorsal-fin origin slightly behind or about opposite free rear tips of pectoral fins; first dorsal-fin base considerably closer to pectoral-fin bases than pelvics; second dorsal fin more than twice size of first dorsal fin. Length of dorsal caudal-fin margin slightly less than head length in adults.

Colour: In life, brown above, with underside of head and abdomen abruptly black. Elongate, narrow black marks above, in front of, and behind pelvic fins, at caudal-fin base, and along the caudal vertebral axis.

Distribution: This species is given a wide range in the literature, from off Uruguay, Argentina, Namibia, South Africa, Mozambique, Tanzania, Japan, Taiwan, Viet Nam, Indonesia, the Philippines, Australia, New Zealand, and New Caledonia. It is uncertain at present whether all of these records are of this species or if some

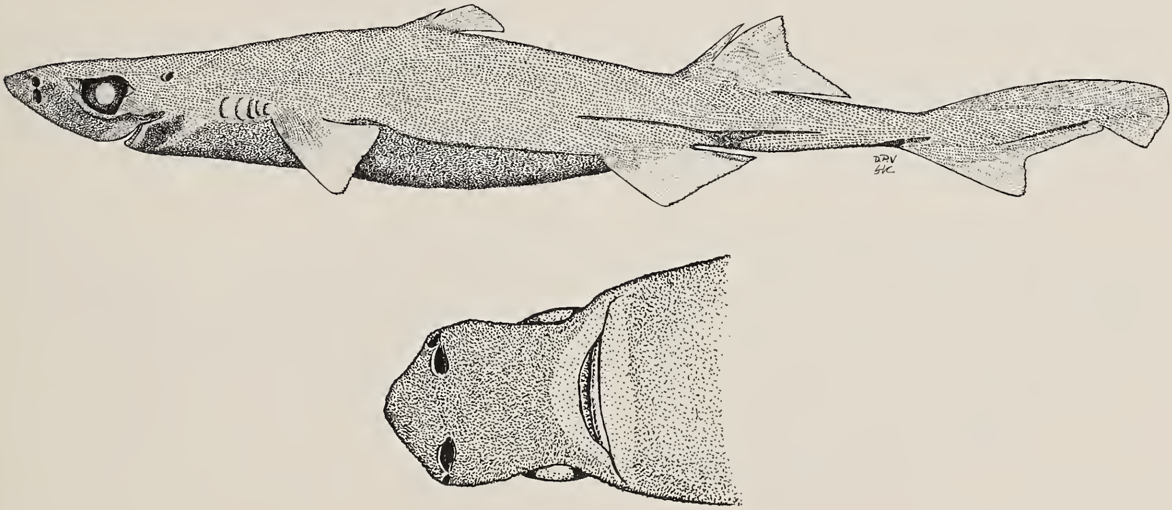
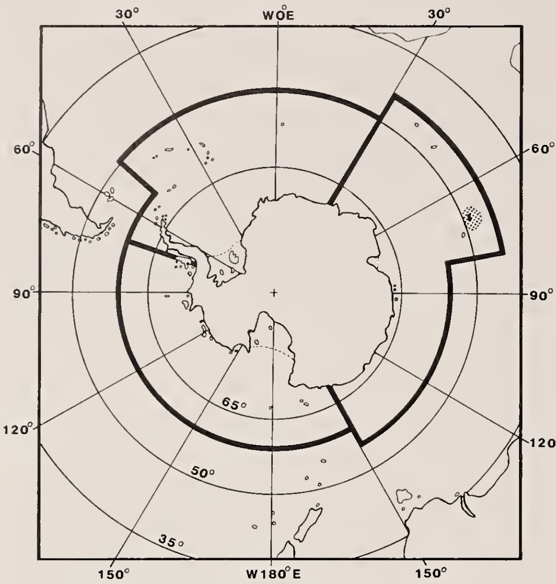


Fig. 1. *Etmopterus lucifer* SU6863, 281 mm TL, holotype, adult male

include closely related species, especially *E. brachyurus* and *E. molleri* (see Yamakawa *et al.* 1986). The record of *E. lucifer* in the area stems from Duhamel & Hureau (1982), who record a single small specimen from 800–1,000 m off the Kerguelen Islands, taken by a Soviet vessel and now in the collection of the Azovo-Chernomorsk Museum, USSR. This specimen needs to be re-examined to check the validity of this record.



Distribution of *E. lucifer*

Remarks: This poorly-known epibenthic shark occurs on the outer shelves and upper slopes at depths of 183 to 823 m. In temperate waters it feeds on squid, small mesopelagic schooling fishes (mostly lanternfish) and shrimp (Compagno 1984). It is ovoviviparous.

Attains 42 cm.

Genus ***Somniosus*** Lesueur, 1818

Spines absent from dorsal fins; first dorsal-fin origin over or behind pectoral fin bases, first dorsal-fin base well in front of pelvic-fin origins; second dorsal fin as large as first. Pectoral fins small, with rounded free rear tips. No precaudal pits. Caudal fin nearly symmetrical, with long ventral lobe and strong subterminal notch. Snout length half of head length or less; anterior nasal flaps not expanded as barbels. Gill openings about equally wide. Lips thin, without folds, not capable of suction. Teeth differing in upper and lower jaws; upper teeth with narrow, erect cusps and no cusplets; lower teeth larger, blade-like, with oblique cusps and distal blades, forming a saw-like cutting edge; tooth rows 35–63/34–68. Dermal denticles low and curved, thorn-like. Cloaca without a luminous gland. Photophores absent. Size moderate to gigantic, 1.4–6.4+ m TL.

This genus of 3 species includes 2 well-marked subgenera, the subgenus *Rhinoscymnus* with the small (to 1.4 m), wide-ranging *Somniosus rostratus* (Risso, 1826); and the subgenus *Somniosus* with 2 nominal giant species (to over 6 m), the North Pacific *Somniosus pacificus* Bigelow & Schroeder, 1944, and the wide-ranging *Somniosus microcephalus* (Bloch & Schneider, 1801).

Identification of the single species in the area, *Somniosus microcephalus* is highly provisional. Whitley (1939) proposed a new species, *Somniosus antarcticus* from a sketch and descriptive data of a large shark found dead on a beach at Macquarie Island. While this was definitely a member of the subgenus *Somniosus* and is more similar to descriptions of *S. microcephalus* than of *S. pacificus* details of its morphology are sufficiently vague to make its identification uncertain. However, there is nothing to justify the recognition of *S. antarcticus* disregarding its geographic distribution. Bass *et al.* (1976), Duhamel & Hureau (1982), Compagno (1984), Duhamel & Compagno (1985) and Gushchin *et al.* (1987) tentatively included all Southern Hemisphere specimens of the subgenus *Somniosus* in *S. microcephalus.* In contrast, Francis *et al.* (1988) considered representatives of the subgenus *Somniosus* they recorded from Australia and New Zealand to be *S. pacificus*, and cast doubt on the presence of *S. microcephalus* in the Southern Hemisphere. However, Southern Hemisphere members of this subgenus have never been critically compared with Northern Hemisphere specimens of either *S. microcephalus* or *S. pacificus* which in turn need critical comparison to confirm their separation. The task is made difficult by the size of most specimens of the subgenus *Somniosus* and the paucity of material in museum collections.

Somniosus microcephalus
(Bloch & Schneider, 1801)
Greenland shark

Fig. 2

Squalus microcephalus Bloch & Schneider, 1801: 135. "Habitat in mari glaciali". Holotype: None.

?*Somniosus antarcticus* Whitley, 1939: 242. Macquarie Island. Holotype: None.

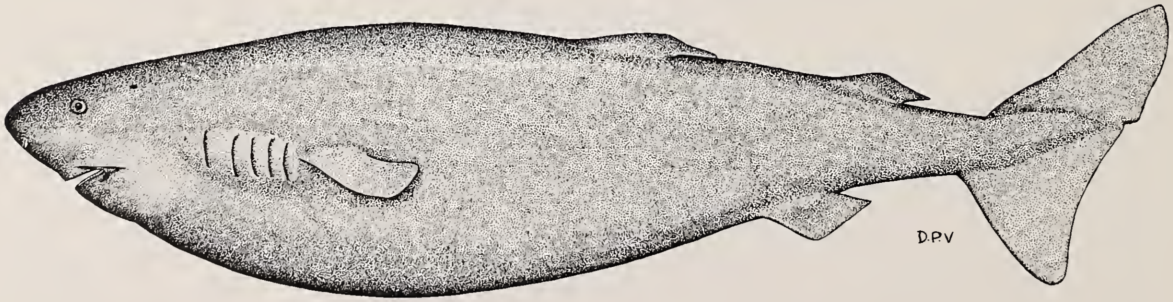
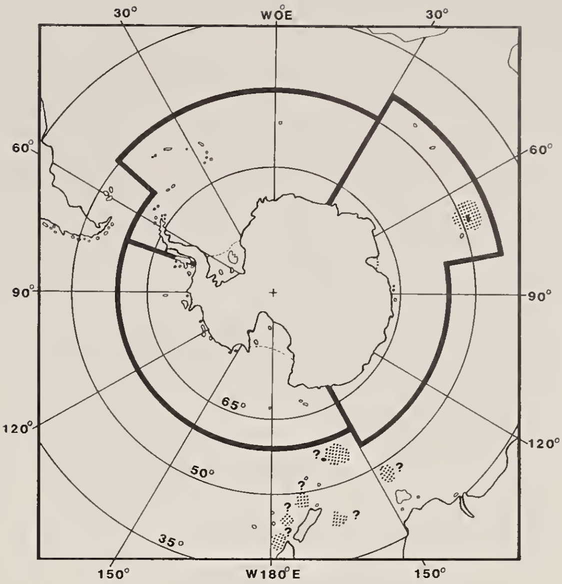


Fig. 2. *Somniosus microcephalus* 4.4 m TL, female, off Cape Columbine, South Africa (from a cast in the South African Museum; colour pattern from a photograph by G. Duhamel of a shark captured in Kerguelen Islands)

Diagnosis: Head length about 23% TL. Snout short and broadly rounded. Interdorsal space greater than distance from snout tip to second gill slits. Dorsal-caudal space less than twice second dorsal-fin base. Pelvic-caudal space less than dorsal caudal-fin margin. Rear end of first dorsal-fin base slightly closer to pelvic-fin origins than rear end of pectoral-fin bases. Cusps of lower teeth short, low, and oblique, tooth roots high; tooth row count 45–52/48–53. Vertebral centra obsolete, notochord secondarily expanded.

Colour: In life, dusky grey to dark brown or blackish above and below, sometimes with obscure narrow, dark, transverse bands and small white spots.

Distribution: Most records of the Greenland shark are from the North Atlantic and Arctic: from Cape Cod and the Gulf of Maine (eastern USA) to the Gulf of St. Lawrence, Ellesmere Island, Greenland, Iceland, Spitzbergen, the White Sea (north-western USSR), Norway, the United Kingdom, France, and possibly Portugal. In the South Atlantic there are records of this shark from Cape Columbine, South Africa, and from southern Argentina, and another possible record from Macquarie Island in the western South Pacific. In the Southern Ocean it occurs around the Kerguelen Islands (Duhamel & Compagno 1985).



Distribution of *S. microcephalus*

Remarks: The Greenland shark is a sluggish shark of cold waters, which regularly occurs inshore in high Arctic latitudes but seems to be confined to deep water and the upper slopes down to at least 1,200 m depth closer to the Equator. This shark is an uncommon, seasonal, but regular trawl catch on the Kerguelen Shelf at depths of 200 to 360 m and at water temperatures of 1.8–3°C. The Greenland shark is a voracious, indiscriminate predator that feeds on a wide variety of pelagic and bottom-living bony fishes and chondrichthyians, as well as seals and small cetaceans, sea birds, crustaceans, cephalopods, gastropods, echinoderms, and even jellyfish. It readily scavenges on carrion from sealing, whaling, and fishing operations, and has been known to eat dead reindeer and horses. Off the Kerguelen Islands, *Champsocephalus gunnari*, *Notothenia squamifrons* and skates (Rajidae) are recorded as prey (Duhamel & Compagno 1985). Greenland sharks are ovoviviparous, with 1 litter of 10 young reported. It is one of the largest living sharks, attaining a maximum length of at least 6.4 m and possible up to 7.4 m, but most adults are between 2.4 and 5 m.

RAJIDAE

Skates

by M. STEHMANN & D.L. BÜRKEL

Head and body extremely flattened dorsoventrally. Head, trunk and the greatly expanded pectoral fins forming a sub-rhombic to sometimes rather rounded disc. Pectorals completely fused to sides of head and trunk from about snout tip to pelvic insertion. Tail distinctly marked off from disc, rather slender, usually gradually tapering to its tip, less than twice disc width in length, and with lateral folds over part or entire length. Eyes and spiracles on top of head; nostrils, mouth and 5 pairs of gill slits on underside of head. Snout shape varies from acutely angled and long to obtusely rounded and short. Front of cranium extended in most species as a rostral process, which may be stout or delicate, in the latter case sometimes segmented basally or distally. Anterior pectoral-fin rays and their basal elements either extending almost to snout tip in "soft-snouted" species with a delicate or even reduced rostral process, or only to about midlength of snout in "hard-snouted" species with stout rostrum.

Mouth transverse, with numerous small teeth in bands along jaws. Teeth obtuse to pointed, showing sexual dimorphism in many species, and set either in pavement pattern (quincunx), or in parallel rows, or in combination of both. Nostrils and corners of mouth connected by oronasal grooves covered by expanded inner margins of nostrils, which form a large bilobed, transverse nasal curtain in front of mouth. Anterior lobe of pelvic fin set off by a notch in lateral margin of fin. Two, small, subequal dorsal fins on rear end of tail. Tail tip with low upper caudal fold and sometimes also with rudimentary lower fold or keel.

Dermal denticles (placoid scales) never cover completely upper and lower surfaces of disc and tail, and modifications of such spinules as thornlets and/or thorns usually present on upper side only. Thorns almost regularly arranged in pattern of patches, rows and singly on distinct regions, and at least a median row of thorns present along upper tail. Generally, malar and alar thorn patches on outer disc developed in sexually mature males only. Squamation may vary with growth and sexual maturity.

Coloration extremely variable, also intraspecifically, depending on habitat, nature of substrate, growth, age and even sex. Ground colour of both surfaces may be white, or almost black to all shades of grey and brown; a few species are reddish or bluish-violet. Besides plain coloration, all kinds of pattern may be shown especially on upper side, and sensory pores are marked blackish in some groups. Underside of disc usually differing from upper side in being less variegated and predominantly white in shallow water species.

Excluding 4 rajoid genera with uncertain family assignment, there are at present 12 genera with about 150 species world-wide. Rajids range from about 20–30 cm TL, e.g. in *Neoraja* and *Gurgesiella*, to more than 2 m TL, e.g. in *Bathyraja* and *Raja* (*Dipturus*). Skates occur in all oceans from Arctic to Antarctic latitudes and from coastal waters down to the abyssal plains, and they become rare only in shallow tropical waters and coral reef areas. Exclusively marine, they are typical bottom dwellers and relatively stationary, except for migrating large deep water forms, and feed on all kinds of benthic prey. All skates are oviparous, depositing on the bottom large rectangular horny egg-capsules, and have a very low annual reproductive rate. Skates are commercially fished in several parts of the world, and only their wings (pectoral fins) are used for human consumption.

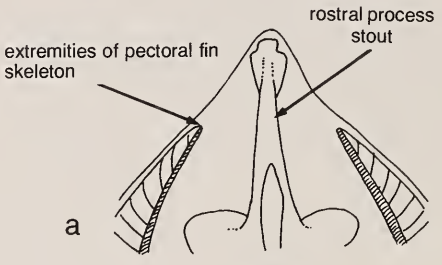
In Antarctic waters south of 60 °S, rajids are the only chondrichthyan representatives, and even in sub-Antarctic latitudes, rajids are the dominant group of cartilaginous fishes. Skates are a regular bycatch in bottom trawl fisheries, and their commercial exploitation on a moderate level can be expected in the Southern Ocean.

Major taxonomic revisions were on a regional basis only, or treated only selected infrafamilial taxa, e.g. Ishiyama (1952, 1958), Bigelow & Schroeder (1948, 1953), Hulley (1970, 1972), Stehmann (1970, 1985), McEachran (1982).

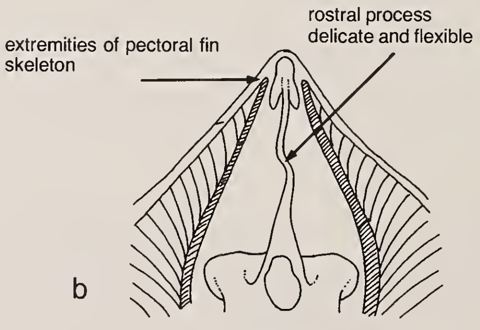
KEY TO GENERA

1a Rostral process stout and firm, extending beyond extremities of P skeleton (visible in transmitted light) which distinctly fall short of snout tip (hard-snouted species, Fig. 2a) ...... *Raja*

1b Rostral process delicate and flexible, extending to snout tip, where almost reached by extremities of P skeleton (soft-snouted species, Fig. 2b (visible in transmitted light)) .... *Bathyraja**



Raja



Bathyraja

Fig. 2. The rostral process and anterior end of pectoral fin skeleton in skates of the genera *Raja* (a), and *Bathyraja* (b)

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* Would equally apply to 1 species in the area possibly representing a 3rd genus and here provisionally keyed out as *Bathyraja* sp.

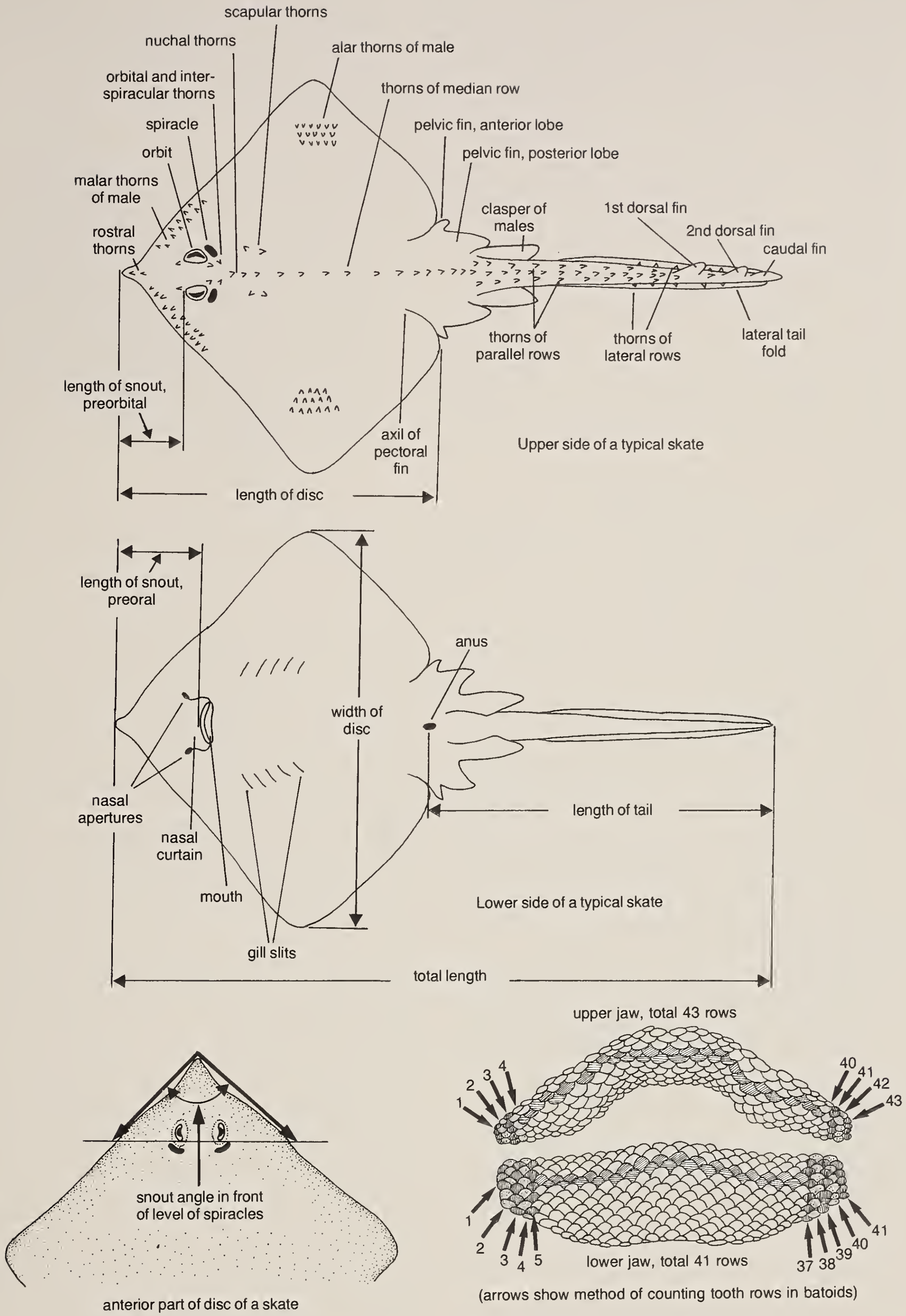

Fig. 1. Technical terms and method of measurements used in the study of skates

Genus *Bathyraja* Ishiyama, 1958

See key to genera for diagnostic characters. In addition, claspers of adult males rather long and slender, with the glans short, hardly widened and with a few simple structures only. Alar thorns of mature males stiff, claw-like, permanently erect and not embedded in dermal pockets.

This genus represents by far the greatest specific diversity among all rajoid genera with at present about 45 species known from all around the world. These represent 3 morphotypes of shallow water, transitional, and deep-water species (Stehmann 1986), of which only the latter morphotype so far has not been reported from the Southern Ocean. Six species are known in circum-Antarctic continental waters and around sub-Antarctic islands, where they represent the dominant rajid group. Species range from very small (*Bathyraja* sp., possibly representing a related genus however) to rather large size of more than 100 cm TL. Reported from the Ross Sea (rare), around Kerguelen Islands, from the continental margin in the Indian Ocean sector, the Weddell Sea, around the Antarctic Peninsula, South Shetland and South Orkney islands, and at the deep slope of South Georgia.

KEY TO SPECIES

1a Thorns absent on disc dorsally; only a median row present along tail 2

1b Orbital and/or nape and shoulder thorns present and a median row along tail, which extends onto disc in juveniles of some species 4

2a Plain dark to blackish-brown on both surfaces; nostrils, jaws, gill slits, tip of anterior V lobes, and origin of tail may be marked white ventrally; 37–39 thorns along midline from nape to D_1, of which about 10 on body are probably lost in adults (see also couplet 5a) .... *B. meridionalis*

2b Underside of disc predominantly white 3

3a A band of densely set fine prickles around disc margins and along midbody dorsally; but centres and rear margins of P are smooth (except for entirely spinulose small juveniles); 8–18 small, widely-spaced, median thorns along tail to D_1 (posterior thorns may be reduced in adults); (see also couplet 7b) .... *B. eatonii*

3b Upper side of disc always entirely and densely set with coarse spinules. 18–29 indistinct median tail thorns to D_1; disc plain dark above except in juveniles less than 25 cm TL, which show pattern of light dots and streaks; underside of disc and tail whitish; pale dark spots may be present on tail and centrally on disc; mouth cavity and underside of nasal curtain at least partly pigmented dark .... *Bathyraja* sp.*

4a Underside of disc and tail mostly, or entirely dark 5

4b Underside of disc and tail entirely, or mostly white 6

5a Plain blackish-brown below, only nostrils, jaws, gill slits, tips of anterior V lobes, and origin of tail may be marked white; no orbital or nape/shoulder thorns, but a median row of about 40 thorns from nape to D_1 in juveniles and halfgrown specimens, of which about 10 thorns on disc probably lost in adults (see also couplet 2a) .... *B. meridionalis*

5b Predominantly dark brown ventrally, but always with an irregular white band from mouth along 2/3 of midbody; ventral dark brown areas may fade to pale greyish-brown and thus become less obvious in large adults; 1 preorbital and 1 postorbital thorn always present; additionally 1 or 2 supra-orbital and 1 postorbital thorns may also be present; 9–23 indistinct median thorns along tail to D_1; dorsal side plain dark and entirely, and very densely, set with coarse spinules .... *B. irrasa*

6a Upper side of disc generally very rough, with scattered coarse spinules and thornlets; P centres more or less smooth only in mature males; 1 preorbital, and 1 postorbital thorn, as well as 2 or 3 thorns medially along nape/mid-shoulder and 1 or 2 on each shoulder; juveniles with a continuous median row of 21–26 distinct thorns from behind shoulder girdle to D_1, reduced to 12–19 on tail in larger specimens.... *B. murrayi*

6b Upper side of disc largely smooth in P centres, except in very small juveniles; median thorns on disc generally absent posterior to shoulder girdle; orbital and/or nape and shoulder thorns present or absent 7

7a A distinct thorn in front of and behind each eye and on each shoulder; median thorns on disc absent; 8–15 distinct thorns along midline of tail to D_1 .... *B. maccaini*

7b No thorns on disc (see also couplet 3a), or 1 or 2 large median thorns on nape/shoulder; 8–18 indistinct median tail thorns, of which posterior ones in front of D_1 often reduced .... *B. eatonii*

Bathyraja eatonii (Günther, 1876)
Fig. 3

Raja eatonii Günther, 1876: 390, Royal Sound, Kerguelen Islands. Holotype: BMNH 1876.3.23.21.

Diagnosis: Snout projecting and pointed at an angle of less than 90°, except for small juveniles. Tail length exceeding disc length in juveniles less than 25 cm TL, but tail shorter than disc length in larger specimens. Lateral folds along almost entire tail length; originating at pelvic axils as indistinct keels, widening as narrow folds from shortly before dorsal fins onward, and terminating a short distance before tail tip. Small juveniles finely spinulose over entire upper side of disc. Larger specimens largely smooth on disc dorsally, with bands of fine and (with growth) coarser spinules along anterior margins, parallel to posterior margins and along midbody and tail. Pectoral centres and pelvics usually smooth, occasionally slightly prickly. Underside perfectly smooth. Disc with only 1 or 2 thorns medially on posterior nape/mid-shoulder (these may be lost but scars usually remain); 8–18 relatively small thorns along midline of tail, with posterior ones tending to become reduced in large specimens, and occasionally a small thorn between dorsal fins.

Colour: In life, dorsal surface in various shades from pale through dark ochre to greyish-brown, with the semi-transparent "rostral triangle" usually appearing lighter. Individuals may be plain coloured, but more often show patterning of dark and/or light spots or even a marbled pattern. Specimens with predominantly pale circular blotches occur, as well as those with a pair of large, light pseudo-ocellar blotches on posterior pectorals. Underside of disc white, although greyish-brown speckles may appear mainly along posterior disc margins and around the anus. Underside of tail may be entirely brown, or with a brown median stripe, or at least partly spotted brown (mainly in specimens from Kerguelen Islands). Specimens from the Atlantic Ocean sector and 1 recorded from the Ross Sea have a white underside of tail with, at most, a few pale brown spots.

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* A full species description is currently being prepared by M. Stehmann (ISH). Probably represents a genus of "soft-snouted" skates different from *Bathyraja*. Identical with specimens misidentified as the Patagonian *Bathyraja griseocauda* (Norman, 1937a) by Bigelow & Schroeder (1965), and Springer (1971). Though possibly the most abundant rajid species in the Atlantic sector, where commonly trawled e.g. on the shelf around South Orkney Islands, it represents a presently unresolved nomenclatorial problem; see Stehmann (1985: 222 for *Bathyraja* sp. 2 and *Raja arctowskii* Dollo, 1904). Apparently mainly inhabiting shelves off South Orkney and South Shetland islands; rarer on continental shelf and slopes, even to greater depth around the Weddell Sea, from which areas ISH holds more than 200 specimens. Few additional records (Stehmann, unpubl. data) from Indian Ocean continental waters indicate a possibly circum-Antarctic distribution.

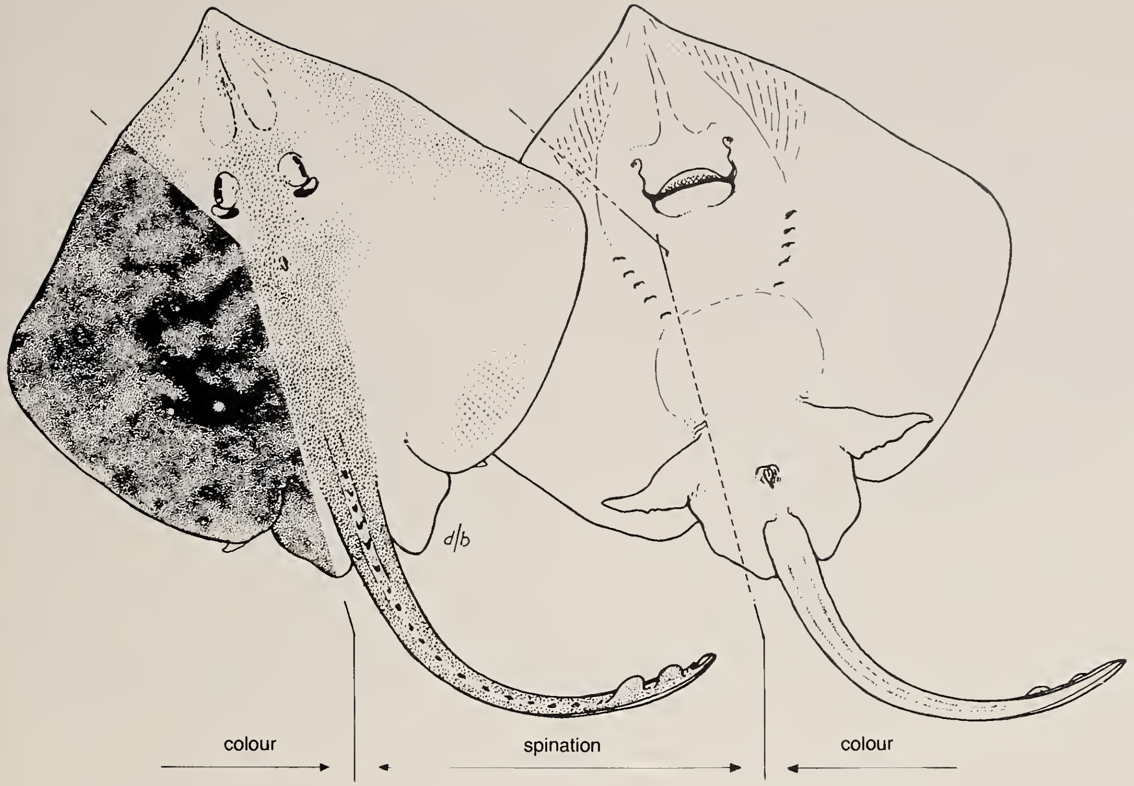


Fig. 3. *Bathyraja eatonii* ISH 277/81, 287 mm TL, juvenile female, off South Shetland Islands (61°05.2′S, 56°03.5′W), 200–250 m

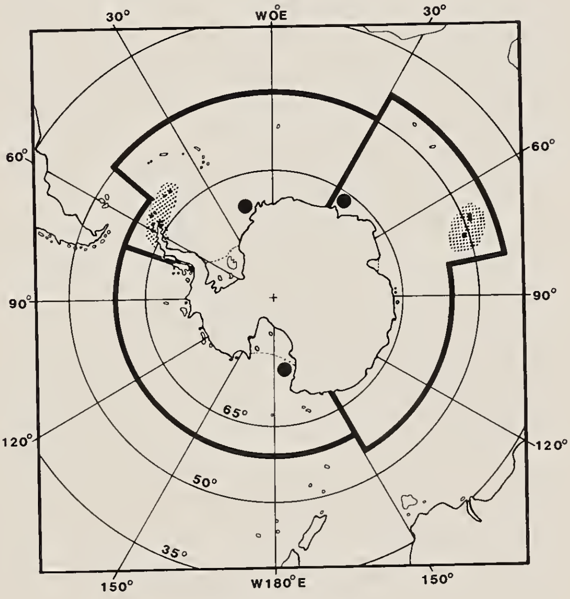
Distribution: Common on the Kerguelen Plateau and its slopes at depths of about 15–800 m. Also known from around South Orkney and South Shetland islands, towards the Antarctic Peninsula, and in the northeastern Weddell Sea and on Gunnerus Ridge (Stehmann, unpubl. records). Only a single record from the Pacific Ocean sector; *Eltanin* station 2031 at 535 m depth in the inner Ross Sea (Stehmann, unpubl.), a juvenile female (LACM 11108–2).

Remarks: The confirmed distributional records, of which those from the Atlantic and Pacific sectors are rather recent, indicate a circum-Antarctic occurrence of the species. Previously the species was considered to be endemic to Kerguelen waters (e.g. Hureau 1966c). In the latter area, the species is exploited commercially by trawler fisheries.

Hulley (1970: 215) has synonymised *B. eatonii* with the South African *B. smithii* (Müller & Henle, 1841) based on a preliminary external examination of the claspers of both species. This synonymy appears to be incorrect, although there has been no detailed comparison of the skeletal anatomy of these species. Even juvenile *B. eatonii* never possess orbital, scapular and midbody thorns as do juvenile *B. smithii*. In addition, larger *B. smithii* have a shorter, more bluntly angled snout, are dorsally prickly on the entire disc, lack any thorns on upper disc, and have the white underside of the disc and pelvics edged blackish—all characters not applying to *B. eatonii.*

Smallest postembryos are about 170 mm TL. Egg-capsule illustrated by Meissner (1987: fig. 2b).

Attains over 100 cm TL.



Distribution of *B. eatonii*

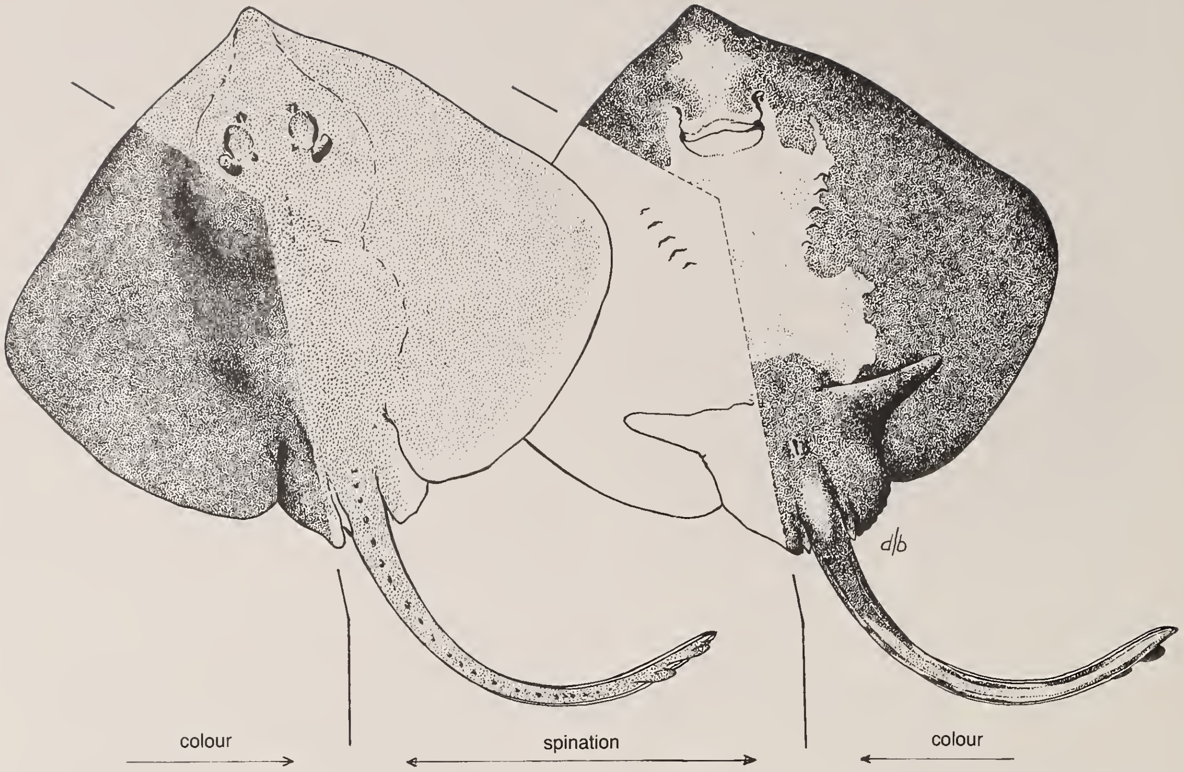


Fig. 4. *Bathyraja irrasa* MNHN 1980–1095, 356 mm TL, paratype, juvenile male, off Kerguelen Islands (48°43.5′S, 71°06.5′E), 925–937 m

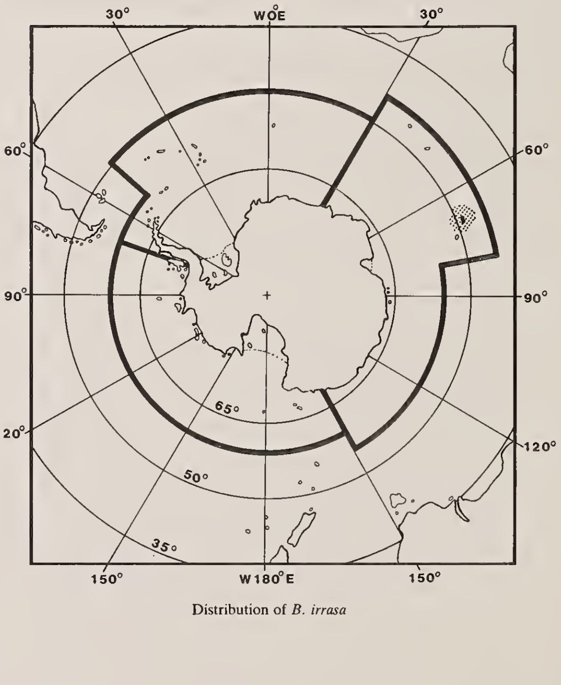
Bathyraja irrasa Hureau & Ozouf-Costaz, 1980
Fig. 4

Bathyraja irrasa Hureau & Ozouf-Costaz, 1980a:19, figs. 2, 3, 6a, off Kerguelen Islands (46°47.7′S, 70°30.2′E). Holotype: MNHN 1980–1092.

Diagnosis: Snout moderately short and bluntly angled. Tail length about equal to disc length. Lateral folds along almost entire tail length; originating at pelvic axils as indistinct keels, widening as narrow folds from shortly before first dorsal fin onward, and terminating variably at post-dorsal tail length. Upper side of disc, including eyes, posterior pelvic lobes, tail and dorsal fins, totally and densely set with coarse spinules; only margins of disc and pelvic fins narrowly smooth, as well as almost entire anterior pelvic lobes. Lower surfaces completely smooth. A pair of distinct preorbital thorns always present, additional smaller supra- and/or postorbital thorns may occur, but no other thorns on disc; 9–23 indistinct thorns widely spaced along midline of tail, of which those in posterior third of tail often become very small or totally reduced. No thorns in short interspace between dorsal fins.

COLOUR: In life, dorsal side plain dark greyish-brown, with midline of body and tail sometimes darker coffee-brown. Lower side of disc and pelvics predominantly dark brown, but always an irregular-shaped broad whitish band from about mouth rearward along two-thirds of midbody. The dark brown areas may be faded to much less obvious pale greyish-brown in large adults. Underside of tail plain brown, or whitish with brown spots, but origin and tip of tail always white.

Distribution: Moderately rare on slopes around Kerguelen Islands at about 300–1,200 m. Egg-capsules and young found as shallow as about 140 m (Stehmann, unpubl.) As a rather deep-dwelling species, *B. irrasa* may have a wider distribution along the slopes of the Kerguelen Plateau and even the Antarctic continent in the Indian Ocean sector.



Distribution of *B. irrasa*

Remarks: Egg-capsule illustrated by Meissner (1987: fig. 2d).

Attains about 120 cm TL.

Bathyraja maccaini Springer, 1971
Fig. 5

Bathyraja maccaini Springer, 1971: 7, figs. 3, 4C, Low Island, Antarctic Peninsula (63°25′30″S, 62°09′30″—62°05′36″W). Holotype: USNM 202702.

Raja rakusai Rembiszewski, 1980: 95, fig. 1, off Elephant Island (61°11′—61°20′S, 56°04′—56°32′W).

Diagnosis: Snout moderately short and bluntly angled. Tail length exceeding disc length in juveniles to 25 cm TL, but equal to or shorter than disc in larger specimens. Lateral folds along almost entire tail length; originating as keels at pelvic axils, widening as narrow folds from shortly before first dorsal fin onward, and terminating a short distance before tail tip. Small juveniles entirely spinulose on upper disc, though pectoral centres even at small size loosely prickly only. In larger specimens, upper side of disc largely smooth centrally, with broad bands of coarse and rather sparsely scattered spinules around outer margins of disc, along midbody and on tail. Underside completely smooth. A pair of large thorns always present in pre- and postorbital position and on shoulders, but no further thorns on disc; 9–15 rather distinct thorns along midline of tail to first dorsal fin, and occasionally a small thorn between dorsal fins. Thorns often blunt, with tips abraded in larger specimens.

Colour: In life, upper side medium to dark greyish-brown, with the semi-transparent "rostral triangle" often appearing lighter. Regularly with pattern of more or less distinct light spots and circular blotches on disc, pelvics, and laterally on tail, the spots being more obvious in smaller specimens; 1 or more pairs of pseudo-ocellar pale blotches may be apparent on posterior pectorals. Lower side of disc predominantly white, but larger specimens may show pale greyish-brown speckles or speckled-blotches at and around anus, laterally along belly, at shoulders, and along posterior disc margins. Underside of tail usually plain white, rarely with some greyish spots or median stripe.

Distribution: Probably the most abundant larger species of *Bathyraja* in the Southern Ocean. Frequently recorded from the Atlantic Ocean sector only around South Orkney and South Shetland islands to the Antarctic Peninsula at depths from inshore shelf to about 500 m. Two specimens were collected in 1987 in Prydz Bay at depths of 307–319 and 431 m. Probably more widespread in continental Antarctic waters into the Weddell Sea and eastward, as well as into the Pacific Ocean sector westward.

Remarks: Regularly taken as bycatch in bottom trawl hauls and probably utilized for fishmeal.

Attains about 120 cm TL.

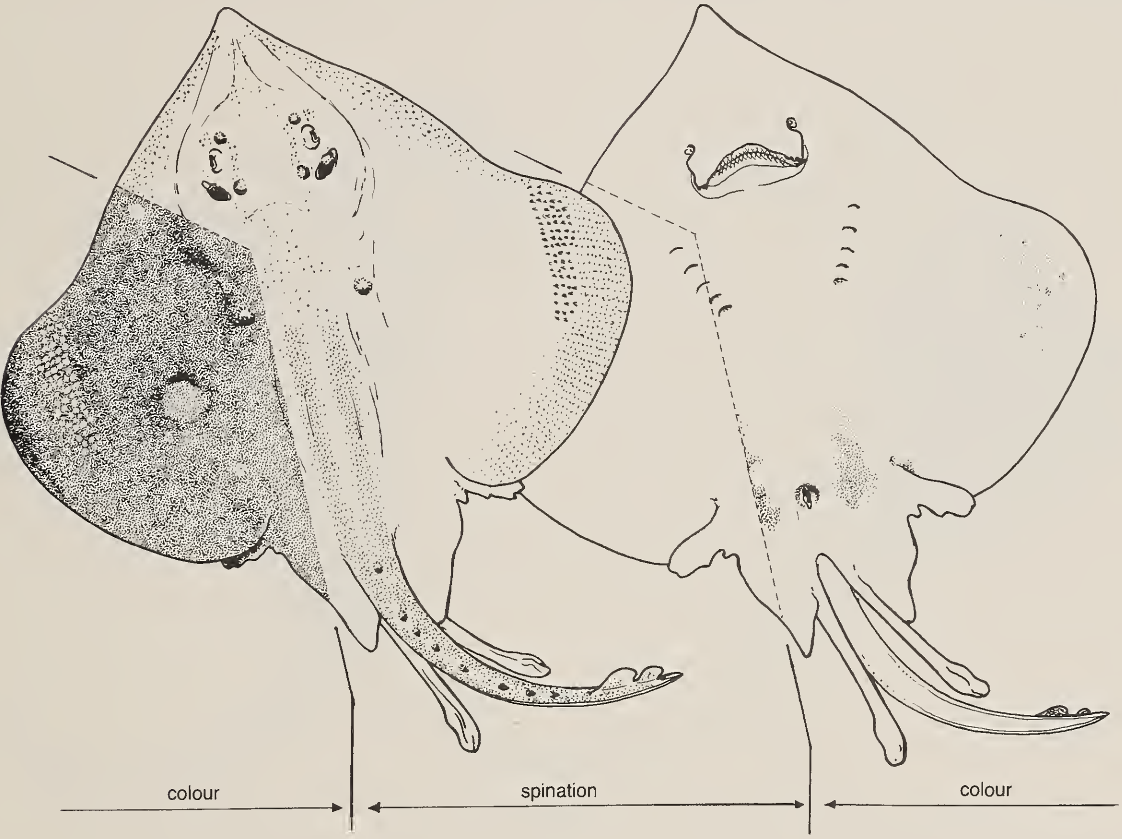
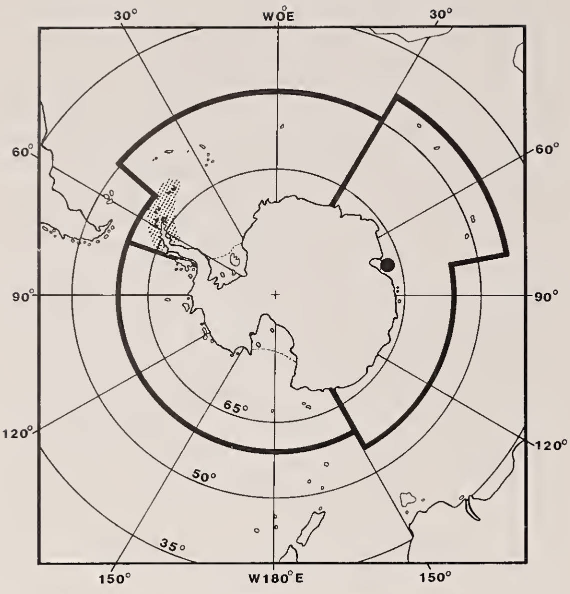


Fig. 5. *Bathyraja maccaini* ISH 298/77, 94 cm TL, male, off South Shetland Islands (61°15.4′S, 56°04.8′W), 288–300 m



Distribution of *B. maccaini*

Bathyraja meridionalis Stehmann, 1987
Fig. 6

Bathyraja meridionalis Stehmann, 1987: 35, figs. 1–9, east of South Georgia Island (53°56′S, 35°40′W). Holotype: ISH 328/76.

Bathyraja sp. 1: Stehmann, 1985: 220, 221, 222; Stehmann, 1986: 263.

Diagnosis: Snout moderately short and bluntly angled. Tail length somewhat exceeding disc length. Lateral folds along almost entire tail length; originating as keels at pelvic axils, widening as narrow folds in posterior two-thirds, and terminating shortly before tail tip. Dorsal side of disc covered with scattered, coarse, sharp prickles, more densely set only at anterior disc margins, in a broad band along midbody, and along sides of tail. Pelvic fins smooth above, except for few spinules scattered at rear margin of posterior lobes. Ventral surfaces smooth, except for a row of spinules scattered along edges of tail origin. A continuous median row of 37–39 distinct thorns from nape to first dorsal fin and smaller thorn between dorsal fins; no further thorns on disc. Median thorns on disc may be lost in fully-grown specimens, so that only 28 along tail would persist.

Colour: In life, plain coffee- to blackish-brown dorsally with spinules and especially the thorns marked off milky-white. Lower surfaces, including pelvic fins and tail, plain dark greyish-brown. Nasal flaps, edges of nasal curtain, jaws, gill slits, and anterior distal edge of anterior pelvic lobes marked creamy-white.

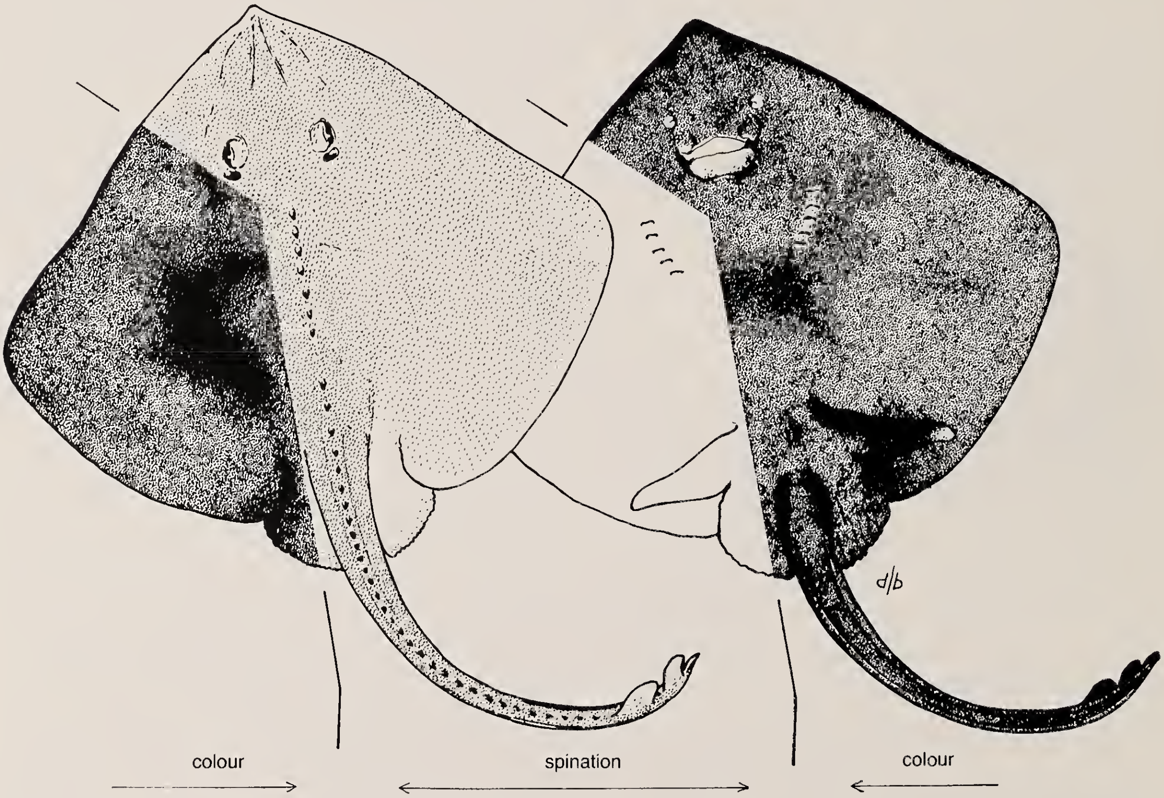
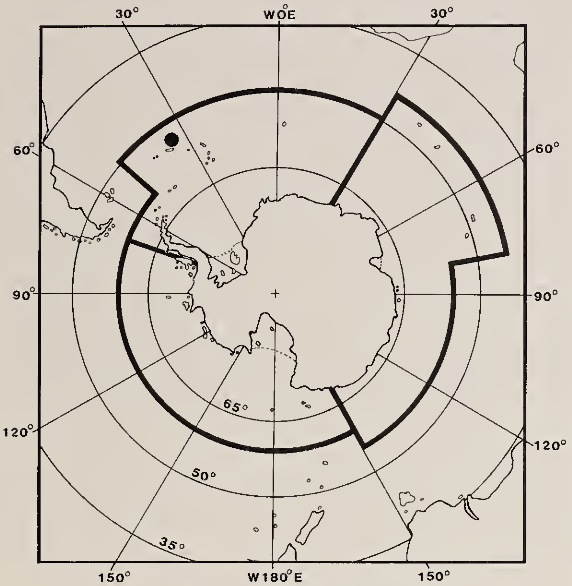


Fig. 6. *Bathyraja meridionalis* ISH 348/76, 446 mm TL, paratype, juvenile female, off South Georgia Island (53°44′S, 36°17′W), 767–800 m

Distribution: Known only from the type specimens, a juvenile female of about 45 cm and a subadult male of about 120 cm TL, which were both taken on the eastern slope of South Georgia Island at 760–800 m depth.



Distribution of *B. meridionalis*

Remarks: According to Dr A. Neelov (ZIN, pers. comm. 1986), a few large specimens (about 150 cm TL) of a skate were reported by Soviet colleagues from near Balleny Islands in the western Pacific sector from deep water. Part of these were found in sperm whale stomachs, others were caught. As none of these specimens were preserved, their specific identity cannot be verified. Having compared notes on these specimens with photographs and a brief diagnosis provided of the ISH specimens, however, Dr Neelov considered the Soviet records to be the same species. This would indicate a circumglobal Southern Ocean distribution of *B. meridionalis*, which can be expected of such a deep-water species.

Attains more than 120 cm TL, as the subadult holotype measures this length.

Note: Table 2 of the original description erroneously notes 10 *Diplospinus multistriatus* among the bycatch of the paratype's station WH 39/76. In fact, these were *Paradiplospinus gracilis* as were the 12 specimens of the holotype's station WH 33/76.

Bathyraja murrayi (Günther, 1880)
Fig. 7

Raja murrayi Günther, 1880: 15, pl. V, Kerguelen Island. Syntypes: BMNH 1953.8.10.2–5.

Diagnosis: Snout short, and more or less bluntly angled, however more narrowly angled in adults. Tail length exceeding disc length in small specimens, about equal in adults. Lateral folds along almost entire tail length;

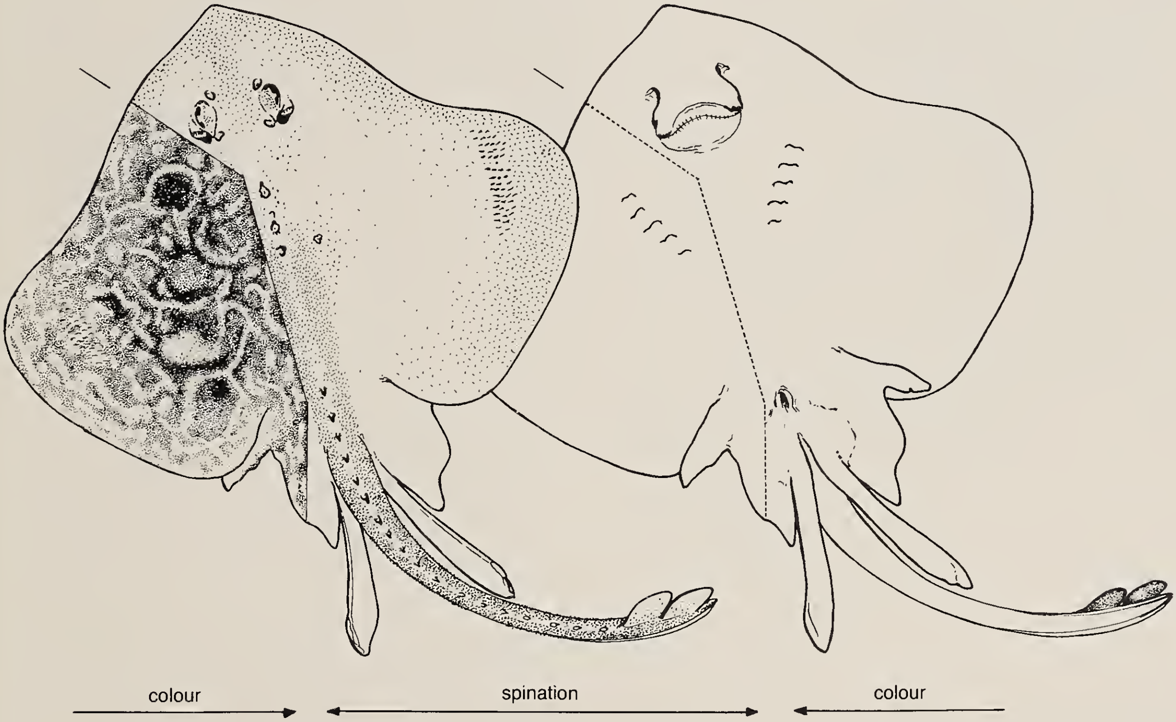
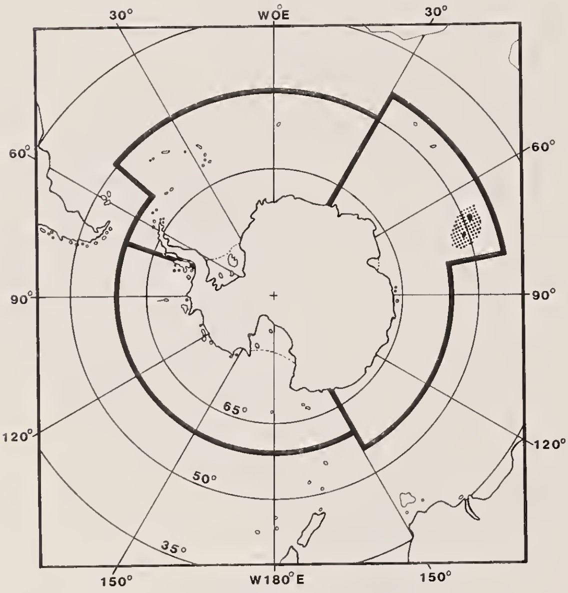


Fig. 7. *Bathyraja murrayi* ISH 60/83, 468 mm TL, male, off Kerguelen Islands (48°12'S, 70°50'E), 145 m

originating as keels at pelvic axils, widening as narrow folds in posterior third, and terminating a short distance before tail tip. Upper side of disc very rough with scattered coarse spinules and, in larger specimens, additional thornlets; adult males may show bare pectoral centres, while adult females may have these sparsely spinulose. Lower surfaces completely smooth. A pair of distinct pre- and postorbital thorns, 2 or 3 on midline of nape, 1 or 2 on each shoulder, and usually 1 on mid-shoulder; smaller additional thorns may be present in supraorbital, supra- and interspiracular positions. Up to 26 thorns in a median row from behind shoulder girdle to first dorsal fin in juveniles, with only 12–19 remaining along tail in larger specimens.

Colour: In life, often plain medium to dark brown, or greyish-brown dorsally, but specimens with extremely variegated patterns are common. Such individuals may be light and dark spotted to even marbled appearance, and large specimens tend to show a pair (rarely more) of light, dark-edged large pseudo-ocellar blotches on inner pectorals. Underside extremely variably patterned, although mostly predominantly white; the disc often with solid or blotched broad dark margins, and additional dark spots may be scattered on disc. Specimens with a predominantly dark disc occur but they still have irregular white areas across the centre and around mouth. Underside of tail may be plain white, but is usually speckled or spotted brown, or with brown median or lateral stripes, and may even be almost plain dark.

Distribution: A common species around Kerguelen and Heard islands at about 30–650 m depth, but more abundant at shallower depths.



Distribution of *B. murrayi*

Remarks: *B. murrayi* is currently considered an endemic of the Kerguelen Plateau. It is frequently taken in commercial bottom hauls, but probably not much utilised due to its small size. Smallest post-embryos known are about 110 mm TL. The egg-capsule was illustrated by Meissner (1987: fig. 2c).

Attains about 60 cm TL.

Genus *Raja* Linnaeus, 1758

See key to genera for diagnostic characters. Claspers of mature males more or less elongated and rather solid, with the glans relatively long and more or less widened and containing quite a number of fleshy and cartilaginous structures in a complicated arrangement. Alar thorns of adult males awl-shaped, embedded in dermal pockets and erectile.

This genus combines the greatest number of rajoid species, but has been subdivided by authors into a number of well defined subgenera during the past 40 years, however none of these subgenera is comparable in its specific diversity to the genus *Bathyraja*. Species range from about 50 cm TL (e.g. subg. *Rajella)* to more than 200 cm TL (e.g. subg. *Dipturus*, *Rostroraja)* and are found over a depth range from inshore to deep slope waters. Probably only the subgenus *Amblyraja* Malm, 1877 occurring in the Southern Ocean with 2 species.

Remarks: *Raja arctowskii* Dollo, 1904, was originally described based on 3 empty egg-capsules and on this basis cannot be related with certainty to any described Southern Ocean rajid species, or be verified as a valid taxon. The species therefore is excluded here, but the case is under investigation by the author at ISH.

A *Raja* sp. n., as mentioned by McCleave *et al.* (1977: 20) from South Georgia waters, has been cited by Stehmann (1985: 222) as *Raja* sp. of uncertain nature. Nothing further has been published on that juvenile specimen, which was said to be similar to the Brazilian *R. agassizi* Müller & Henle, 1841. However, the latter can hardly be expected as far south as sub-Antarctic waters. The particular specimen was not made available to the present author for investigation. Based on colour photographs of the questionable specimen, provided by Dr R. R. Eakin (USA) to the present author, it is here identified as an immature *Raja georgiana*. The latter is hitherto the only rajid species known from the shelf and upper slope of South Georgia and its vicinity, so that the capture locality also supports the correctness of the identification.

KEY TO SPECIES

1a Usually 24–28 (rarely as few as 20) prominent thorns in a median row from behind shoulder girdle to D_1; most juveniles variegated on upper disc with a pale reticulum, which with growth becomes reduced to numerous light spots, often mixed with more or less distinct dark blotches; large specimens may additionally show pseudo-ocellar pale blotches on inner P; upper side of anterior V lobe as dark as the disc, at most pale-edged. (Atlantic sector, South Georgia mainly) . . . . *R.* (*Amblyraja*) *georgiana*

1b Usually 15–18 (rarely as many as 20) prominent thorns in a median row from behind shoulder girdle to D_1; in all growth stages, dorsal colour pattern of more or less distinct dark blotches on greyish-brown ground colour, sometimes mixed with pale spots but without pseudo-ocelli; anterior V lobes usually white dorsally with sometimes a few dark spots; rarely dark with light edges only. (Indian Ocean sector, Kerguelen-/Crozet islands' slopes) . . . . *R.* (*Amblyraja*) *taaf*

Raja (*Amblyraja*) *georgiana* Norman, 1938
Fig. 8

Raja georgiana Norman, 1938: 4, fig. 1, east Cumberland Bay, South Georgia. Holotype: BMNH 1937.7.12.1.

Diagnosis: Disc broadly subrhombic, with outer corners rather sharply angled. Snout short and obtusely angled, not flexible due to broad and stiff rostral cartilage. Mouth very wide, with 33–42 tooth rows in upper jaw. Tail solid and depressed, its length at most equal to disc length and distinctly shorter in larger specimens. Lateral folds along almost entire length of tail; originating as keels at pelvic axils, widening as narrow folds in posterior half, and terminating a short distance before tail tip. Entire upper side of disc very rough with scattered very coarse spinules and, in half-grown and large specimens, additional strong thornlets. The latter most concentrated on snout, along anterior disc margins, and from pectoral-fin axils along insertion. Midline of body and sides of tail also set with rows of thornlets in larger specimens. Posterior pelvic lobes also rough, with spinules and thornlets, whereas anterior lobes smooth. In mature males, the pectoral centres may be sparsely prickly or almost smooth. Underside of disc, pelvics and tail often completely smooth, but some specimens may have a narrow strip of a few spinules medially on snout tip, and mostly large females also have spinules along outer snout margins. Typically, the dorsal thorns are very large, have a distinctly ribbed basal cone and a radiated basal plate (as have the thornlets too), and are set in almost constant arrangement and number. A pair of preorbital, postorbital and supraspiracular thorns, 1 or 2 medially on nape, 1 on midshoulder, 2 or 3 on each shoulder in oblique or triangular arrangement respectively; 20–28 (usually 24–28) in a regular median row from behind shoulder girdle to first dorsal fin, of which 4–6 are on the body to pectoral axils. Occasionally a small thorn between dorsal fins.

COLOUR: In life, dorsal ground colour rather dark brown to greyish-brown. Specimens may be plain coloured, but more often are patterned with light spots all over the disc and posterior pelvic lobes, the spots at times arranged in oblique lines. Most specimens show pale cross-bars and/or lateral spots on tail. Small juveniles have a reticulated or honeycomb pattern of obvious light lines, which becomes reduced with growth to numerous light spots. Large specimens may additionally show paired pale pseudo-ocellar blotches on the pectorals. Underside of disc and pelvics predominantly white, but regularly with greyish outer margins which may also be speckled or spotted brown; additional dark spots and blotches may be distributed irregularly on centre of disc, at anus, and on pelvic tips. Underside of tail plain white, speckled or spotted pale brown, or with brown median strip.

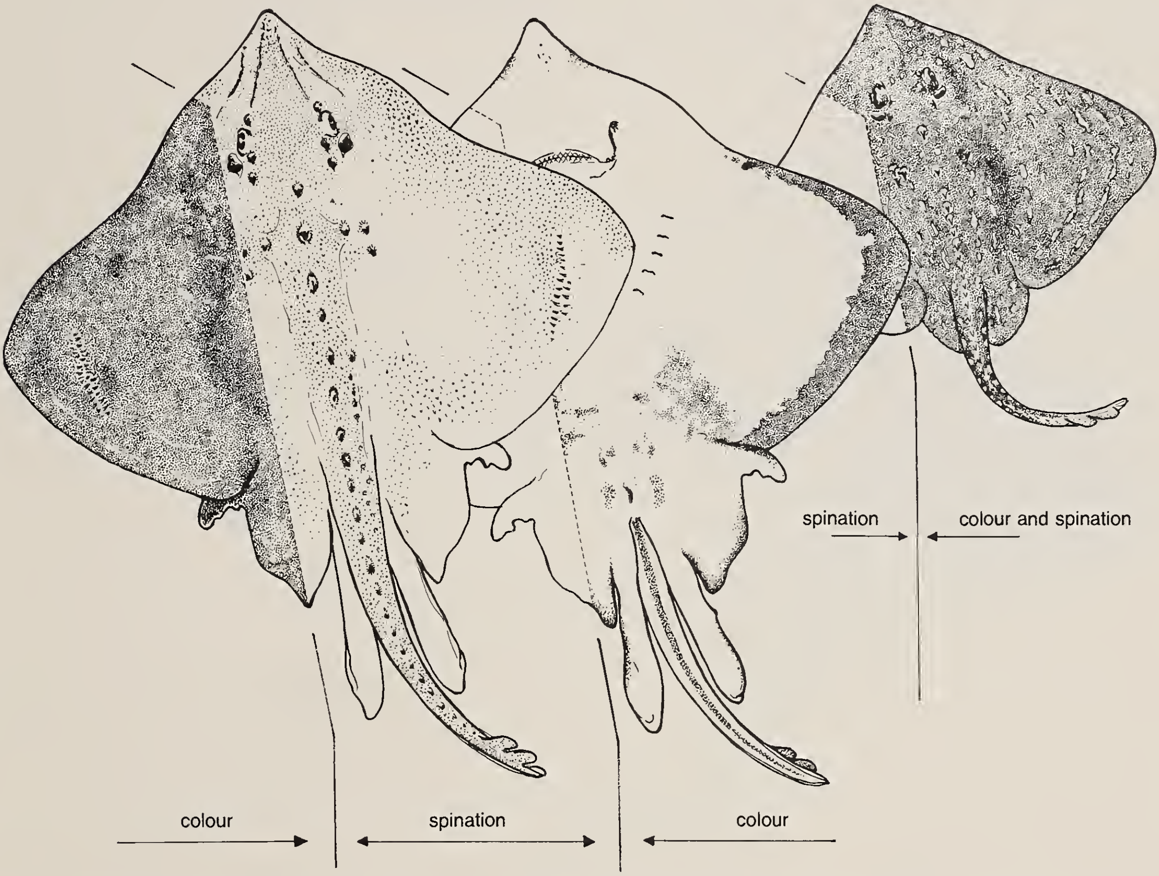
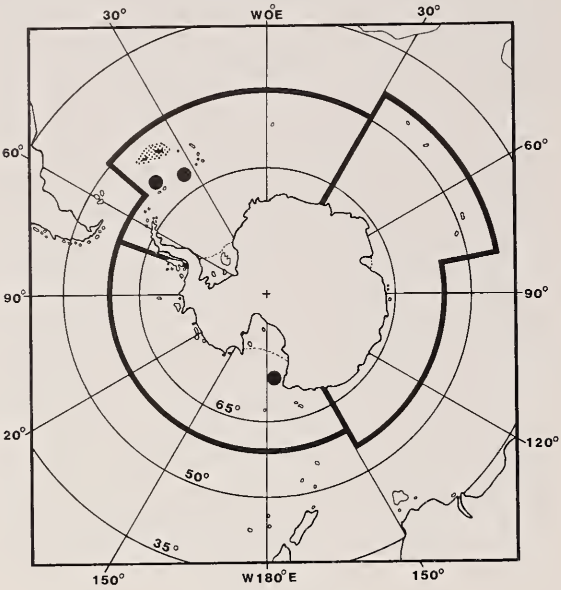


Fig. 8. *Raja* (*Amblyraja*) *georgiana* ISH 1020/76, 88 cm TL, male, off South Georgia Island (53°45′S, 37°38′W), 277–295 m; ISH 1012/76, 240 mm TL, juvenile male, off South Georgia Island (54°25′S, 37°26.5′W), 280–317 m. (Dorsal view at right to show juvenile colour pattern)

Distribution: This abundant species is the only skate on the shelf and upper slope around South Georgia Island and on the ridge westwards toward Black Rocks at about 20–350 m depth. Found occasionally on the Scotia Ridge (Stehmann, unpubl.) as deep as about 660 m and possibly toward the Antarctic Peninsula. The deepest record so far from the Atlantic Ocean sector is an egg-capsule from 90 miles north of South Orkney Islands at about 1,130 m; it contained a late male embryo of 159 mm TL with small yolk sac (ZIN 305–972, Stehmann unpubl.)

So far only 1 juvenile has been reported from the Pacific Ocean sector on the Ross Sea slope (Springer 1971) at 1,232 m depth.



Distribution of *R. georgiana*

Remarks: Frequently taken in bottom hauls around South Georgia and in its vicinity. Probably processed on board commercial trawlers for fishmeal, but the massive wings of this rather large species possibly not used for human consumption due to the extreme roughness of its squamation. Much less abundant outside South Georgian waters and farther south.

Attains 100 cm TL.

Raja (*Amblyraja*) *taaf* Meissner, 1987
Fig. 9

Raja taaf Meissner, 1987: 1840, figs. 1–2, Lena Bank (53°01'S, 44°25'E). Holotype: ZIK 91514.

Raja sp. I Meissner & Kratkii, 1978: 17, sub-Antarctic region of the Indian Ocean sector.

Raja sp. and *Raja* (*Amblyraja*) sp. Stehmann, 1985: 220 (in key), 222 (in list of species), 232 (in comparison with *R. georgiana*).

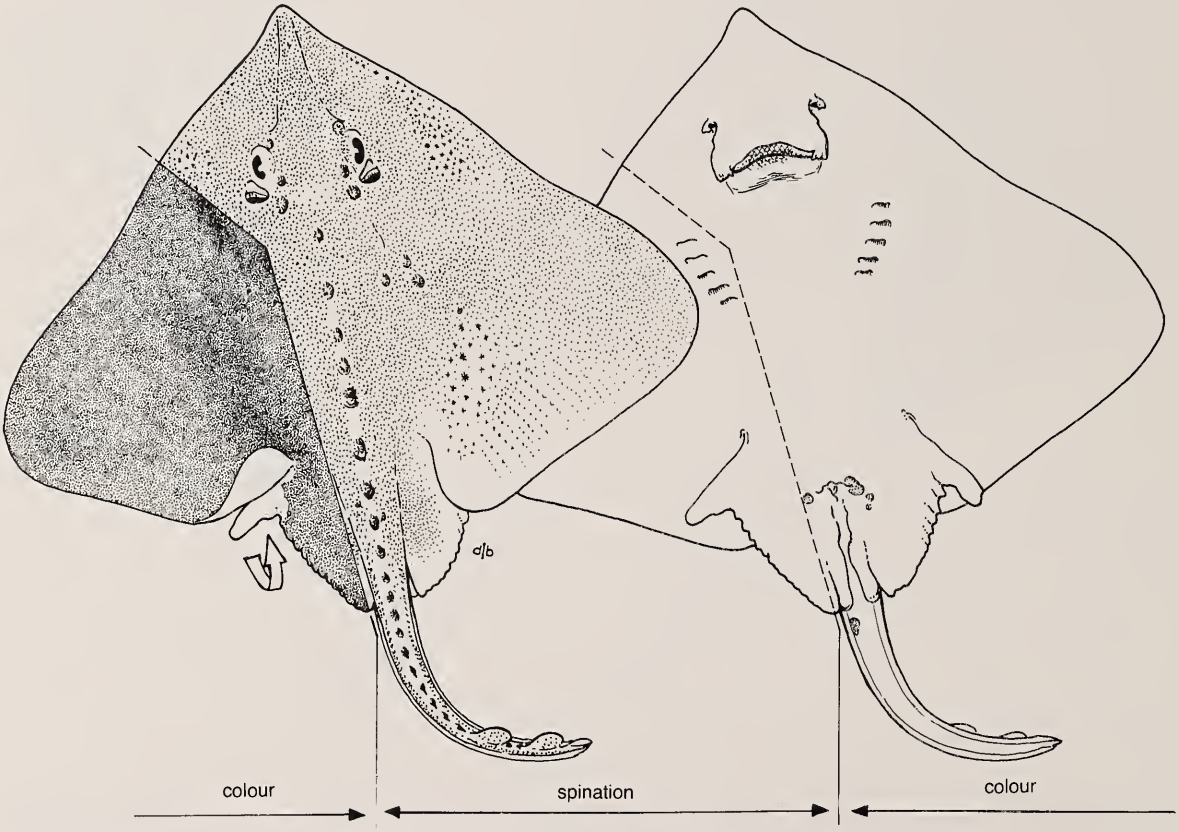
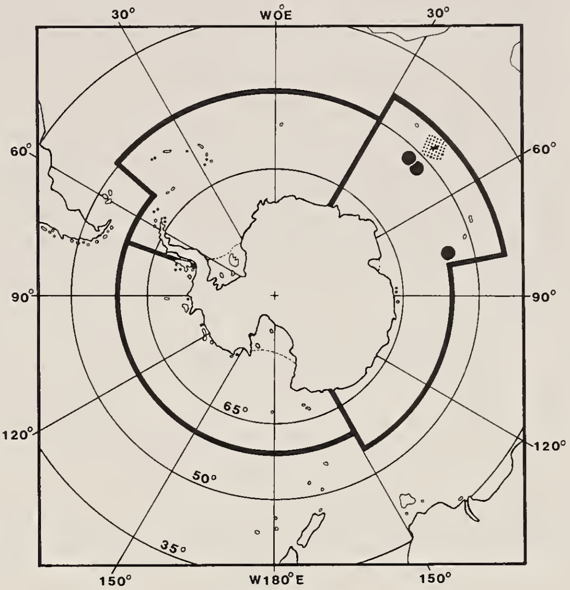


Fig. 9. *Raja* (*Amblyraja*) *taaf* ISH 59/83, 56 cm TL, juvenile male, Crozet Island (45°46'S, 50°03'E), 200–205 m

Diagnosis: Disc broadly subrhombic, the outer corners sharply angled. Snout short and obtusely angled, not flexible due to massive and stiff rostral cartilage. Mouth very broad, with 29–39 tooth rows in upper jaw. Tail solid and broadly depressed, its length about equal to disc length in juveniles but distinctly shorter in adolescent and mature specimens. Lateral folds along almost entire length of tail; originating as keels at pelvic axils, widening as narrow folds posteriorly, and terminating a short distance before tail tip. Entire upper side of disc very rough, with numerous more or less loosely scattered coarse and sharp spinules and, in larger specimens, additional strong thornlets. The latter more concentrated on snout, along anterior and posterior disc margins, and from pectoral-fin axils alongside back to shoulders. Rows of thornlets in larger specimens also along midbody and upper sides of tail. Posterior pelvic lobes also with spinules and thornlets, whereas anterior lobes smooth. Most adult males may have the pectoral centres less prickly. Underside of disc, pelvics and tail mostly smooth, but larger specimens may have a strip of spinules along snout tip. Characteristically, the upper thorns are very large, have an obviously ribbed basal cone and a radiated basal plate, as well as all thornlets too, and are set in almost constant pattern and number: 1 or 2 preorbital; if 2, the outer one may be smaller; 1 postorbital; 1 supraspiracular; 1 medially on nape and on mid-shoulder, respectively; 1 to 4 on each shoulder, mostly 3 in a triangle; and 15 to 20 (usually 16 to 18) in a regular median row from behind shoulder girdle to first dorsal fin, of which 3 to 5 on body to level of pectoral-fin axils. About every second specimen has a small median thorn between dorsal fins.

Colour: In life, dorsal ground colour mostly medium greyish-brown to chestnut-brown, occasionally mainly juveniles lighter to even ochre. Specimens may be plain coloured but more frequently are patterned with more or less distinct large, circular dark blotches on entire disc and posterior pelvic lobes. Only exceptionally faint pale spots are found in addition. Disc and posterior pelvic lobes narrowly edged whitish. Lateral tail-folds light, and occasionally faint pale blotches at sides of tail. The most extraordinary feature of a dorsally dark rajoid, is that the majority of *R. taaf* specimens show a limestone to creamy-white upper side of the anterior pelvic lobes, which thus are distinctly marked off from the dark upper side in general. Rarely specimens have white-edged dark anterior pelvic lobes, and others may show few greyish-brown spots or median stripes on the largely white lobes. Underside of disc and pelvic fins totally or predominantly white. Dark speckles frequently on gill area, margins of disc, along edges of belly, and around anus and on pelvics. Often a pair of dark blotches at anus, and male claspers blotched dark. Underside of tail rarely plain white but more often speckled brown in varying extension, even edged brown, and occasionally almost totally dark.

Distribution: Apparently relatively wide-spread in the sub-Antarctic Indian Ocean at about 150–600 m depth, but it may even be found at greater depths. Records existing from the slopes around Crozet Islands, where most abundant, and from the oceanic submarine Banzare, Kara Dag, Lena and Ob banks. May also occur at greater depth around Prince Edward, Kerguelen and Heard islands.



Distribution of *R. taaf*

Remarks: See remarks under *Raja georgiana* regarding potential utilisation. *Raja taaf* is hereby assigned to the subgenus *Amblyraja* Malm, 1877, of *Raja* Linnaeus.

Embryos hatch at about 170 mm TL, including embryonic tail filament. Egg-capsule illustrated by Meissner (1987: fig. 2a).

Attains 90 cm TL.

HALOSAURIDAE

Halosaurs

by O. GON

Body eel-like, tapering posteriorly to a point. Caudal fin absent, but a pseudo-caudal may be present in specimens with a regenerated tip of tail (McDowell 1973a). Body compressed, head slightly depressed and snout spatulate. A single short-based dorsal fin on front half of body. Anal fin very long, ending at tip of tail. Pelvic fins abdominal. Pectoral fins set on upper half of body. Mouth inferior, with minute teeth in both jaws; teeth present on both maxilla and premaxilla, palatines, and ectopterygoids. Supramaxilla present. Body covered with large cycloid scales. Lateral line near ventral profile of body, its scales enlarged. Head sensory canals well developed. Gill opening large and unrestricted. Gill membranes separate, but membrane of left side overlying right side. Light organs absent.

Three genera and 16 species of benthopelagic fishes, ranging from the continental slope down to the abyssal plains of warm and temperate seas. Larvae pelagic leptocephali probably of the "Tiluropsis" type (Castle 1984). Sexes separate and sexual dimorphism evident in size and colour of male nostrils of adults. Recent revision by McDowell (1973a), and regional treatments by Filatova (1985) and Sulak (1986). One species in our area.

Genus ***Halosauropsis*** Collett, 1896

Monotypic.

Halosauropsis macrochir (Günther, 1878)

Fig. 1; Pl. 1, Fig. 1

Halosaurus macrochir Günther, 1878: 250, off Strait of Gibraltar (*Challenger* station 5) and between Cape of Good Hope and Kerguelen Islands (46°46′S, 45°31′E). Sub-Antarctic syntypes: BMNH 1887.12.7.38–40.

Halosaurus goodei Gill, 1883: 257 (38°53′N, 69°23′30″W) (in part).

Halosaurus niger Gilchrist, 1906: 170, pl. 51, off Cape Point.

Diagnosis: D 10–13; P I,10–13; V I,8–9; GR 3+(12–13) (8 specimens; including rudiments); LL scales in front of anus 24–32; pyloric caeca 7–13; branchiostegal rays 10–13; precaudal vertebrae 56 (1 fish). Body proportions are given as percentage of preanal distance. Greatest body depth 13.2–20.9, depth at level of anal-fin origin 9.8–16.6, head length 25.2–35.2, and head depth 12.2–16.0. Snout length 12.1–19.2, preoral snout length 2.7–6.6, and orbit diameter 2.7–5.4. Predorsal distance 64.3–77.5, prepectoral distance 33.0–44.0, and prepelvic distance 62.2–73.2. Spine of pectoral and pelvic fins much shorter than adjacent soft-ray. Pelvic fins inserted slightly in front of dorsal-fin origin. Both jaws, palatines and ectopterygoids with polyserial bands of small, conical teeth; palatines wide and oval, separated by a small median gap in the front and contiguous with the ectopterygoids in the rear. Lateral-line scales much larger than body scales (arranged as 1 scale every 2–3 vertical rows of body scales). Small scales cover proximal half of dorsal and anal fins. Head naked except for a small patch of scales on upper cheek and temporal area.

Colour: In alcohol, body brown, fins somewhat paler. Head dark brown. Lateral line appears as a dark brown stripe in adults, but has general body colour in young fishes (less than 170 mm preanal distance). Peritoneum dark. Stomach and pyloric caeca pale, gut dusky.

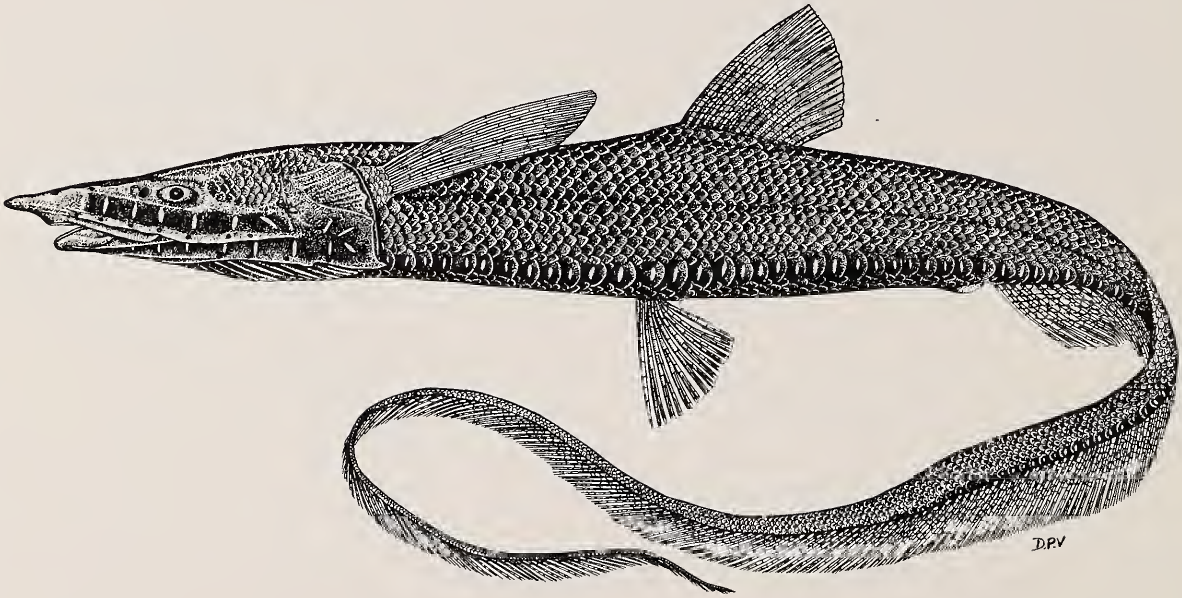
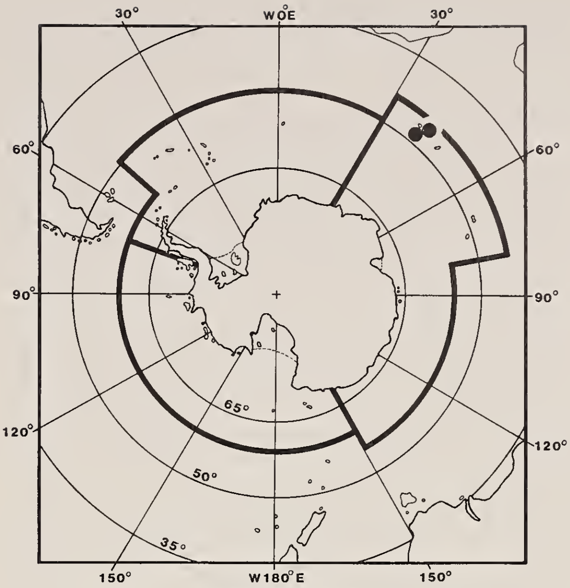


Fig. 1. *Halosauropsis macrochir* BMNH 1887.12.7.38–40, 48 cm TL, syntype, near Marion Island.

Distribution: Probably circumglobal, confined to continental slopes and rises, and slopes of islands and seamounts of the Atlantic and the South Indian oceans. In the Pacific Ocean, *H. macrochir* has been collected only near New Zealand (Paulin & Moreland 1979). In the Southern Ocean, apart from the *Challenger* specimens, Filatova (1985) reported this species from a collection made north of the Kara Dag Seamount (45°51′S, 41°54′ E). The depth range of *H. macrochir* is 1,080–3,105 m (Filatova 1985).

Remarks: The absence of scales from the dorsal surface of the head and the pale pyloric caeca will separate *H. macrochir* from all other halosaurid fishes. The anterior nostril tube of mature males is distinctly longer and darker than in females. *H. macrochir* is a benthopelagic species feeding mainly on crustaceans and polychaetes (McDowell 1973a; Sulak 1986). According to Filatova (1985), fishes from different oceans vary considerably in meristics, but within the Indian Ocean there was little variation. Sulak (1977) found that in the North Atlantic Ocean *H. macrochir* is distributed mainly in waters colder than 4 °C. In the Southern Hemisphere, this species reaches as far south as the sub-Antarctic waters of the Indian Ocean (3 °–7 °C).

Attains about 90 cm TL.



Distribution of *H. macrochir*

NOTACANTHIDAE

Spiny eels

by O. GON

Body elongate and compressed. Dorsal fin with 6–46 short and isolated spines, but without conspicuous soft rays. Dorsal-fin origin varies from immediately behind opercle to between levels of pelvic fins and anus. Anal fin begins with similar, but connected spines which grade into soft rays posteriorly. Anal fin confluent with a residual caudal fin. Pelvic fins abdominal and connected to each other basally. One or several (outermost) pelvic-fin rays appear as spines. Eyes covered by transparent skin. Nostrils at most 1 eye diameter apart. Mouth small and inferior. Posterodorsal end of maxilla with a posteriorly pointing spine. Maxilla toothless, but premaxilla and dentary bearing teeth. Gill membranes united over isthmus, but attached only to its anterior end. Gill rakers well developed. Minute cycloid scales present. Lateral line present, not reaching end of tail.

Two genera and 9 species world-wide excluding polar seas. Benthopelagic fishes of continental edges from the shelf down to the continental rise. Sex ratio highly in favour of females. Breeding condition males exhibit sexual dimorphism in nostril coloration and sometimes eye size. Larvae probably *Tilurus* type leptocephali (Smith 1970, 1984; Castle 1984). No commercial value. Recent taxonomic revisions by McDowell (1973b) and Sulak *et al.* (1984).

Genus ***Polyacanthonotus*** Bleeker, 1874

Dorsal-fin origin above or in front of pectoral fins. Dorsal-fin base longer than gnathoproctal length (GPL). Dorsal-fin spines 26–46. Branchiostegal rays 6–9. Pyloric caeca 3.

Three species, 1 in our area.

Polyacanthonotus challengeri (Vaillant, 1888)

Fig. 1

Notacanthus challengeri Vaillant, 1888b: 387, South of Yedo (34°37′N, 140°32′E). Holotype: BMNH 1887.12.7.247.

Macdonaldia alta Gill & Townsend, 1897: 232, Bering Sea (54°54′N, 168°59′W).

Macdonaldia longa Gill & Townsend, 1897: 232, Bering Sea (54°11′30″N, 167°25′W).

Macdonaldia africana Gilchrist & von Bonde, 1924: 11, pl. 3, off Table Bay.

Polyacanthonotus vaillanti Fowler, 1934: 266 (erroneous type locality); Grey, 1956: 157 (correct type locality 38°47′20″N, 72°37′W).

Diagnosis: Based on Sulak *et al.* (1984). Data in parentheses refer to the single specimen known from the Southern Ocean (MNHN 1977-207). D 32–46 (39) (last spine split to base); P I, 9–14 (14); V I, 8–10 (8); LL pores to level of vent 54–61 (59); GR (4–6) + (8–16) (4+18); vertebrae to dorsal-fin origin 11–18 (14); vertebrae underlying dorsal-fin base 90–107 (97); vertebrae to anal-fin origin 54–61 (59 or 60); total vertebrae 254–284. Gnathoproctal length 34–41% TL (40%). Head length 29–45% (31%) and body depth at level of A origin (22%) GPL. Snout length 27–36% (29%), pre-oral snout length (17%) and eye diameter 11–17% (15%) HL. Dorsal-fin base (127%), predorsal distance 27–56% (40%), preanal distance 103–114% (106%), prepelvic distance (87%), and distance from pelvic insertion to anus (15%) GPL. Nostrils near eye, internarial distance 33–62% (57%) eye diameter. Infraorbital sensory canal conspicuous from level of rear nostril posteriorly (Fig. 2). Anterior section of this canal as well as other cephalic sensory canals indistinct. Maxilla extending to anterior margin of eye. Both jaws and palatines with a single row of slender conical teeth; premaxilla with 31 (in Southern Ocean specimen) fixed teeth; dentary and palatine teeth depressible. Large, club-like papillae on palate, in front and behind palatine teeth; tongue with similar but smaller papillae and 2 median teeth (in Southern Ocean specimen). Ventral surface of pre-oral snout naked but appears rough due to numerous papillae. Dorsal-fin origin slightly in front, to slightly behind pectoral-fin base.

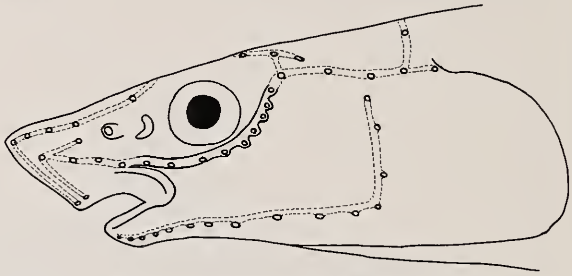


Fig. 2. Lateral view of the head sensory canal pores of *P. challengeri* (MNHN 1977–207)

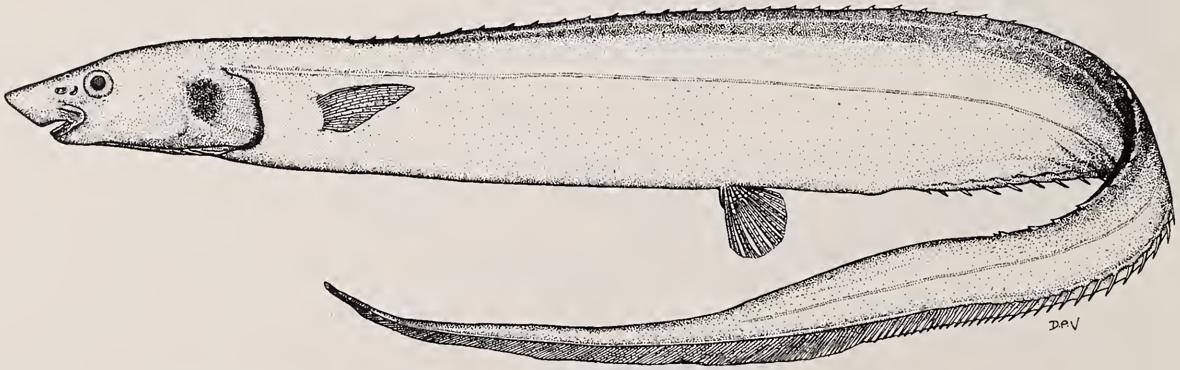


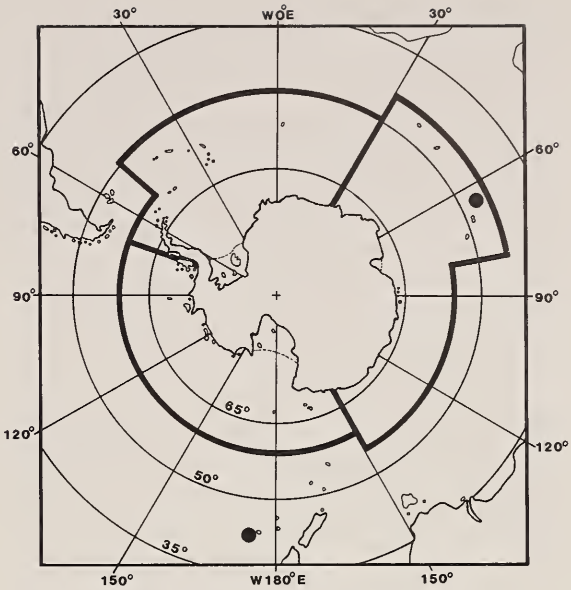
Fig. 1. *Polyacanthonotus challengeri* MNHN 1977–207, 46 cm TL, Kerguelen Islands

Colour: In alcohol, pale grey with head and bases of unpaired fins somewhat darker. A large, dark spot on opercle. Mouth cavity, gill chamber and gill membranes dark. Peritoneum and stomach almost black. Intestine dark greyish brown.

Distribution: Predominantly antitropical in all oceans. Sulak *et al.* (1984) reported 2 captures off the west African coast in latitudes lower than 20 °N. Southern Hemisphere records are between 30 °-50 °S. A single specimen was collected near the Kerguelen Islands in the sub-Antarctic region of the Indian Ocean sector of the Southern Ocean. Usually caught on the lower continental slope and rise between 1,302–3,753 m.

Remarks: Although more widely distributed, *Polyacanthonotus challengeri* is rarely encountered compared to its congeners *P. rissoanus* (Fillipi & Vérany, 1859) and *P. merretti* Sulak, Crabtree & Hureau, 1984. The specimen from the Kerguelen Islands is the only one known from the Indian Ocean. Apart from 2 South African specimens (Gilchrist & von Bonde 1924), none were collected in the South Atlantic Ocean and only 1 specimen was captured in the South Pacific Ocean near New Zealand (Crabtree *et al.* 1985).

P. challengeri is a benthic feeder, preying on small benthic crustaceans and polychaetes. The Kerguelen Islands specimen had a 28 mm long hyperiid amphipod in its buccal cavity and the South African type specimen of *M. africana* (junior synonym of *P. challengeri)* had 4 polychaete worms in its mouth. Reproductive biology unknown, but it is anticipated that the sexual dimorphism in nostril size and colour described for *P. merretti* and *P. rissoanus* (Crabtree *et al.* 1985) is present in *P. challengeri* as well. Crabtree *et al.* (1985) counted at least 30,000 ova in a mature female collected in the Middle-Atlantic Bight.



Distribution of *P. challengeri*

Attains about 60 cm TL.

SYNAPHOBRANCHIDAE

Synaphobranchids

by O. GON

Body elongate and compressed. Snout short and blunt to long and pointed; tip of snout sometimes overhanging lower jaw and may have conspicuous ridges and papillae. Eye small to relatively large (up to about 20% HL). Nostrils broadly separated; anterior nostril tubular, anteriorly directed and placed near tip of snout; posterior nostril usually with an elevated rim, placed in front of eye. Mouth small to large with gape reaching beyond level of eye; jaw teeth small, uni- to multiserial; teeth on vomer usually larger and may be few or in a band. Dorsal and anal fins confluent with caudal fin; dorsal-fin origin from close behind head to behind level of anus; anal-fin origin adjacent to anus; pectoral fins present or absent. Gill slits ventral to ventrolateral, horizontally or obliquely positioned and may be completely separate or confluent in a common groove. Scales (when present) elongate, non-imbricate and embedded in skin, and arranged in a basket-weave pattern. Lateral line present, either complete or reduced to a few pores anteriorly.

Three subfamilies, 11 genera and 21 species distributed in all oceans. In their recent comprehensive revision of western North Atlantic species, Robins and Robins (1989) recognize only 8 genera (with *Diastobranchus* and *Histiobranchus* considered as synonyms of *Synaphobranchus*). Epibenthic fishes of no commercial value found on continental slopes and deeper. Predators, demersal feeders and possibly scavengers. Larvae pelagic leptocephali characterised by telescopic eyes. Recent taxonomic treatments by Robins & Robins (1989), Merrett & Saldanha (1985) and Castle (1986).

KEY TO GENERA

1a D origin well behind anus; gill slits ventrolateral, separate on throat and extend to P base .... *Diastobranchus*

1b D origin above or just behind P, well in front of anus; gill slits ventral, horizontal, nearly confluent anteriorly, but never reach P base .... *Histiobranchus*

Genus ***Diastobranchus*** Barnard, 1923

Monotypic. Osteology and relationships were studied by Castle (1975).

Diastobranchus capensis Barnard, 1923

Fig. 1

Diastobranchus capensis Barnard, 1923: 441, near Cape Point, South Africa. Syntypes: SAM 12766; 12792.

Synaphobranchus danae Bruun, 1937: 13, pl. 1, figs. 1, 3, east of New Zealand (description of leptocephalus larva).

Diastobranchus danae: Whitley, 1952: 27, fig. 1, east of Maria Island, Tasmania (description of an adult related to the leptocephalus larva of Bruun, 1937).

Diagnosis: D 366 (1 specimen); A 337 (1 specimen); LL pores in front of anus 22–27; branchiostegal rays 15–19; vertebrae 162–174. Head length 12.1–14.6%, pectoral fin length 6.6–6.8%, gape 6.5–7.6%, predorsal distance 29.5–37.5%, preanal distance 21.4–24.9% TL. Mouth terminal; cleft of mouth reaches about half eye diameter behind eye; jaws slightly curved inward at their anterior end; premaxillary teeth in a round to oval patch, separate from or continuous with vomerine band of teeth; jaw teeth in a narrow band, becoming progressively smaller posteriorly; premaxillary teeth usually largest. Scales present on body and head. Lateral line a slightly elevated ridge on side of body, with pores opening along its ventral part. Pectoral fin pointed, its uppermost rays longest, usually ending in a short filament, and reaching to or slightly past anus. Anus placed at end of anterior quarter of total length.

Colour: Castle (1961) described fresh specimens as dark chocolate-brown over most body surface, darker along midlines, around fins and branchial aperture. Pectoral fins, jaws and branchial apertures tinged with violet. Free edges of fins black, mouth cavity dark bluish-brown. In alcohol, small juveniles pale brown with black peritoneum showing through body wall; snout darker. Edge of fins around tail dark. Adults dark brown all over.

Distribution: Circumglobal in the subtropical and temperate waters of the Southern Hemisphere. On the continental slope of South Africa, off Tasmania, New

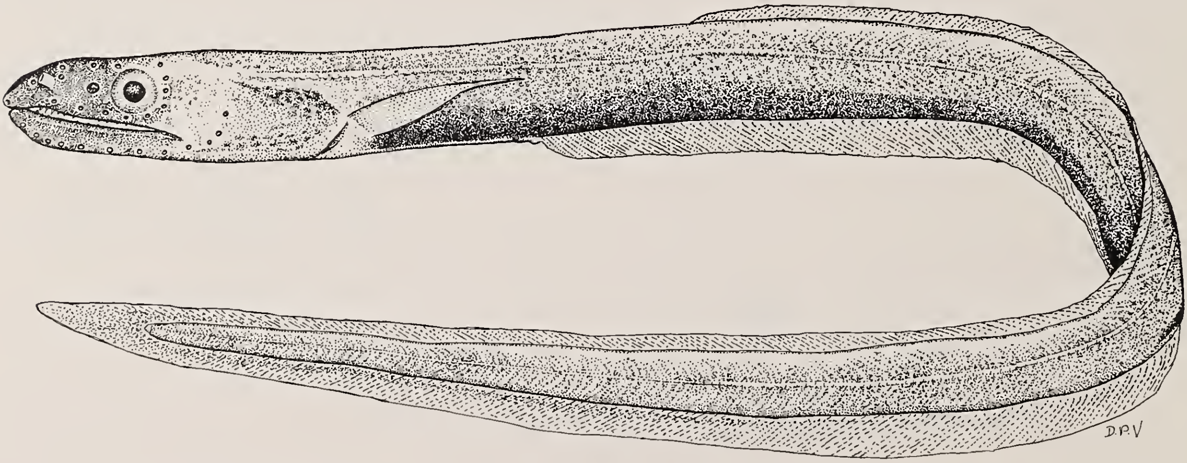
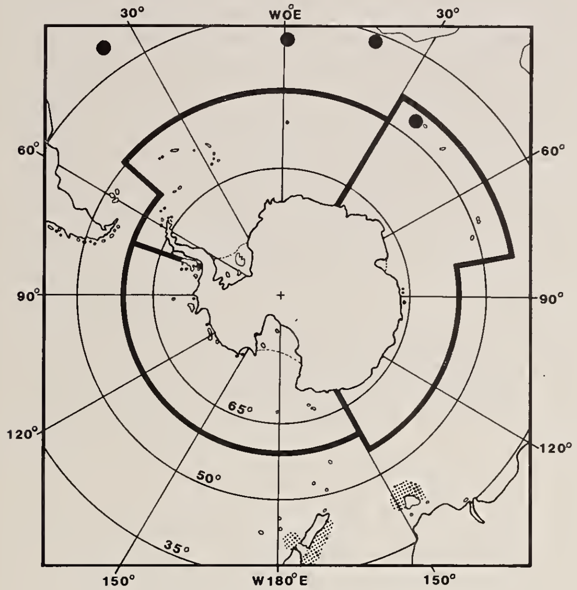


Fig. 1. *Diastobranchus capensis* RUSI 29016, 153 mm TL, juvenile, Prince Edward Islands (47°02′S, 37°57′E)

Zealand, Discovery Seamount and the Rio Grande Rise off South America (Castle 1961; Golovan 1976; Pakhokurov 1976; Golovan & Pakhokurov 1983; Pavlov & Andrianov 1986), and the Prince Edward Islands. Depth range 600–1,400 m. The depth of capture, 180 m, reported by Whitley (1952) was considered by Castle (1961) as exceptionally shallow.



Distribution of *D. capensis*

Remarks: In addition to the characters given in the key, *D. capensis* differs from the other synaphobranchid eel in the area, *H. bathybius*, in having a longer pectoral fin, more vertebrae, and more dorsal and anal fin rays. In addition, scales are absent from the head of *H. bathybius*.

In the CCAMLR area, *D. capensis* is known from a single juvnile specimen recently collected by dredge between Marion and Prince Edward islands in the Indian Ocean at 680–715 m. The biology of *D. capensis* is unknown; Barnard (1923) reported "various crustaceans" as food items found in the fish he examined.

Attains over 120 cm TL.

Genus *Histiobranchus* Gill, 1883

Dorsal-fin origin above pectoral fin or slightly behind it. Anus at middle of body length. Gill slits ventral, confluent anteriorly and slightly divergent posteriorly. Mouth extending more than 2 eye diameters behind eye. Scales present on body but not on head. Lateral line complete. Robins & Robins (1989) included this genus within *Synaphobranchus*. Following Merrett & Saldanha (1985) and Castle (1986), I regard *Histiobranchus* as a valid genus. Two species, 1 in our area.

Histiobranchus bathybius (Günther, 1877)

Fig. 2

Synaphobranchus bathybius Günther, 1877: 445, *Challenger* stations 146 (46°46′S, 45°31′E) and 246 (ca. 36°N, 178°E). Syntypes: BMNH 1887.12.7.251–255.

Histiobranchus infernalis Gill, 1883: 255 (38°30′30″N, 60°08′25″W).

Synaphobranchus australis Regan, 1913: 235, pl. 8, fig. 5. *Challenger* station 146 (46°46′S, 45°31′E).

Diagnosis: Based on the holotype of *S. australis*. Data in parentheses represent ranges in fishes collected outside the Southern Ocean (Castle 1964; Merrett & Saldanha 1985; Okamura & Machida 1987). D before vent about 80 (87–123); total D 283 (265–331); A 213 (188–203); P 15; LL pores before vent (47–52); precaudal vertebrae 72 (76); total vertebrae 130 (126–146). Body depth at level of pectoral-fin base 8.3% (8.6%) and at level of anal-fin origin 7.6% (5.8–9.1%) TL. Head length (measured to level of rear end of gill slits) 13.5% (9.4–14.3%) and pectoral fin length 3.2% (3.1–4.4%) TL. Snout length 28.3% (24.8–30.2%), eye diameter 14.7% (11.6–14.0%), interorbital space 25.3% (16.3–23.0%) HL. Distances from snout to dorsal-fin origin 20.9% (13.9–18.8%), to upper pectoral-fin base 14.6% and to anal-fin origin 47.0% (40.5–49.5%) TL. Vomer with 2–3 rows of teeth. Premaxillary teeth arranged in an elongate triangular patch in front of vomer and separated from it by a distinct toothless space. Pectoral fins small, placed on lower third of body. Head naked, but scales present on occiput and nape.

Colour: In alcohol, generally brown with pale head, but darker on snout and throat. Fins somewhat paler than body. Peritoneum dark. Intestine pale.

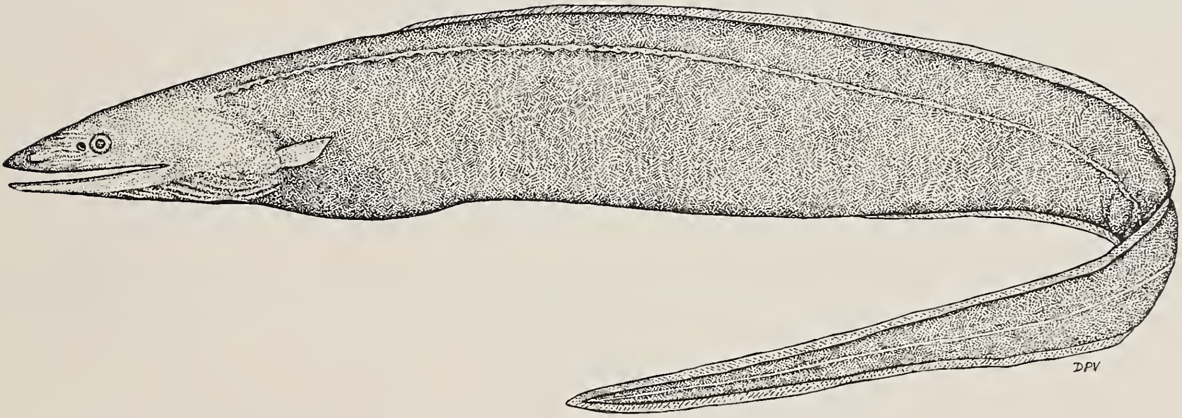
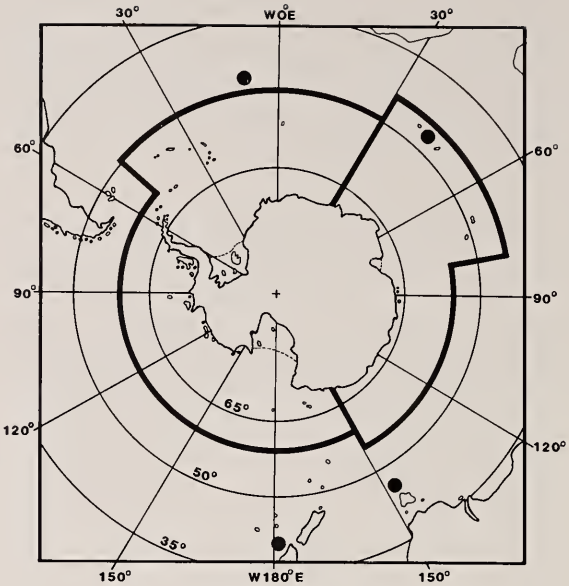


Fig. 2. *Histiobranchus bathybius* BMNH 1887.12.7.255, 35 cm TL (holotype of *Synaphobranchus australis* Regan, 1913)

Distribution: Circumglobal except in polar waters. In the Southern Ocean it is known only from the sub-Antarctic region of the Indian Ocean sector. Depth range of catches: 644–5,440 m.

Remarks: The *Challenger* specimen described above is the only one collected in the Southern Ocean. Adults of *H. bathybius* are known to live in water temperatures as low as 1.5 °C (Castle 1964), but it is unknown whether their leptocephalus larvae can tolerate such temperatures. *H. bruuni* Castle, 1964, the only congener of *H. bathybius* was collected south-east of New Zealand at 54°55′ S, 159°52′ W and may be found within the Southern Ocean in the future. *H. bruuni* has higher counts of vertebrae (160–164), lateral-line pores anterior to vent (65–68), dorsal-fin rays (328–365) and anal-fin rays (200–244) (Castle 1968). Günther (1887) described the colour of apparently fresh specimens of *H. bathybius* as black, but pointed out that the *Challenger* specimen described above was an albino.

Attains 74 cm TL.



Distribution of *H. bathybius*

MICROSTOMATIDAE

Microstomatids

by O. GON

Body long and slender, subcylindrical to slightly compressed. Dorsal-fin origin at about midbody level or behind it. Dorsal adipose fin present or absent. Pectoral fins lateral. Pelvic fins insertion from well in front of dorsal-fin origin to below last dorsal-fin ray or slightly behind it. Anal-fin base equal to or shorter than caudal peduncle length. Parietals large, usually meeting along mid-line. Frontals not fused. Mesocoracoid absent. Well-developed physoclistous swim-bladder. Mouth small, maxilla not reaching behind front margin of eye. Teeth absent from maxilla, premaxilla and tongue, but present on vomer, palatines and dentaries. Scales large, cycloid and deciduous. Lateral-line scales larger than body scales and extend onto caudal fin. Head scaleless. Branchiostegal rays 3–4. Vertebrae 35–50 (excluding *Xenophthalmichthys*).

Three genera and 16 species, distributed in all oceans from the sub-Arctic to the sub-Antarctic; one genus represented in the Southern Ocean. In recognizing Microstomatidae, I follow a recent analysis of interrelationships within the suborder Argentinoidei by Ahlstrom *et al.* (1984).

Genus ***Nansenia*** Jordan & Evermann, 1896

Dorsal adipose fin present above anal fin. Pelvic fins inserted behind dorsal-fin origin. Predorsal length less than 61% SL. Epi- and mesopelagic fishes, but sometimes found in the benthopelagic zone of continental and insular slopes (Kawaguchi & Butler 1984). Distribution as for family. Recent revision by Kawaguchi & Butler (1984). Thirteen species, 1 in our area. Methods follow Gon (1987a).

Nansenia antarctica Kawaguchi & Butler, 1984
Fig. 1

Nansenia antarctica Kawaguchi & Butler, 1984: 8, fig. 7 (55°57′S, 159°23′W). Holotype: LACM 10875.

Diagnosis: D 9–10; A 9–10; P 12–14; V 9–10 (excluding short spine sometimes found anterior to first pelvic-fin ray); LL 48–49; GR (10–14) + (21–30); pyloric caeca 7–8; vertebrae 48–50; branchiostegal rays 3. Body depth at pectoral-fin base 8.9–11.4, at pelvic-fin insertion 10.4–13.3 and at anal-fin origin 14.0–15.7 in SL. Body width 0.8–1.0 in its depth. Head length 4.1–4.9 and head depth at level of preopercle edge 8.6–10.4 in SL. Snout length 5.5–7.3 and eye diameter 2.1–2.6 in HL. Caudal peduncle depth 2.1–2.9 in its length and the length 7.3–8.7 in SL. Anal-fin base 1.5–1.9 in caudal peduncle length. Distances from snout to dorsal-fin origin 2.1–2.2, to pelvic-fin insertion 1.8–2.0, and to anal-fin origin 1.2–1.3 in SL. Suborbital bones well ossified and cover the whole cheek.

Colour: In alcohol, body pale brown with dark lining of body cavity showing through its thin walls. Opercle and snout darker than body, but cheek pale. All fins pale. Peritoneum and stomach dark brown, intestine pale. Mouth cavity and gill chamber dark.

Otoliths

Diagnostic features: The elongate and sagittate shape, the elongate sulcus acusticus with a distinctly constricted collum in association with the large proximally broad and distally slender but rounded rostrum.

Note: The geometric shape of the otolith and the shape of the rostrum of the otolith of *Nansenia* is markedly different from those of the *Bathylagus* species.

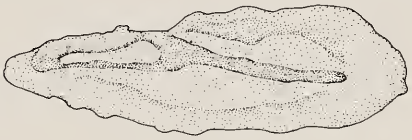


Fig. 2. Representative otolith of *N. antarctica*; fish length 103 mm SL

Distribution: Probably circum-Antarctic in sub-Antarctic water. The lack of records from most of the Indian and the south-east Atlantic Ocean sectors is probably due to insufficient sampling. The catch data of the specimens of *N. antarctica* studied by Kawaguchi & Butler (1984) give no indication of the true depth range of this species as the gear (open nets) was towed between the surface and more than 5,000 m. Depth records of the specimens used in this study showed a much shallower range of 485–1,020 m.

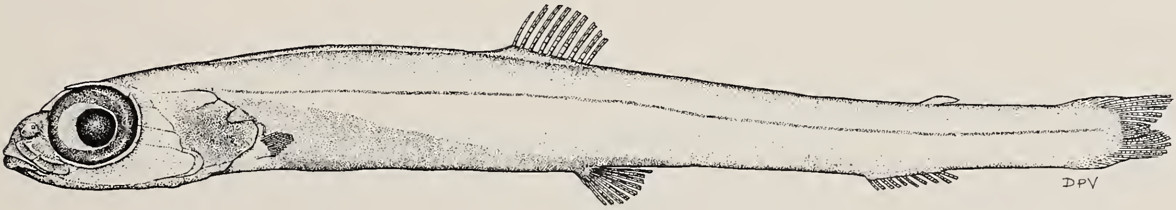
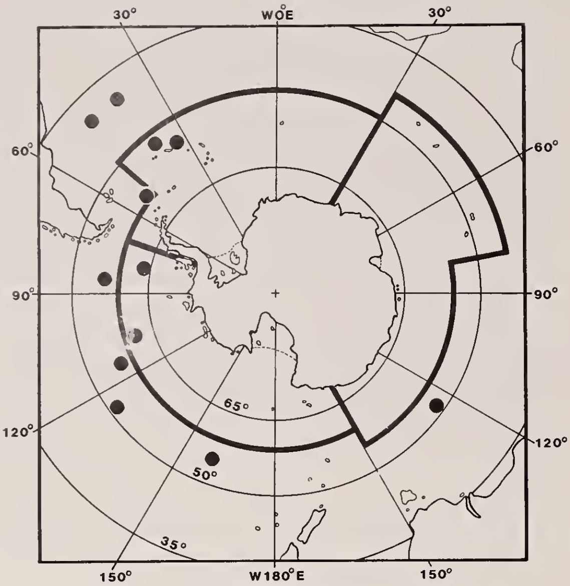


Fig. 1. *Nansenia antarctica* BAS 831406, 108 mm SL (56°06′S, 37°22′W)



Distribution of *N. antarctica*

Remarks: In addition to allometric growth of the caudal peduncle in *N. antarctica* (Kawaguchi & Butler 1984), the head length in specimens smaller than 110 mm SL was 4.1–4.4 in SL, but proportionally smaller (4.4–4.9) in larger specimens.

Although adults are easily separated, a difficulty may arise in distinguishing juveniles of *N. antarctica* from those of Southern Ocean *Bathylagus* species. Young of both groups resemble each other in general morphology and often lose their scales and much of their scale pockets in the trawls. However, in all Southern Ocean *Bathylagus* there are only 2 branchiostegal rays, the anal-fin base is longer than the caudal peduncle, the number of anal-fin rays is 15–24, and the number of pyloric caeca is usually 3–6. A mouth structure similar to *Bathylagus* suggests feeding on small, soft-bodied zooplankton. Better ossification of superficial cephalic bones and firmer body musculature indicate existence in shallower depths than Southern Ocean *Bathylagus*.

Attains about 22 cm SL.

BATHYLAGIDAE

Deepsea smelts

by O. GON

Body long and compressed; in some species, body relatively deep in front, tapering to a narrow caudal peduncle. Head moderate to small; snout short and blunt; eyes large, never tubular. Supraorbital bones well developed and suborbital bones weakly developed. Mouth small; no teeth on upper jaw or tongue; vomer and palatines with 1 row of spaced, small, conical teeth; dentary with a single row of close-set, small triangular teeth fused to the bone. No spines in fins; dorsal fin at about midbody length; anal fin on posterior third or fourth of body; pectoral fins near ventral surface of body; pelvic fins inserted under dorsal fin or slightly behind it; adipose fin present. Scales large, cycloid and deciduous; lateral line complete. Gill membranes united and gill opening restricted in some species at level of upper pectoral-fin base or slightly above it; gill rakers long and triangular, leaflike; pseudobranch well developed. Branchiostegal rays 2. Pyloric caeca 3–12. Swim-bladder absent. Frontals not fused; parietals separated; postcleithra and mesocoracoid absent. Photophores absent. Anus in front of anal-fin origin. The larvae of some species with stalked eyes.

Meso- to bathypelagic fishes in all oceans. Some species were recorded from the surface to 1,500 m and may perform vertical migrations. Zooplankton grazers. World-wide 8 genera (Kobyliansky 1986), 1 in the Southern Ocean. Nowhere commercially exploited. Although fur seals in the Bering Sea feed on *Bathylagus*, bathylagid fishes have not been reported from stomach contents of Antarctic animals. At least 2 species of seals, Weddell and Elephant seals, and 2 species of penguins, King and Emperor, are capable of diving to depths where these fish may be found.

Taxonomic revisions, mostly on regional basis, were done by Norman (1930), Blache (1964), Cohen (1964), Rass & Kashkina (1967), Kobyliansky (1985, 1986) and Gon (1987a). Gorelova & Kobyliansky (1985) reported on the feeding habits of selected species.

Genus *Bathylagus* Günther, 1878

Caudal peduncle shorter than length of anal-fin base. Gill opening restricted at level of upper pectoral-fin base. Dorsal-fin origin anterior to or at midbody length. Pyloric caeca 3–6. Weak ridges radiating from center of opercle and fingerlike projections on rear edge of opercle absent. Orbitosphenoid well developed. Basisphenoid, metapterygoid and mesocoracoid poorly developed or absent (Kobylianski 1986). Seven valid species, 3 in the Southern Ocean. The key and species accounts below are based on Gon (1987a).

KEY TO SPECIES

(for specimens larger than 100 mm SL)

1a Vertebrae 43–48; GR 24–30; LSS 37–43; eye diameter 2.0–2.8 in HL. 2

1b Vertebrae 48–52; GR 26–36; LSS 31–38; eye diameter 1.8–2.4 in HL; body depth at A origin 7.4–11.1 in SL. . . . . *B. antarcticus*

2a Vertebrae 43–47; A 15–20; caudal peduncle length 1.3–2.5 in A base; peduncle depth 1.3–1.8 in its length; body depth at A origin 9.0–14.0; distance between P and V bases (measured horizontally) 4.0–4.2 in SL. . . . . *B. gracilis*

2b Vertebrae 46–48; A 20–24; caudal peduncle length 2.2–4.1 in A base; peduncle depth 0.8–1.2 in its length; body depth at A origin 6.9–8.6; distance between P and V bases 2.9–3.9 in SL . . . . *B. tenuis*

Bathylagus antarcticus Günther, 1878

Fig. 1; Pl. 1, Fig. 2

Bathylagus antarcticus Günther, 1878: 248 (53°55′S, 108°35′E). Holotype: BMNH 1887.12.7.230.

Bathylagus glacialis Regan, 1913: 231, pl. 9, fig. 2 (68°25′S, 27°10′W; 68°32′S, 12°49′W; 71°50′S, 23°30′W; 71°22′S, 16°34′W; 71°32′S, 17°15′W).

Bathylagus gracilis (*non* Lönnberg): Andriashev, 1959: 4.

Bathylagus gracilis (*non* Lönnberg): Lisovenko *et al.*, 1986: 216.

Bathylagus sp. Krefft, 1958: 251; Kock, 1982: 98, 108.

Diagnosis: Data in parentheses refer to fishes 48–165 mm SL (n=59); otherwise, data refer to specimens larger than 100 mm SL. D 8–11; A 16–24; P 9–12; V 8–9; GR 26–36; LSS 31–38; pyloric caeca 3–5; vertebrae 48–52. Body elongate and compressed, deep in front of dorsal fin and somewhat more slender behind it. Depth of head at preopercle 5.2–6.9 (5.2–8.9), depth of body at pectoral-fin base 4.4–6.7 (4.4–8.6) and at anal-fin origin 7.4–11.1 (7.4–15.5), and head length 4.0–5.6 (3.9–4.8) in SL. Eye diameter 1.8–2.4 (1.4–2.5) in HL. Maxilla reaching under anterior margin of eye. Gill opening restricted to lower quarter or third of head. Predorsal distance 2.0–2.3 (2.0–2.3) and length of anal-fin base 5.4–6.8 (4.2–7.0) in SL. Caudal peduncle length 10.2–12.6 (8.4–15.9) in SL and its depth 1.2–1.6 (1.0–2.0) in the length. Pelvic fins inserted closer to pectoral fin, midway between pectoral and anal fins or closer to the latter, depending on size of specimen.

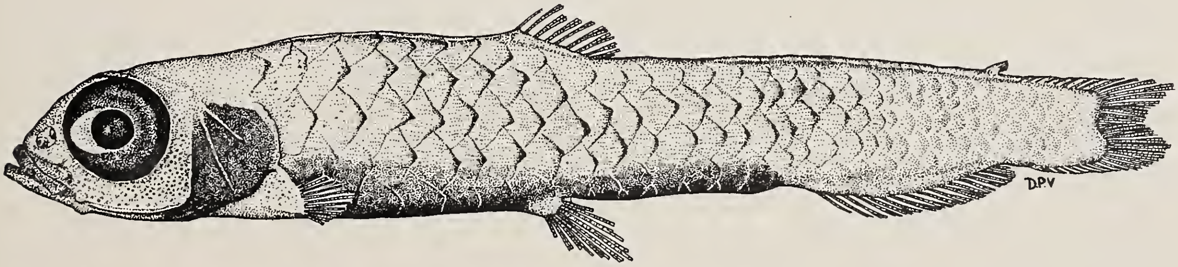


Fig. 1. *Bathylagus antarcticus* RUSI 22662, 107.3 mm SL, male (62°01.7′S, 57°57.7′E)

Colour: In live fish, upper part of body and tail pale blue; lower half of body from opercle to anal-fin origin dark, metallic blue to black. Snout and jaws dark, but cheek paler; lining of lower half of orbit iridescent blue. Rear margin of scale pockets dark. Body, head and fins sometimes covered with small dark spots which may be larger on the cheek. Fins dusky.

In alcohol, pattern remains the same. The general colour may change from yellow to brown, depending on period in preservative; dark blue areas turn to dark brown or black. Intestine pale; peritoneum, mouth and gill chamber dark.

Otoliths

Diagnostic features: The ovate shape, rounded posteriorly, extremely pointed anteriorly, and medio-laterally thin; sulcus acusticus ostial to ostio-pseudocaudal and homosulcoid; ostium only present on dorsal face of rostrum; rostrum distinctly elongate, prominent and pointed distally; rostrum measures 33.57 ± 6.31% (range 25–42.86) in total otolith length; antirostrum usually absent, if present then minute and rounded distally.

Intraspecific variation: The antirostrum is either present or absent and the sculpture of the anterodorsal margin varies from sinuate, dentate to lobed.

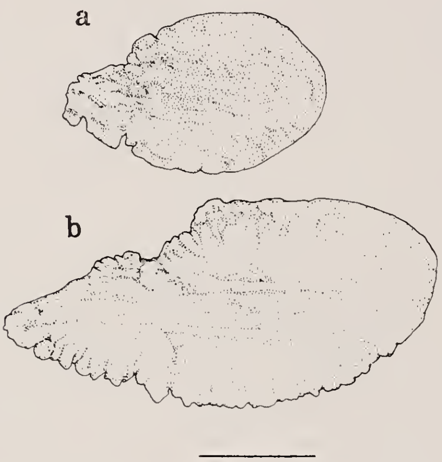
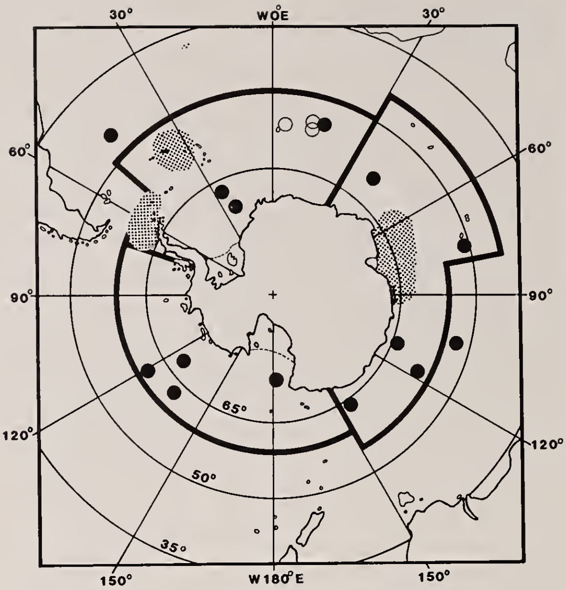


Fig. 2. Representative otoliths of *B. antarcticus*; fish lengths: (a) 85 mm and (b) 140 mm SL

Distribution: Circum-Antarctic and southern Atlantic, Indian and Pacific oceans (Norman 1937b; Cohen 1986a). Specimens of *B. antarcticus* were caught between the surface and about 4,000 m.

Remarks: *Bathylagus antarcticus* is closely related to *B. gracilis* (see key above for differences) and *B. pacificus* Gilbert, 1890. The latter species has fewer vertebrae (45–48) and pectoral-fin rays (8–10) (Gon 1987a).



Distribution of *B. antarcticus*

Norman's (1930) series of *Discovery* specimens of *B. antarcticus* are of special interest. He reported 7 specimens from 3 different stations. Of these, the specimen from Station 71 (BMNH 1930.1.12.36), labelled as *B. benedicti* was originally identified as *B. antarcticus* (A. Wheeler *pers. comm.*), but was reidentified as *B. tenuis* (Gon 1987a). The large specimen (BMNH 1930.1.12.37) and at least the largest of the 3 small ones (BMNH 1930.1.12.38) from Station 101 are probably *B. bericoides*. Of the 2 specimens from Station 151 (BMNH 1930.1.12.39–40), one is B. *antarcticus* and the other was lost (A. Wheeler *pers. comm.*); another specimen from this station (BMNH 1930.1.12.44), originally labelled as *B. benedicti* was correctly reidentified possibly by Norman, as *B. antarcticus*. A specimen from Station 169 (BMNH 1930.1.12.48) was reported by Norman (1930) as *B. euryops* but was redetermined as *B. antarcticus* at a later stage, possibly when he worked on the fishes of B.A.N.Z. Expedition (Norman 1937b). In addition, in a footnote at the end of his account on *B. glacialis*, Norman (1930: 295) stated that of the 2 syntypes held in the British Museum collection 1 is *B. euryops*. I have examined these syntypes, both of which proved to be *B. antarcticus*. Norman (1930) apparently based his identification on the relatively low number of anal-fin rays of the syntypes (17 and 18). However, both specimens have counts of 50 vertebrae and 31 gill rakers, typical of *B. antarcticus* whereas *B. euryops* has 44–48 vertebrae and 24–28 gill rakers (Gon 1987a).

The *Bathylagus* larvae included in the type series of *Stylophthalmus paradoxus* (Brauer 1902, 1906) are *B. antarcticus*. They are likely to be the specimens listed by Brauer (1906) from 3 Southern Ocean localities (shown as open circles in map). *S. paradoxus* of Pappenheim (1914) is also this species. For a more detailed discussion see Remarks of *Idiacanthus atlanticus* (Stomiidae) below.

Studies on the feeding (Gorelova & Kobyliansky 1985) and reproduction (Lisovenko *et al.* 1986) of *B. gracilis* south of the Antarctic circle most probably refer to *B. antarcticus*, the only bathylagid species found in these latitudes (Gon 1987a). Euphausiids comprised 46% by weight of the food consumed by *B. antarcticus*. Appendicularians, polychaetes and copepods were less important in terms of weight, but were found in more stomachs than other items (Gorelova & Kobyliansky 1985). Males (maximum 14 cm SL) are smaller than females (maximum 17 cm SL) and mature at a smaller size (8.8 cm versus 11.2 cm SL). Ripe eggs are about 1.8–2.0 mm in diameter. Relative fecundity increases with size; ripe eggs numbered 228 in an 11 cm SL specimen and 1300 in a 16 cm SL fish. Spawning probably occurs 3–4 times a year (Lisovenko *et al.* 1986).

Bathylagus gracilis Lönnberg, 1905
Fig. 3

Bathylagus gracilis Lönnberg, 1905a: 762; 1905b: 68 (49°56′S, 49°56′W). Syntype: NRM SYD 1902 265.4197.

Bathylagus euryops (*non* Goode & Bean): var. *latifrons* Lönnberg, 1905b: 67. (49°56′S, 49°56′W).

Bathylagus antarcticus (*non* Günther): Lisovenko *et al.*, 1986: 216.

Diagnosis: Data in parentheses refer to fishes 55–217 mm SL (n=18); otherwise, data refer to specimens larger than 100 mm SL. D 9–11; A 15–20; P 8–10; V 8–9; GR 24–29; LSS 38–43; pyloric caeca 3–6 (1 with 9); vertebrae 43–47. Body elongate and compressed, the anterior half deep and robust and the posterior half considerably more slender. Depth of head at preopercle 5.5–7.1 (5.5–8.0), depth of body at pectoral-fin base 4.6–6.8 (4.6–9.1), depth of body at anal-fin origin 9.1–14.0 (9.1–17.8), and head length 4.0–4.8 (4.0–4.8) in SL. Eye diameter 2.0–2.7 (2.0–2.7) in HL. Maxilla reaching slightly beyond anterior margin of eye. Gill opening restricted to lowest quarter of head. Predorsal distance 2.0–2.2 (2.0–2.3) and length of anal-fin base 5.6–7.9 (5.1–7.9) in SL. Caudal peduncle length 10.5–13.8 (10.5–13.8) in SL and its depth 1.3–1.8 (1.3–1.8) in the length. Pelvic fins inserted closer to anal-fin origin than to pectoral-fin base.

COLOUR: In alcohol, generally brown, abdomen dark brown to black. Body and head covered with diffuse pigment that sometimes forms minute dark spots. Operculum and snout dark, cheek paler. Mouth and gill chamber dark. Fins dusky and sometimes spotted. Peritoneum black and intestine pale.

Distribution: Scotia Sea, south-west Atlantic Ocean and south-east Pacific Ocean. *B. gracilis* were caught at various depths between the surface and 2,700 m.

Remarks: *Bathylagus gracilis* is closely related to *B. antarcticus* (see key for differences), but more so to *B. pacificus*. Counts (on 20 specimens) and measurements (on 8 specimens 73.8–163.3 mm) of *B. pacificus* from the North Pacific Ocean and Bering Sea, and the data published by Rass & Kashkina (1967) were compared to *B. gracilis*. Most of the counts for these 2 taxa were in complete agreement, except for a slightly wider range in *B. pacificus* for the dorsal-fin rays (8–11), anal-fin rays (15–21), pectoral- and pelvic-fin rays (7–10), as well as a range of 37–42 lateral-line scales (Rass & Kashkina 1967). The number of gill rakers, however, has a much wider range in *B. pacificus* (25–34). The measurements were also in agreement between the 2 species.

Distribution of *B. gracilis*

On one hand, the agreement in the measurements and most of the counts indicates a possible synonymy. On the other hand, the wider range of the gill raker counts in *B. pacificus* as well as an apparent difference in the maximum size attained by these species opposes such synonymy. The maximum size measured was 217 mm SL for *B. gracilis* and 170 mm SL for *B. pacificus*.

As in the case of *B. antarcticus*, Norman's (1930) *Discovery* series of *B. gracilis* contained more than 1 species. The Southern Ocean specimens collected by the *William Scoresby*, Station 303 (BMNH 1930.1.12.34) and 307 (BMNH 1930.1.12.35) and at least 1 specimen from Station 151 (BMNH 1930.1.12.31–33) were re-identified as *B. antarcticus*. The specimens from Station 76 (BMNH 1930.1.12.29–30), outside the Southern Ocean, are provisionally regarded as *B. gracilis* but also agree with *B. pacificus*.

It should be noted that Lönnberg (1905a, b) published 2 descriptions of *B. gracilis* n. sp. with conflicting locality data. However, in a footnote in the earlier, original description Lönnberg (1905a) stated that the locality data may have to be changed as the scientific account of the observations had not yet been completed. The corrected localities were included in the second description, in the complete report on the fishes collected during the Swedish South Polar expedition (Lönnberg 1905b).

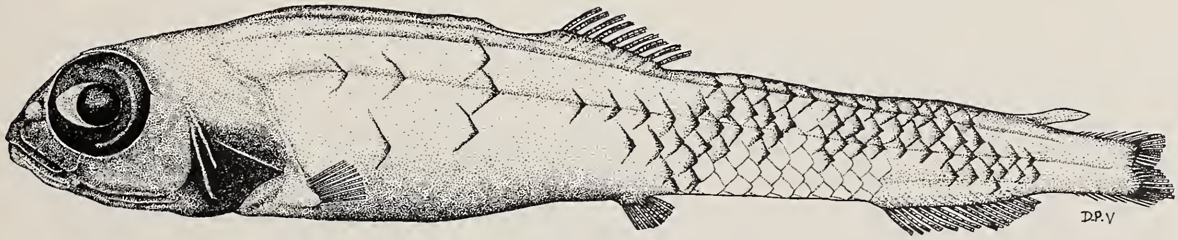


Fig. 3. *Bathylagus gracilis* ISH 421/76, 217 mm SL, female (51°05.5′S, 39°56.5′W)

Bathylagus tenuis Kobyliansky, 1986
Fig. 4

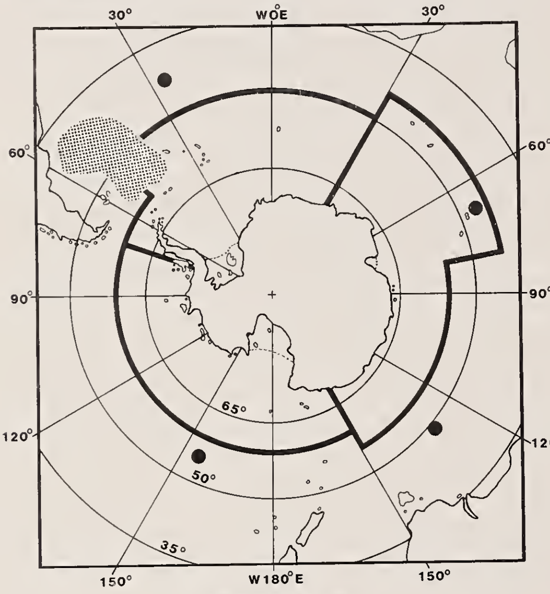
Bathylagus tenuis Kobyliansky, 1986: 40, fig. 20a (40°17′ S, 50°01′ W). Holotype: MMSU 16695.

Bathylagus antarcticus (*non* Günther): Norman, 1930: 276 (in part).

Diagnosis: Based on 12 fishes 48–165 mm SL. D 9–11; A 20–24; P 8–10; V 8–9; LSS 37–41; GR (7–9)+(16–21)=24–30; pyloric caeca 4–6; vertebrae 46–48. Body relatively short and compressed, the depth decreasing gradually towards the tail. Depth of head at preopercle 5.5–6.4, depth of body at pectoral-fin base 4.6–5.7 and at anal-fin origin 7.0–8.6, and head length 4.1–4.8 in SL. Eye diameter 2.1–2.5 in HL. Maxilla reaching under anterior margin of pupil. Gill opening restricted to lower quarter of head. Predorsal distance 2.0–2.2 and length of anal-fin base 4.4–6.0 in SL. Caudal peduncle length 13.4–19.2 in SL and its depth 0.8–1.2 in the length. Pelvic fins inserted closer to anal-fin origin than to pectoral-fin base.

Colour: In alcohol, generally brown, head and body covered with small. dark spots. Snout and opercle dark, cheek pale. Abdomen dark brown to black. Fins dusky and spotted. Scale pockets pale purple with dark rear edge. Mouth cavity and gill chamber dark; gill arch and gill rakers dusky. Peritoneum black and intestine pale.

Distribution: Scotia Sea, central South Pacific Ocean and south-east Atlantic Ocean. *B. tenuis* were caught at various depths between the surface and 2,600 m.



Distribution of *B. tenuis*

Remarks: Despite the apparent similarity in shape, *Bathylagus tenuis* is not closely related to either *B. antarcticus* or *B. gracilis*. Nevertheless, the morphometric characters of *B. tenuis* show a higher degree of resemblance to *B. antarcticus*. Regressions, against SL, of vertical measurements (depth of head, body and caudal peduncle) of both species closely follow each other, while *B. gracilis* shows a different growth pattern. The regression of peduncle length for *B. tenuis*, however, is separated from both other species thus making it a key character for identification (Gon 1987a). The situation is reversed with regard to meristic characters. *B. tenuis* is closer to *B. gracilis* in its counts of vertebrae, pyloric caeca, gill rakers and lateral scale series. In addition, a marked difference was observed in the shape of the opercle between *B. tenuis* and the other 2 species (Fig. 5). A comparison of *B. tenuis* with the data given by Cohen (1964) for *B. euryops* Goode & Bean, 1896, suggests a close relationship between these species.

Biology unknown. Attains 16.0 cm SL.

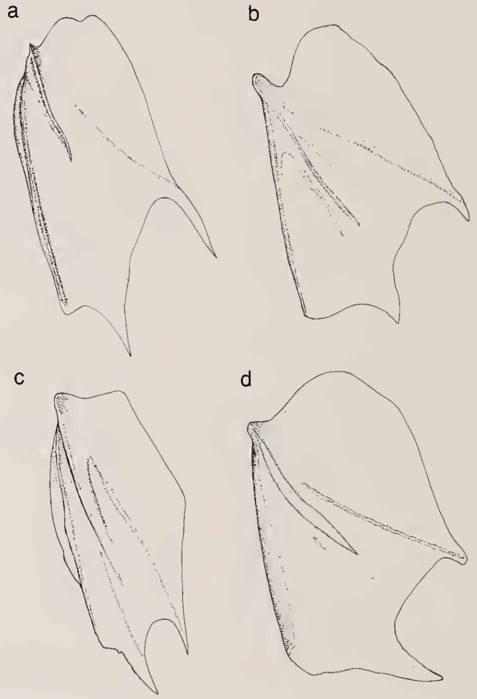


Fig. 5. Opercular bones of some *Bathylagus* species: a) *antarcticus;* b) *gracilis;* c) *tenuis;* d) *pacificus*

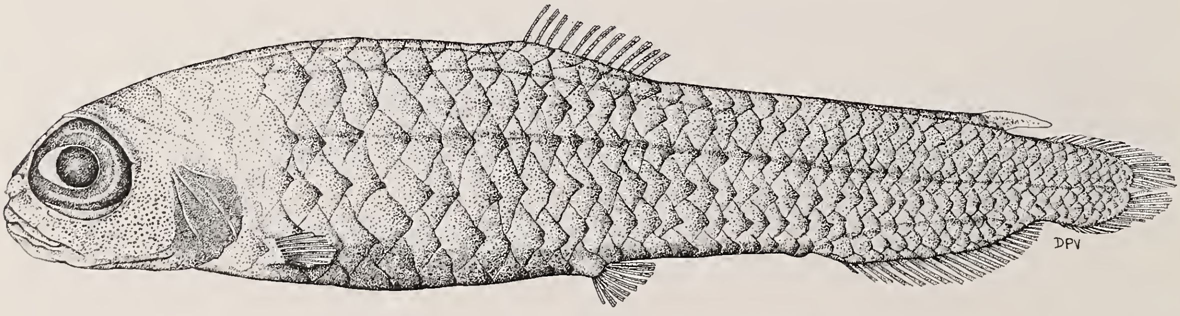


Fig. 4. *Bathylagus tenuis* ISH 377/76, 138 mm SL, female (54°07′S, 39°59′W)

ALEPOCEPHALIDAE

Slickheads

by Yu. SAZONOV & D.F. MARKLE

Salmoniform fishes with vertical fins in the posterior half of the body (dorsal and anal fin bases often subequal and opposite). No postcleithral papilla or black subcutaneous sac with luminous fluid. No gas-bladder. Adductor mandibulae muscle with a tendon separate from the primordial ligament and inserted on maxilla. A pair of pharyngeal sacs (crumenal organ) formed by upper pharyngeals, gill rakers and tooth plates of 4th and 5th branchial arches.

Colour blackish, brown, bluish or grey. Head may be darker than body, sometimes blue or with bluish tinge; no differences in pigmentation between dorsal and ventral parts of body. Maximum size of adults variable: from about 10 cm up to almost 100 cm SL.

Deep-sea fishes, engybenthic, rarely meso- or bathypelagic at depths of 150–5,000 m; most species at depths greater than 1,000 m. Distributed in all oceans but absent from the Central Arctic Basin, some continental seas and the continental slope of Antarctica; a few records from the Kerguelen Plateau and off South Georgia.

About 20 genera with more than 90 species; 4 genera and species are known from the sub-Antarctic region.

KEY TO GENERA

1a Body covered with deciduous scales (at least scale pockets remain); 2 supramaxillae 2
1b Body completely naked (rudimentary tubular scales sometimes present inside the sensory canal on body); a single supramaxilla... 3
2a D origin in advance of A origin; maxilla toothed, teeth in jaws multiserial .... *Narcetes*
2b D and A origins opposite; maxilla in most species toothless; teeth on premaxillary and dentary uniserial. . .*Alepocephalus*
3a Body rather short and deep; bases of D and A relatively short, subequal and opposite; procurrent C rays do not extend anteriad along caudal peduncle; maxilla toothed, extends behind vertical from mid-orbit.................... *Rouleina*
3b Body low, elongate, tapering caudally; base of D notably shorter than base of A; D origin well behind vertical from A origin; procurrent C rays extend anteriad along caudal peduncle almost to the posterior D and A rays but not confluent with these fins (in sub-Antarctic species); maxilla toothless, does not reach vertical from mid-orbit.............. *Leptoderma*

Genus *Alepocephalus* Risso, 1820

Dorsal and anal fin origins almost opposite, subequal (except for *A. bicolor*). Pectoral-fin rays 8–13 and pelvic-fin rays 6–9. Scales large or medium-sized, no more than 120 in a longitudinal row above lateral line; head scaleless. Posterior end of maxilla does not extend beyond eye. Premaxillae, dentaries and palatines toothed, maxillae and vomer toothless (with very few exceptions, e.g. *A. dentifer*). Two supramaxillae. Branchiostegal rays 6–8. Pyloric caeca about 8–30.

Type species *A. rostratus* Risso, 1820 by monotypy. About 20 species were described, some of which are likely to become junior synonyms in the future. Many species are still undescribed (see, for example, Sazonov & Ivanov 1980). Two species (both undescribed) are known from the Southern Ocean: 1 (off South Georgia) will be described elsewhere (Krefft 1985, in litt.), and another is diagnosed below.

Alepocephalus sp. A

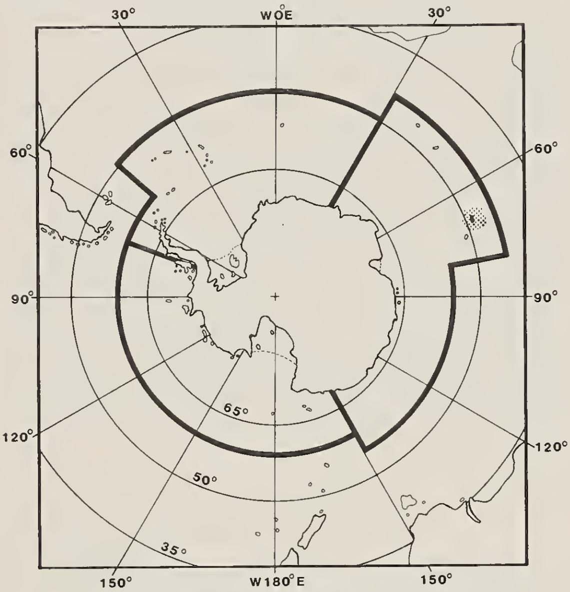
Fig. 1

Alepocephalus sp. 7 cf. *A. antipodiana* (Parrott): Sazonov & Ivanov, 1980: 52 (in key).

Diagnosis: D 15–18; A 15–18; P 10–13; V 7–8; LL 57–67; scales above LL in a longitudinal series 58–68; GR (6–8)+(14–17)=20–24; pyloric caeca 14–24. Dorsal and anal-fin bases short (about 10–14.5% of SL). Head length 2.8–3.1 in SL. Snout 22.4–26.2% HL, approximately equal to orbit diameter (23.4–26.8/29.1/ % HL). Interorbital width about equal to half orbit diameter. Posterior margin of maxilla slightly beyond vertical of mid-orbit. Longitudinal bony crest on premaxilla very low and poorly developed. Subopercle with a crest, tapering caudally and ending in a single point. Testes with 2–3 lobes.

Colour: Body grey-brown, scales opaque with black margins; head and fins blackish.

Distribution: This species is rather common on the Kerguelen Plateau at depths of 1,150–1,650 m, more numerous at 1,500–1,650 m.



Distribution of *Alepocephalus* sp. A

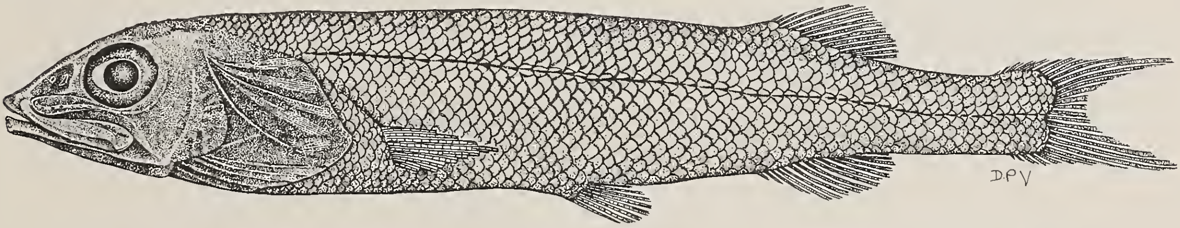


Fig. 1. *Alepocephalus* sp. A, from a photograph of *Alepocephalus* sp. 7 of Sazonov & Ivanov (1980)

Remarks: This species belongs to a group with moderate scale counts (within the genus *Alepocephalus)* including *A. productus*, *A. blanfordii*, *A. antipodiana*, etc. Its proper allocation seems problematical due to inadequate diagnoses of the species listed above and necessitates direct comparison of type specimens. It is probable that the specimens from the Kerguelen Plateau belong to a new species.

Biology unknown. Attains at least 42 cm SL.

Genus ***Leptoderma*** Vaillant, 1886

Body elongate, tapering caudally. Dorsal-fin base longer than anal-fin base and commencing ahead of origin of latter; both fins extend to, and sometimes confluent with, procurrent caudal-fin rays. Pelvic-fin rays 4–6. Body naked, tubular scales present in some species inside the tubular lateral line or both are absent and lateral line marked with neuromasts only. No photophores. Eyes very large. Jaws short, posterior end of maxilla at about vertical from anterior margin of eye. Only premaxilla and dentary are toothed. A single (posterior) supramaxilla. Preopercle very narrow and attached to anteroventral margin of opercle. Gill opening and first gill slit restricted dorsally. Stomach U-shaped, with 2 short pyloric caeca. Testes without lobes or convolutions.

Type species *L. macrops* Vaillant, 1886. Six or 7 species (including several undescribed ones). One undescribed species was recorded from the Southern Ocean.

Leptoderma sp. A

Fig. 2

Leptoderma affinis (*non* Alcock): Pakhorukov, 1976: 322.

Leptoderma lubricum (*non* Abe, Marumo & Kawaguchi): Markle, 1976: 150.

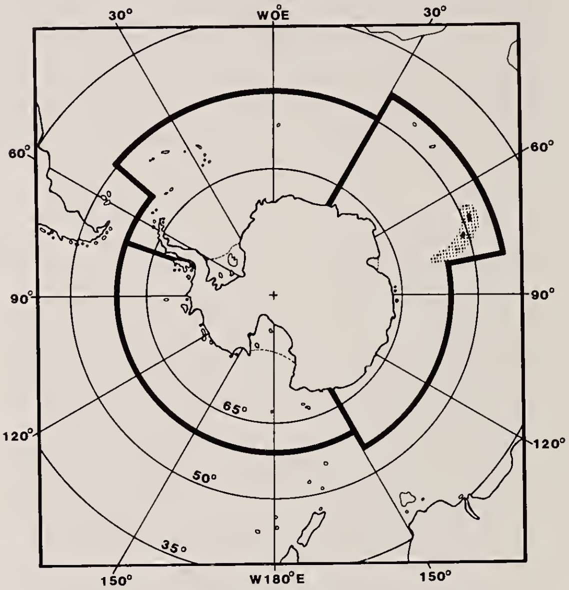
Leptoderma sp. Markle & Quéro, 1984: 245.

Leptoderma sp. 1 Sazonov & Ivanov, 1980: 94.

Diagnosis: D (21) 28–35: A (35) 41–50; P 6–9; V 4–5; GR 14–19. Vertical fins with relatively short bases, not confluent with procurrent caudal fin-rays. Caudal peduncle distinct. Right and left pelvic fins sometimes fused at bases. Lateral line without dermal canal and tubular scales, with free neuromasts only. Skin rather thick. Head 3.8–4.5 in SL. Snout somewhat shorter than orbit. Orbit 2.5–3.1 in HL. Interorbital width 2.6–4.9 % of SL.

Colour: Head and body black with bluish opalescence; skin around eyes blue as well as on jaws and gular membrane. Peritoneum, stomach, intestines and ovarian tunic blackish.

Distribution: A widely distributed species, known from off Azores, coast of north-western Africa, Rio-Grande Rise, Ninety East and Broken ridges, off California and Peru and Chile. Known from several localities at Kerguelen Plateau and Banzare Rise. Fishes outside the Southern Ocean were caught at 1,170–2,287 m. Fishes from sub-Antarctic localities were recorded at depths of 950–1,500 m.



Distribution of *Leptoderma* sp. A

Remarks: This species remains still undescribed but it differs distinctly from its congeners (see, for example, Sazonov & Ivanov, 1980).

Biology unknown. Attains 27 cm SL.

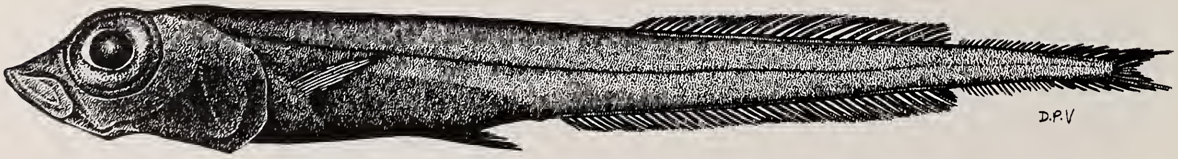


Fig. 2. *Leptoderma* sp. A, from a photograph of *Leptoderma* sp. 1 of Sazonov & Ivanov (1980)

Genus *Narcetes* Alcock, 1890

Dorsal-fin origin well ahead of vertical at anal-fin origin; pelvic fins with 7–10 rays. Supraorbital and antorbital bones present. Premaxillae meet one another at midline of snout and extend beyond the tip of ethmoid bone. Maxilla long, its posterior end behind vertical from posterior margin of orbit. Two supramaxillae. Teeth in jaws multiserial, present on maxilla, vomer and palatines. Branchiostegal rays 8–9. Pyloric caeca 6–17; GR (3–6)+(11–18)=14–23; vertebrae (25–33)+(18–25)= 48–56.

Type species *N. erimelas* Alcock, 1890 by monotypy. Of the 3–4 species recognised in this genus, only 1 is known from the Southern Ocean.

Narcetes stomias (Gilbert, 1890)

Fig. 3

Bathytroctes stomias Gilbert, 1890: 53, north-east Pacific. Holotype: USNM 43081

Narcetes pluriserialis Garman, 1899: 289, pl. 57, fig. 3, east Pacific (05°31′N, 86°31′W)

Narcetes affinis Lloyd, 1906: 308, Gulf of Aden.

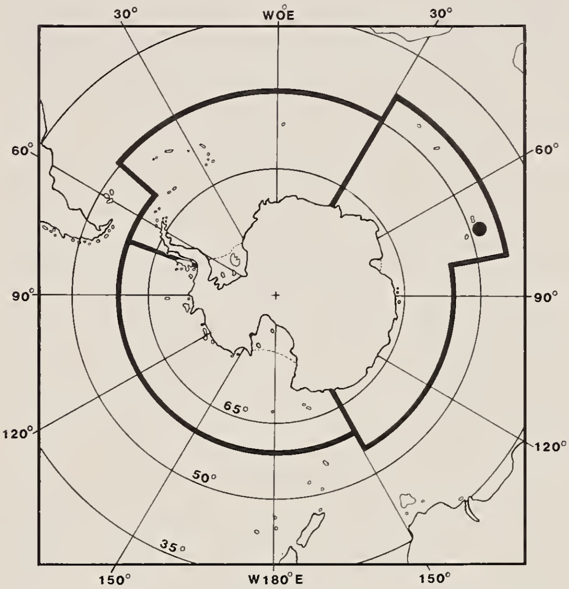
Narcetes stomias: Grey, 1958: 153.

Diagnosis: D 17–21; A 14–17; P 8–12; V 7–10; LL 51–81; scales in longitudinal row above LL 80–110; GR (3–4)+(11–15)=14–19; pyloric caeca 6–11; vertebrae (25–28)+(21–23)=47–50. Maximum body depth 5.2–6.9 in SL. Head 3.1–3.7 in SL. Snout 1.4–1.9 longer than orbit diameter. Skin on head not thickened; sensory canals simple without branches, pores in canals not numerous. Head length, snout length, width of skull, jaw length and orbit diameter negatively allometric. In large adults upper jaw hooked. Gill filaments short, fused at bases. Pyloric caeca present; intestine with 2 loops. Testes consist of 4 lobes.

Colour: blackish, head darker than body.

Distribution: North and South Atlantic, continental slope of southern Africa, Indian Ocean including Arabian Sea, Gulf of Oman, Mascarene Plateau, Ninety East Ridge, Broken Ridge, Exmouth Plateau and some other seamounts, eastern and western Pacific Ocean (north and south). Depth range from 1,200 to 2,334 m. Two records from the Kerguelen Plateau (309 and 315 mm SL).

Remarks: Biology unknown. Attains 53 cm SL, possibly more.



Distribution of *N. stomias*

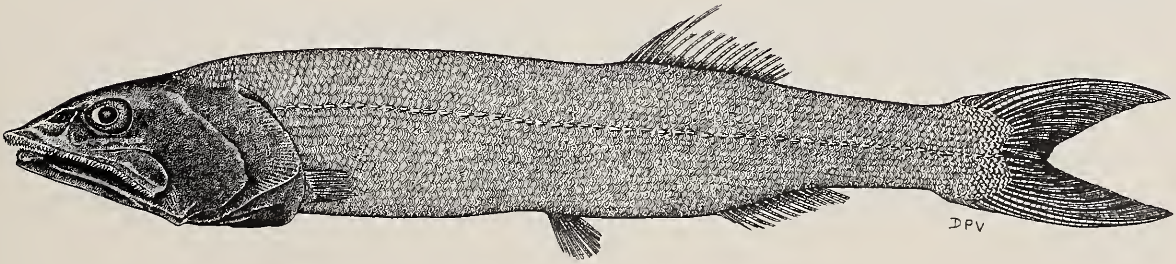


Fig. 3. *Narcetes stomias* USNM 215513, 45.5 cm SL, Hudson Canyon (38°50′ N, 72°34.5′W)

Genus ***Rouleina*** Jordan, 1923

Vertebrae (19–24)+(24–28)=43–50. Pyloric caeca 7–13. Gill rakers (5–10)+(15–21)=20–31. Dorsal and anal fins subequal and opposite, with less than 25 rays. Body naked, skin with small longitudinal compartments; lateral line with ring-like rudimentary scales inside the canal tube between pores (rarely both canal and scales absent and replaced by free neuromasts). Dermal papillae (free neuromasts?) also scattered over the head and body. Small iridescent nodular photophores present or absent but never stalked. Head length very short to extremely long. Supramaxillae 1 or 2 (anterior rudimentary). Teeth on premaxilla, maxilla and dentary uniserial; vomer and palatines toothless. No supraorbital and antorbital. Subopercle rudimentary, narrow, attached to the anteroventral margin of opercle. Gill openings rather wide.

Type species *Aleposomus guentheri* Alcock, 1892 by original designation of Jordan, 1923. Seven or 8 species, most of them in tropical Indo-west Pacific. Two species (*R. maderensis* and *R. attrita)* are circumglobal in tropical and temperate regions of all major oceans; *R. attrita* also occurs in the Southern Ocean.

Rouleina attrita (Vaillant, 1888)

Fig. 4

Bathytroctes attritus Vaillant, 1888b: 158, pl. 12, fig. 2a-c, south of Azores; Cape Verde, Banc d'Arguin. Syntypes: MNHN 85-166; MNHN 85-169.

Bathytroctes mollis Koehler, 1896: 517, pl. 26, fig. 2, Golfe de Gascogne.

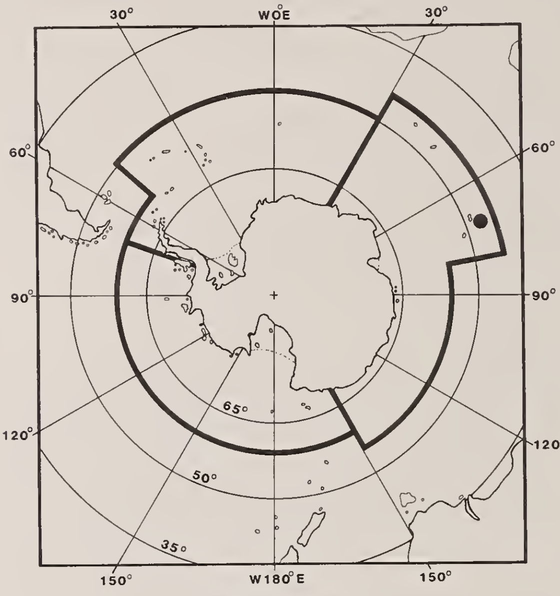
Bathytroctes aequatoris Goode & Bean, 1896: 44, fig. 50, off Ecuador.

Rouleina mollis: Markle, 1976: 164.

Rouleina attrita: Grey, 1959: 325.

Diagnosis: D 16–21; A 18–21; P 4–8; V 6–8; GR (5–8)+(16–21); LL 44–48; pyloric caeca 7–11; vertebrae (19–22)+(22–26)=43–45. Photophores absent. Sensory papillae on body and head numerous, especially along lateral line. Lateral line with narrow ring-like scales inside dermal tube. Head massive, less than 3.3 in SL. Snout 1.2–1.6 times longer than orbit (in specimens larger than 200 mm SL), orbit 4.2–5.6 in HL. Interorbital width slightly less than orbit diameter. Head length, head width, snout length, orbit diameter, interorbital width, and jaw length are negatively allometric. Maxilla very wide; single supramaxilla. Gill opening wide. Gill filaments with very short free part, widely united at bases. Testes convoluted, never lobate.

Distribution: Probably circumglobal on the continental slopes and submarine ridges excluding Arctic and Antarctic continent. Depth range in Atlantic Ocean 1,400–2,100 m, in Indian Ocean 1,120–1,650 m, and in Pacific Ocean 800–1,400 m. Known in Southern Ocean from 2 specimens (185 and 198 mm SL) from 2 localities on Kerguelen Plateau.



Distribution of *R. attrita*

Remarks: Biology unknown.

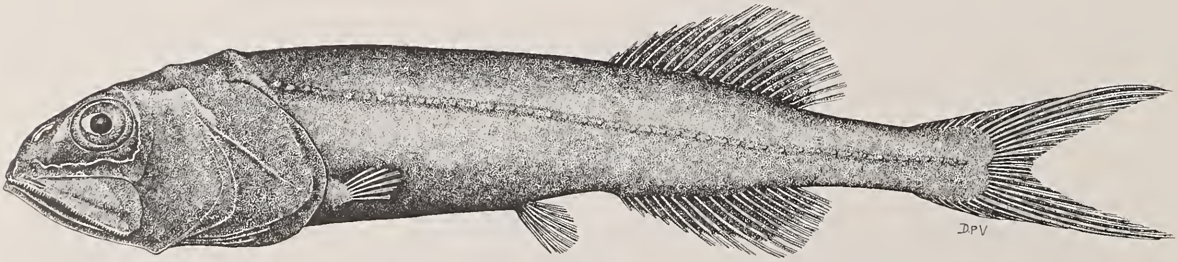


Fig. 4. *Rouleina attrita* USNM 215481, 37.5 cm SL, Atlantic Ocean (36°40.1'N, 74°25.4'W)

PLATYTROCTIDAE

Tubeshoulders

by P.C. HEEMSTRA

Body elongate (in Southern Ocean species), somewhat compressed and covered with deciduous scales. Photophores present or absent. Head naked. Dorsal and anal fins on rear half of body; no fin spines; pectoral fins small, almost rudimentary, located near ventral edge of body; pelvic fins abdominal, with 6–10 rays; no adipose fin. Luminous fluid can be discharged from a sac in the shoulder region via a short tube visible externally just below the lateral line and posterior to the shoulder girdle. This unique, flask-shaped, shoulder organ is located in the body musculature medial to the cleithrum and extends from the pectoral-fin base to the dorsal end of the cleithrum. Teeth on jaws uniserial in most species; vomer with 2–4 teeth; tongue usually with teeth. Gill rakers present. Branchiostegal rays 6–9. Vertebrae 40–52.

Platytroctids are moderate-sized (12 to about 30 cm SL) mesopelagic or bathypelagic fishes of the open ocean, generally found in depths of 200 to 2,000 m near continents, islands and seamounts. They are not really Antarctic fishes, but the family is here included on the basis of a record of 1 species from 59 °S in the Atlantic Ocean sector. No commercial importance.

In their recent comprehensive taxonomic review of the Platytroctidae, Matsui & Rosenblatt (1987) recognise 37 species and 13 genera. Only 1 species is likely to be found in the Southern Ocean.

Genus ***Normichthys*** Parr, 1951

Body moderately deep, its greatest depth contained less than 5 times in SL, and compressed, with a dorsal keel of nonmuscular tissue in front of the dorsal fin. Dorsal and anal fins equal and opposite. Photophores rudimentary or absent. Lateral line without a canal or modified scales. Mouth small, the upper jaw not reaching past eye. One or more large openings (as large as a scale) in scale pockets behind shoulder girdle.

Two species, but only 1 is known from the Southern Ocean. *N. operosus* Parr, 1951, occurs in the eastern Atlantic Ocean from 66 °N to 18 °S. It has fewer scales in the midlateral series (80–100), body more elongate (depth 4–5 in SL), and more gill rakers (28–30).

Normichthys yahganorum Lavenberg, 1965

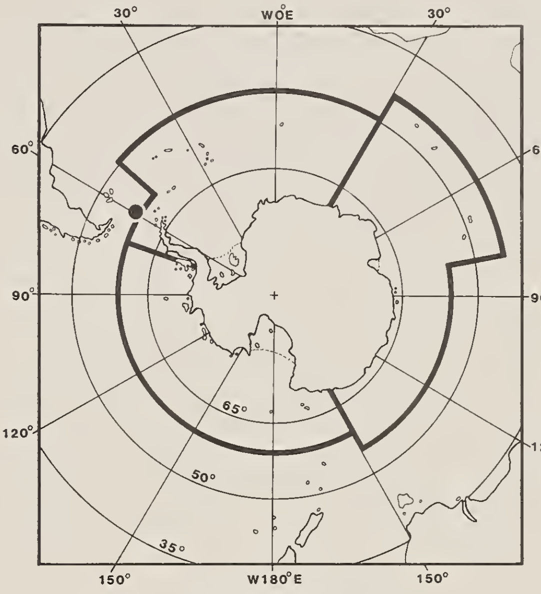
Fig. 1

Normichthys yahganorum Lavenberg, 1965: 3–7, figs. 1–2, off Chile (45 °01′S, 76 °33′W, 0–1,100 m). Holotype: LACM 10264.

Diagnosis: D 17–20; A 16–19; P 14–19; V 6–8; branchiostegal rays 7–8; GR (6–8)+(17–21)=24–28; vertebrae (21–24)+(22–24)=44–47. Body depth 3.4–4.0 in SL.

Colour: Blackish? Skin mostly missing in the material examined.

Distribution: Circumglobal in the Sub-tropical Convergence region of the Southern Hemisphere, mostly between 30 °S and 50 °S; one record from 59 °S, 60 °W (Matsui & Rosenblatt 1987: fig. 18). *N. yahganorum* is a bathypelagic species associated with the Antarctic Intermediate Water in depths of 785–2,000 m (Krefft 1976).



Distribution of *N. yahganorum*

Remarks: Biology unknown. The maximum size recorded for this species is 164 mm SL.

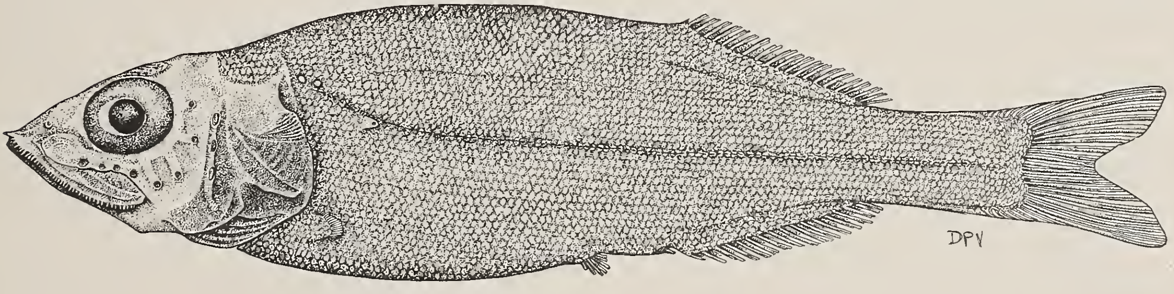


Fig. 1. *Normichthys yahganorum* ISH 824/71, 116 mm SL (39 °55′S, 26 °02′W)

GONOSTOMATIDAE

Bristlemouths

by O. GON

Body elongate and compressed. Eye small to large. Barbel absent. Mouth large, with small teeth in both jaws; enlarged teeth may be present, usually on upper jaw, but large canines or fangs absent. Teeth present or absent on vomer, palatines pterygoids and tongue. Maxilla reaching far beyond eye. Premaxilla less than half length of toothed section of maxilla. Gill rakers well developed. Pseudobranch present or absent. Scales, when present, large, cycloid and deciduous. Pelvic fins abdominal. Pectoral fins situated low on body side. Position of dorsal, anal and pelvic fins in relation to each other variable. Anal-fin base longer than dorsal-fin base. Dorsal adipose fin present or absent, ventral one absent. SO photophores present or absent. Serial photophores discrete, in 1 or 2 lengthwise rows and 8 or more BR photophores (except *Cyclothone obscura*). OA photophores ending at or anterior to anal-fin origin. Less than 25 AC photophores. No photophores on isthmus.

Following Ahlstrom *et al.* (1984), Gonostomatidae is viewed here as containing 4 genera, *Bonapartia, Gonostoma, Margrethia* and *Cyclothone.* The former 3 genera are grouped by a specialized metamorphosis and photophore development (Ahlstrom 1974). *Cyclothone* apparently shares with these genera autapomorphies of jaws and associated muscles (Fink 1984) and the primitive type Beta photophores. Ahlstrom *et al.* (1984) hypothesized that *Cyclothone* may have lost the specialized photophore development known to occur in the first 3 genera through paedomorphosis.

About 21 species of mostly small meso- to bathypelagic (200–3,500 m during day) fishes distributed worldwide. Some species perform diel vertical migration. During metamorphosis larvae sink from the near surface to greater depths, thus forming vertical stratification by size during day hours. Some species with great abundance form sound scattering layers. Zooplankton grazers. Intrafamilial and ordinal relationships were recently discussed by Fink (1984, 1985) and Ahlstrom *et al.* (1984). Recent revisions of genera were done by Mukhacheva (1972, 1974, 1976), Kobayashi (1973) and Parin (1982). One genus represented in Southern Ocean.

Genus *Cyclothone* Goode & Bean, 1883

Dorsal adipose fin absent. Dorsal- and anal-fin origins opposite each other. Pelvic fin inserted in front of dorsal-fin origin. Anus at mid-distance between pelvic-fin insertion and anal-fin origin or nearer the former. Eye minute, its diameter smaller than snout length. Tongue toothless. Vomerine teeth usually present. Pseudobranch absent. SO photophores absent. Females larger than males. Photophore distribution is shown in Fig. 1.

Cyclothone is cosmopolitan from sub-Arctic to Antarctic waters. Species of this genus have progenetic tendencies (Marshall 1984). Limited diel vertical migration performed by at least 1 species (Willis & Pearcy 1982). About 12 species, of which at least 4 in our area. Recent revisions by Kobayashi (1973) and Mukhacheva (1974). Regional taxonomic treatment by Badcock (1982, 1984a) and Schafer *et al.* (1986).

Remarks: The presence of *C. microdon* in the Southern Ocean was reported by a number of past Antarctic expeditions. Considering that *Cyclothone* taxonomy was set on a firm footing only in recent years (Kobayashi 1973; Mukhacheva 1974), the inadequate descriptions provided by early Southern Ocean ichthyologists prevent verification of their identifications. In addition, *Cyclothone* spp. collected during BIOMASS still await identification to species. Consequently, it is impossible at this time to determine patterns of distribution in the Southern Ocean with certainty.

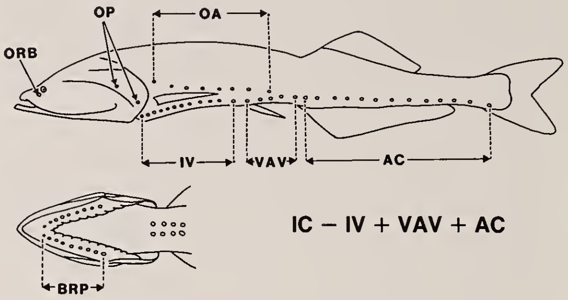


Fig. 1. Photophores of the genus *Cyclothone.* ORB—photophores associated with eye and positioned anteroventrally to orbit. OP—photophores on opercle. BRP—photophores on branchiostegal membrane. OA—complete lateral series, from behind opercle to anal-fin origin. IV—ventral series, from isthmus to pelvic- (ventral-) fin insertion. VAV—ventral series, from pelvic- (ventral-) fin insertion to anal-fin origin. AC—photophores of the ventral series from anal-fin origin to caudal-fin base. IC—complete ventral series, from isthmus to caudal-fin base.

KEY TO SPECIES

1a Gill filaments free or fused basally, forming a narrow flap, equally wide along cerato- and hypobranchials of first gill arch (Fig. 2a) 2

1b Gill filaments of hypobranchial of first gill arch fused, forming a broad flap distinctly wider than that of ceratobranchial (Fig. 2b) 3

2a Teeth on rear part of maxilla large, strongly curved forward; no smaller teeth separating large ones; pyloric caeca 3 .... *C. acclinidens*

2b Teeth on posterior part of maxilla only slightly curved forward and large ones separated by smaller teeth; pyloric caeca 4 .... *C. pallida*

3a Total GR 18–23; GR on hypobranchial of first gill arch 4–5; OA photophores 8–9 4

3b Total GR 15–18; GR on hypobranchial of first gill arch 3; OA photophores 7 .... *C. braueri*

4a Pigment of branchiostegal membrane uniform and may be only slightly darker along rays and margins (Fig. 3a); pyloric caeca 3 (rarely 4); area between posterior end of body cavity and anal-fin origin dark .... *C. microdon*

4b Pigment of branchiostegal membrane (relatively large spots) concentrated along rays and margins or in a wide band along middle of membrane (Fig. 3b); pyloric caeca 4; area between posterior end of body cavity and anal-fin origin pale .... *C. pseudopallida*

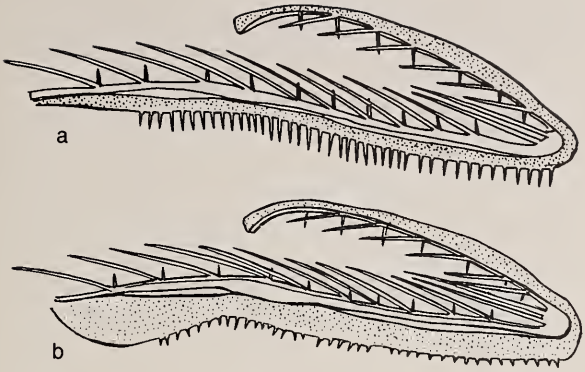


Fig. 2. Gill filaments (stippled) on first gill arch (left side) of Southern Ocean *Cyclothone*: a. *acclinidens* and *pallida*; b. *braueri, microdon* and *pseudopallida*.

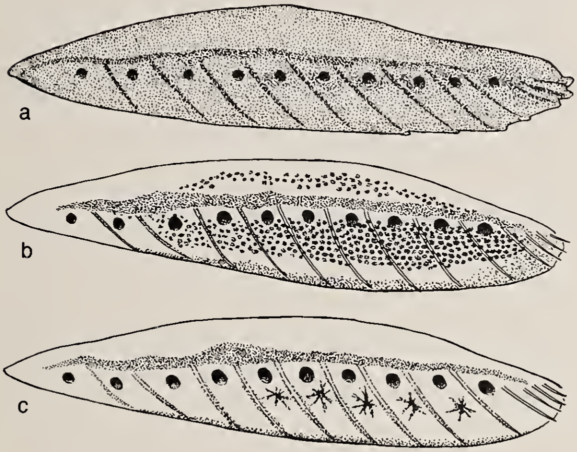


Fig. 3. Pigment pattern of the branchiostegal membrane (ventrolateral view of left side) of Southern Ocean *Cyclothone*: a. *acclinidens, microdon* and *pallida*; b. *pseudopallida*; and c. *braueri*.

Cyclothone acclinidens Garman, 1899

Fig. 5

Cyclothone acclinidens Garman, 1899: 247, pl. J, fig. 4, Gulf of Panama? Syntype: USNM 120400.

Diagnosis: D 13–15; A 18–20; P 8–10; V 5–6; GR 21–25; branchiostegal rays 13–15; vertebrae 30–32; pyloric caeca 3. Photophores: ORB 1; OP 2; BR 9–11; OA 8–9; IV 12–14; VAV 4–5; AC 14–17. Origin of dorsal and anal fins opposite each other or the former is slightly in advance. Anus at mid-distance between pelvic-fin bases and anal-fin origin or slightly closer to the former, usually between second and third VAV photophores.

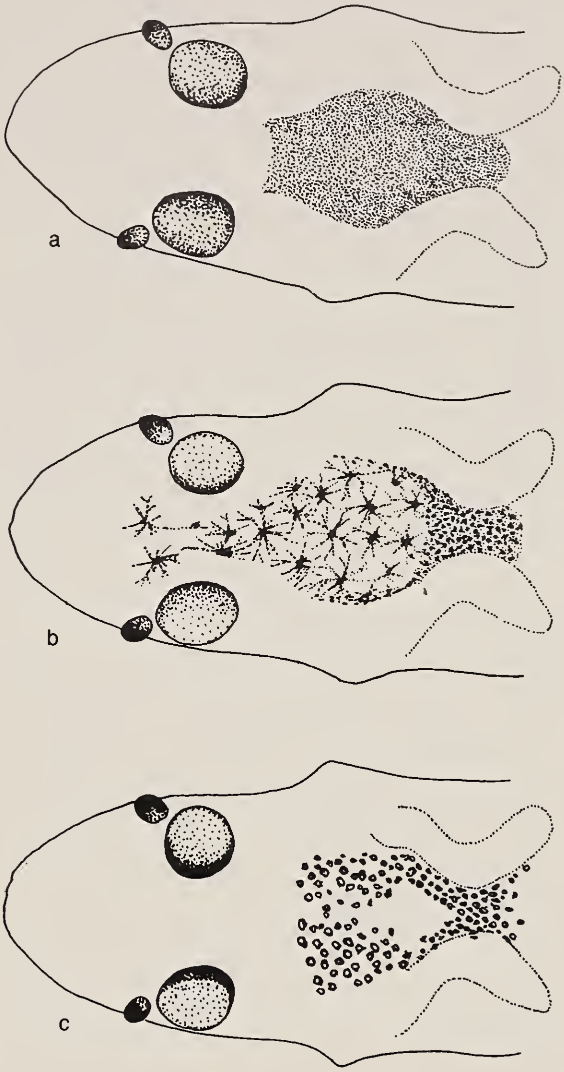


Fig. 4. Pigment pattern of the meningeal membrane (dorsal view) of Southern Ocean *Cyclothone*: a. *acclinidens, microdon* and *pallida*; b. *braueri*; and c. *pseudopallida*.

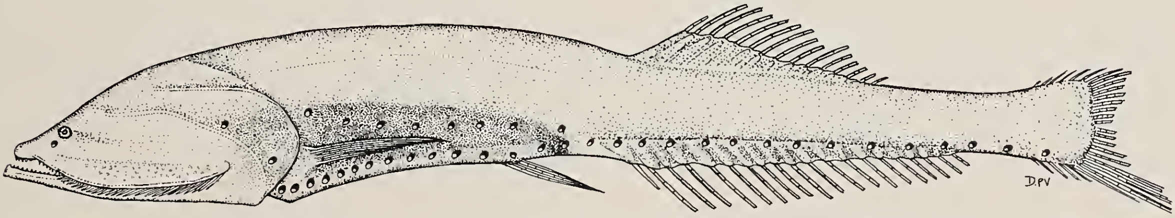
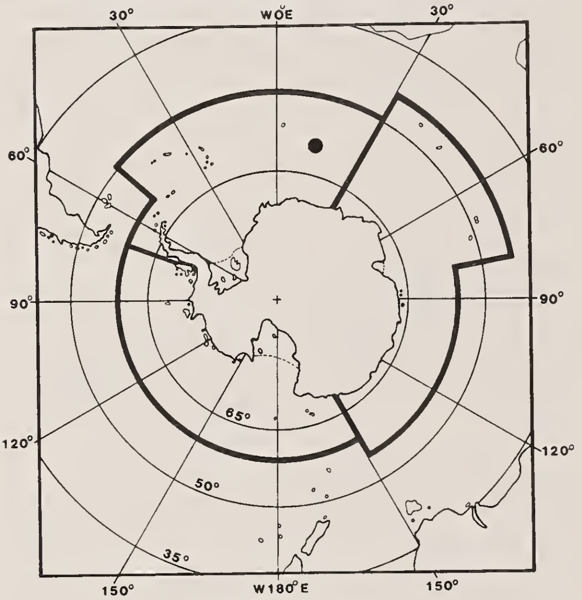


Fig. 5. *Cyclothone acclinidens* LACM 10222, 32 mm SL, Peru-Chile Trench (33°33′S, 72°45′W)

Premaxillary teeth even. Gill filaments free to base or fused basally into a narrow strip equally wide along cerato- and hypobranchial of first gill arch (Fig. 2a). No gill raker at angle of first arch. Gill rakers on hypobranchial of first arch 5–6. First OA photophore slightly elevated. Last 1 or 2 OA photophores separated from anterior ones by a larger gap and placed behind level of pelvic-fin insertion. Two AC photophores between last anal-fin ray and first procurrent caudal-fin ray. Supra- and infracaudal luminescent gland well developed. The former appearing as a thick mass of pale tissue reaching forward to rear end of dorsal-fin base.

Colour: In alcohol, light to dark brown with concentration of pigment on head, nape and abdomen. Dark, subcutaneous patches sometimes visible between anal- and dorsal-fin pterygiophores. Area between rear end of body cavity and anal-fin origin pale. Pigment of branchiostegal membrane and membrane underlying occipital area diffuse (Figs. 3c and 4a respectively).

Distribution: Tropical and subtropical in all major oceans, but may occur in reduced numbers in the temperate eastern North Atlantic Ocean. In the Southern Ocean, a single specimen was captured by the *Valdivia* Expedition (Brauer 1906) in the Atlantic Ocean sector near Bouvet Island (56°30′ S, 14°29′ E). The depth of the capture is not stated, but apparently was below 520 m (Brauer 1906). In areas north of the Southern Ocean juveniles and adults were found between 300–1,200 m (Badcock 1984; Schaefer *et al.* 1986).



Distribution of *C. acclinidens*

Remarks: In addition to the characters given in the key above, *C. acclinidens* differs from its other congeners in the Southern Ocean in having a distinct, well-developed supracaudal luminescent gland. Mukhacheva (1964) described the supracaudal gland of *C. pallida* as well-developed. However, it is not as distinct and massive as in *C. acclinidens*.

Inclusion of *C. acclinidens* in the Southern Ocean fauna is based on the *Valdivia* specimen, which I have not been able to examine. As this capture was far from the normal range of *C. acclinidens*, misidentification is possible though unlikely due to the distinct features of this species. Whether *C. acclinidens* is a resident of sub-Antarctic waters still remains to be confirmed.

Males attains 36 mm and females about 65 mm SL.

Cyclothone braueri Jespersen & Tåning, 1926
Fig. 6

Cyclothone braueri Jespersen & Tåning, 1926: 7, figs. 4, 6, 7, Mediterranean. Syntypes: ZMUC P207585-P207678.

Diagnosis: D 12–15; A 18–20; P 9–10; V 6–7; GR (5–6)+(10–12) = 15–18; branchiostegal rays 12–14; vertebrae 30–32; pyloric caeca 3. Photophores: ORB 1; OP 2; BR 8–10; OA 7; IV 12–13; VAV 4; AC 13–15. Origin of dorsal and anal fins opposite each other or anal-fin origin slightly in advance. Anus at about quarter distance between pelvic-fin base and anal-fin origin behind the former. No enlarged teeth on premaxilla. Gill filaments along hypobranchial of first arch fused basally, forming a broad flap with a convex distal margin (Fig. 2b). Three gill rakers on hypobranchial of first arch. No gill raker at angle of first arch. Photophores relatively large. First OA elevated to slightly above level of dorsal OP. Anterior pair of VAV close together, both in front of anus. One AC photophore between last anal-fin ray and first procurrent caudal-fin ray.

Colour: In alcohol, pale with star-shaped melanophores mostly on back and top of head. Pigment on branchiostegal membrane concentrated mainly along rays and on margin. Stellate melanophores frequently present between posterior branchiostegal rays (Fig. 3c). Membrane underlying occipital region with no pigment or with few distinct stellate melanophores in its anterior section (Fig. 4b). Peritoneum black and clearly shows through body wall. Area between rear end of body cavity and anal-fin origin pale.

Distribution: Tropical and subtropical Atlantic, Indian, western and eastern South Pacific oceans, and Mediterranean Sea (Mukhacheva 1974); also in the temperate North Atlantic Ocean, as far as 66°N (Badcock 1984a).

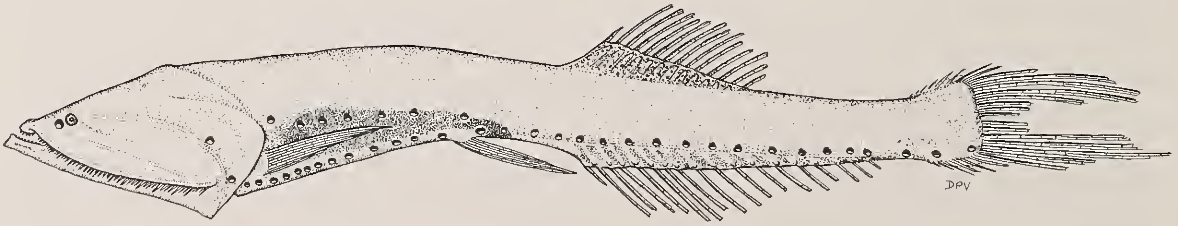
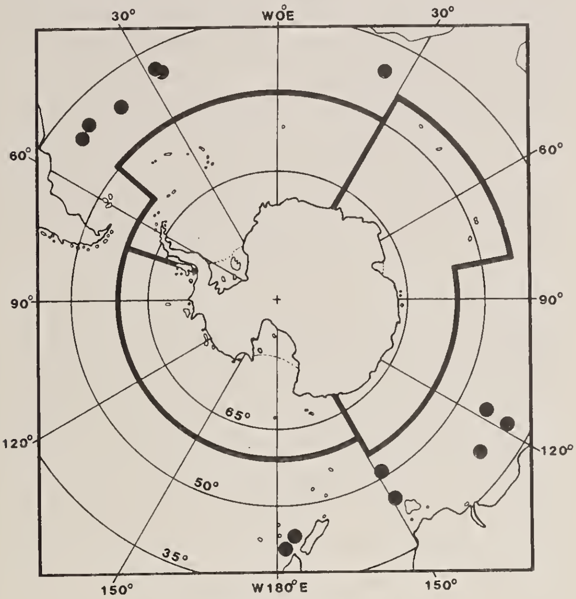


Fig. 6. *Cyclothone braueri* LACM 10198, 28.7 mm SL, Peru-Chile Trench (7°47.5′S, 81°23′W)

Not reported yet from our area, but known from sub-Antarctic water south of Australia (Miya *et al.* 1986). Vertically, adults and juveniles were collected in tows between 200–900 m (Badcock 1984a; Schaefer *et al.* 1986). Larvae and postlarvae were caught between the surface and 600 m, depending on the degree of development, with the more developed in deeper water.



Distribution of *C. braueri*

Remarks: Apart from the characters given in the key above, *Cyclothone pseudopallida* differs from *C. braueri* in having many distinct punctate melanophores on the anterior part of the membrane underlying the occipital region (Fig. 4c). The biology of *C. braueri* in sub-Antarctic water is unknown. Breeding populations near New Zealand (30°S) were investigated by Spanovskaya & Grigorash (1978). Sexual maturity was reached at 17–20 mm length. Males outnumbered females in the 15–22 mm size group and females outnumbered males in the 23–30 mm size group. In aggregations of fishes close to spawning, however, the sex ratio was nearly 1:1. Ovaries contained eggs of various sizes, the largest being 0.5 mm. The number of eggs per ovary pair was highly variable, 170–671, and positively correlated with increasing body length. In the north Atlantic Ocean (30°–60°N) Badcock (1984a) observed higher fecundity, up to 900 eggs per ovary pair and noted that fecundity increased in higher latitudes. Marshall (1984), based on the data of Badcock & Merrett (1976) concluded that *C. braueri* is semelparous and has a life span of 1 year. Feeds on small zooplankton, mostly copepods.

Males attain 26 mm and females about 38 mm SL.

Cyclothone microdon (Günther, 1878)

Fig. 7

Gonostoma microdon Günther, 1878: 187, Atlantic and Pacific (precise locality unknown). Syntypes: BMNH 1887.12.7.164–171; BMNH 1887.12.7.173–178 (another jar labelled 1887.?.?.?. is possibly 1887.12.7.172; J. Chambers pers. comm.)

Cyclothone lusca Goode & Bean, 1883: 221.

Neostoma quadrioculatum Vaillant, 1888b: 99, pl. 8, fig. 2, Gulf of Gascogne.

Diagnosis: D 12–15; A 17–20; P 8–10; V 5–6; GR (6–8)+(13–15) = 19–23; branchiostegal rays 12–15; vertebrae 31–33; pyloric caeca 3–4 (usually 3). Photophores: ORB 1; OP 2; BR 9–10; OA 8–9; IV 12–14; VAV 4–5; AC 13–15. Origin of dorsal and anal fins opposite each other, or dorsal-fin origin slightly in advance. Anus closer to pelvic-fin base than to anal-fin origin, usually between second and third VAV photophores. Premaxillary teeth uneven, usually in single row, but sometimes in 2 irregular rows. Gill filaments along hypobranchial of first arch fused basally, forming a broad flap with a convex distal margin (Fig. 2b). Gill rakers on hypobranchial of first arch 4–5. No gill raker at angle of first arch. Anterior 2 or 3 OA photophores elevated, first one highest but below level of dorsal OP photophore. Last 1 or 2 OA photophores separated from anterior OA photophores by a large gap and situated behind level of pelvic-fin insertion. VAV photophores more or less evenly spaced. One, rarely 2, AC photophores between last anal-fin ray and first procurrent caudal-fin ray.

COLOUR: In alcohol, dark brown to nearly black. Pigment on branchiostegal membrane evenly spread so that there are no distinctly pale areas (Fig. 3a). Membrane underlying occipital region evenly pigmented, sometimes with a few ill-defined darker spots (Fig. 4a). Peritoneum dark and does not normally show through body wall. Stomach dark and intestine pale. Area between rear end of body cavity and anal-fin origin dark.

Distribution: Atlantic Ocean and southern parts of Indian and Pacific oceans (Mukhacheva 1964, 1974). Probably circum-Antarctic between the Antarctic Polar Front and the Antarctic continental shelf (see Remarks

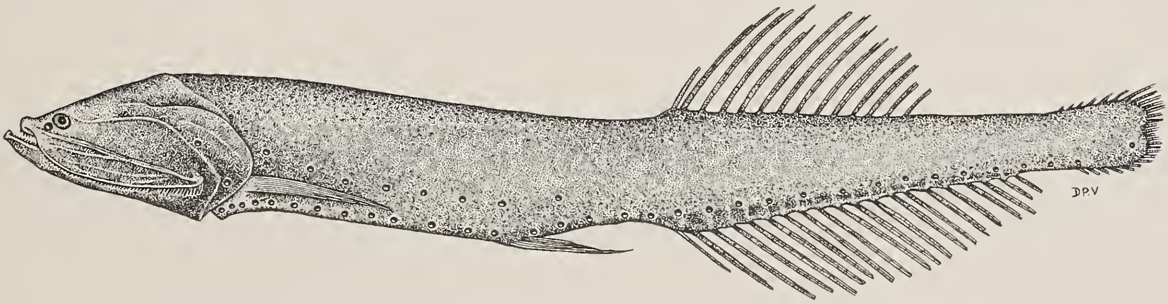
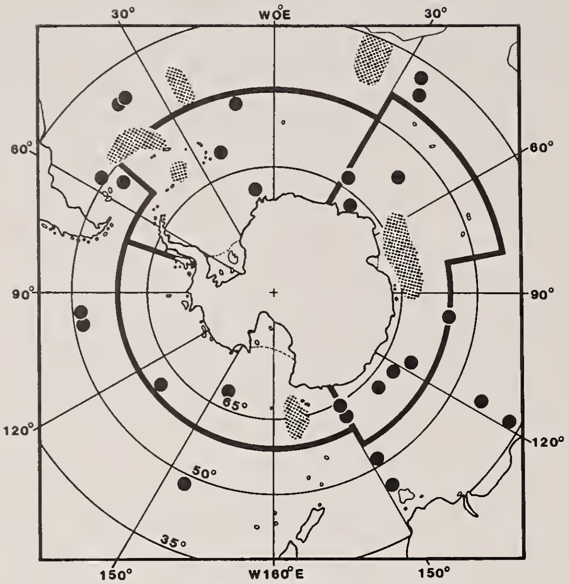


Fig. 7. *Cyclothone microdon* ADH S85/293–297, 52 mm SL (63°00.8′S, 67°57.4′E)



Distribution of *C. microdon*

below). Vertically, larvae near surface, postlarvae at 400–800 m with depth increasing with size, and juveniles and adults at 500–3,000 m, but the range is likely to vary geographically.

Remarks: A number of characters of Southern Ocean *C. microdon* showed variation not reported for this species in other areas (Mukhacheva 1964, 1974; Badcock 1982, 1984a; Schaefer *et al.* 1986). These include pyloric caeca (6.6% with 4 vs 3 in other areas), and counts of dorsal-fin rays (5% with 12 vs 13–15 in other areas) and pectoral-fin rays (6.5% with 8 vs 9–10 in other areas). The normal position of the anus is slightly in front of the third VAV photophore and the genital pore is usually close behind this photophore. In some specimens examined during this study, both openings were found slightly forward so that the anus was close behind the second VAV photophore and the genital opening was in front of the third VAV photophore. Variation in the position of the anus and genital opening has also been found in *C. pallida* from the western North Pacific Ocean (Kawaguchi 1971). Thus, the use of the number of VAV photophores anterior to the genital pores as a diagnostic character in species identification (Badcock 1982) should be exercised with caution. One specimen had distinct punctate pigment on the branchiostegal membrane and the membrane underlying the occipital region. However, the pigment spots on the branchiostegal membrane were evenly spread so that no distinct unpigmented areas were evident on the membrane. In all its other characters this specimen agreed with *C. microdon*.

Cyclothone microdon reaches maturity at about 30–35 mm SL. In comparing populations between 35 °–65 °S in the western Pacific Ocean, Spanovskaya & Lapin (1981) found that maximum size and mean length of sampled fishes increased with latitude. At 35 °S most of the sample was in the range of 26–42 mm SL and at 65 °S most of the specimens were 48–60 mm SL. Most interesting was the observation that the fishes of the latter sample had underdeveloped gonads which could not be sexed. Spanovskaya & Lapin (1981) hypothesized that the high Antarctic latitudes form a "sterile zone" for *C. microdon*. Underdeveloped gonads apparently were not observed in specimens collected at 55 °S or farther north. The implication is that the Antarctic Polar Front may be acting as a reproductive barrier for *C. microdon*. The material used in this study (Indian Ocean sector only) agrees with the findings of Spanovskaya & Lapin (1981) regarding length frequency distribution. It does not, however, support the idea of a sterile zone. In specimens larger than 45 mm (most of the sample) gonads were mature and enlarged, though not ripe, and no difficulties were experienced in sexing the fish. The state of gonad development (stages III & V) suggests that spawning may take place at the end of summer-autumn months. Protandrous sex reversal has been observed in fishes from the eastern North Atlantic Ocean (Badcock 1984a, 1986). *C. microdon* is the most common species of *Cyclothone* in the Indian Ocean sector of the Southern Ocean. Feeds on small zooplankton, mostly copepods.

Males attain about 50 mm and females about 72 mm SL.

Cyclothone pallida Brauer, 1902
Fig. 8

Cyclothone pallida Brauer, 1902: 281, Atlantic and Indian oceans. Holotype: probably in ZMB; this species is based on a single 5 cm SL specimen of the *Valdivia* Expedition, station 207; a 47 mm SL specimen from station 207 is present at ZMB but not registered as type (H.-J. Paepke, pers. comm.)

Cyclothone canina Gilbert, 1905: 604, pl. 71, fig. 2, vicinity of Kauai, Hawaiian Islands.

Diagnosis: D 12–15; A 16–19; P 9–11; V 6–7; GR 22–25; branchiostegal rays 13–15; vertebrae 31–33; pyloric caeca 4. Photophores: ORB 1; OP 2; BR 9–11; OA 8–9; IV 13; VAV 4–5; AC 14–15. Origin of dorsal and anal fins opposite each other or the former is slightly in advance. Anus closer to pelvic-fin base than to anal-fin origin, usually between second and third VAV photophores. Premaxillary teeth uneven, with at least 1 tooth, the fourth, much larger. Gill filaments fused basally into a narrow strip of equal width along entire length of cerato- and hypobranchial of first gill arch (Fig. 3a). Gill

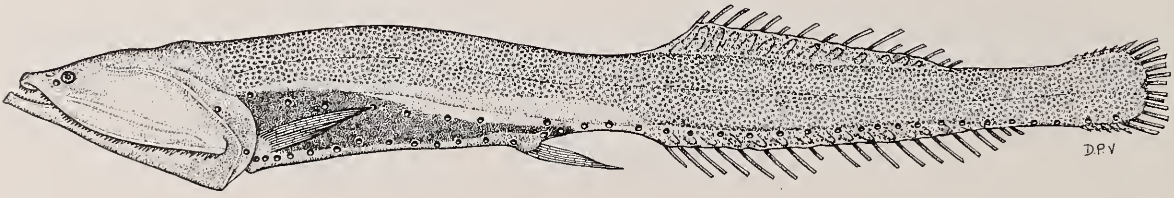
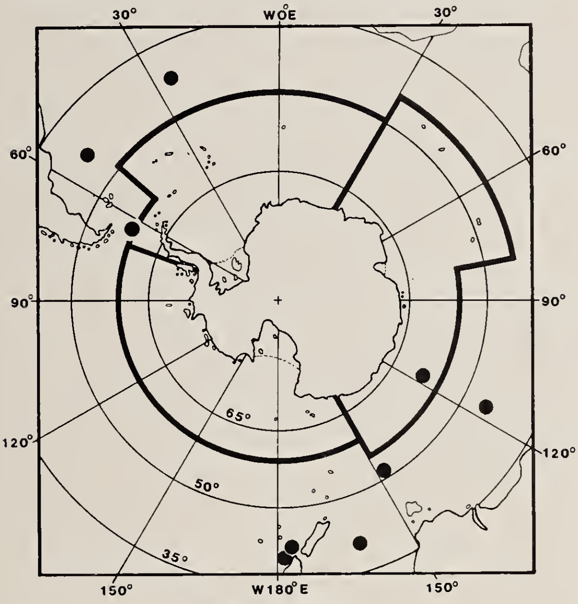


Fig. 8. *Cyclothone pallida* LACM 10359-2, 66.6 mm SL, Drake Passage

rakers on hypobranchial of first arch 4–5. No gill raker at angle of first arch. First 2 OA photophores slightly elevated. Posterior 1 or 2 OA photophores separated from anterior OA photophores by a large gap and situated behind level of pelvic-fin insertion. Two, rarely 3, AC photophores between last anal-fin ray and first procurrent caudal-fin ray.

Colour: In alcohol, pale to dark brown, covered with small, black spots mostly on head and sides of body; pale area present anterior to anal-fin origin. Dorsal- and anal-fin rays usually dark, but sometimes lightly speckled. Pigment on branchiostegal membrane diffuse, without distinctly pale areas (Fig. 3a). Membrane underlying occipital region evenly pigmented (Fig. 4a), often extending to posterior margin of eye or slightly in front of it, to pineal body. Internasal area dark, though usually skin absent due to net damage. Peritoneum dark, sometimes visible through ventral body wall. Area between rear end of body cavity and anal-fin origin pale or with light pigmentation.

Distribution: Tropical to temperate waters of 3 major oceans. Southern Ocean captures in the Indian Ocean sector south of Australia (Miya *et al.* 1986). Vertically, juveniles and adults were collected in tows between 400–1,300 m, but with evident geographical variation in depth range (Badcock & Merret 1977; Maynard 1982; Miya & Nemoto 1987). Occurrence in the Southern Ocean, south of the Antarctic Polar Front, is probably incidental.



Distribution of *C. pallida*

Remarks: Variation in the position of the anus and genital pore was observed by Kawaguchi (1971) and Badcock (1982). The most common condition is with the anus just behind level of second VAV photophore and the genital pore immediately in front of third VAV photophore. Occasionally, the anus is moved forward, and has one VAV photophore anteriorly, or backward closer to the third VAV photophore. In the latter case, the genital pore has 3 VAV photophores in front of it. *C. pallida* closely resembles *C. microdon* in colour and size. In addition to the characters given in the key, *C. pallida* differs from *C. microdon* in having a longer caudal peduncle (11.2–15.4 vs 10.8–12.0% SL), relatively larger photohpores (Mukhacheva 1964), and the pale area in front of anal-fin origin. Another, closely related species is the tropical *C. parapallida* Badcock, 1982, which has fewer gill rakers (21, rarely 22–23); no pigment spots on internasal area; unpigmented dorsal- and anal-fin rays; and meningeal pigment that does not extend to the posterior margin of the eye (see Badcock 1982 for full discussion of the differences). See also remarks for *C. pseudopallida*.

Biology in the Southern Ocean unknown. In Japanese waters, *C. pallida* reaches sexual maturity at 3–4 years and is probably iteroparous (Miya & Nemoto 1987). Females mature at 40–45 mm SL and males at 30–35 mm SL. Fecundity apparently varies geographically. Egg counts ranged between 1,840–2,797 in fishes collected in Japanese waters (Miya & Nemoto 1987), whereas in fishes from the Hawaiian Islands it was 1,251–1,454 (Maynard 1982).

Males attain 48 mm and females about 75 mm SL.

Cyclothone pseudopallida Mukhacheva, 1964

Fig. 9

Cyclothone pseudopallida Mukhacheva, 1964: 104, fig. 7a (38°34′N, 144°18′E). Holotype: ZIN 37444.

Diagnosis: D 13–14; A 18–20; P 9–10; V 6; GR (5–6)+(12–13) = 17–19; branchiostegal rays 12–14; vertebrae 30–33; pyloric caeca 4. Photophores: ORB 1; OP 2; BR 9–10; OA 8; IV 13; VAV 5; AC 14–16. Origin of dorsal and anal fins opposite each other or the latter slightly in advance. Anus closer to pelvic-fin base than to anal-fin origin, usually between second and third VAV photophores. Premaxillary teeth uneven. Gill filaments fused into a broad flap with a convex distal margin along hypobranchial of first gill arch (Fig. 2b). No gill raker at angle of first arch. Four gill rakers on hypobranchial of first arch. First OA photophore elevated. Last OA photophore separated from anterior ones by a gap somewhat larger than space between anterior photophores and placed behind level of pelvic-fin insertion.

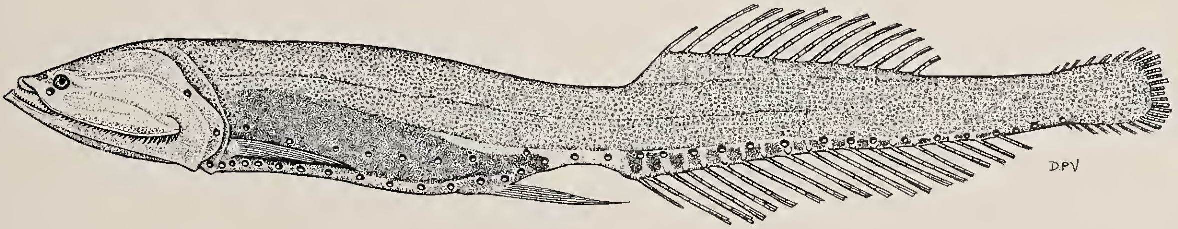
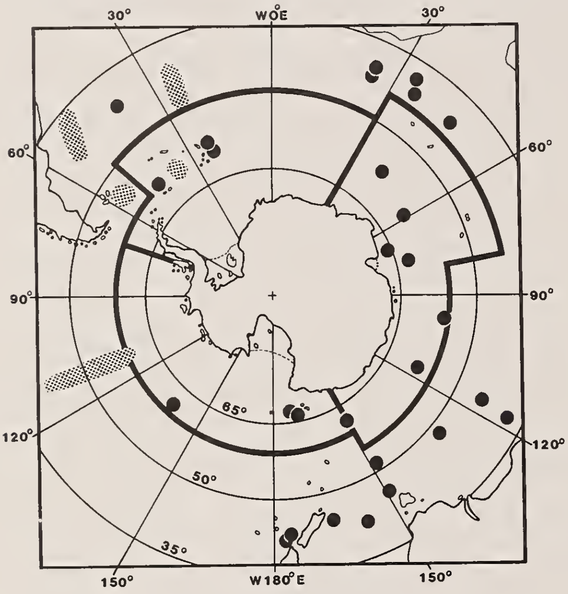


Fig. 9. *Cyclothone pseudopallida* ADH ex-S85/0013–0027, 42 mm SL (66°00.2′S, 67°58.1′E)

Two, rarely 3, AC photophores between last anal-fin ray and first procurrent caudal-fin ray.

Colour: In alcohol, ground colour pale. Body covered with relatively large and well defined pigment spots (not necessarily round), except for a narrow, continuous pale zone from above middle of body cavity to lower caudal-fin base. Head mostly pale. Peritoneum dark and showing through wall of body cavity. Area between rear end of body cavity and anal-fin origin unpigmented. Dark subcutaneous patches between anal-fin pterygiophores. These patches may become larger posteriorly, merging with each other under rear anal-fin rays and continue to anterior procurrent caudal-fin rays. Branchiostegal membrane with punctate dark spots except for an area between anterior-most rays and above (proximal to) BR photophores (Fig. 3b). Posterior, narrow part of membrane underlying occipital area usually with diffuse pigment, but sometimes with small, distinct spots. Anterior, v-shaped area of this membrane with larger, punctate pigment spots (Fig. 4c).

Distribution: Tropical to temperate in all 3 major oceans. In the Southern Ocean, between the Antarctic Polar Front and the Antarctic continental shelf of the Indian Ocean sector, near Balleny Islands, and the Scotia Sea. Vertically, adults in our area were captured in tows between 400–1,029 m. In other oceans, juveniles and adults were found at 300–900 m (Badcock 1984a; Schaefer *et al.* 1986). The 6 records south of Australia (open circles), refer to a closely related undescribed species, *C. sumiae* (Kobayashi 1973).



Distribution of *C. pseudopallida*

Remarks: Although the distance between the first and second VAV photophores is smaller than the distance between the second and third ones, it is nonetheless more than 60% of the latter. Consequently, the position of the anus, though clearly in the anterior half of the distance between pelvic-fin insertion and anal-fin origin, is not immediately behind the pelvic-fin bases (Badcock 1982). In fact, it is only slightly anterior to the position of the anus in *C. pallida* and *C. microdon*. Occasionally, the anus may be found just in front of the second VAV photophore, thus bringing the genital pore forward, to immediately behind second VAV photophore. However, the number of VAV photophores anterior to the genital pore is always 2. The most noticeable difference between the Antarctic material (Indian sector only) and descriptions from the Atlantic Ocean (Badcock 1982, 1984a) and South Africa (Schaefer *et al.* 1986) is in the pigmentation of the branchiostegal membrane which was restricted to the section between posteriormost rays in the non-Antarctic fishes. In addition, Atlantic and South African fishes had a smaller range of AC photophores (14–15) and one less AC photophore (1–2) between last anal-fin ray and first procurrent caudal-fin ray (Badcock 1984a; Schaefer *et al.* 1986). The photophores of *C. pseudopallida* are relatively larger than those of *C. pallida* and *C. microdon,* but smaller than *C. braueri* (Mukhacheva 1964). As I have not examined specimens of *C. sumiae* (Kobayashi 1973), it is possible that the Antarctic material mentioned above will prove to be this species.

The biology of *C. pseudopallida* in the Southern Ocean is unknown. The Antarctic specimens used in this study were individuals found within large catches of *C. microdon*. The fishes were collected in summer (January), they were sexually mature, with ovaries containing ripe eggs. A 42.0 mm SL female collected at 66 °S, 67 °58′ E had about 380 nearly ripe yellowish eggs. The mean egg diameter was 0.35 mm (in preservative). In other areas, *C. pseudopallida* was found to be iteroparous, releasing 300–1,500 eggs in a single spawning (Badcock & Merrett 1976; Maynard 1982; Miya & Nemoto 1986).

Males attain 43 mm and females 58 mm SL.

STERNOPTYCHIDAE

Hatchetfishes

by O. GON

Four bony pectoral-fin radials. Branchiostegal rays 6–10, of which 3 always on epihyal. Photophores arranged in distinct, well-separated groups; in some groups photophores combined to form compound light organs. Photophores present on isthmus. BR photophores 3–7. Scales present, deciduous.

Small, primarily mesopelagic fishes of all but polar oceans. Some perform diel vertical migration, others partial or non-migrants. Ten genera and about 45 species, of which some members of tribe Sternoptychini occur in sub-Antarctic waters. Osteology was studied by Weitzman (1974) and development was reviewed by Ahlstrom *et al.* (1984). Relationships were discussed in both papers.

Tribe **Sternoptychini**

Body short and greatly compressed. Eyes large, sometimes tubular. One or more anterior dorsal pterygiophores enlarged, forming a bony blade or a spine-like extension in front of dorsal-fin rays. Dorsal adipose fin present. Abdominal keel made of bony, scale-like plates. Pelvic-fin rays 5–7, fin base vertically oriented. Spines present on preopercle and on ventral edge of body in front of pelvic fins. Mouth oblique to vertical; teeth small. Symphysial photophores absent. Photophores in abdominal (AB) group 10–12; in branchiostegal (BR) group 3 or 6; and in subcaudal (SC) group 4. Photophore distribution is shown in Figs. 1 and 3.

Three genera and about 31 species (Baird 1986). Members of 2 genera occasionally occur in sub-Antarctic water. Recent revisions by Baird (1971), Baird & Eckhardt (1972). Regional treatment by Badcock (1984b) and Baird (1986).

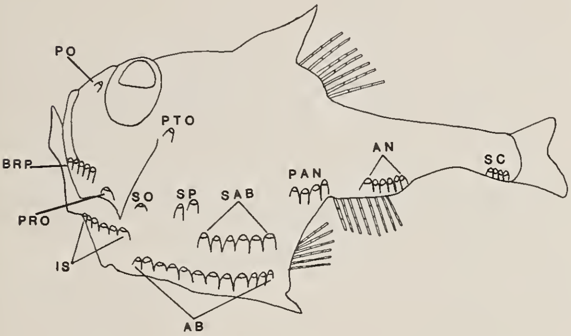


Fig. 1. Photophores in the genus *Argyropelecus*: PO—preorbital photophore; BRP—photophores on branchiostegal membrane; IS—photophores on isthmus; PTO—postorbital photophore; PRO—pre-opercular photophore; SO—subopercular photophore; SP—photophores above (supra) pectoral fin; AB—abdominal photophores, ventral series located between pectoral- and pelvic-fin bases; SAB—photophores above (supra) abdominal series (absent in *Sternoptyx*); PAN—photophores anterior to anal fin; AN—photophores above anal-fin base; SC—photophores on ventrolateral part of caudal peduncle.

KEY TO GENERA

1a Eyes tubular, dorsally directed; dorsal blade made of several pterygiophores; branchiostegal rays 10; AB photophores 12; BRP photophores 6. . . . . *Argyropelecus*

1b Eyes normal, laterally directed; dorsal blade made of a single pterygiophore; branchiostegal rays 6; AB photophores 10; BRP photophores 3. . . . . *Sternoptyx*

Genus *Argyropelecus* Cocco, 1829

Eyes tubular, directed upward. Dorsal blade large, consisting of 7 enlarged pterygiophores, the exposed part of the last 2 fused together. Pelvic-fin rays 6. Branchiostegal rays 10. Photophores (Fig. 1): PO 1 (pigmented); BRP 6; IS 6; SAB 6; PRO, PTO and SO present (1 each); AB 12; SP 2; PAN 4; SC 4. PO photophore anterior to and directed towards eye.

Most species perform a limited diel migration. Seven species, 1 of which borders with CCAMLR area in the South Pacific Ocean. Several other species included in the key below (in brackets) are probably incidental in sub-Antarctic waters (Baird 1971; Bekker & Evseenko 1987). Recent revisions by Baird (1971) and Borodulina (1978); regional treatment by Haruta (1975) and Pafort-van Iersel (1981).

KEY TO SPECIES

1a PAN and AN photophgores more or less on a straight line with SAB photophores; a distinct gap present between individual SC photophores; anal fin continuous. . . . . (*A. gigas*)

1b PAN and AN photophores distinctly higher than level of SAB photophores; SC photophores grouped in a single compound light organ; anal-fin rays in 2 groups separated by a distinct space. 2

2a A single posteriorly direct post-abdominal spine with serrated edge, bearing a much smaller basal posterodorsal spine; posteriormost blade spines barbed; D 8. . . . . *A. hemigymnus*

2b Two post-abdominal spines directed anteroventrally and posteroventrally; blade spines not barbed; D 9–10 3

3a Posteroventrally directed post-abdominal spine longer than anteroventrally directed spine; body depth less than 3.4 in SL; vertebrae 34–36. . . . . (*A. aculeatus*)

3b Post-abdominal spines subequal; body depth more than 3.5 in SL; vertebrae 36–38 . . . . (*A. olfersi*)

Argyropelecus hemigymnus Cocco, 1829

Fig. 2

Argyropelecus hemigymnus Cocco, 1829: 146, Messina, Mediterranean Sea. Holotype unknown (lost?).

Argyropelecus d'urvilli Valenciennes, 1849: 405, Atlantic Ocean.

Argyropelecus intermedius Clarke, 1878: 244, pl. 6, Hokitika, New Zealand.

Argyropelecus heathi Gilbert, 1905: 601, pl. 72, fig. 1, Kaiwi Channel, between Oahu and Molokai, Hawaiian Islands.

Diagnosis: D 8; A 11–12; P 10–11; GR 17–24; vertebrae 36–39. Dorsal blade with barbed tip posteriorly (easily damaged). Horizontal preopercular spine long, extending beyond posterior margin of preopercle. Posttemporal spine well developed. Anal-fin rays divided into 2 distinct groups with a gap under AN light organ.

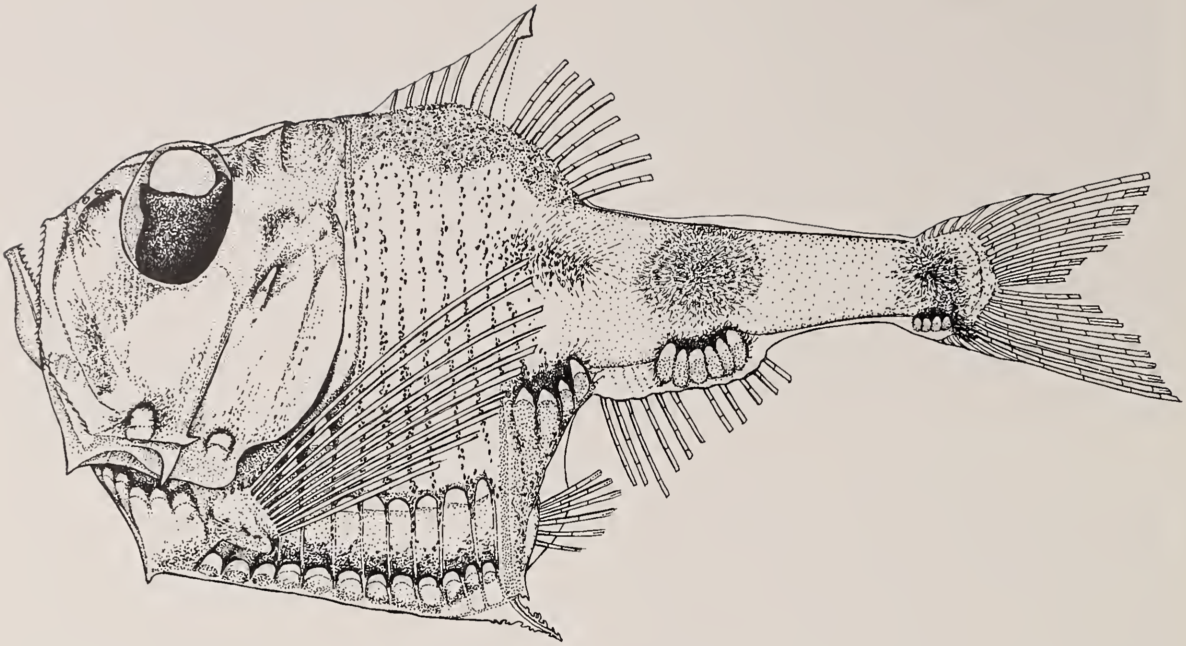
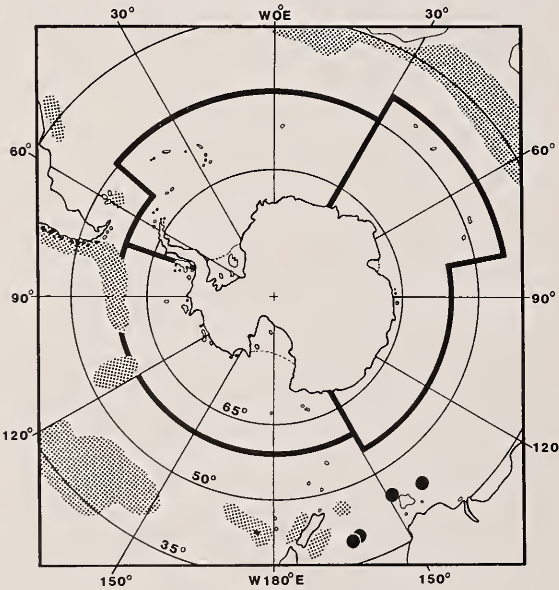


Fig. 2. *Argyropelecus hemigymnus* RUSI 5355, 26.0 mm SL, north of Durban, South Africa, nocturnal pigmentation

Colour: In alcohol, deep part of trunk and cheek silvery. A dark brown band on back, along dorsal-fin base and blade. Narrow part of trunk and caudal peduncle pale, with dark pigment patches present above PAN, AN and SC light organs (see also Remarks below).

Distribution: Circumglobal in tropical to temperate waters and Mediterranean Sea. Reaches south to 60 °S in the south-east Pacific Ocean and to the Falkland Islands in the South Atlantic Ocean (Baird 1971). Adults and sub-adults are distributed between 200–800 m during the day and 100–600 m during the night. Pre-metamorphic postlarvae are found between 50–300 m and metamorphic ones at 300–600 m, with youngest stages deepest (Badcock 1984b).



Distribution of *A. hemigymnus*

Remarks: *Argyropelecus hemigymnus* is a small oceanic species, easily recognised by its single, serrate post-abdominal spine. Body pigmentation is well defined during the day. Nocturnally, the pigment disperses, leading to a dusky night coloration (Badcock 1969). The extent of adult vertical migration may vary geographically, and vertical displacement within the depth range may occur seasonally (Badcock 1984b; Baird 1986; Howell & Kruger 1987). Breeding apparently takes place throughout the year with seasonal spawning peaks (Howell & Kruger 1987), but Badcock (1984b) reported that in the Atlantic Ocean, north of 40 °N, the spawning season is more or less restricted to the first half of the summer. A similar restriction is likely to exist in the cold water of the Southern Hemisphere. *A. hemigymnus* is dioecious, both sexes apparently reach maturity at about 1 year of age and die shortly after spawning (Howell & Kruger 1987). Sanzo (1928) described eggs of *A. hemigymnus* as being 0.9–1.0 mm in diameter and containing a single large oil globule. Sexual dimorphism exists with regard to body size.

Males attain 28 mm and females 39 mm SL.

Genus *Sternoptyx* Hermann, 1781

Eye normal, laterally directed. Dorsal blade consists of a single, enlarged pterygiophore with a serrate leading edge. Pelvic-fin rays 5. Branchiostegal rays 6. Photophores (Fig. 3): PO 1 (unpigmented); BRP 3; IS 5; PRO, PTO and SO present (one each); SP 3; AB 10; PAN 3; SAN 1; AN 3; SC 4. PO photophore midventral to eye. Anterior anal pterygiophore elongate, ending with an external preanal spine and supporting a transparent membrane anterodorsally to anal fin.

Four species, of which 1 borders on our area. Recent revisions by Borodulina (1978) and Badcock & Baird (1980); regional treatment by Haruta & Kawaguchi (1976).

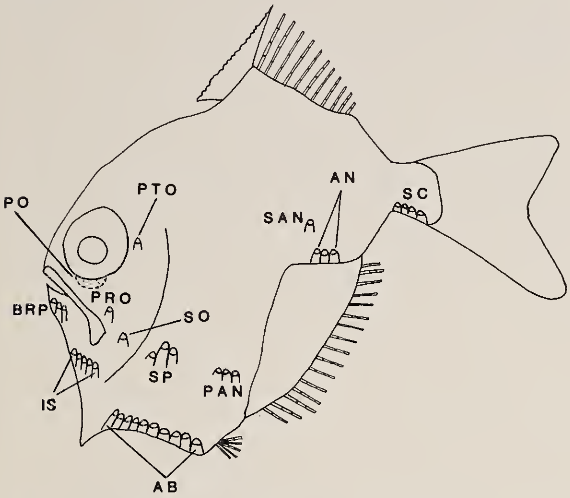


Fig. 3. Photophores in the genus *Sternoptyx*. SAN, photophore above anal (AN) series; other abbreviations as in Fig. 1

Sternoptyx pseudodiaphana Borodulina, 1977

Fig. 4

Sternoptyx pseudodiaphana Borodulina, 1977: 791, fig. 1, off Tasmania (42°S, 138°28′E). Holotype: ZIN 43119.

Sternoptyx diaphana (*non* Hermann): Baird, 1971: 75 (in part; Southern Ocean population, p.78).

Diagnosis: D 9–13; A 12–16; P 10–11; GR 6–8; vertebrae 29–32. In adults, height of SAN (measured from its dorsal margin to anteroventral edge of AN group) less than 3.0 in trunk depth (measured between posterior end of dorsal-fin base and anteroventral edge of AN group).

Colour: In alcohol, body silvery with diffuse brown pigment, except on back. Back pale brown, but darker along dorsal contour of body. A dark horizontal strip of pigment (not well defined) above midline of body; area adjacent to midline pale. Caudal-fin base pale. Ventral-most caudal-fin rays of large adults (40 mm SL or more) with dark pigment spots. In juveniles, bases of pectoral-fin rays pigmented.

Distribution: Circumglobal in the subtropical and temperate waters of the Southern Hemisphere. Another (possibly disjunct) population found in the tropical eastern North Atlantic Ocean (Badcock & Baird 1980). Not recorded within CCAMLR area, but a few specimens were collected in sub-Antarctic waters of the south Pacific Ocean (Baird 1971; Borodulina 1977, 1978). In the Southern Hemisphere, *S. pseudodiaphana* is usually taken at 800–1200 m (Baird 1971; Badcock & Baird 1980). Vertical stratification of life history stages apparently exists, in which depth increases with age (Badcock & Baird 1980). No marked vertical migration.

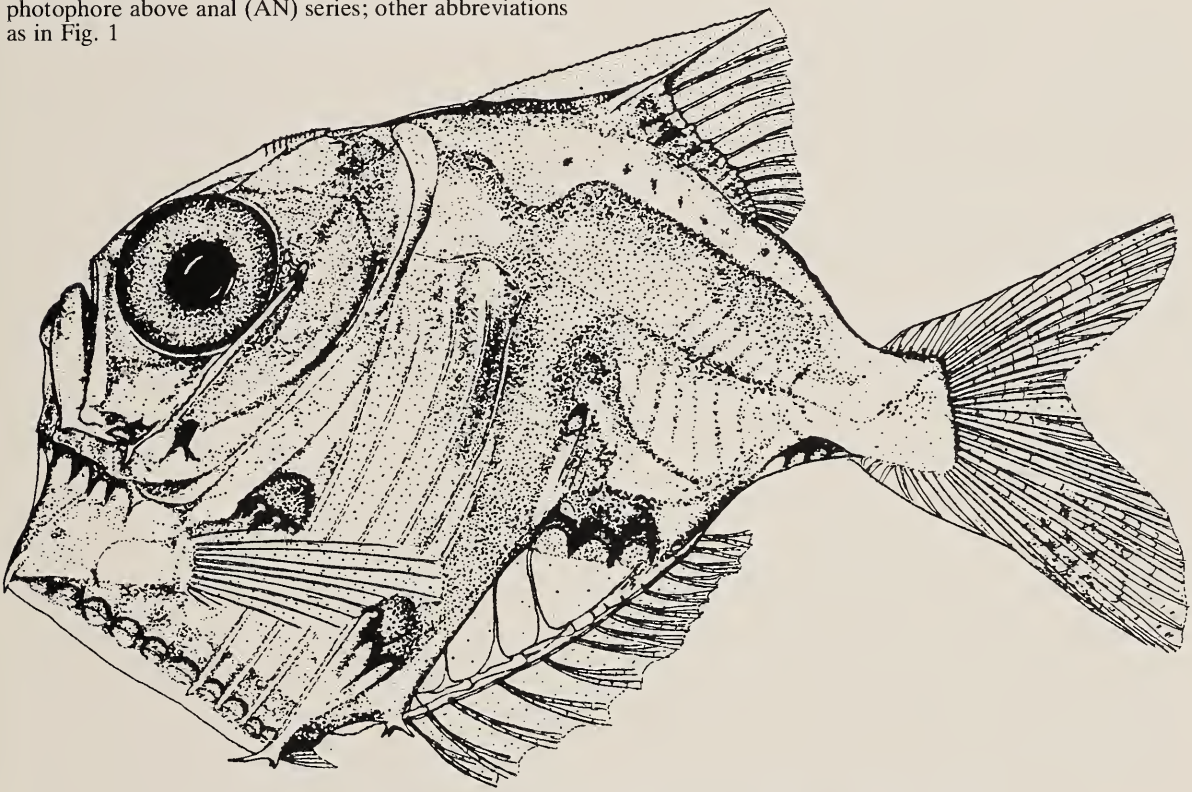
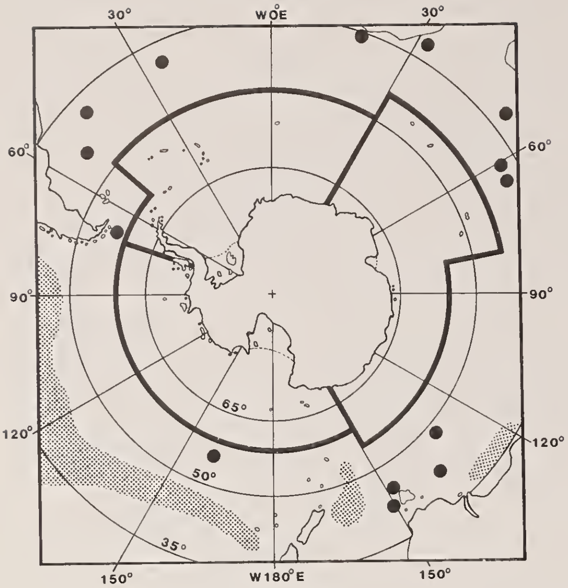


Fig. 4. *Sternoptyx pseudodiaphana* 59.0 mm SL (after Badcock & Baird 1980)



Distribution of *S. pseudodiaphana*

Remarks: The data of Baird (1971), Borodulina (1977, 1978) and Badcock & Baird (1980) on the distribution of *S. pseudodiaphana* in the Southern Hemisphere indicate that at the northern part of its range sympatry may occur with *S. diaphana* in the south-west Pacific and Indian oceans, and with *S. pseudobscura* in the south-west Indian Ocean.

S. diaphana can be distinguished from *S. pseudodiaphana* by its smaller number of vertebrae (27–29), and the lower position of the SAN photophore (photophore depth more than 3.0 in trunk depth, in adults). *S. pseudobscura* is distinguished in the higher position of its SAN photophore (less than 2.5 in trunk depth and sometimes placed on trunk midline); the presence of a larger gap between the posterior margin of the AN light organ and anal-fin base (little or no gap in *S. pseudodiaphana*); the position of the posterior end of anal-fin base at, or slightly below, level of the ventral edge of the AN light organ (distinctly above AN photophores in *S. pseudodiaphana*); the noticeably smaller eye; and a smaller number of vertebrae (28–30). Badcock & Baird (1980) presented a more detailed discussion of species differences. Postlarval development of *S. pseudodiaphana* was described by Badcock & Baird (1980) and Belyanina (1983).

Attains over 60.0 mm SL.

STOMIIDAE

Scaly dragonfishes

by O. GON

Body generally elongate, but varying from relatively short and compressed to eel-like. Scales absent (except *Chauliodus* and *Stomias*). Mental barbel present (except *Malacosteus, Photostomias* and male *Idiacanthus*). True gill rakers absent in adults, but gill teeth may be present. Mouth large, jaws with fixed and/or depressible teeth of various sizes. Supramaxilla usually present (absent in *Astronesthes niger),* but may be small or extremely reduced (*Stomias, Chirustomias* and *Trigonolampa*). Palatine bones ossified (except *Malacosteus*). Palatine teeth present or absent. A single variously sized infraorbital bone present. Five hypural bones. Epipleural bones present (except *Heterophotus*). Light organs present on head and body.

Remarks: Weitzman (1967a,b) questioned the validity of the traditional classification of stomiiform fishes created largely by Regan & Trewavas (1930) and Beebe & Crane (1939). In a new classification of the families within the suborder Stomiatoidei, Weitzman (1974) formed the superfamily Stomiatoidea by grouping the families Astronesthidae, Chauliodontidae, Stomiidae, Melanostomiidae, Idiacanthidae and Malacosteidae. He concluded that the relationships of these groups need (p. 340) "considerable clarification and probably alteration" and predicted the expansion of the family Stomiidae to include astronesthid, chauliodontid and melanostomiid genera. Fink & Weitzman (1982) showed that the Stomiiformes is a monophyletic group with 8 shared synapomorphies and, agreeing with Rosen (1973), recommended that it should be removed from the Salmoniformes and recognised as a separate order within the Neoteleostei. Fink (1984, 1985) studied the relationships of the families of Weitzman's (1974) Stomiatoidea by comparing 323 characters. He concluded that the traditional arrangement of genera and families within this superfamily should be replaced as it is (1985: 2) "neither informative about relationships nor useful as indicators of gradal morphology". From the point of view of nomenclature, Fink (1985) proposed the least disturbing arrangement by expanding the family Stomiidae to include all the families of Weitzman's Stomiatoidea. This scheme is followed here. The Stomiidae is an assemblage of fishes characterised by numerous morphological specialisations which may, at times, mask relationships, but make the group easily recognisable in the adult form.

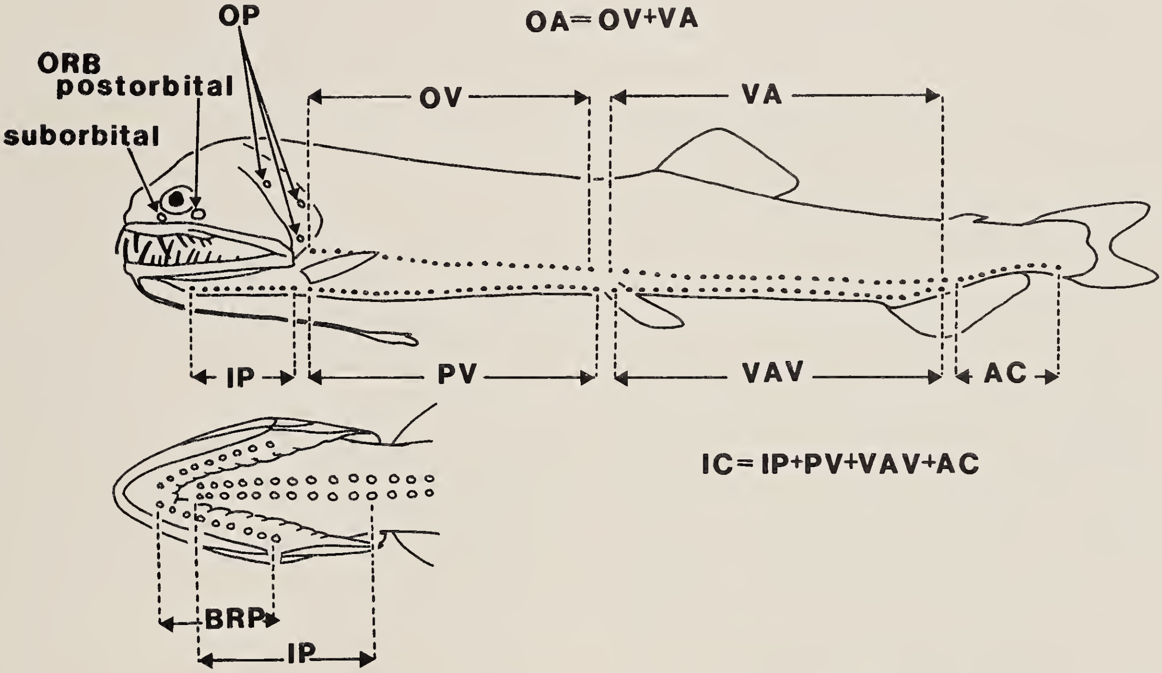


Fig. 1. The distribution and abbreviated terminology of luminous organs of the family Stomiidae:

ORB—photophore associated with the eye, may be divided into suborbital and postorbital organs; OP—photophores on opercle; BRP—photophores on branchiostegal membrane; OV—lateral series, from behind opercle to above pelvic- (ventral-) fin insertion; VA—lateral series, from behind pelvic- (ventral-) fin insertion to above anal-fin base; OA—complete lateral series, from opercle to anal-fin base; IP—ventral series, from isthmus to below anterior end of pectoral-fin base; PV—ventral series, from pectoral-fin base to pelvic- (ventral-) fin insertion; VAV—ventral series, from behind pelvic- (ventral-) fin insertion to anal-fin base at level of last VA photophore; AC—ventral series, from behind level of last VA photophore to caudal-fin base; IC—complete ventral series, from isthmus to caudal-fin base.

KEY TO GENERA

1a Body depth more than 10 in SL........................2
1b Body depth less than 10 in SL........................3
2a Body depth 10–20 in SL; D 17–23; V always present and inserted well in front of D origin; P present; body with a distinct pattern of hexagons............................*Stomias*
2b Body depth more than 20 in SL; D 54–74; V present only in females and inserted slightly in front to behind D origin; P absent (present in larvae); no pattern of hexagons on body ....*Idiacanthus*
3a D origin above A origin and far back on body; V insertion well in front of D origin; adipose fin absent; a large, white patch of luminous tissue on cheek..................*Trigonolampa*
3b D origin slightly behind mid-body length, well in front of A and above to slightly behind V insertion; adipose fin present; no large patch of luminous tissue on cheek.......*Borostomias*

Genus *Borostomias* Regan, 1908

Predorsal distance 60% or less of SL. Dorsal-fin origin above, or slightly behind pelvic-fin insertion. Maxilla with 6–10 widely spaced (compared to a comb-like structure as in *Astronesthes)* caniniform teeth. Premaxilla and anterior part of lower jaw with large fangs. Postorbital luminous organ (ORB) single or divided into a small anterior and larger posterior organs. No gaps in lateral photophore series. Ventral AC series separated from VAV by a distinct space. Dorsal adipose fin present. Found in tropical and temperate water of all oceans.

About 5 species, pending revision.

Borostomias antarcticus (Lönnberg, 1905)
Fig. 2

Astronesthes antarcticus Lönnberg, 1905a: 762; 1905b: 65 (48°27′S, 42°36′W). Holotype: NRM SYD/1902261. 4001.

Borostomias macrophthalmus Regan & Trewavas, 1929b: 25 (39°38′00″N, 71°39′45″ W).

Diplolychnus bifilis Regan & Trewavas, 1929b: 28, pl. 5, fig. 3 (46°28′N, 8°01′W).

Borostomias roulei Regan & Trewavas, 1929a: 96, Atlantic Ocean.

Borostomias macrophthalmoides Koefoed, 1956: 5, pl. 1, fig. B (50°13′N, 4°23′W and 50°22′N, 11°44′W).

Diagnosis: D 11–13; A 16–17; P 7–9; V 7; GR (5–6)+(12–16); branchiostegal rays 19–23; vertebrae 58–60. Photophores: ORB 2; BR 18–20; OA 44–47; IC 67–69. Body depth 6.5–7.1 and head length 4.9–5.1 in SL. Eye diameter 5.5–5.8 and barbel length 0.6–1.3 in HL. Distances from snout to dorsal-fin origin 1.7–1.9, to pectoral-fin base 4.4–5.2, to pelvic-fin insertion 1.8–2.0, and to anal-fin origin 1.2–1.3 in SL. Premaxilla with 5 large fangs. Palatines with 4–6 widely spaced short teeth and vomer with 0–2 similar ones. Postorbital luminous organ divided into 2 sections, the anterior one small. Barbel ends with an elongate bulb bearing 2 photophores and 1–2 filaments.

Colour: In alcohol, pale brown with no pattern. Skin usually missing, but remains indicate dark brown to black colour in life.

Otoliths

Diagnostic features: The square shape, the ostial and homo- to heterosulcoid sulcus acusticus, the dorsal projection of the crista inferior which splits the sulcus into ostium and cauda, the oval ventral area and the distinct ridge below the ventral area, the squared off and blunt rostral projections and the presence of both pseudorostrum and antirostrum.

Fig. 3. Representative otolith of *B. antarcticus*; fish length unknown; scale bar 1 mm

Distribution: Circumglobal in the Southern Hemisphere in temperate and sub-Antarctic water. Also known from the western Mediterranean and north Atlantic to 66°N (Gibbs 1984a). Captured between 350–2,630 m. Two sub-Antarctic captures were made at 650–700 m.

Remarks: Some morphometric characters exhibit proportional changes with growth in *B. antarcticus*. The barbel and its distal bulb become relatively longer in larger fishes. The relative size of the head, snout, eye and upper jaw as well as the predorsal length decrease with the increase in length (Gibbs 1964a). Sexual dimorphism apparently exists with regard to barbel length; the barbel of a 168 mm SL female measured 30.3% SL; in 3 larger males (179.5–212.0 mm SL) the barbel length was 15.6–21.6% SL. In North Atlantic specimens, Gibbs

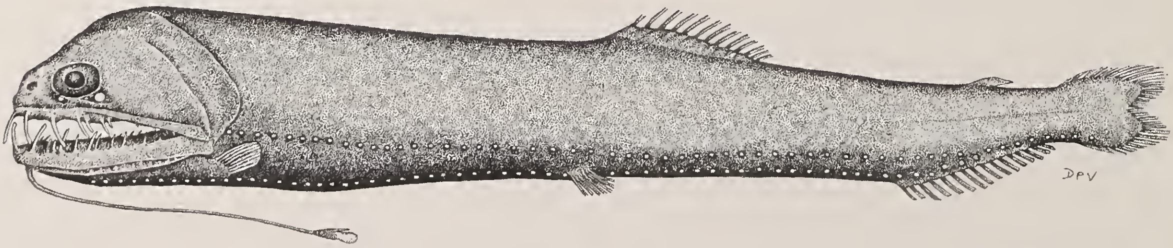
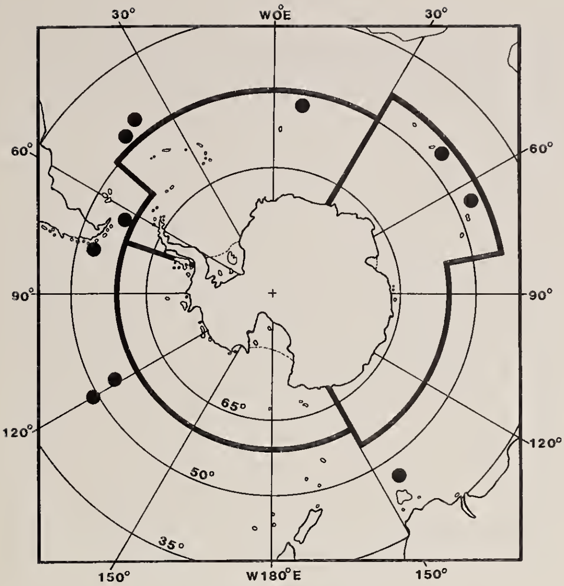


Fig. 2. *Borostomias antarcticus* BMNH 1930.1.12.474, 168 mm SL (52°55′S, 9°50′E)



Distribution of *B. antarcticus*

(1964a) showed that the barbel length increases with the fish length, but did not relate it to sex; his longest barbel (26% SL) was measured in a 275.1 mm SL specimen.

According to Parin *et al.* (1974) and Krefft (1976), *B. antarcticus* reaches south to sub-Antarctic waters, but Gibbs (1984a) maintained that it is distributed as far as 65°S. However, I was unable to confirm Gibbs' (1984a) statement in the existing literature and no specimen from this latitude has been found in the holdings of the United States National Museum.

Biology unknown. Attains about 30 cm SL.

Genus *Idiacanthus* Peters, 1877

Body very long and slender, slightly compressed and ending with a small forked caudal fin. Head depth larger than body depth. Dorsal-fin much longer than anal fin and its origin on anterior half of body. Most dorsal and anal rays accompanied anterolaterally by short and sharp spines. Scales absent. Pectoral fins present in larvae but absent in adults. Pseudobranch and gill rakers absent. No adipose fins. Lateral and ventral rows of serial photophores present. Small photophores scattered all over head and body. Distinct groups of small photophores present between serial photophores and on upper part of body. Sexes markedly dimorphic. Males have a semilarval appearance, are much smaller than females and lack pelvic fins, jaw teeth and chin barbel. Anterior anal rays of males modified and fused with sperm duct, forming an intromittent organ. Postorbital luminous organ of males larger than in females, about as large as eye. Jaws of females with depressible, barbed fangs of variable size. Chin barbel of females longer than head. Stylophthalmid larvae typically with eyes on long stalks, gradually becoming shorter with growth.

Tropical to temperate oceanic midwater. Ichthyophagous, feeding mainly on myctophids and gonostomatids that form the sound scattering layers (Borodulina 1972). Three species, 1 in our area. Latest revision by Novikova (1967).

Remarks: Unlike many stomiid fishes, the ventral photophore series (IC) in *Idiacanthus* appears to be continuous. The distinct space, or shift in level, that defines the end of the VAV and the beginning of the AC sections respectively in other stomiid taxa is inconspicuous in *Idiacanthus,* especially in damaged specimens. In the counts below, the anal-fin origin served as the breaking point between the VAV and AC series (Morrow 1964; Weitzman 1986). In the past, authors apparently counted the VAV along within VAL photophores of *Idiacanthus* as their numbers were usually matching, but presented a separate VAV count to anal-fin origin (Brauer 1906; Regan & Trewavas 1930; Beebe 1934; Novikova 1967). Consequently, these authors counted AC photophores starting from the last VAV photophore posteriorly. Later on, VAV count to the anal-fin origin was adopted as the standard method, but without clearly defining how AC organs should be counted. This shift in the method resulted in an apparent "loss" of photophores of the VAV-AC section of the ventral series as well as misleading counts. For example, Novikova (1967) counted VAV 30–36 (13–18 to anal-fin origin), but Fujii (1984; probably based on the former) presented his count as VAV 13–18. Thus Novikova's IC series amounted to 75–94 photophores whereas Fujii (1984) had only 59–75. The same argument applies to the low VAV-AC count for *Idiacanthus* of Kawaguchi & Moser (1984).

Idiacanthus atlanticus Brauer, 1906

Fig. 4

Idiacanthus atlanticus Brauer, 1906: 62, fig. 21 (25°25′3″S, 6°12′4″E). Syntypes: ZMB 17452 (2 of 3 fishes used in original description).

Stylophthalmus paradoxus Brauer, 1902: 298 (in part; Atlantic Ocean).

Idiacanthus niger Regan, 1914a: 14, New Zealand.

Idiacanthus aurora Waite, 1916: 53, pl. 5, fig. 1, text figure 11, 25 miles north of Macquarie Island.

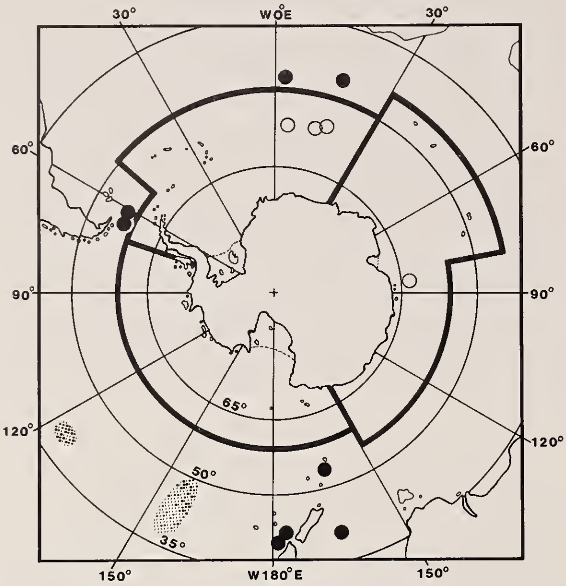
Idiacanthus retrodorsalis Thompson, 1916: 462, pl. 6, fig. 2, off Lota, Chile (38°08′S, 75°53′W).

Idiacanthus sp. Andriashev & Permitin, 1961: 270, Antarctic water of the South Pacific Ocean; Andriashev, 1961: 234, Drake Passage.

Diagnosis (of females): D 54–63; A 35–41; V 6; branchiostegal rays 14–16; vertebrae 82–86. Photophores: ORB 2; BR 15–16; lateral series—OV 25–27; VA 32–36; ventral series—IV 36–38; VAV (to anal-fin origin) 19–21; AC (from anal-fin origin) 33–34. Body depth 22.5–26.7 and head length 14.8–16.4 in SL. Snout length 4.0–4.5, fleshy interorbital width 3.2–3.6 and eye diameter 5.4–5.6 in HL. Distances from snout to dorsal-fin origin 2.2–2.3, to pelvic-fin insertion 2.5–2.6 and to anal-fin origin 1.4–1.5 in SL. Barbel length 0.4–0.5 in HL. Dorsal-fin origin well behind pelvic-fin insertion. Vomer and palatines with 1–2 caniniform teeth. End of anal fin behind level of dorsal-fin ending. Body segments, between pairs of serial photophores, with 3 distinct patches of luminous tissue; a vertically elongate, dorsolateral patch and 2, more or less circular, ventrolateral patches between OA and IC pairs. Distal third of barbel expanded, slightly compressed at base and tapering to a point. A short, slender filament at base of distal expansion supported by thin membranes along most of its length. A thin, transparent membrane present along entire length of distal expansion.

Colour: In alcohol, head dark brown and body black. Barbel dark brown, but filament as well as barbel's tip pale.

Distribution: Subtropical to temperate in the Southern Hemisphere, probably limited by the subtropical convergence. Incidental occurrence in sub-Antarctic waters of the Southern Ocean. Females apparently live below 500 m during the day and perform vertical migration at night to shallower depths. Males always in deep water, possibly 1,000–2,000 m (Gibbs 1984b).



Distribution of *I. atlanticus*

Remarks: Brauer (1902, 1906) listed 3 Southern Ocean localities (*Valdivia* stations 132, 135, 136; open circles in map) at which specimens of *Stylophthalmus* (=*Idiacanthus*) *paradoxus* were collected. A fourth record, station 139, is probably erroneous as it was mentioned only in Brauer (1902), but excluded from the species description of Brauer (1906: 68) and was not listed in the catch for station 139 (Brauer 1906: 360). As recognised by Gibbs (1964b), larval *Bathylagus* were included in Brauer's type series of *S. paradoxus*. Two of these were illustrated (Brauer 1906: pl. 5, figs. 1–3, 5) and clearly relate to *Bathylagus antarcticus* (Efremenko 1979a, 1983; Gon 1987a). Since all Brauer's (1906) other captures were far north, the southernmost being 36°23′4″S, 17°38′01″E, the fishes collected at the Southern Ocean stations are most probably *B. antarcticus*. Moreover, large *B. antarcticus* were also collected at station 136 (Brauer 1906). Pappenheim (1914) reported an 18 mm specimen of *S. paradoxus* from 64°35′S, 85°25′E (open circle). This fish is probably another *B. antarcticus* since Pappenheim must have based his identification on Brauer's (1906) illustrations. All Pappenheim's (1914) other records were from localities outside the Southern Ocean, north of the STC.

It is surmised that *I. atlanticus* has a subtropical convergence distribution (Bekker & Evseenko 1987) with northern extensions in eastern boundary currents (Hulley 1986a), up to 25°S along the South African west coast, probably associated with Antarctic Intermediate Water. The inclusion of *S. paradoxus* in the synonymy above is based on the assumption that Brauer's larvae from off the west coast of South Africa were collected in a potential breeding area of *I. atlanticus*.

Biology unknown. Attains more than 43 cm SL.

Genus *Stomias* Cuvier, 1816

Body very elongate and compressed. Dorsal and anal fins on rear end of body, their origin opposite each other or anal-fin origin slightly in advance. Preventral distance 60% or more of SL. No adipose fin. Maxillary bones loosely attached to each other medially and to premaxillary bones on their anterior end. Jaws protrusible. One or 2 widely separated teeth on anterior half of palatines. Thin, non-imbricate scales embedded in gelatinous membrane over body. Body pigment arranged in a distinct pattern of hexagons. Males smaller than females and with larger eyes and postorbital luminous organ (Gibbs 1969).

Mesopelagic fishes that occur in oceânic water worldwide, except the Arctic and the Antarctic, and perform vertical migration. Eleven species, 2 in the Southern Ocean. Ichthyophagous, feeding mainly on myctophid and gonostomatid fishes that form the sound scattering layers, and perform diel migrations with them (Borodulina 1972). Recent taxonomic revision by Gibbs (1969) and a phylogenetic analysis by Fink & Fink (1986). Fink (1985) discussed intrafamilial relationships.

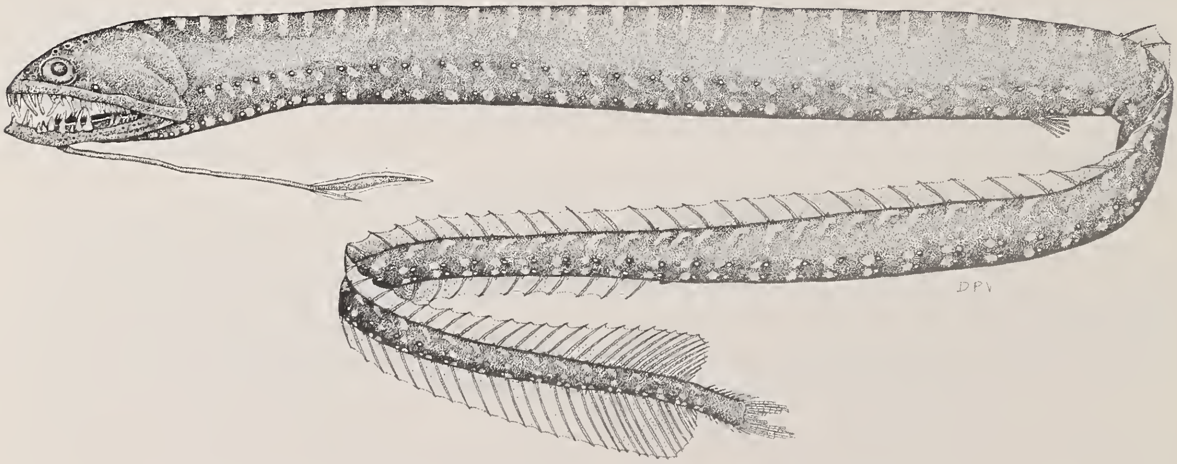


Fig. 4. *Idiacanthus atlanticus* BMNH 1930.1.12.536– 537, 43 cm SL, female (45°03′ S, 17°03′E)

KEY TO SPECIES

1a IC photophores 92–102; OA photophores 65–71; PV photophores 53–57; vertebrae 86–92 .... *S. gracilis*
1b IC photophores 79–88; OA photophores 57–62;PV photophores 44–50; vertebrae 74–82 .... *S. boa boa*

Stomias boa boa (Risso, 1810)
Fig. 5

Esox boa Risso, 1810: 330, pl. 10, fig. 34, Mediterranean Sea. Holotype: MNHN specimen apparently lost. (According to M.L. Bauchot (pers. comm.), the specimens mentioned by Bertin (1940) as holotype (A.2519, 160 mm) and paratype (A.2521, 174 mm) cannot be the types as Risso (1810: 331) based the description on a specimen 300 mm long).

Stomias barbatus Bonaparte, 1841, punt. 158, Sicily.

Stomias bonapartei Fowler, 1911: 556 (new name for *S. barbatus* Bonaparte).

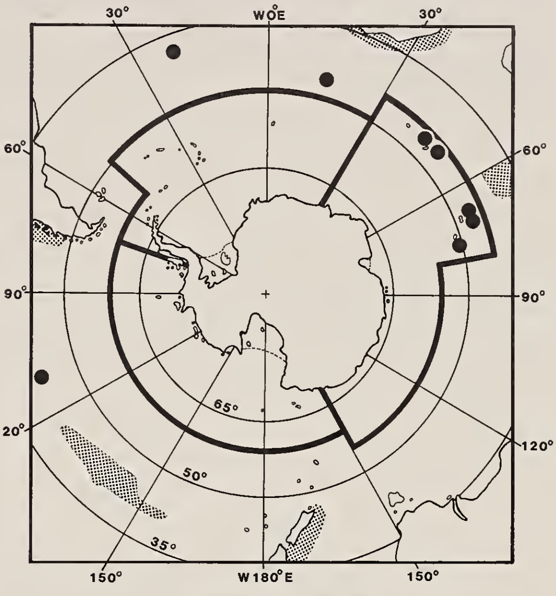
Stomias elongatus var. *atlanticus* Pappenheim, 1914: 169 (35°10′S, 2°33′E).

Stomias atlanticus Norman, 1930: 316, fig. 26 (46°25′S, 15°13′E).

Diagnosis: D 17–20; A 18–23; P 6; V 5; GR 0+(7–8); vertebrae 74–82. Photophores: ORB 1; ventral series —IP 9–12; PV 44–50; VAV 10–14; AC 13–18; total (IC) 79–88; lateral series—OV 44–49; VA 11–15; total (OA) 55--62. Body depth 11.2–18.4 and head length 8.4–10.8 in SL. Length of premaxilla 1.5–1.6 and barbel length (excluding filaments) 0.8–1.3 in HL. Distances from snout to dorsal- and anal-fin origin 1.1–1.2, and to pelvic-fin insertion 1.3–1.4 in SL. Premaxilla with 5 teeth, the first smallest and second largest. Gill rakers consist of a short bony base and 2–3 gill teeth. Six rows of hexagons above lateral row of photophores. Barbel ends with 2–3 filaments.

Colour: In alcohol, dark brown to black all over. Ventral part of body below lateral photophores darkest. Fins pale. Barbel stem usually pale. Distal bulb white and its filaments dark.

Distribution: Mainly in the Southern Hemisphere between 20°–50°S. A separate population in the Mediterranean and along the north-west African coast. In the Southern Ocean, specimens were collected in the sub-Antarctic region of the Indian Ocean sector south to Heard Island. Night catches indicate presence in the upper 200 m and at 400–500 m. Day depth range not established, but catches suggest a possible occurrence at 900–1,500 m (Gibbs 1969).



Distribution of *S. boa boa*

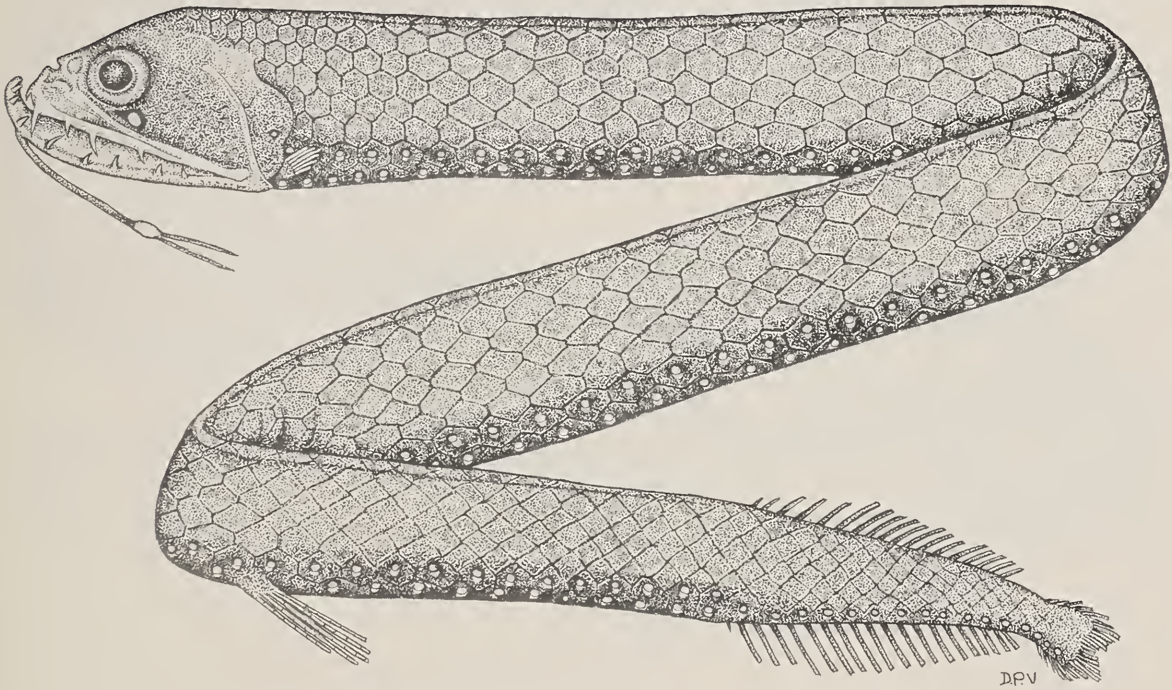


Fig. 5. *Stomias boa boa* BMNH 1930.1.12.545, 23 cm SL (46°25′S, 15°13′E)

Remarks: The illustrated specimen is rather unusual in that it has 2 instead of 3 filaments at the distal end of the barbel. Moreover, the stem of the barbel was short, 78.6% of head length, and the filaments about 37% of the stem length. In addition, apart from its base, the stem was as dark as the body. In other specimens the filaments are about 25% of the stem length. *S. boa boa* appears to be parapatric to its southern congener *S. gracilis* (Gibbs 1969; Shcherbachev & Novikova 1976) and separated from the latter by the STC (Gibbs 1969). *S. boa* is regarded as a sister group of *S. gracilis* (Fink & Fink 1986). If their distribution pattern is the outcome of resource partitioning along a spatial (habitat) axis, then recent captures of *S. boa boa* in the sub-Antarctic region of the Indian Ocean sector may be interpreted as resulting from southward drifting warm core eddies.

Females attain over 30 cm SL, males 10–20% shorter (Gibbs 1969, 1986).

Stomias gracilis Garman, 1899
Fig. 6

Stomias boa (*non* Risso): Günther, 1887: 204. South of Australia (50°01′S, 123°04′E).

Stomias gracilis Garman, 1899: 274 (based on Günther's specimen). Holotype: BMNH 1887.12.7.223.

Stomias boa gracilis: Ege, 1934: 25 (based on Günther's specimen).

Stomias boa (*non* Risso): Nakamura, 1986a: 92, northeast of Falkland Islands.

Diagnosis: D 17–23; A 17–23; P 6; V 5; GR 0+(7–9); vertebrae 86–92. Photophores: ORB 1; ventral series—IP 10–12; PV 53–57; VAV 12–16; AC 13–20; total (IC) 92–102; lateral series—OV 54–55; VA 12–17; total (OA) 65–71. Body depth 13.5–20.9 and head length 9.5–12.0 in SL. Length of premaxilla 1.3–1.8 and barbel length (excluding filaments) 0.9–1.2 in HL. Distances from snout to dorsal-fin origin 1.1, to anal-fin origin 1.1–1.2 and pelvic-fin insertion 1.4 in SL. Premaxilla with 5–6 teeth, first of which smallest and second largest. Gill rakers consist of a short bony base and 2–3 teeth. Six rows of hexagons above lateral row of photophores. Barbel ends with 3 filaments.

Colour: In life, metallic black all over. Paired fins black, other fins dark. Barbel pale on proximal half, becoming black distally. Bulb pale, filaments dark. Ventral part of photophores (reflector?) metallic gold. In alcohol, dark brown to black all over.

Distribution: Subtropical convergence and sub-Antarctic waters of the Southern Hemisphere. Day catches indicate presence at 400–500 m, but higher abundance at 500–800 m. At night *S. gracilis* was found in the upper 100 m, but peak abundance was at 200–300 m, 500–600 m, and 900–1,250 m (Gibbs 1969). *S. gracilis* apparently remains within the Antarctic Intermediate Water throughout its vertical migration (Gibbs 1969 with reference to Reid 1965).

Remarks: Females attain 29 cm SL (Ege 1934) and males about 26 cm SL. See also Remarks of *S. boa boa* above.

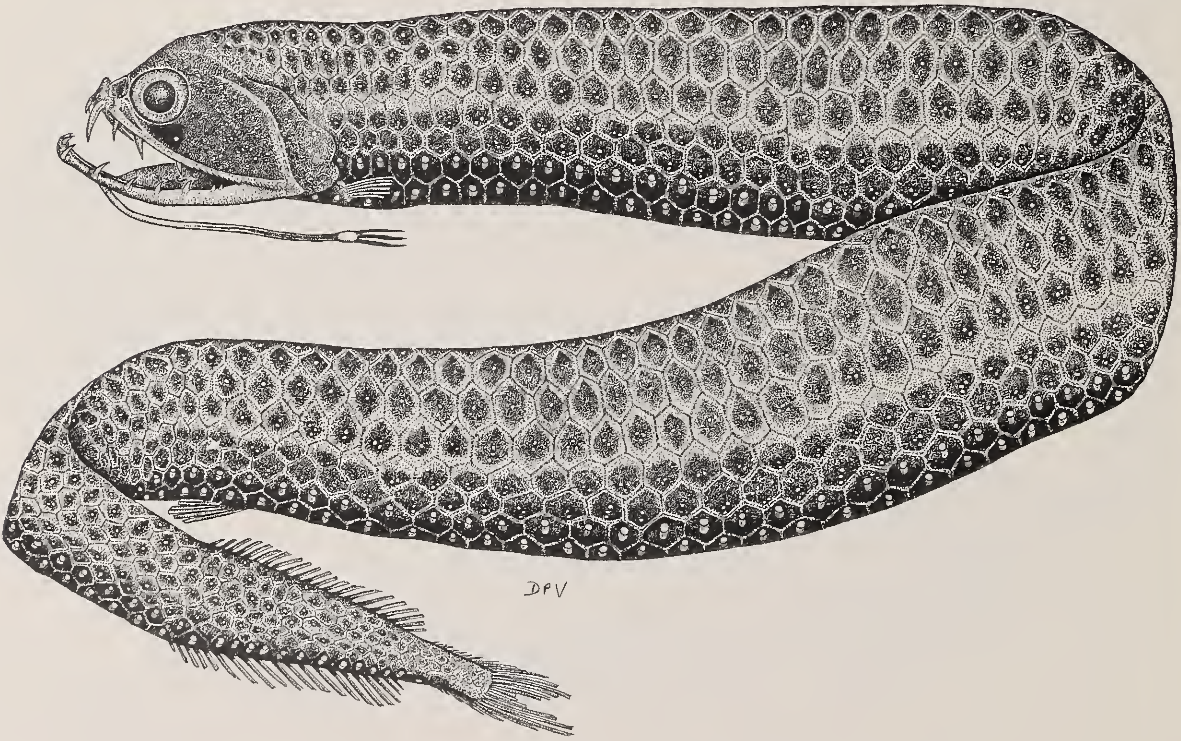
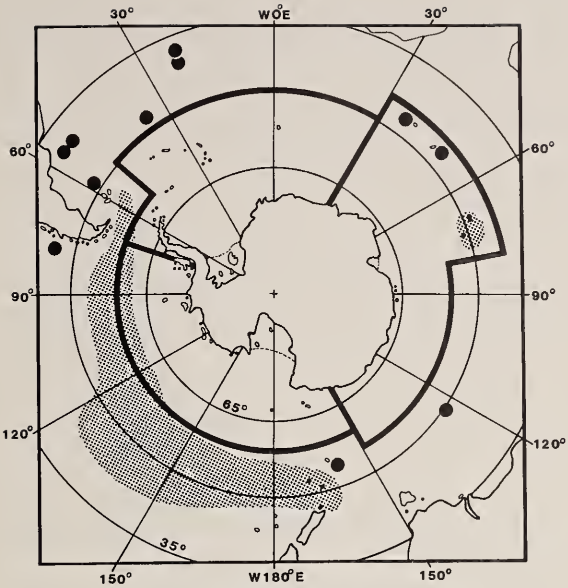


Fig. 6. *Stomias gracilis* RUSI 28209, 26 cm SL, female, Marion Island



Distribution of *S. gracilis*

Genus ***Trigonolampa*** Regan & Trewavas, 1930

Monotypic. Recent revision by Morrow & Gibbs (1964). Relationship to other stomiid genera analysed by Fink (1985).

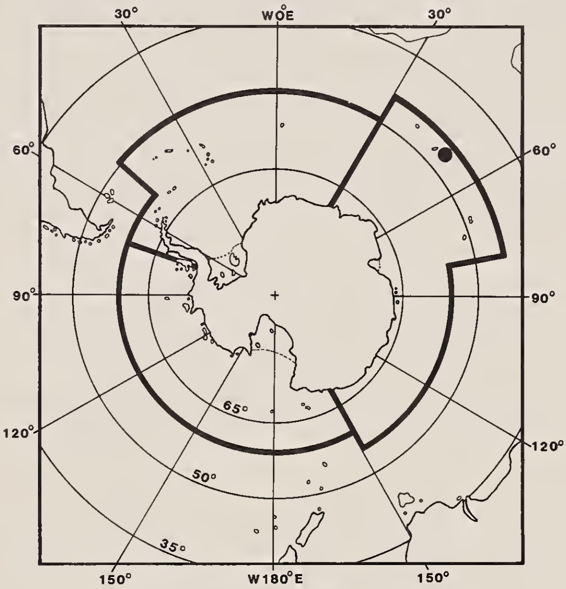
Trigonolampa miriceps Regan & Trewavas, 1930
Fig. 7

Trigonolampa miriceps Regan & Trewavas, 1930: 55, pl. 1, fig. 2 (48°42′N, 12°20′W). Holotype: Probably lost.

Diagnosis: D 17–20; A 16–19; P 3–7; V 7; GR 3+15; vertebrae 61–64; branchiostegal rays 14–18. Photophores: ORB 2; OP 1; BR 15–16; ventral series—IP 10–12; PV 21–26; VAV 20–24; AC 10–14; total (IC) 65–70; lateral series— OV 22–25; VA 22–27; total (OA) 47–49. Body elongate and compressed. Body depth 6.6–8.1 and head length 5.0–6.2 in SL. Body width 1.9 in the depth. Snout length 4.6–4.9, eye diameter 5.0–5.8, and interorbital width 3.3–3.7 in HL. Barbel length 75.0–81.2% HL. Distances from snout to dorsal-fin origin 1.3, to anal-fin origin 1.2–1.3, and to pelvic-fin insertion 1.8–2.1 in SL. Dorsal and anal fins on rear part of body, and pelvic fins inserted behind midbody length. No adipose fin. Snout noticeably longer than eye diameter. Both jaws with strong, curved caniniform teeth. Longest teeth about half eye diameter. Vomer with 1–2 teeth on each side. Palatines, each with a series of 12–14 teeth. Suborbital photophore small and postorbital one large. A large patch of white luminous tissue on cheek, sometimes with stripes stretching as far as edge of opercle and/or with some smaller patches around it. A single photophore (OP) on posterior edge of opercle, between opercle and subopercle. A mass of luminous tissue present on membrane between 2 uppermost pectoral-fin rays. Gill rakers consist of irregularly spaced groups of 2–4 small gill teeth. Barbel ends with a small bulb bearing a single short filament.

Colour: In alcohol, dark brown all over. Fins pale. Body with pale, thin vertical lines of luminous tissue. A large white patch of luminous tissue on cheek. Barbel stem pale to dark, bulb and filament pale.

Distribution: North Atlantic up to 65°N, and Southern Hemisphere south of 30°S to STC (Gibbs 1984c, 1986). In the Southern Ocean, 1 specimen was recently collected at Crozet Islands at 995–1,055 m (Duhamel 1987b). The holotype was collected in an open net tow with 1,860 m wire out.



Distribution of *T. miriceps*

Remarks: *Trigonolampa miriceps* is a rare species, currently showing anti-tropical distribution. Closest records to the tropical region are from the Canary Islands (Gibbs 1984c) and off the west coast of South Africa (Gibbs 1986).

Biology unknown. Attains 32 cm (Gibbs 1986).

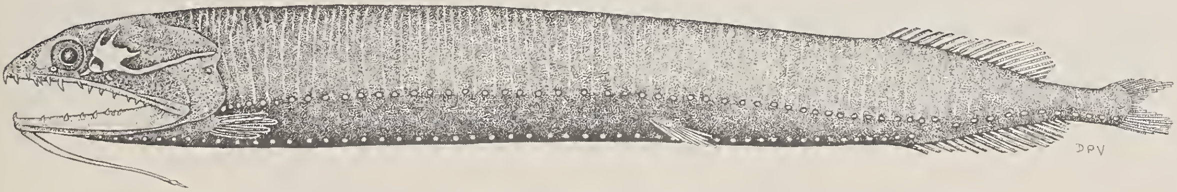


Fig. 7. *Trigonolampa miriceps* MNHN 1988–25, 26 cm SL (45°50′S, 51°17′E)

SCOPELARCHIDAE

Pearleyes

by A. POST

Body moderately elongate, subcylindrical to laterally compressed. Fins without spines; dorsal fin short, set about midway between edge of gill opening and anal-fin origin or farther forward, well before midlength of body, with 5–10 rays; pelvic-fin rays 9, fin origin slightly before to slightly behind dorsal-fin origin; anal-fin rays 17–39 (24–39 in Southern Hemisphere species), fin origin at or behind midlength of body; pectoral fins set low on body, with 18–28 rays; principal caudal-fin rays 10+9; a dorsal adipose fin above posterior anal-fin rays. Branchiostegal rays 8. Vertebrae 40–65 (46–65 in Southern Hemisphere species). Mouth terminal, gape extending well beyond vertical through middle of eye; premaxillary teeth small, fixed, in 1 row; dentary teeth in 2 rows, outer teeth small and fixed, inner teeth large, depressible canines. Two pairs of nostrils set well in front of eye. Gill rakers reduced to small, fixed gill teeth. Eyes large, tubular, directed upwards. No light organs in Antarctic species. All species so far examined are synchronous hermaphrodites.

Small to medium sized meso- and bathypelagic fishes up to about 350 mm SL. World-wide except in the Arctic Ocean and Mediterranean Sea. One genus in the Southern Ocean, but 1 other species is distinguished in the generic key as it approaches 50°S. Recent taxonomic revision of scopelarchids were done by Rofen (1966b) and Johnson (1974).

KEY TO GENERA

1a Distinct stripes of pigment above and below LL; V insertion distinctly behind a vertical from last D ray (D 7–8; A 24–29; P 8–21; LL scales 47–51; vertebrae 46–52) .... *Scopelarchus guentheri* Alcock, 1896
1b Colour uniformly yellowish to brownish, with edges of scales more heavly pigmented; V insertion below or in front of a vertical from first D ray....................... *Benthalbella*

Genus ***Benthalbella*** Zugmayer, 1911

In adults pelvics well in advance of dorsal-fin origin. Vertebrae 54–65; lateral-line scales 54–66. Dermal pigment stripes absent. Larvae lacking peritoneal pigment. Anus moderately in advance of anal fin. Body colour uniformly brown, pigment present evenly on fins. Large bodied scopelarchids, reaching over 30 cm SL.

Five species, 2 in our area.

KEY TO SPECIES

1a D 9–10; A 24–28; P 19–23; A origin distinctly behind midbody length .... *B. elongata*
1b D 5–6; A 35–39; P 25–27; A origin at midbody length... *B. macropinna*

Benthalbella elongata (Norman, 1937)
Fig. 1

Scopelarchus elongatus Norman 1937b: 86, southern Indian Ocean (45°53′ S, 84°33′ E). Holotype: BMNH. 1937.9.21.196.

Diagnosis: D 9–10; A 24–28; P 19–23; LL 61–65; vertebrae 61–65. Snout length 2.5–3.0 in HL, distinctly longer than horizontal eye diameter; interorbital width 1.6–2.1% SL.

Colour: In alcohol, uniformly yellowish to brownish with edges of scale pockets slightly darker. All fins pigmented. Peritoneal pigment sparse.

Otoliths

Diagnostic features: The lunate anterior margin with reniform sulcus acusticus and dorsally directed cauda.

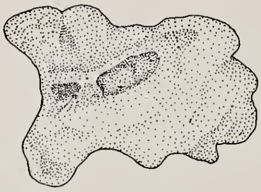


Fig. 2. Representative otolith of *B. elongata*; fish length 186 mm TL

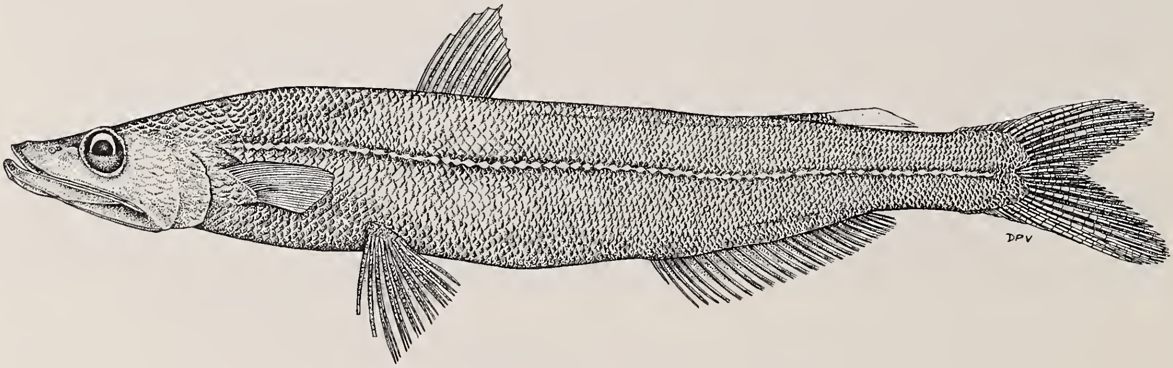
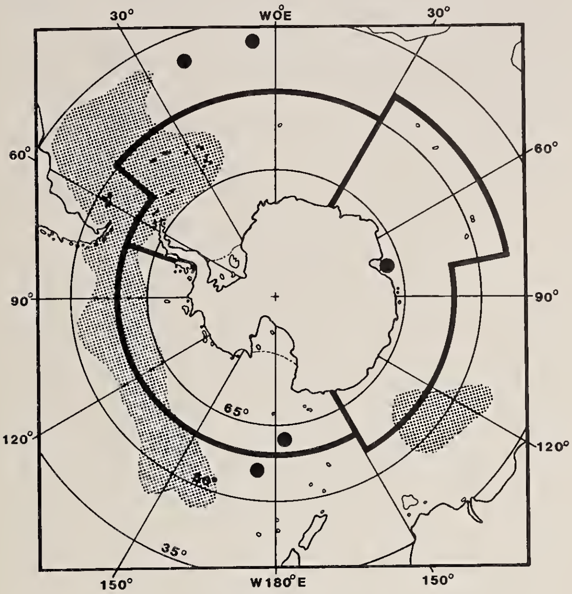


Fig. 1. *Benthalbella elongata* ISH 603/76, 228 mm SL (39°08.4′S, 39°59.8′W)

Distribution: Circumglobal in the Southern Hemisphere from about 40 °S to Antarctica in pelagic waters. Adults mesopelagic, living below 500 m, rarely caught shallower; larvae have been taken in the upper 200 m.

Remarks: Biology unknown. Attains about 35 cm SL.



Distribution of *B. elongata*

Benthalbella macropinna Bussing & Bussing, 1966

Fig. 3

Benthalbella macropinna Bussing & Bussing 1966: 53, figs. 1–2, Scotia Sea (56°17′ S 58°09′ W). Holotype: LACM 10118.

Diagnosis: D 5–6; A 35–39; P 25–27; LL 62–65; vertebrae 60–62. Snout length 3.5–4.5 in HL, equal to or shorter than horizontal eye diameter; interorbital width 0.9–1.3% SL.

Colour: In alcohol, uniformly yellowish to brownish, with edges of scale pockets darker. All fins pigmented. Peritoneum uniformly black.

Otoliths

Diagnostic features: The near rectangular shape except for deep excisura ostii, and the dorsally directed sulcus acusticus.

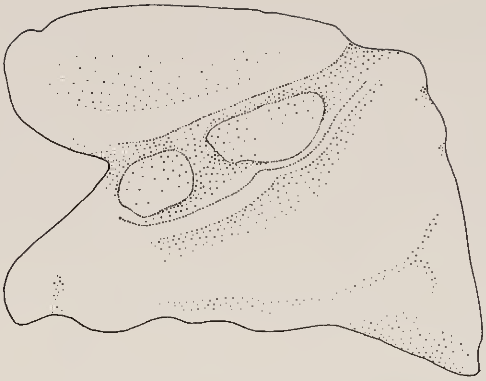
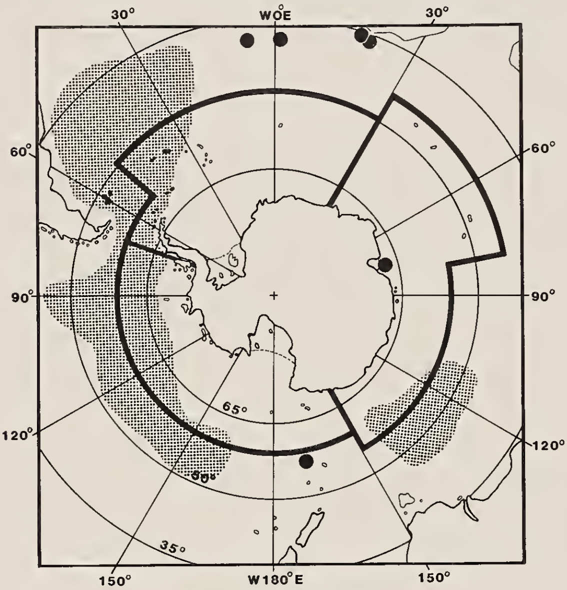


Fig. 4. Representative otolith of *B. macropinna*; fish length unknown

Distribution: Circumglobal in the Southern Hemisphere from about 35 °S to Antarctica in pelagic waters. Meso- to bathypelagic species, rarely taken shallower than 500 m.

Remarks: Biology unknown. Attains 24 cm SL.



Distribution of *D. macropinna*

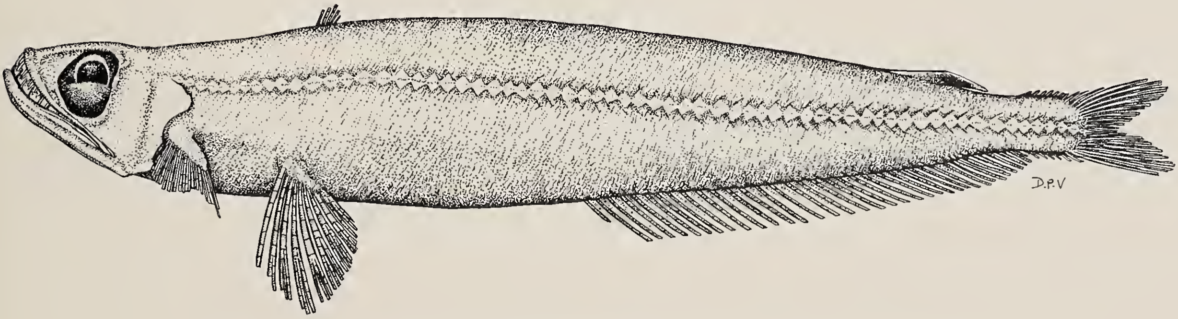


Fig. 3. *Benthalbella macropinna* ISH 1560/68, 21 cm SL (34°01′ S, 47°39′ W)

NOTOSUDIDAE

Notosudids

by G. KREFFT

Small to medium-sized fishes, similar in shape to paralepidids. Body elongate, subcylindrical, increasingly compressed in the abdominal region. Head small to moderately large, tapering forward from the cheeks to a long, rather spatulate snout. Mouth large, with small conical teeth, uniserial (young) or in a narrow band (adults) on premaxilla; dentary with similar teeth in 2 well-separated bands; vomer and palatines with groups of similar teeth. Gill rakers lath-like, 1 (rarely 2) on the upper limb, 1 at angle and 13–30 on lower limb of first arch. Teeth and gill rakers are resorbed at the onset of sexual maturity. All fin rays soft; dorsal fin short, originating at about midpoint of body, with 9–14 rays; dorsal adipose fin short, above anal fin; anal fin in last quarter of body, with 16–21 rays; pectoral fins completely lateral, with 10–15 rays; pelvic fins below or in front of dorsal fin, almost always with 9 rays; caudal fin forked, with 17 principal, branched rays. Vertebrae 42–67. Scales cycloid, deciduous. Lateral line single.

Pseudoceanic hermaphroditic fishes, feeding predominantly on plankton. Mainly inhabitants of the warm to temperate parts of the oceans. Adults of a few species undertake far-ranging feeding migrations into sub-Arctic and sub-Antarctic waters. Three genera with about 16 species (Bertelsen *et al.* 1976). No commercial importance.

KEY TO GENERA

1a Snout length more than 10% SL; posterior end of maxilla below anterior half of eye; posterior circumorbital bones fused into a large, crescentic plate with a nearly smooth posterior border; lower GR 27–31 .... *Luciosudis* (A single species, *L. normani* Fraser-Brunner, 1931, in the Atlantic, Indian and West-Pacific oceans between about 30 °S and 45 °S, not yet found in the Southern Ocean.)

1b Snout length 5.5–10% SL; posterior end of maxilla below or beyond posterior half of eye; posterior circumorbital bones separate, never fused into a large plate; lower GR 13–21 .... *Scopelosaurus*

Genus *Scopelosaurus* Bleeker, 1860

Head length 18.5–30.0% SL. Posterior circumorbital bones separate, consisting of an anterior crest bordering eye and a posterior, more or less expanded, lobed lamella. Maxilla surpassing eye in adult specimens, shorter in juveniles and subadult fishes. Mandible with an anteriormost unpaired primary pore, followed by 2 pairs of such pores in the anterior half of the lower jaw, secondary pores numerous. Bases of pelvic fins distinctly in front of dorsal-fin origin. Skeleton moderately to well ossified.

Thirteen species in all oceans, 1 in the Southern Ocean.

Scopelosaurus hamiltoni (Waite, 1916)

Fig. 1

Notosudis hamiltoni Waite, 1916: 56, Macquarie Island (54°45′ S, 158°05′ E, "on a beach"). Holotype: SAMA F382.

Diagnosis: D 10–13; A 18–21; P 11–14; V 9; lower GR 18–21; LL 63–70; vertebrae 63–67; pyloric caeca 15–20. Body depth 8.7–10.2 and head length 3.6–4.3 in SL. Eye diameter 3.7–4.8 and interorbital space 3.7–5.5 in HL. Scales deciduous, scale pockets rather weakly defined, about 3 rows between dorsal-fin origin and lateral line, and 3 rows between lateral line and anal-fin origin. Origin of pelvic fins about 7–8% SL, in front of dorsal fin. Upper jaw surpassing orbit in adults, but shorter (to middle of eye) in juveniles.

Colour: In alcohol, very dark brown to blackish, gradually lighter on lower lateral parts; juveniles nearly black with some metallic bronze on gill covers, when freshly caught. Peritoneum and mouth cavity black.

Distribution: Temperate to sub-Antarctic waters in southern Atlantic, Indian and West-Pacific oceans. Subadult and adult fishes migrate into the Southern Ocean (up to 60 °S) to feed. Not yet found in the south-eastern parts of the Pacific. Juveniles and larvae almost exclusively between 30° and 40°S. Larvae and juveniles pseudoceanic in midwater, adults were taken by bottom- and pelagic trawls on or just outside the slopes of Argentina and oceanic islands (South Georgia, Macquarie Island) in about 600–800 m depth.

Remarks: Large adults of *S. hamiltoni* feed on euphausiids, hyperiids and other crustaceans as well as on small fishes (e.g. myctophids), juveniles eat small zooplankton, especially copepods.

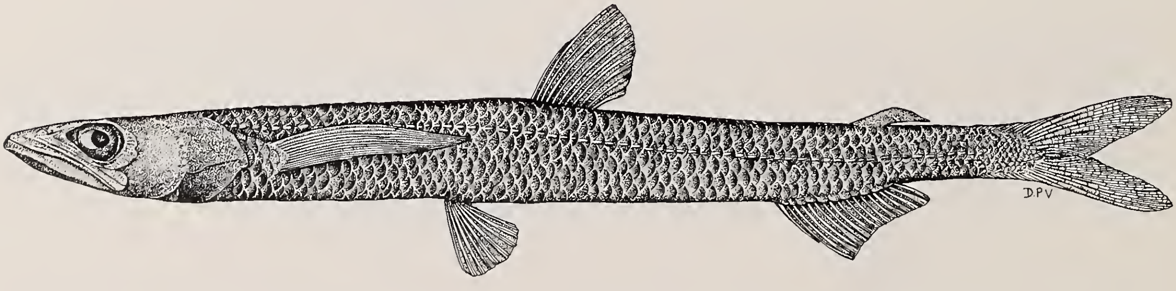
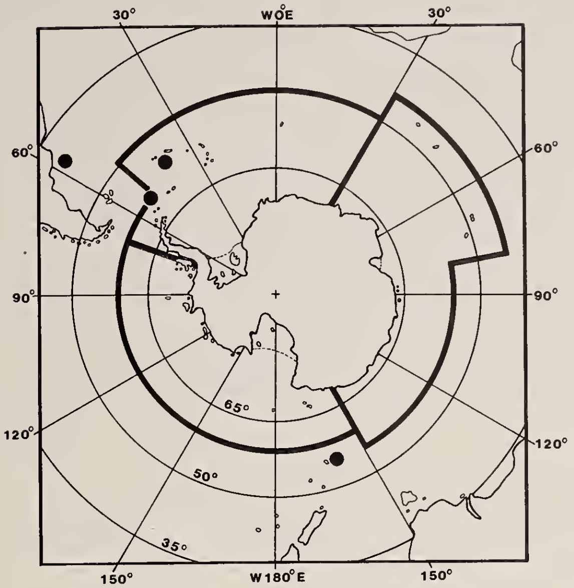


Fig. 1. *Scopelosaurus hamiltoni* ISH 147/78, 31 cm SL (42°54.9′S, 58°47.1′W)



Distribution of *S. hamiltoni*

With approaching sexual maturity the gill rakers begin to atrophy, first on the hypobranchial, proceeding in a caudal direction. Resorption starts at the tips of the rakers with the appearance of membranous sacks filled with melanophores. The sacks slowly increase in size and move down to the basis of the gill rakers. At the final stage, observed only in *Luciosudis normani* and *Ahliesaurus berryi*, all rakers have disappeared; dark pigment spots remain in their places. Atrophy could be seen in every *S. hamiltoni* larger than 280 mm SL. The teeth are also resorbed at the same time as the gill rakers.

S. hamiltoni appears to be rare; no more than 10 adult and sub-adult specimens are known to the author, 8 of them taken by R/V *Walther Herwig* and now in the ISH collection, including 2 from the Atlantic sector of the Southern Ocean.

The few adult and sub-adult specimens known range from 205–352 mm SL, except for the holotype, measuring originally 505 mm TL (Waite 1916) and about 450 mm SL.

PARALEPIDIDAE

Barracudinas

by A. POST

The family Paralepididae includes 2 subfamilies: Lestidiinae and Paralepidinae. Only species of the latter group have been reported from CCAMLR area. Species of the subfamily Paralepidinae are distinguished in having cycloid scales on the head and the body.

PARALEPIDINAE

Body elongate and slender, subcylindrical to laterally compressed. Unpaired fins without spines; 1 short dorsal fin, 8–11 rays, pelvic-fin rays I, 8, both set behind midpoint of body; anal-fin rays 20–35, its origin distinctly behind dorsal fin; pectoral-fin rays I,10–16, set low on body; principal caudal-fin rays 9+10; a dorsal adipose fin always present above last rays of anal fin. Branchiostegal rays 8. Vertebrae 60–89. Snout pointed; mouth terminal, the lower jaw projecting, with a non-ossified process. Two nostrils. Alternating fixed and depressible fang-like teeth on lower jaw, palatines and ectopterygoid (roof of mouth); premaxillary with 3–5 fangs at tip followed by small saw-like canines. Gill rakers reduced to teeth or spines in multiple series on a bony shield. Scales cycloid and easily shed. No light organs in Antarctic species. No swim-bladder. Hermaphroditic.

Four genera and 9 species of medium-sized fishes, ranging from 20 cm to over 50 cm SL. Three genera and 4 species in our area. Meso- to bathypelagic, swift swimming predators. No commercial importance. Recent taxonomic revisions by Rofen (1966a) and Post (1987). Regional treatment by Post (1985).

KEY TO GENERA

1a A 25–33 (rarely 24 in *N. annulata*); hind tip of maxilla below a vertical from nostrils; maximum size about 40 cm SL 2

1b A 20–24 (one *M. prionosa* has 25); hind tip of maxilla distinctly behind a vertical from nostrils; maximum size about 50 cm SL .... *Magnisudis*

2a V in front of a vertical from first D ray; rim of opercle deeply notched between ends of thin, finger-like bony filaments (Fig. 1a) .... *Notolepis*

2b V behind a vertical from last D ray; rim of opercle between ends of bony filaments slightly irregular but not notched (Fig. 1b) .... *Arctozenus*

Genus ***Arctozenus*** Gill, 1864

Origin of pelvic fins distinctly behind a vertical from first dorsal-fin ray, usually below or behind last dorsal-fin ray. Base of adipose fin short, not longer than height of caudal peduncle. Lateral-line scales distinct, ending above posterior anal-fin rays. Posterior margin of operculum smooth or irregular (Fig. 1b). Upper jaw reaches to below nostrils. Monotypic.

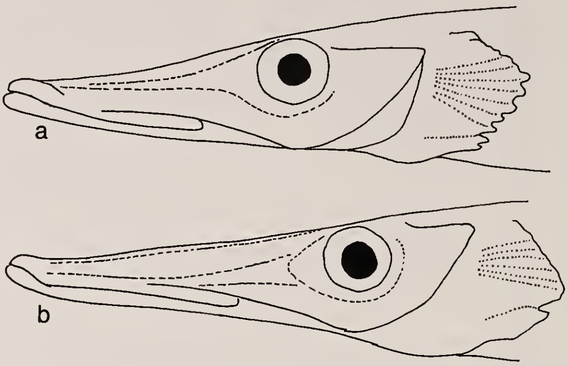


Fig. 1. The structure of the opercular posterior margin of (a) *N. coatsi*, and (b) *A. risso*.

Arctozenus risso (Bonaparte, 1840)
Fig. 2

Paralepis Risso Bonaparte, 1840: punt. (152) fasc. XXIX, Mediterranean. Holotype: Specimen lost; species based on description of Cuvier in Cuvier & Valenciennes (1829: 357; *Paralepis coregonoide*).

Diagnosis: Based on specimens taken south of 40°S. D 9–10; A 28–35; P I,10–11; GR 29–42; LL 59–67; vertebrae 80–83. Body depth 5.9–7.7%, head length 21.8–27.5%, and eye diameter 2.9–4.9%SL; head grows isometrically.

COLOUR: In life when fully scaled, generally silvery, but more greyish dorsally, lighter ventrally. Small, distinct black spots scattered along rear part of body. A black area at base of anterior anal-fin rays. Young specimens with at least 7 peritoneal sections, confluent in larger adolescents.

Distribution: World-wide from the Arctic to the Antarctic; most abundant in temperate waters. Probably pseudoceanic, spawning at continental slopes and on oceanic banks from northern through tropical to southern temperate waters. Records from the Southern Ocean probably refer to expatriated (i.e. sterile) specimens, at the southern margin of the geographical range of this species.

Remarks: Morphological features highly variable, being correlated to the water temperature in the spawning area (Post 1968). Range of vertebrae worldwide 75–85.

Biology unknown. Attains about 30 cm SL.

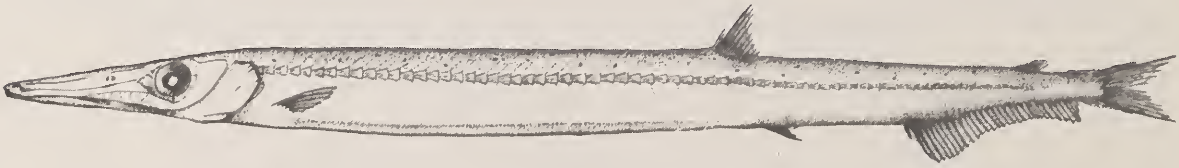
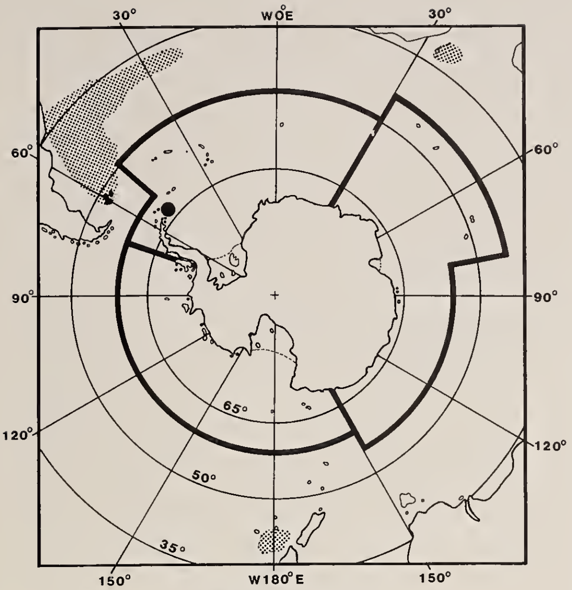


Fig. 2. *Arctozenus risso* ISH uncatalogued, 22 cm SL, Strait of Denmark



Distribution of *A. risso*

Genus *Magnisudis* Harry, 1953

Rather large and compact fishes. Body height about 10–13% and head length about 25% SL. Upper jaw extending far beyond nostrils, ending slightly before eye; anal fin far back on body, with 21–24 rays. Pectoral-fin rays I, 13–16; origin of pelvic fins below or slightly behind first dorsal-fin ray. Lateral line distinct, ending above posterior part of anal fin, visible part of scales higher than long on anterior part of body. Vertebrae 59–73. Three species, 1 in our area. Expatriated (i.e. sterile) specimens of *M. atlantica* may occasionally enter into CCAMLR area.

KEY TO SPECIES

1a Vertebrae 59–61; 4 peritoneal sections in juveniles (tropical Indian and Pacific oceans) .... *M. indica*
1b Vertebrae 63–73; 3 peritoneal sections in juveniles 2
2a Vertebrae 63–67 (mainly Northern Hemisphere).......... ....*M. atlantica*
2b Vertebrae 68–73 ....*M. prionosa*

Magnisudis prionosa (Rofen, 1963)
Fig. 3

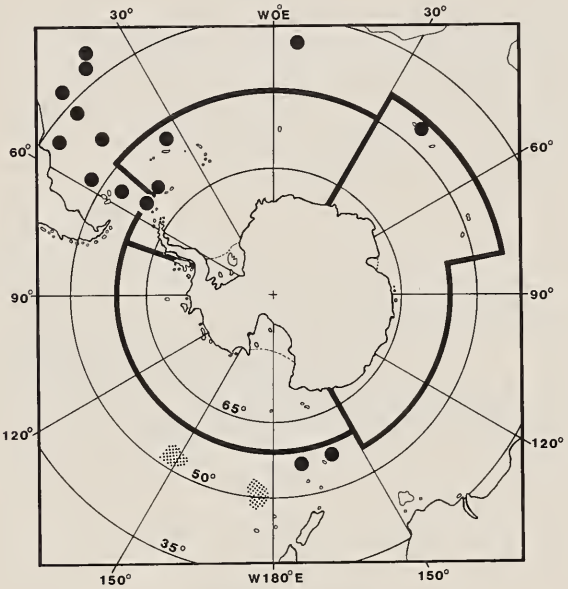
Paralepis atlantica prionosa Rofen, 1963: 1, Antarctica (from stomach of whale). Holotype: SU 55091.

Diagnosis: D 9–11; A 21–25 (usually 22–24); P I, 14–16; GR 30–42, highly variable and depending on age; LSS (above lateral line) 57–65; vertebrae 68–73 (urostyle excluded). Body depth about 9.8–12.5%, head length 21.1–32.5%, and eye diameter 3.3–5.9%SL, both showing allometric growth.

COLOUR: In life, silvery when fully scaled, but usually scales lost except for lateral line scales; dorsally brown to grey with a violet tinge, ventrally light; fins greyish to black. Juveniles light with black peritoneum shining through the transparent belly.

Distribution: Southern Hemisphere. Not recorded from the Indian Ocean sector, but Gon & Klages (1988) reported otoliths from stomachs of king penguins at the Prince Edward Islands. Probably circumglobal from about 20 °S to Antarctica; spawning area between 20 °S and 30 °S. Southernmost record near to the ice border in the Atlantic Ocean sector, probably expatriated (sterile) specimens. Vertically, juveniles from near surface to about 200 m and adults down to 1,000 m, but mainly between 300–800 m.

Remarks: Biology unknown. Attains over 50 cm SL.



Distribution of *M. prionosa*

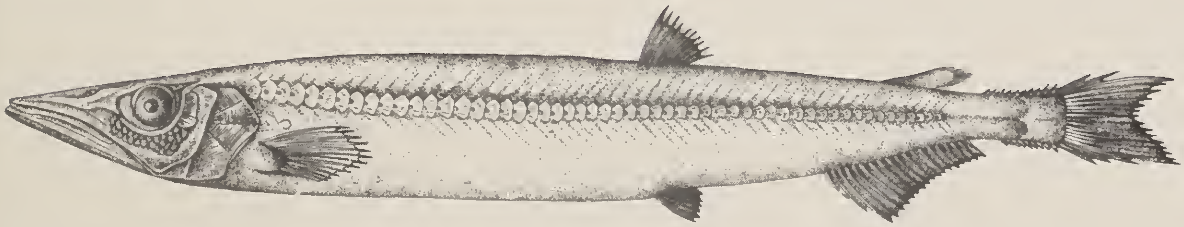


Fig. 3. *Magnisudis prionosa*? ISH 14/72, 41 cm SL, locality unknown

Genus *Notolepis* Dollo, 1908

Origin of pelvic fins distinctly in front of a vertical from first dorsal-fin ray. Base of adipose fin long, at least twice the height of caudal peduncle. Posterior margin of opercle deeply notched, forming a fan-like structure (Fig. 1a). Upper jaw reaches to below nostrils.

KEY TO SPECIES

1a LL ending above middle of A; LL scales inconspicuous, without dorsal and ventral extensions; gill chamber black ... . *N. coatsi*

1b LL ending at base of C; LL scales with long dorsal and ventral extensions; gill chamber pale................. *N. annulata*

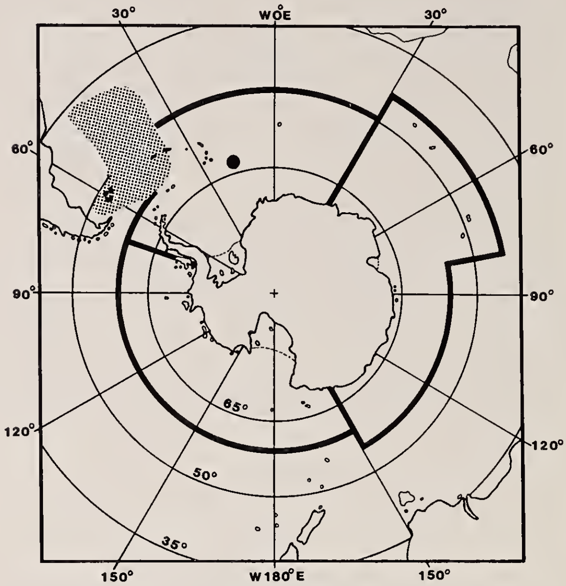
Notolepis annulata Post, 1978
Fig. 4

Notolepis annulata Post, 1978: 10, fig. 2 (50°47′ S 50°01′ W). Holotype: ISH 779/76.

Diagnosis: D 8–10; A 23–28; P I,9–10; GR only in young specimens, adults have none; LL 75–86; vertebrae 74–83. Lateral line conspicuously modified: dorsal and ventral extensions of each scale reach to dorsal and ventral midline of body, thus forming a pattern of transverse striations on body.

Colour: Brownish in alcohol and greyish in life, with a continuous sequence of light and dark stripes. Young specimens yellowish with the black peritoneum shining through the abdominal wall.

Distribution: Known only from the western Atlantic Ocean, between 37°S and 72°S; probably circumglobal in Antarctic waters. Juveniles were captured at 45 m; adults from 550 to more than 2,000 m.



Distribution of *N. annulata*

Remarks: The dorsoventral extension of the lateral-line scales of *N. annulata* is a unique feature within the family. It has been interpreted as a special adaptation to detect fishes in krill swarms (Post 1978). *N. annulata* is polyphagous, feeding on krill and fishes.

Fig. 4. *Notolepis annulata* ISH 793/76, 25 cm SL (42°57.9′S, 39°53.2′W) (from Post 1978)

Notolepis coatsi Dollo, 1908
Fig. 5

Notolepis coatsi Dollo, 1908: 60 (60°03′42″S 44°48′33″W). Holotype: NSMZ 1921.143.0331.

Diagnosis: D 8–10; A 26–29; P I,8–10; GR only in young specimens, adults have none; LL 65–69; vertebrae 86–89. Lateral line ending above middle of anal fin, its scales almost cryptic.

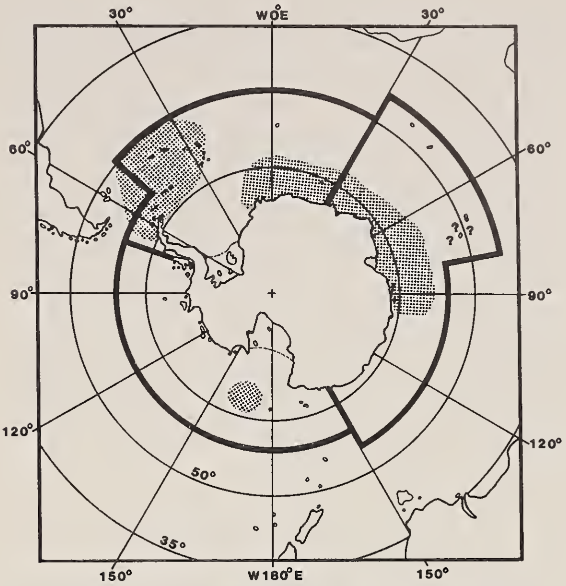
Colour: In alcohol, pale yellow except for some brownish to blackish areas at tip of snout around nostrils and at the bases of fins (skin usually missing). These dark areas and the totally black gill chamber, indicate that adults are heavily pigmented in life but lost their skin in the fishing gear.

Otoliths

Diagnostic features: The oval to rectangular shape, the fused cristae anterior to the cauda, the raised dorsal margin, the down turned antero- and posteroventral corners, the absence of the ostium and the prominent cauda and posterior colliculum.

Fig. 6. Representative otolith of *N. coatsi*; fish length 26 cm SL; scale bar 1 mm

Distribution: Probably circumglobal in Antarctic pelagic waters. Vertically, from surface (holotype) to more than 2,000 m.



Distribution of *N. coatsi*

Remarks: *Notolepis coatsi* seems to feed exclusively on krill as no other prey items were found in the stomachs of the material examined (ISH fishes). Its distribution pattern is therefore likely to follow that of the krill.

Attains at least 38 cm SL.

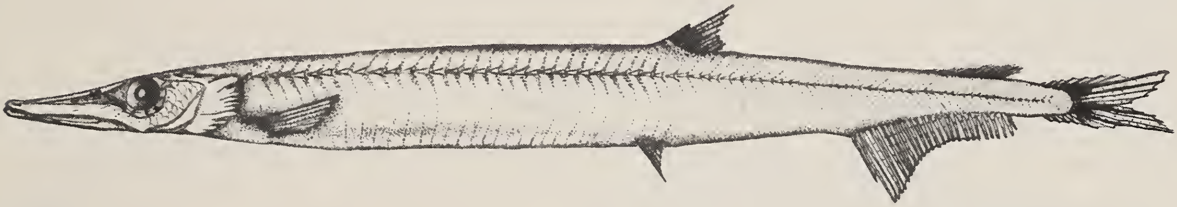


Fig. 5. *Notolepis coatsi* ISH 392/76, 38 cm SL (54°12′ S, 40°02′ W) (from Post 1978)

ANOTOPTERIDAE

Daggertooths

by P.C. HEEMSTRA

Body greatly elongated, compressed anteriorly (body depth just behind the head about 4 times its width), oval in cross-section posteriorly. Scales and photophores absent. Lateral line inconspicuous or absent. Head long and compressed (interorbital width less than or equal to orbit diameter). Jaws large, more than 10% SL; a row of enormous knife-like teeth on each palatine; teeth on jaws smaller than palatine teeth. Nostrils confluent, high on snout, about an orbit diameter in front of eye. Rayed dorsal fin absent; adipose dorsal fin well developed. Anal fin far back, under the adipose fin and near the caudal fin. Pelvic fins slightly behind middle of SL. No fin spines. Caudal fin forked, the lobes about equal. Vertebrae 78–83; epipleural and pleural ribs well-developed; intermuscular bones numerous and greatly elongated. Swim-bladder absent; skeleton poorly ossified. Gills 4; no gill rakers or teeth on gill arches; pseudobranch well developed. Branchiostegal rays 7, the membranes separate and not joined to isthmus.

A single genus and species.

Genus ***Anotopterus*** Zugmayer, 1911

Four nominal species have been described, but the data presented by Rofen (1966), Templeman (1970a) and Rembiszewski (1981) indicate a single, world-wide species.

Anotopterus pharao Zugmayer, 1911
Fig. 1

Anotopterus pharao Zugmayer, 1911: 13, off Portugal, Gettysburg Seamount (36°54′30″ N, 11°49′ W). Holotype: MOM 911154.

Eugnathosaurus vorax Regan, 1913: 234, fig. 1, off Coats Land (71°22′ S, 16°34′ W); head only, taken in a bottom trawl.

Anotopterus antarcticus Nybelin, 1946: 3, figs. 1–3, taken from the stomach of a whale caught in the Weddell Sea (62°S, 38°W).

Anotopterus arcticus Nybelin, 1946: 8, fig. 4, based on a head found in the stomach of a halibut, *Hippoglossus hippoglossus*, caught off the west coast of Greenland (64°25′ N, 53°30′ W).

Diagnosis: P 12–15; V 7–10; A 13–16; vertebrae 78–83. Greatest body depth 14.0–25.0 and head length 4.0–5.0 in SL. Eye diameter 5.6–7.3% HL. Two low dermal keels at base of caudal fin, not extending forward to below adipose fin.

Otoliths

Diagnostic features: The square to near discoid shape, the entire margin and the homomorph and prominent colliculi.

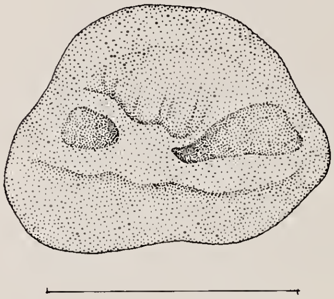


Fig. 2. Representative otolith of *A. pharao*; fish length unknown; scale bar = 1 mm.

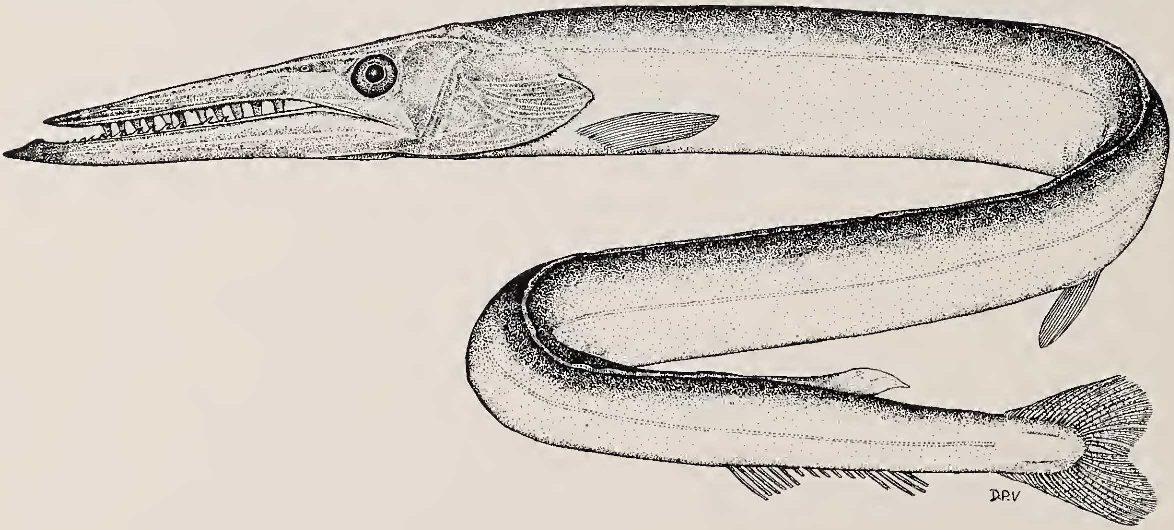


Fig. 1. *Anotopterus pharao*, CAS 26911, 98 cm SL, 25 miles west of Cape Mendocino, Humboldt, California.

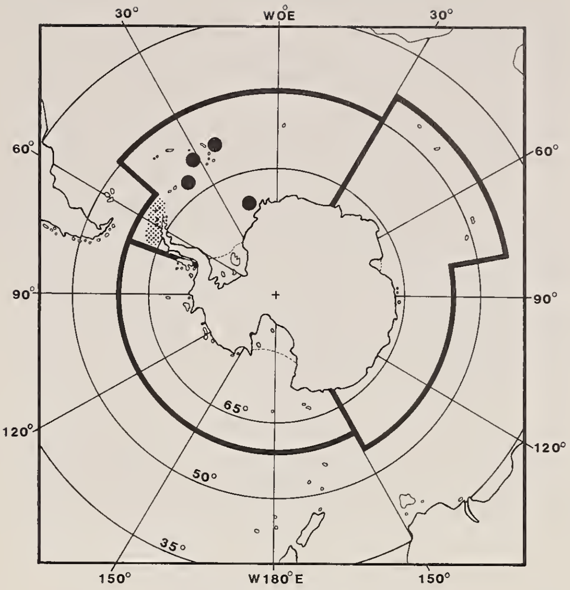
Distribution: A world-wide species occurring from polar to temperate waters. In the Southern Ocean, *Anotopterus* is known from the Scotia Sea, Weddell Sea, and off Coats Land (synonymy above and Rembiszewski 1981); it probably occurs all round the continent.

Remarks: *Anotopterus* is a member of the epipelagic ichthyofauna (Parin 1970), but during the daylight hours this species is usually found below 1,000 m. Its apparent rarity is likely due to the difficulty of capturing large epipelagic fishes with conventional gear.

The daggertooth is a large, piscivorous predator. Its distensible body wall and large stomach are capable of accommodating prey up to half its own length (Rofen 1966; Templeman 1970a). The formidable dentition is also indicative of an active fish predator.

Anotopterus is a synchronous hermaphrodite that undergoes a remarkable transformation—loss of teeth and atrophy of gut (stomach and intestine)—in conjunction with enlargement of the gonad (and ova) in preparation for spawning (Maul 1971). The only specimen that has been found with an enlarged gonad is a 77 cm SL fish caught off Madeira. Based on the absence of teeth, non-functional gut, and enormous gonad with large ova (0.9 mm), Maul (1971:13) concluded that the (once only) spawning of *Anotopterus* may represent the final stage in the life of this species.

Attains a length of at least 105 cm SL (Rembiszewski 1981).



Distribution of *A. pharao*

ALEPISAURIDAE
Lancetfishes

by O. GON

Body elongate, almost eel-like, and slightly compressed. Dorsal fin long, extending along most of body length, and very high. Adipose fin present. Anal fin low and shortbased, situated below end of dorsal fin. Pelvic fins abdominal. Pectoral fins inserted low on ventral part of body. Caudal fin forked and relatively large. Swimbladder and scales absent. Mouth large with numerous small teeth and some large, sharp fang-like teeth. A low, fleshy lateral keel present along posterior half of body.

A single genus of pelagic carnivores found in all oceans, down to about 1,000 m.

Genus *Alepisaurus* Lowe, 1833

Two species, 1 in our area. Recent taxonomic treatment by Gibbs & Wilimovski (1966), Francis (1981), Post (1984) and Heemstra & Smith (1986).

Alepisaurus brevirostris Gibbs, 1960
Shortsnout lancetfish
Fig. 1

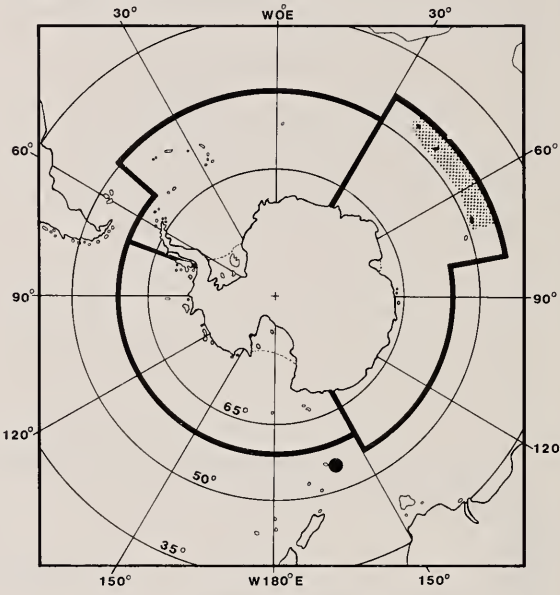
Alepisaurus brevirostris Gibbs, 1960: 2, fig. 1 (38°49′N, 64°02′W). Holotype: USNM 186197.

Alepisaurus brevirostris crozetensis Hureau, 1967: 833. Crozet Islands.

Diagnosis: D 47–48; A 16–17; P 13; V 9; GR 4+(20–23); branchiostegal rays 6–7. Head length 7.2–8.3 and body depth 11.8 in SL. Snout length 2.9–3.1, fleshy eye diameter 4.0–5.4, interorbital space 4.8–5.0 and upper jaw length 1.3–1.4 in HL. Distances from snout to dorsal-fin origin 9.0–10.2, to pectoral-fin base 6.7–8.0, to pelvic-fin insertion 2.2, and to anal-fin origin 1.3 in SL. Upper jaw bearing small, conical teeth. Each side of lower jaw with a single large fang followed by about 5 small teeth, 1–5 smaller fangs and a series of 11–12 smaller, laterally compressed triangular teeth. Each palatine with 1–2 large fangs followed by a space, 2–4 additional fangs and a series of 7–8 small, laterally compressed teeth. An elongate patch of pharyngobranchial teeth on each side. Dorsal fin high, with a convex profile and its origin above middle of opercle. Opercle with distinct ridges radiating from its anterodorsal corner. Gill rakers consist of a short base and 1–3 long and slender spines.

Colour: In life, back black, becoming brownish underlaid with silver. Ventral part of body silvery overlaid with brownish-black. Lower half of body sprinkled with small black spots. Opercle slightly paler than body and head. Pectoral and pelvic fins silvery at base, gradually becoming black distally. Underside of pectoral fin black. Dorsal fin black with white spots along its proximal third. Lateral keel black. Peritoneum black.

Distribution: In all major oceans except the North Pacific Ocean. In the Southern Ocean, it was reported from all the sub-Antarctic islands of the Indian Ocean (Hureau 1967; Duhamel & Hureau 1982; Shcherbachev & Meisner 1973; Gon & Klages 1988) as well as Macquarie Island (Williams 1988). Epipelagic fishes. Gibbs (1960) reported catches as shallow as 36 m, and Shcherbachev & Meisner (1973) caught a specimen at 235 m. Hureau (1967), however, maintained that *A. brevirostris* may venture as deep as 1,800 m.



Distribution of *A. brevirostris*

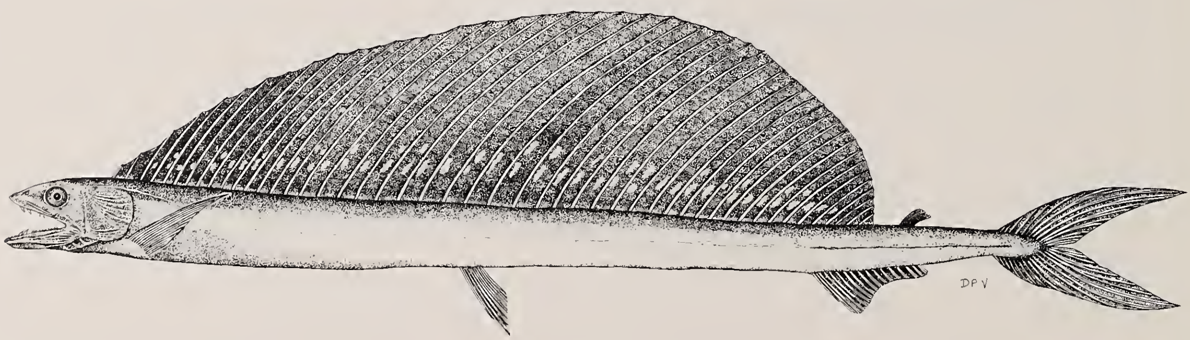


Fig. 1. *Alepisaurus brevirostris* RUSI 26635, 94 cm SL, Marion Island (the dorsal fin has been reconstructed following the illustration of Gibbs, 1960)

Remarks: The diagnosis above is based on 2 specimens from the sub-Antarctic Prince Edward Islands. The meristic and morphometric data agree with those of Gibbs (1960), Gibbs & Wilimovski (1966) and Francis (1981) from other oceans. It should be noted that the dorsal- and anal-fin ray counts of the sub-Antarctic specimens are on the high end of the range given by these authors, with the range of the anal-fin count extended to 17 (previously 16). My specimens lacked lingual teeth, thus agreeing with Gibbs (1960) and Shcherbachev & Meisner (1973), rather than Hureau (1967) who found 3 teeth on each side of the tongue (probably anteriormost hypobranchial teeth).

The congener *A. ferox* is distinguished in having its dorsal-fin origin above or behind the posterior margin of the opercle. In specimens larger than 50 cm SL *A. ferox* has a larger head (less than 6.2 in SL) and snout (less than 2.8 in HL) (Francis 1981). The dorsal fin of *A. ferox* is notched and its longest anterior rays filamentous.

A. brevirostris is hermaphroditic. The elongate ovaries are in the posterior third of the body cavity and a pair of thin testes are lying dorsally in the groove formed by the ovaries (Gibbs 1960). *A. brevirostris* has been observed swimming at the surface at the Crozet Islands (Hureau 1967) and is preyed upon by giant petrels (*Macronectes* spp.) which apparently consume only its internal organs (Arnaud 1972). This behaviour of the giant petrels was recently observed in Marion Island. A mutilated specimen of *A. brevirostris* was recovered after chasing away the bird which was busy eating it (Gon & Klages 1988). In this fish, as well as in another found some months later on the beach, the ventral part of the body was split open and the internal organs were mostly missing. Hureau (1967) and Duhamel & Hureau (1982) found only euphausiid shrimps in stomachs of *A. brevirostris* collected at Crozet and Kerguelen islands. In the tropical and subtropical Indian Ocean, Parin *et al.* (1969) found that fishes constitute the main food component of *Alepisaurus* spp. Based on their analysis of prey species, they postulated that these predators feed mostly at the depth range of 100–300 m.

A. brevirostris attains about 100 cm TL, which is half the maximum size known for *A. ferox*.

FAMILY MYCTOPHIDAE

Lanternfishes

by P.A. HULLEY

Head and body compressed. Eyes large and lateral (dorsolateral in *Protomyctophum (Hierops)*). Mouth terminal (subterminal in *Centrobranchus, Gonichthys, Loweina*); jaws extending to or beyond vertical through posterior margin of eye; maxilla excluded from gape, expanded posteriorly and truncate. Jaw teeth numerous, small, and closely set in bands, those of inner rows sometimes slightly enlarged (some species with posterior teeth broad-based and hooked forward); vomer with a cluster of small teeth on each side; palatines with a close-set band or with 1 or 2 rows of enlarged, widely-spaced teeth; and mesopterygoids with a close-set patch of small teeth or a patch of widely-spaced, enlarged teeth. Branchiostegal rays usually 7–11. Gill rakers well developed, except in *Centrobranchus*. All fins lacking spines (a rudimentary spine at origin of dorsal and anal fins at uppermost pectoral ray and outermost pelvic ray); dorsal adipose fin present; anal-fin origin under or close behind dorsal-fin base; pelvic fins abdominal, with 8 principal rays, except in *Notolychnus* (6) and *Gonichthys* (7); caudal fin with 10 dorsal and 9 ventral principal rays. Scales cycloid or ctenoid, but easily lost except in some shallow-living species. Photophores (absent in *Taaningichthys paurolychnus*), arranged in distinct groups on head and trunk (Fig. 1); smaller "secondary" photophores on head, trunk and fins in some species. Luminous organs of various shapes and sizes on head or caudal peduncle, and at base of adipose fin in some species. Luminous patches or scales at bases of fins and different parts of body in some species.

Colour: Mainly brown to black in forms that lose their scales, but shallow-living species silvery-scaled; some species with metallic-green to metallic-blue scales.

Myctophids, which range in size from 20 mm to 300 mm SL, are widely distributed in the world's oceans in the mesopelagic and bathypelagic zones or in the pelagic and epibenthic faunas above continental shelf and slope regions. Mesopelagic and pseudoceanic species exhibit diurnal vertical migration to between the surface of the sea and 200 m depth at night, some showing size stratification with depth and some with adults and/or juveniles non-migratory. Bathypelagic species do not migrate vertically. Lanternfishes are mainly opportunistic feeders on copepods, amphipods, ostracods, euphausiids, chaetognaths, fish eggs, and fish larvae and juveniles.

Most myctophids are abundant, although a few species are rare. They represent a potentially important alternative fishery resource for the production of fish meal and fish oil. Some species from the Southern Ocean (*Gymnoscopelus* spp.) have been fished on a commercial basis; for human consumption the fishes are smoked.

More than 340 species have been described, but only about 250 species (in 30 genera) are currently recognised. Bekker (1983) has published a synthesis of the family on a global basis. Andriashev (1962) reviewed myctophid species found south of the Antarctic Convergence, and McGinnis (1982) studied the distribution of myctophids between 30°S and the Antarctic continent. A key to the genera and a list of species recorded from or potentially occurring in the Southern Ocean have been given by Hulley (1985). A number of these species have not yet been taken within the limits of CCAMLR area and are therefore not included: *Diaphus meadi* Nafpaktitis, 1978; *Gonichthys barnesi* Whitley, 1943; *Hygophum hanseni* (Tåning, 1932); *Lampadena dea* Fraser-Brunner, 1949; *Lampadena notialis* Nafpaktitis & Paxton, 1968; *Lampadena speculigera* Goode & Bean, 1896; *Lampanyctus lepidolychnus* Bekker, 1967; *Loweina interrupta* (Tåning, 1928); *Metelectrona herwigi* Hulley, 1981; *Protomyctophum (Hierops) subparallelum* (Tåning, 1932). Since they are Bitemperate or South Temperate Pattern (Convergence) species (Hulley 1981), their occurrence in the northern region of the Indian Ocean sector of the Southern Ocean (45°–50°S, 30°–80°E) is anticipated.

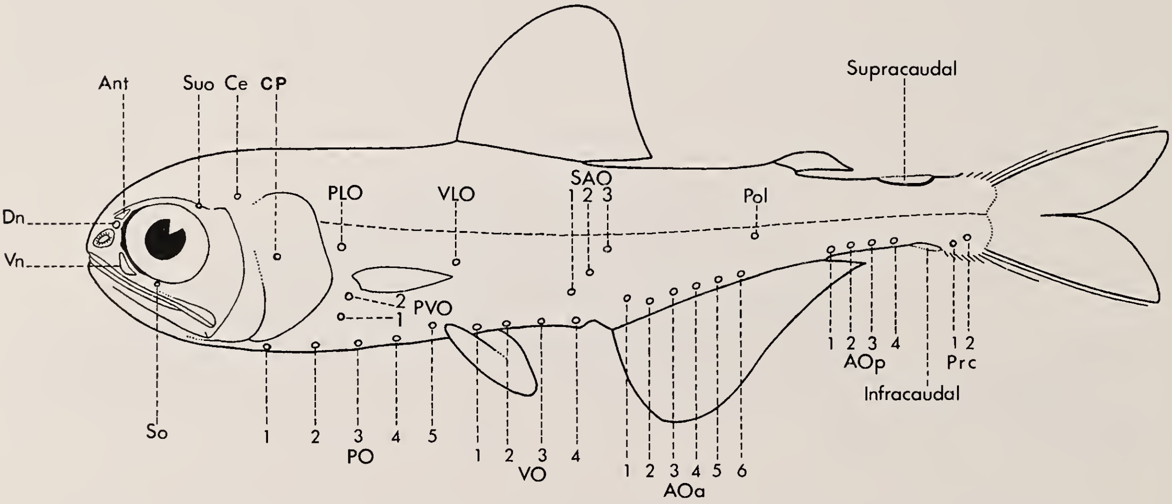


Fig. 1. Distribution and abbreviated terminology of luminous organs in myctophid fishes (based on Nafpaktitis *et al.* 1977)

KEY TO GENERA

1a Two Prc photophores 2
1b More than 2 Prc photophores 6
2a PLO more than its diameter above upper base of pectoral fin; Pol present, AO series divided into AOa and AOp .... *Symbolophorus*
2b PLO more than its diameter below upper base of pectoral fin; Pol absent; AO series continuous, but AO photophores behind end of base of A fin may be depressed, forming "Pol" grouping 3
3a Body slender, with dorsal and ventral profiles almost parallel; PLO, PVO$_1$, PVO$_2$ on a horizontal line; 2 SAO; Prc$_2$ above anterior procurrent C ray, Prc$_1$ in front .... *Krefftichthys*
3b Dorsal and ventral profiles of body not parallel; PLO slightly above to well above PVO$_1$; 3 SAO; Prc$_1$ above anterior procurrent C ray, Prc$_2$ behind 4
4a PLO in front of and slightly higher than PVO$_1$; PLO, PVO$_1$, PVO$_2$ on somewhat angulate line .... *Protomyctophum*
4b PLO almost directly above PVO$_1$; PLO, PVO$_1$, PVO$_2$ forming a triangle 5
5a VO$_2$ elevated; posterodorsal margin of opercle sharply rounded and serrate .... *Metelectrona*
5b VO series level or VO$_2$ only slightly raised; posterodorsal margin of opercle broadly rounded, without serrations .... *Electrona*
6a PO$_1$, PVO$_1$, PVO$_2$ on a straight, ascending, oblique line; VO$_1$, VO$_2$, VO$_3$ on a straight, ascending, oblique line .... *Diaphus*
6b PO$_1$, PVO$_1$, PVO$_2$ not on a straight, ascending, oblique line; VO$_1$, VO$_2$, VO$_3$ not on a straight, ascending, oblique line .. 7
7a Supracaudal and infracaudal luminous glands large, singular, and bordered by heavy black pigment .... *Taaningichthys*
7b Supracaudal and infracaudal glands (when present) consisting of a series of overlapping, scale-like structures, not bordered by heavy black pigment 8
8a PO$_4$ highly elevated and anteriorly displaced to about above PO$_3$ .... *Lampanyctus*
8b PO$_4$ level with rest of that series 9
9a Luminous scale-like structures midventrally between bases of V fins and anus present .... *Ceratoscopelus*
9b No luminous scale-like structures midventrally between bases of V fins and anus 10
10a VO$_2$ elevated; 12–14 A rays .... *Hintonia*
10b VO series level or only slightly arched; more than 17 A rays. 11
11a 3–7 primary cheek photophores; 3 Pol, forming a right angle; "secondary" photophores on head and body .... *Lampichthys*
11b Cheek photophores absent; 2 or 3 Pol, horizontal or in subvertical line with last AOa; no "secondary" photophores on head and body 12
12a AOa$_1$ abruptly elevated; 2 Pol in subvertical line with last AOa; 4 (or more) Prc .... *Gymnoscopelus*
12b AOa$_1$ not elevated; 2 (sometimes 3) Pol in a horizontal line; 3 Prc .... *Notoscopelus*

Genus *Ceratoscopelus* Günther, 1864

Maxilla extending well behind orbit. Pectoral fins large, extending beyond anal-fin origin. Vn present; 5 PO; 5 VO; AO series divided into AOa and AOp; 2 Pol; patches and scale-like structures of luminous tissue on trunk.

Three species, 1 of which is recorded from the Southern Ocean.

Ceratoscopelus warmingii (Lütken, 1892)
Fig. 2

Scopelus (Nyctophus) warmingii Lütken, 1892: 259, fig. 19 (32°06′N, 39°28′W). Holotype: ZMUC 39.

Lampanyctus polyphotis Beebe, 1932: 67, five miles south of Nonsuch Island, Bermuda.

Diagnosis: D 13–15; A 13–15; P 12–15; GR (3–5)+(9–12); AO (5–8)+(4–6).

Otoliths

Diagnostic features: The ovate shape, the ostial and homosulcoid sulcus acusticus and the typically myctophiform colliculi.

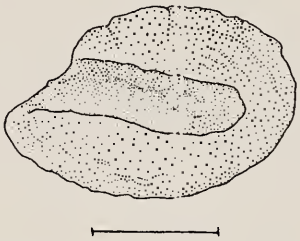


Fig. 3. Representative otolith of *C. warmingii*; fish length 34 mm SL; scale bar 1 mm.

Distribution: Generally, between 35°–42°N and 40°S (Atlantic), 20°N and 45°S (Indian), and tropical/subtropical Pacific, but less numerous in central gyres and absent from regions of low O$_2$-concentration (Bekker 1983). Mesopelagic: Broadly Tropical (Holoeury tropical) Pattern (Hulley 1981): 900 m (day), 25–200 m (night), with small juveniles non-migratory. In

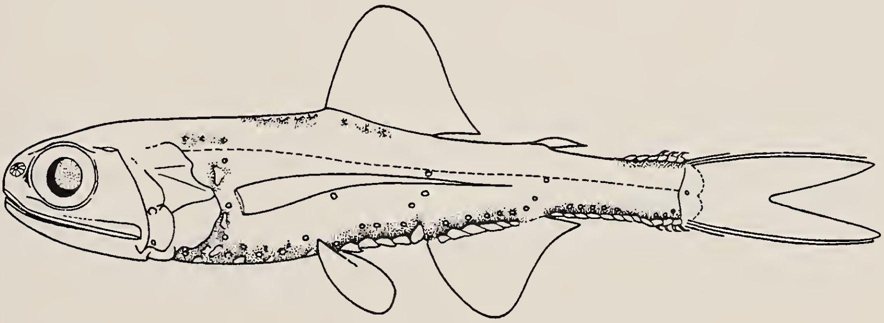
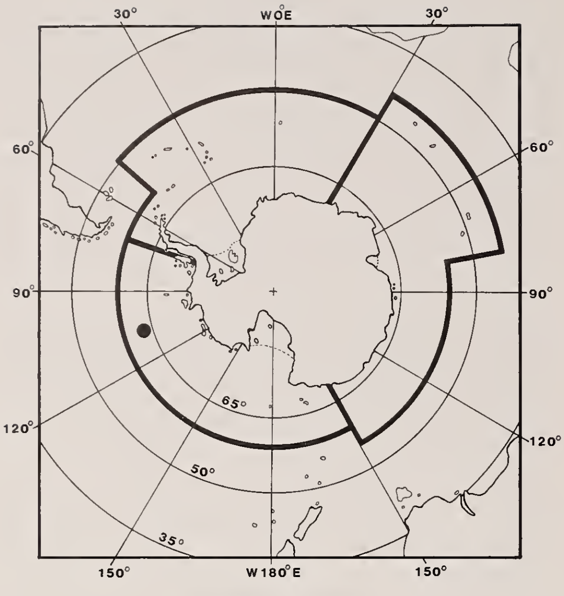


Fig. 2. *Ceratoscopelus warmingii*, 50 mm SL (from *Smiths' Sea Fishes*)



Distribution of *C. warmingii*

the Southern Ocean, recorded from 64°36′S, 108°52′W (Andriashev 1962).

Remarks: *C. warmingii* attains 81 mm SL, but it exhibits apparent sexual dimorphism in size at higher latitudes; females sexually mature from about 44 mm (North and Central Atlantic) and about 59 mm (western South Atlantic). Near Bermuda, the species has a one-year life cycle with a spring-autumn spawning period (Karnella 1983).

The larvae have been described by Shiganova (1977); Miller *et al.* (1979); and Belyanina (1982).

Genus ***Diaphus*** Eigenmann & Eigenmann, 1890

Maxilla not or only slightly expanded posteriorly, extending from slightly behind to well behind orbit. Pterotic spine sometimes well developed. At least 1 pair of sexually dimorphic, luminous glands on head; 5 PO; 5 VO; SAO series curved to strongly angulate; AO series divided into AOa and AOp; AOa$_1$ usually elevated, sometimes level; 1 Pol, sometimes continuous with AOa; 4 Prc. Supracaudal and infracaudal luminous glands absent; usually a luminous scale at PLO.

More than 60 species, of which 2 are recorded from the Southern Ocean.

KEY TO SPECIES

1a Head longer than deep; So present at ventral margin of orbit; AOa$_1$ slightly raised. . . . . *D. hudsoni*

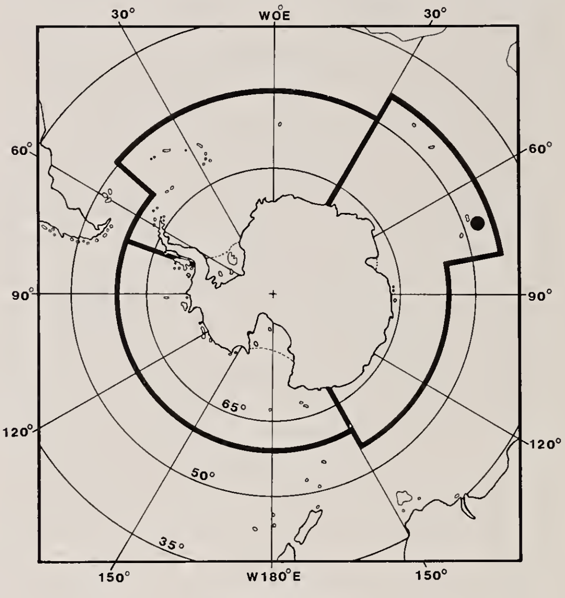
1b Head about as long as deep; So absent; AOa$_1$ highly elevated . . . . *D. ostenfeldi*

Diaphus hudsoni Zubrigg & Scott, 1976
Fig. 4

Diaphus hudsoni Zubrigg & Scott, 1976: 1539, figs. 1–2 (44°14′S, 42°43′W). Holotype: ROM 27569.

Diagnosis: D 13–15; A 12–14; P 10–12; GR (7–9)+(15–19); AO (4–6)+(4–6).

Distribution: Generally, circumglobal between STC and about 50°S, but with northern extensions in eastern



Distribution of *D. hudsoni*

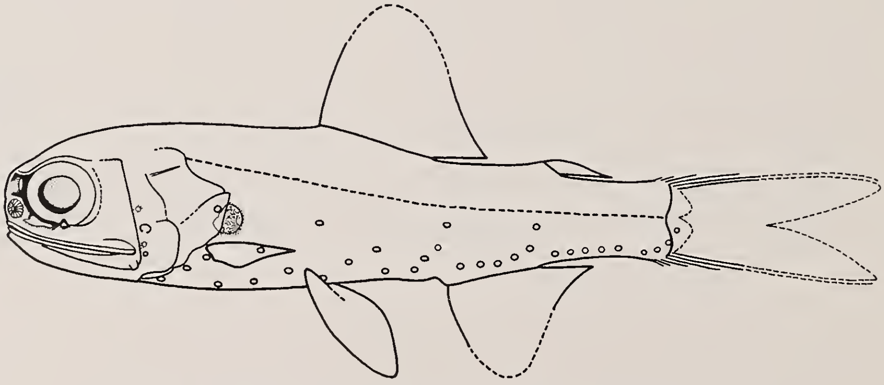


Fig. 4. *Diaphus hudsoni*, 30 mm SL (from *Smiths' Sea Fishes*)

boundary currents. Mesopelagic: South Temperate (Semi-subantarctic) Pattern (Hulley 1981): mainly below 250 m (night). In the Southern Ocean, recorded from 45°10′S, 69°12′E (Bekker 1984).

Remarks: *D. hudsoni* attains 84 mm SL and is sexually mature from about 54 mm SL.

The larvae have been described by Olivar (1987).

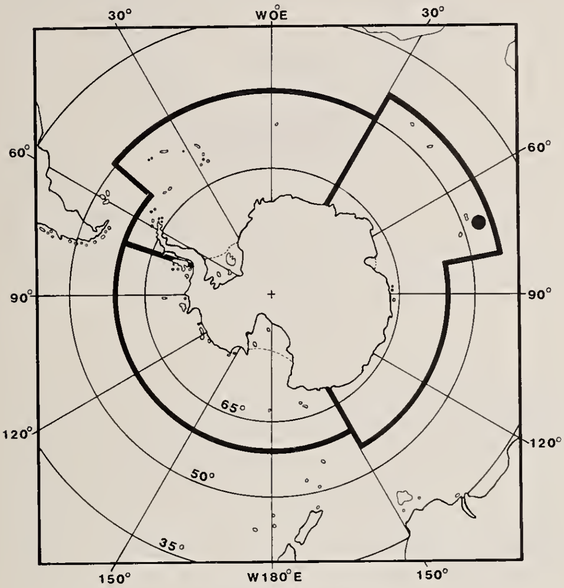
Diaphus ostenfeldi Tåning, 1932
Fig. 5

Diaphus ostenfeldi Tåning, 1932: 143, fig. 15 (35°36′S, 171°52′E). Holotype: ZMUC P2329212.

Diagnosis: D 15–17; A 14–16; P 10–12; GR (8–10)+(15–18); AO (6–7)+(4–7).

Distribution: Generally, circumglobal in the region of the STC (35°–48°S). Mesopelagic: South Temperate (Convergence) Pattern (Hulley 1981): juveniles in upper 100 m (night), adults below about 160 m (night). In the Southern Ocean, recorded from 45°10′S, 69°12′E (Bekker 1984).

Remarks: *D. ostenfeldi* attains 110 mm SL and is sexually mature from about 100 mm SL.



Distribution of *D. ostenfeldi*

Genus *Electrona* Goode & Bean, 1896

Maxilla greatly expanded posteriorly, extending to or slightly beyond posterior margin of orbit. Anal-fin base longer than dorsal-fin base. Dn and Vn present; 5 PO; 4 VO; Pol absent, but AO series behind end of anal-fin base may be depressed.

Five species, of which 4 are recorded from the Southern Ocean.

KEY TO SPECIES

1a So on or slightly behind vertical through middle of orbit; SAO_3 nearer to SAO_2 than to LL .... *E. carlsbergi*

1b So absent; SAO_3 nearer LL than to SAO_2. 2

2a Total GR 16–20; PLO nearer to PVO_1 than to PVO_2; AO series level. .... *E. antarctica*

2b Total GR 21–31; PLO equidistant from PVO_1 and PVO_2; AO series with last 4–5 photophores depressed. 3

3a Total GR 27–31; Prc_1–Prc_2 interspace less than one photophore diameter; PO_5 level with outer base of V fin; VLO usually nearer V base than to LL. .... *E. subaspera*

3b Total GR 21–24; Prc_1–Prc_2 interspace equal to or greater than one photophore diameter; PO_5 elevated, above level of outer base of V fin; VLO usually midway between V base and LL .... *E. paucirastra*

Electrona antarctica (Günther, 1878)
Fig. 6

Scopelus antarcticus Günther, 1878: 184, Antarctic Ocean. Holotype: BMNH 1887.12.7.215.

Scopelus colletti Lütken, 1892: 249 (28°16′S, 97°30′W).

Diagnosis: D 14–16; A 19–22; P 11–13; GR (3–5)+(12–16); AO 17–19. Mature males with 5–7 separate,

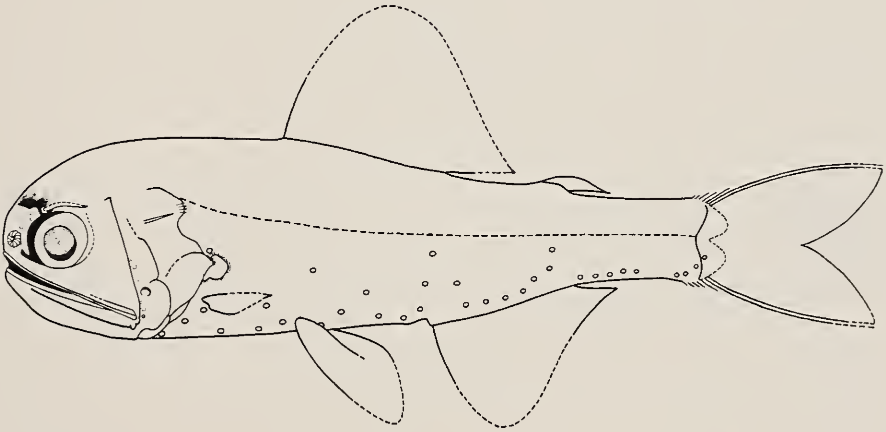


Fig. 5. *Diaphus ostenfeldi*, 35 mm SL (from *Smiths' Sea Fishes*)

supracaudal luminous glands; mature females with 4–6 separate, infracaudal luminous glands.

Otoliths

Diagnostic features: The dorso ventral reniform geometric shape, the homomorph colliculi in association with the pseudo-colliculum below the posterior colliculum and the homosulcoid sulcus acusticus.

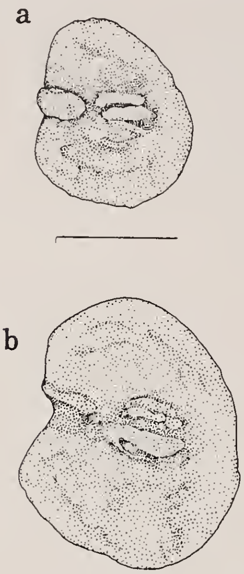
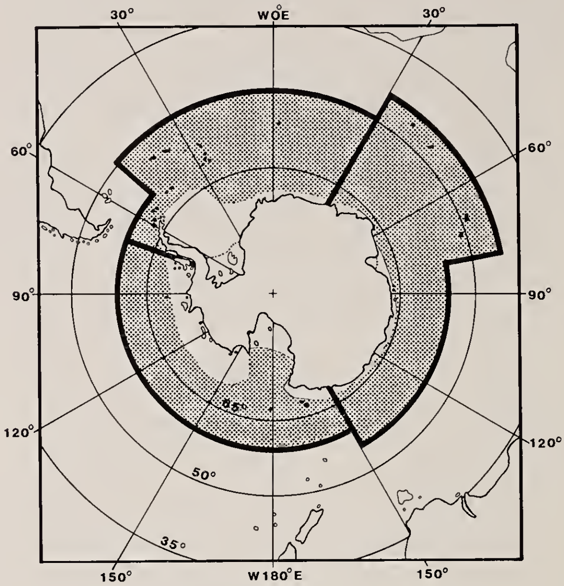


Fig. 7. Representative otoliths of *E. antarctica*; fish lengths: (a) 58 mm, (b) 87 mm SL; scale bar 1 mm

Distribution: Circumpolar south of APF, but absent from Ross Sea; adults only in higher latitudes (South Orkneys, South Shetlands, Peter I Island) and south of the Weddell-Scotia confluence, but adults and juveniles in region of South Sandwich Island, South Georgia and Bouvet (McGinnis 1982; Lubimova *et al.* 1983). Larvae throughout Scotia Sea (Efremenko 1978), in the Gerlache Strait (Mujica & Ascencio 1985) and the Indian Ocean sector (south of Kerguelen Islands to 66°33′S). Mesopelagic: Antarctic Pattern (Hulley 1981): south of the APF adults in upper 250 m (day), 50–100 m (night); occurs deeper northwards to 2,000 m at the STC. Upper limiting temperature of about 3 °C (Andriashev 1965).



Distribution of *E. antarctica*

Remarks: Probably the most common myctophid occurring south of the APF. Females are sexually mature from about 74 mm. Length-frequency distributions indicate a three-year life span (Rowedder 1979a). Batch spawner, with a peak in autumn-winter (Lisovenko 1980, as quoted by Lubimova *et al.* 1983). The diet of juveniles less than 60 mm SL comprises mainly copepods (*Metridia gerlachei, Euchaeta antarctica, Calanus propin-*

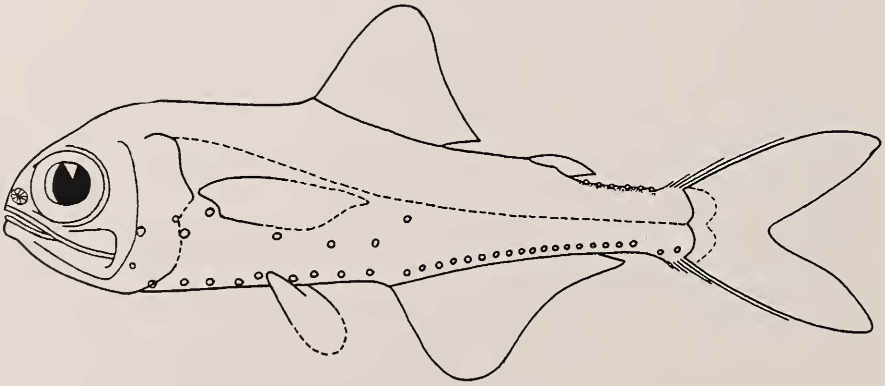


Fig. 6. *Electrona antarctica,* 60 mm SL (from *Smiths' Sea Fishes*)

quus, Calanoides acutus), with some euphausiids and hyperiids. Adults feed more on euphausiids (*Euphausia superba* (up to 50% by weight), *E. frigida, Thysanoessa macrura*), and also take polychaetes, chaetognaths, ostracods, amphipods (*Themisto gaudichaudii*), decapods, molluscs (*Clio pyramidata, Limacina helicina)* and juvenile fishes (Lubimova *et al.* 1983; Williams 1985b; Hopkins 1985).

Adult yearly food ration is about 20 times the body weight; no seasonal variation was detected, but decreased food intake occurs in gravid females (Rowedder 1979b). Oxygen consumption rates were determined by Torres *et al.* (1984). Reinhardt & Van Vleet (1986a, b) examined the lipid composition and pointed out that lipid storage, primarily as wax esters, occurs in intramuscular sacs. These esters are used for increased buoyancy and long term energy reserves.

Early life history stages were described by Pertseva-Ostroumova (1967), Efremenko (1972), Moser & Ahlstrom (1974), Belyanina & Kovalevskaya (1979), Moser *et al.* (1984), and Rasoanarivo & Aboussouan (1985).

Males attain 82 mm and females 103 mm SL.

Electrona carlsbergi (Tåning, 1932)

Fig. 8

Myctophum carlsbergi Tåning, 1932: 126, fig. 1 (44°40′S, 173°39′E). Holotype: ZMUC P2329224.

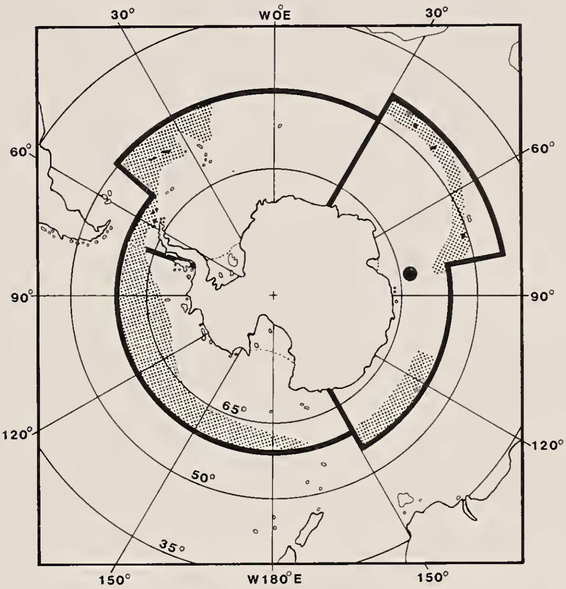
Diagnosis: D 13–15; A 18–20; P 12–13; GR (8–10)+(19–25); AO 13–15. Both sexes with single, small supracaudal and infracaudal luminous glands.

Otoliths

Diagnostic features: The generally discoid shape, the slightly triangular ventral margin, the near equally-sized rostrum and antirostrum, the double anterior colliculum, the single posterior colliculum and the crenate caudal ridge below the posterior colliculum

Distribution: Generally circumglobal between STC and APF. Mesopelagic: South Temperate (Holosubantarctic) Pattern (Hulley 1981): upper 100 m and at surface south of 50°S, but below 550 m near STC. In the Atlantic Ocean sector from 50°–58°S, 15°–50°W and from 60°–62°S, 54°–58°W. In the Pacific Ocean sector from 60°–65°S, 80°–180°W and from 55°–60°S, 110°–150°E; and in the Indian Ocean sector 46°–63°S, 52°–80°E. Population structuring evident within the

Fig. 9. Representative otolith of *E. carlsbergi*; fish length 88 mm TL; scale bar 1 mm



Distribution of *E. carlsbergi*

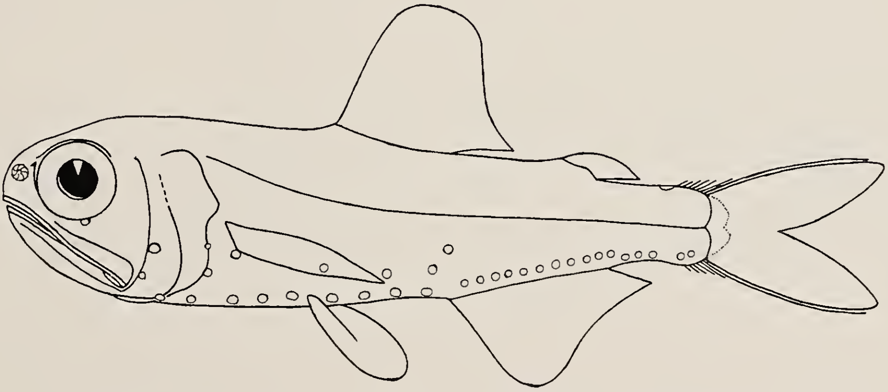


Fig. 8. *Electrona carlsbergi*, 75 mm SL (from *Smiths' Sea Fishes*)

distributional range. Forms dense shoals, particularly in region of APF west of South Georgia and between APF and STC in upper 100–250 m, with catches consisting exclusively of adults (75–90 mm).

Remarks: *Electrona carlsbergi* matures at about 83 mm. There is a slight sexual dimorphism in size and weight, males (90 mm; 12.1 g) are slightly smaller than females (96 mm; 14.6 g).

This species migrates from 80–140 m to the surface at about 18h00 with ascent rate of 0.5 m/minute; the descent rate is 1.8 m/minute (Zasel'sliy *et al.* 1985). *E. carlsbergi* forms the principal component of the Deep Scattering Layer in the Pacific sector (Linkowski 1983). It spawns at either end-of-winter/beginning-of-spring (August-September) (Lubimova *et al.* 1983) or late-spring/early-summer (November-December) (Zasel'sliy *et al.* 1985).

There are 2 feeding periods: an extended evening and shorter morning period. The diet consists of copepods (mainly *Rhincalanus gigas*), hyperiids (mainly *Themisto gaudichaudii)* and euphausiids (mainly *Thysanoessa macrura)* (Lubimova *et al.* 1983), but ostracods and gasteropods were also recorded. The lipid composition (75% trioxyglycerol) was investigated by Reinhardt & Van Vleet (1986a, b).

E. carlsbergi is eaten by squid and, to an insignificent degree, by fishes (Channichthyidae, *Notolepis* sp.) and procellariiform birds (Naumov *et al.* 1981).

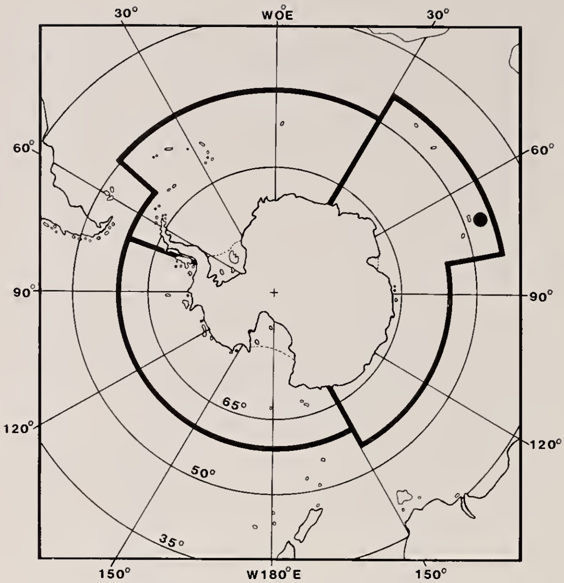
Electrona paucirastra Bolin, 1962

Fig. 10

Electrona paucirastra Bolin, *in* Andriashev, 1962: 280 (39°30'S, 71°16'E). Syntypes: ZIN 36765.

Diagnosis: D 13–15; A 20–21; P 14–16; GR (5–6)+(15–18); AO 14–16, in single series but noticeably depressed behind anal-fin base. Mature males with a single, supracaudal luminous gland; mature females with a small supracaudal gland and 1–3 small, infracaudal luminous patches.

Distribution: Generally, circumglobal in region of STC (35°–48°S). Mesopelagic: South Temperate (Convergence) Pattern (Hulley 1981): from surface to 100 m (night). In the Southern Ocean, recorded from 45°10'S, 69°12'E (Bekker 1984).



Distribution of *E. paucirastra*

Remarks: *E. paucirastra* attains 70 mm SL and is sexually mature from about 60 mm SL.

Electrona subaspera (Günther, 1864)

Fig. 11

?*Scopelus stellatus* Bennet, 1840: 288, Pacific Ocean off South America (43°S).

Scopelus (Dasyscopelus) subasper Günther, 1864: 411 (43°30'S, 123°00'E). Holotype: BMNH 1845.8.5.45.

Myctophum megalops Peters, 1865: 393, Cape Horn.

Diagnosis: D 13–15; A 20–22; P 13–16; GR (7–9)+(18–22); AO 16–18, moderately depressed posterior to

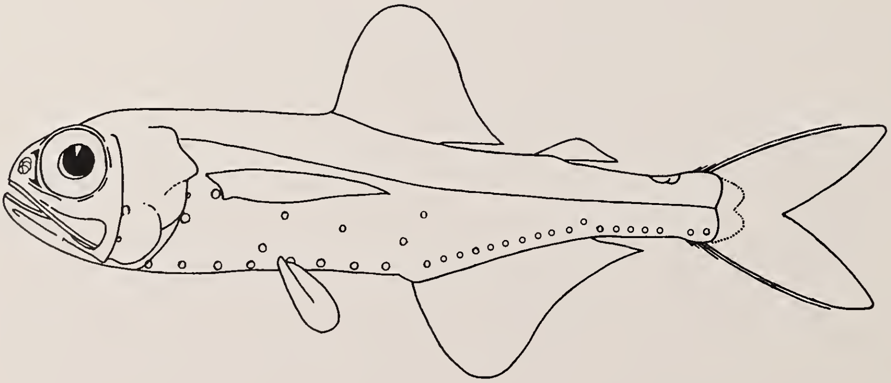


Fig. 10. *Electrona paucirastra*, 70 mm SL (from *Smiths' Sea Fishes*)

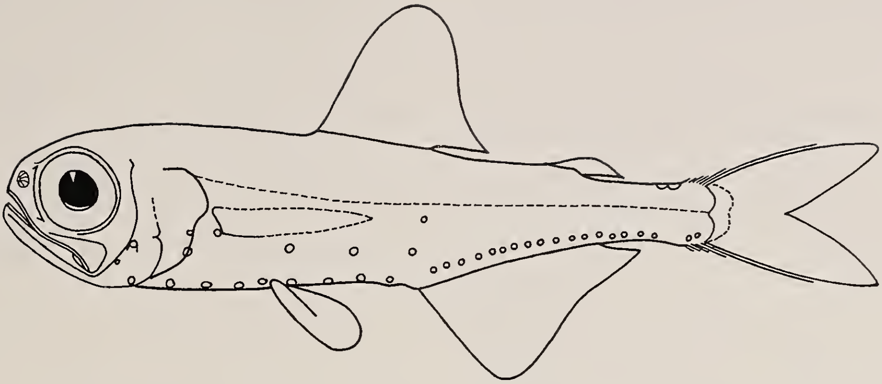


Fig. 11. *Electrona subaspera*, 50 mm SL (from *Smiths' Sea Fishes*)

anal-fin base. Mature males with 1–3 luminous scales supracaudally, forming gland; mature females with supracaudal and infracaudal luminous glands, variously arranged, occasionally with either supracaudal or infracaudal gland.

Otoliths

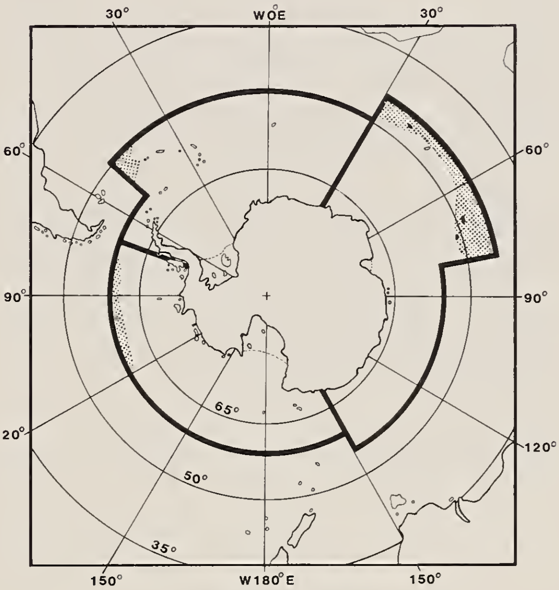
Diagnostic features: The discoid shape, the near homosulcoid sulcus acusticus, the typically myctophiform colliculi, the large anterior colliculum in comparison to the posterior colliculum, the pointed rostrum and the rounded antirostrum.

Fig. 12. Representative otolith of *E. subaspera*; fish length unknown

Distribution: Generally, circumglobal between the STC and the APF. Mesopelagic: South Temperate (Holosubantarctic) Pattern (Hulley 1981): from surface to 200 m (night). In the Atlantic Ocean sector from 51°–53°S, 40°–49°W, in the Indian Ocean sector from 47°–48°S, 70°–71°E, and in the Pacific Ocean sector at about 58°S, 145°W and south of 60°S between about 75°W and 120°W.

Remarks: *E. subaspera* was recorded from the stomachs of *Champsocephalus gunnari* and *Dissostichus eleginoides*. The larvae have been described by Moser & Ahlstrom (1974).

Attains 127 mm SL.



Distribution of *E. subaspera*

Genus ***Gymnoscopelus*** Günther, 1873

Maxilla slightly expanded posteriorly, extending well beyond orbit. Dorsal-fin base longer than anal-fin base. Dn and Vn well developed; 5–7 PO; 5–6 VO; AO series divided into AOa and AOp; 2 Pol; Prc series in 1 or 2 groups. Supracaudal and infracaudal glands absent; some species with irregularly-shaped patches of luminous tissue on body, especially below dorsal-fin base. Two subgenera, both of which are recorded from the Southern Ocean.

KEY TO SUBGENERA

1a PVO$_1$ and PVO$_2$ below level of upper end of P base .... *Gymnoscopelus*

1b PVO$_2$ noticeably above level of P base .... *Nasolychnus*

Subgenus **Gymnoscopelus** Günther, 1873

Four species, all of which are recorded from the Southern Ocean.

KEY TO SPECIES

1a Prc 6–9, the last never widely separated from rest of series; D 17–22, its origin in front of vertical through outer V bases..2
1b Prc 4–5, the last usually widely separated from the rest of the series; D 14–17 (rarely 18), its origin a little behind vertical through outer V bases...............................3
2a Total GR 21–24; D 19–22; usually 5 PO; VLO about midway between LL and V base; caudal peduncle length less than upper jaw length...........................*G. (G.) bolini*
2b Total GR 30–36; D 17–19; usually 6 PO; VLO nearer V base than to LL; caudal peduncle length greater than upper jaw length...................................*G. (G.) nicholsi*
3a Total GR 21–25; 5 PO, with PO_3 elevated above rest of series; caudal peduncle length greater than upper jaw length; predorsal length 43–45% SL...............*G. (G.) braueri*
3b Total GR 25–28; 6–7 PO, all level; caudal peduncle length less than upper jaw length; predorsal length 48–49% SL ....*G. (G.) opisthopterus*

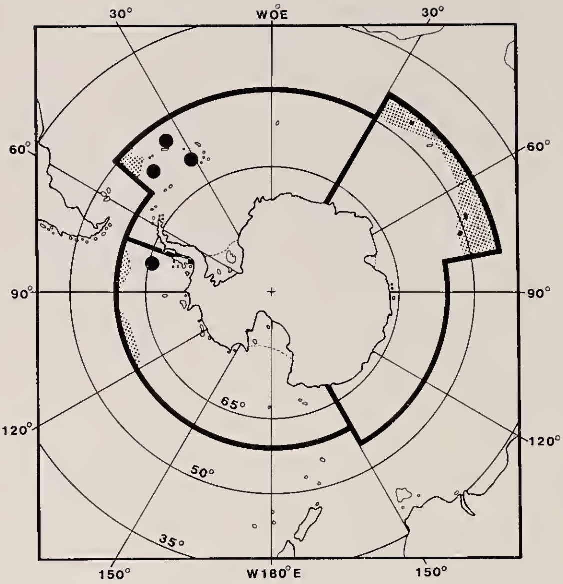
Gymnoscopelus (Gymnoscopelus) bolini
Andriashev, 1962
Fig. 13

Gymnoscopelus bolini Andriashev, 1962: 272, fig. 34 (53°01′S, 109°30′W). Holotype: ZIN 36383.

Diagnosis: D 19–22; A 19–22; P 12–14; GR (6–7)+(14–17); AO (10–12)+(7–9); Prc 5–6.

Distribution: Generally, between APF and STC, with northern extension to about 38°S off Argentina, to 40°S off Chile and to 34°S in the eastern South Atlantic (Hulley 1989). Mesopelagic/epibenthic: South Temperate (Holosubantarctic) Pattern (Hulley 1981): upper 200 m in region of APF, but deeper northwards (night); known also from bottom trawls off the east coast of South Georgia (767–800 m).

Remarks: *G. bolini* matures at about 270 mm SL. The larvae have been described by Shiganova (1977).
Attains 280 mm SL.



Distribution of *G. (G.) bolini*

Gymnoscopelus (Gymnoscopelus) braueri
(Lönnberg, 1905)
Fig. 14

Myctophum (Lampanyctus) braueri Lönnberg, 1905a: 764 (48°54′S, 51°40′W). Holotype: NRM SYD/1902265.4105.

Diagnosis: D 14–17; A 16–20; P 12–15; GR (6–7)+(15–19); AO (8–12)+(8–11); Prc (3–5) + 1.

Colour: Eye colour light blue when freshly caught.

Otoliths

Diagnostic features: The discoid shape, the ostial and homosulcoid sulcus acusticus, the entire margin and the near homomorph and typically myctophiform colliculi. Ontogeny: With an increase in fish size the general geometric shape of the otoliths changes from more dorso ventrally oval to discoid.

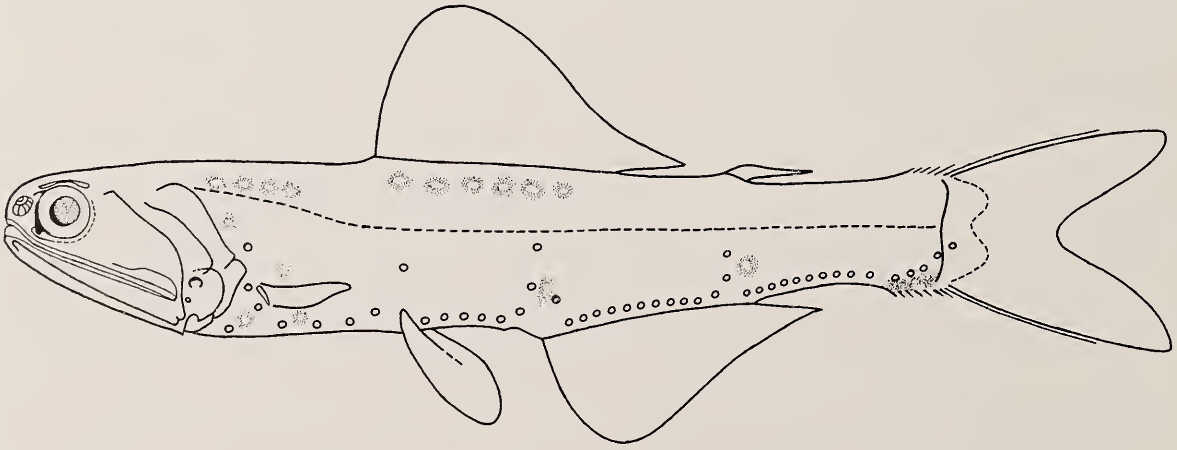


Fig. 13. *Gymnoscopelus (Gymnoscopelus) bolini*, 150 mm SL (from *Smiths' Sea Fishes*)

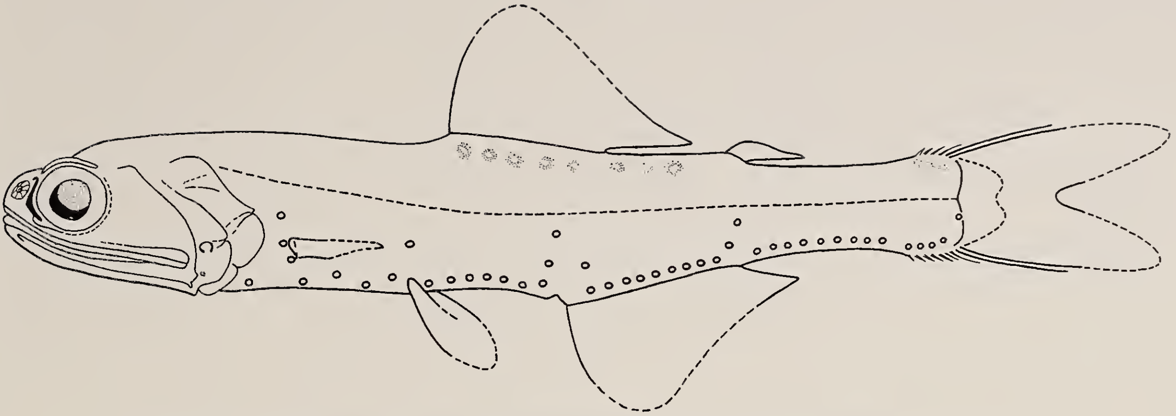
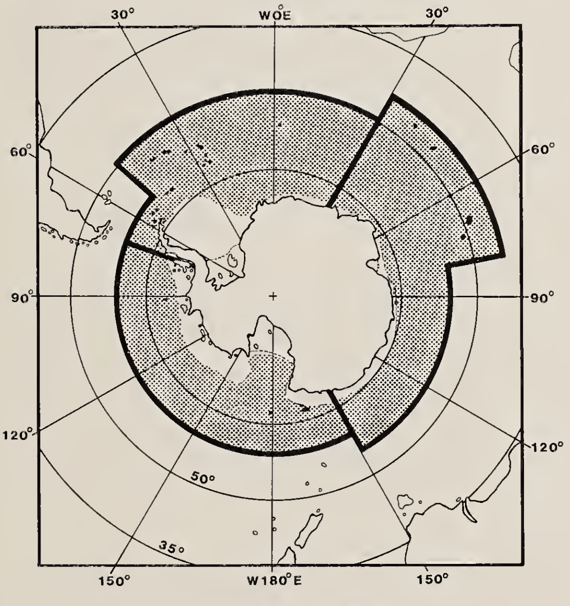


Fig. 14. *Gymnoscopelus (Gymnoscopelus) braueri*, 95 mm SL (from *Smiths' Sea Fishes*)

Fig. 15. Representative otolith of *G.* (*G.*) *braueri*; fish length 118 mm SL; scale bar 1 mm

Distribution: Generally, between the coasts of Antarctica and 33 °S (south-western Atlantic Ocean sector), 46 °S (Indian Ocean sector between 50 °–71 °E), and about 46 °S (Pacific Ocean sector off Chile). Mesopelagic: Broadly Antarctic Pattern (Hulley 1981): upper 200 m (night) but deeper in region of STC. Upper limiting temperature of about 5 °–6 °C.



Distribution of *G. (G.) braueri*

Remarks: *G. braueri* matures at about 114 mm SL. It has been found in the stomach contents of *Dissostichus eleginoides*. As with *G. nicholsi,* the diet consists mainly of *Euphausia superba*; copepods (*Euchaeta antarctica, Rhincalanus gigas*), amphipods (*Primno macropa, Themisto gaudichaudii)* and the euphausiid *Thysanoessa macrura* were also recorded (Williams 1985b). One of the most common myctophids occurring south of the APF.

The larvae were described by Pertseva-Ostroumova (1964, 1977), Belyanina & Kovalevskaya (1979) and Efremenko (1983).

Attains 132 mm SL.

Gymnoscopelus (Gymnoscopelus) nicholsi
(Gilbert, 1911)
Fig. 16

Gymnoscopelus aphya Günther, 1873: 91 (*nomen oblitum)* (55 °S, 85 °W).

Lampanyctus nicholsi Gilbert, 1911: 17, fig. 1 (47 °S, 60 °W). Holotype: AMNH 1919.

Diagnosis: D 17–19; A 19–21; P 13–15; GR (9–12)+(21–24); AO (9–12)+(6–9); Prc 5–8.

Otoliths

Diagnostic features: The virtually straight and entire dorsal margin, the dentate and bulbous ventral margin. The otoliths of *G. fraseri* and *G. nicholsi* are extremely similar in their general geometric shape. They are, however, easily distinguishable from each other by the sculpture of the margins, particularly the ventral margin.

Distribution: Generally, between Antarctica and 35 °S (off Argentina), 47 °S (Falkland Current region), and 47 °–49 °S (between 45 °E and 71 °E). Mesopelagic/epibenthic: Broadly Antarctic Pattern (Hulley 1981). South of the APF, adults in upper 250 m of open ocean and over continental shelves and oceanic banks (spring-summer) during day, migrating to 50–100 m at night, where catches of 200–300 kg have been obtained with a krill trawl (Lubimova *et al.* 1983). Taken in bottom trawls on shelf and slope areas of South Orkneys, South Shetlands and South Georgia in 350–700 m. Adult speci-

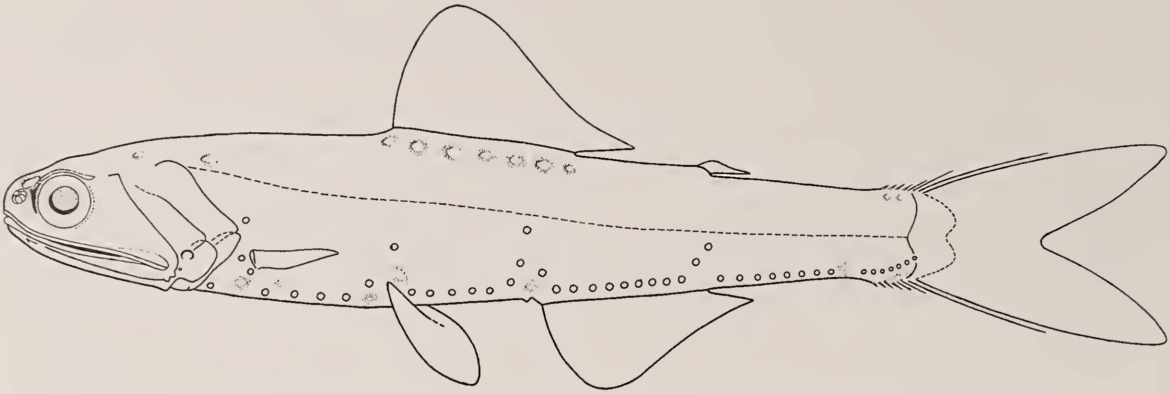


Fig. 16. *Gymnoscopelus (Gymnoscopelus) nicholsi*, 125 mm SL (from *Smiths' Sea Fishes*)

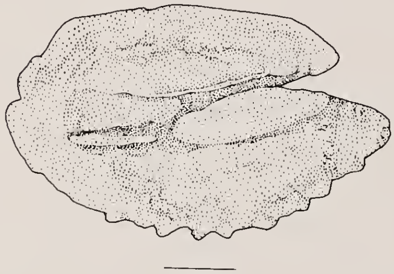


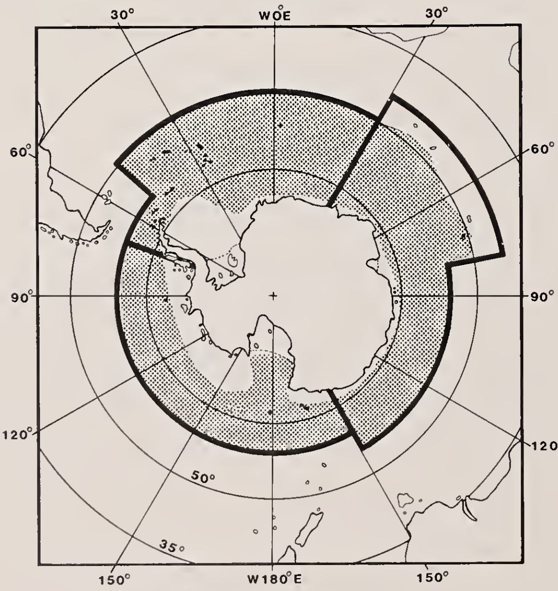
Fig. 17. Representative otolith of *G.* (*G.*) *nicholsi*; fish length 156 mm TL; scale bar 1 mm

mens only in high latitudes (South Orkneys, South Shetlands, Antarctic Peninsula); juveniles and adults in waters around South Georgia and central Scotia Sea.

Remarks: *G. nicholsi* matures from 160–180 mm (? total length). Length-frequency distributions of adults from different areas do not demonstrate distinct changes from year-to-year. The diet consists of euphausiids and euphausiid larvae, hyperiids, and mysids; *Euphausia superba* is an important diet item north of the South Shetland Islands (Takahashi 1983). In addition, Williams (1985b) has recorded the following food items: copepods (*Euchaeta antarctica, Rhincalanus gigas*), amphipods (*Primno macropa, Themisto gaudichaudii)* and euphausiids (*Thysanoessa macrura*). Lipid storage subcutaneously is extensive (Reinhardt & Van Vleet 1986b). *G. nicholsi* was found in the stomach contents of *Dissostichus eleginoides* (Duhamel & Hureau 1982).

The larvae have been described by Pertseva-Ostroumova (1964, 1977), Moser & Ahlstrom (1972), Belyanina & Kovalevskaya (1979), and Moser *et al.* (1984).

Attains 161 mm SL.



Distribution of *G. (G.) nicholsi*

Gymnoscopelus (Gymnoscopelus) opisthopterus Fraser-Brunner, 1949

Fig. 18

Gymnoscopelus opisthopterus Fraser-Brunner, 1949: 1094, text figure; 1102, fig. 13 (64°22.6′S, 106°33.3′E). Holotype: BMNH 1948.5.14.612.

Diagnosis: D 15–18; A 16–18; P 12–14; GR (7–9)+(16–20); AO (9–10)+(7–8); Prc (4)+1.

Colour: Eye colour chocolate-brown when freshly caught.

Otoliths

Diagnostic features: The generally dorso ventrally oval to rectangular shape, the typical myctophiform sulcus acusticus with prominent anterior and posterior colliculi.

Distribution: Circumpolar south of APF, but absent from southern and central regions of Ross and Weddell seas and extending to 40°S in Falkland Current region. Bathypelagic: Antarctic Pattern (Hulley 1981): adults usually deeper than 500 m, but larvae and juveniles in 66–200 m at temperatures of −0.18°C to 6.23°C (Efremenko 1978).

Remarks: The larvae of *G. opisthopterus* were described by Efremenko (1978, 1983).

Attains 162 mm SL.

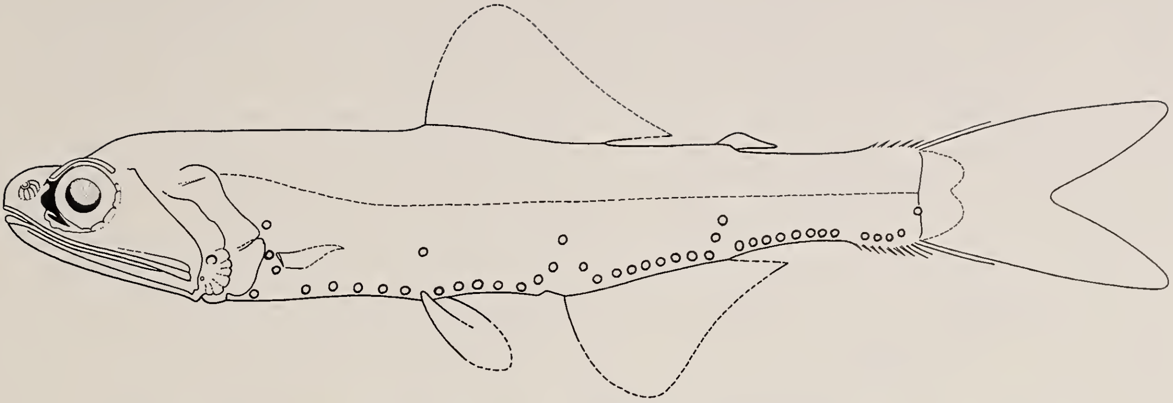
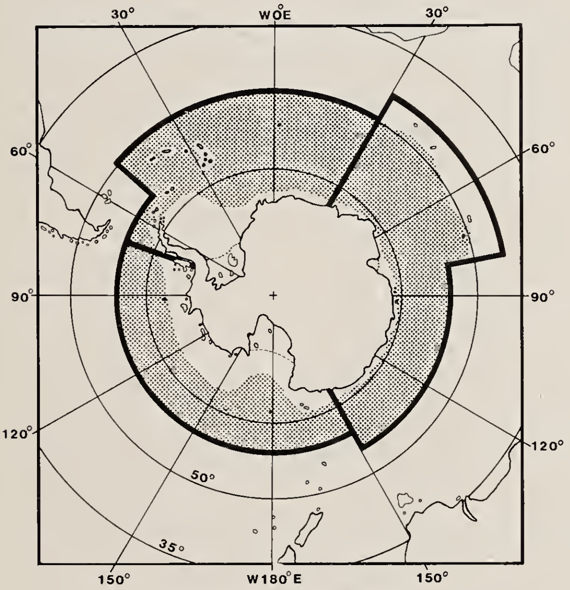


Fig. 18. *Gymnoscopelus (Gymnoscopelus) opisthopterus*, 130 mm SL (from *Smiths' Sea Fishes*)

Fig. 19. Representative otolith of *G.* (*G.*) *opisthopterus*; fish length unknown



Distribution of *G. (G.) opisthopterus*

Subgenus ***Nasolychnus*** Smith, 1933

Four species, all of which are recorded from the Southern Ocean.

KEY TO SPECIES

1a Antorbital luminous tissue confined to upper half of orbit, never extending to anteroventral margin of eye, although black pigmented skin may do so............*G. (N.) fraseri*

1b Antorbital luminous tissue extending below upper half of orbit to anteroventral margin of eye..........................2

2a Distance VO$_5$–SAO$_1$ about 2 times distance SAO$_1$–SAO$_2$; total GR 25–31; eye well above upper lip, the vertical distance from upper lip to lower margin of eye at middle of orbit greater than length of P base.................*G. (N.) hintonoides*

2b Distance VO$_5$–SAO$_1$ about equal to distance SAO$_1$–SAO$_2$; total GR 30–36; vertical distance above upper lip at middle of eye equal to or less than length of P base..............3

3a Caudal peduncle length greater than upper jaw length; adipose-fin base about equal to 1 photophore-diameter; LL narrow, about equal to one photophore-diameter; tips of V rays heavily pigmented ....*G. (N.) piabilis*

3b Caudal peduncle length equal to or less than upper jaw length; adipose-fin base about equal to 2 photophore-diameters; LL about equal to 2 photophore-diameters; tips of V rays not pigmented................*G. (N.) microlampas*

Gymnoscopelus (Nasolychnus) fraseri
(Fraser-Brunner, 1931)
Fig. 20

Lampanyctus fraseri Fraser-Brunner, 1931: 224, fig. 4 (03°18′S, 05°17′E; type locality erroneous). Holotype: BMNH 1931.2.27.6.

Diagnosis: D 16–18; A 17–20; P 12–15; GR (7–9)+(17–20); AO (9–11)+(7–10); Prc (3–5)+1.

Otoliths

Diagnostic features: The ovate to oval shape, the straight dorsal margin, the associated bulbous ventral margin, the ostial and homosulcoid sulcus acusticus, and the large heteromorph colliculi.

Distribution: Mainly in the region of APF, but northwards to STC in Falkland Current region and at 45°E. Mesopelagic: South Temperate (Holosubantarctic) Pattern (Hulley 1981): upper 100 m (night). Upper limiting temperature 6°–8°C, lower limiting temperature 1.5°–2.0°C (Hulley 1981).

Remarks: *G. fraseri* matures at about 73 mm SL. Gravid females have been taken in June-August. This species has been caught in bottom trawls.

The larvae have been described by Pertseva-Ostroumova (1977).

Attains 88 mm SL.

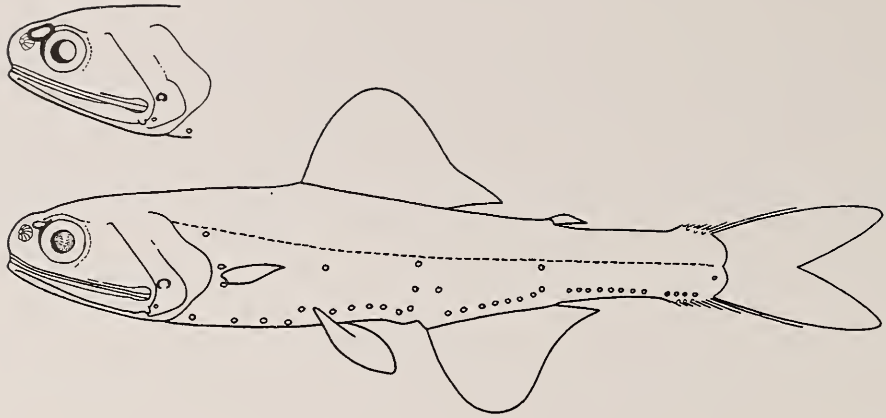


Fig. 20. *Gymnoscopelus (Nasolychnus) fraseri*, 75 mm SL (from *Smiths' Sea Fishes*). Inset figure shows variation in antorbital luminous tissue

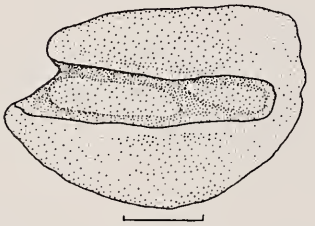


Fig. 21. Representative otolith of *G.* (*N.*) *fraseri*; fish length 77 mm SL, scale bar 1 mm

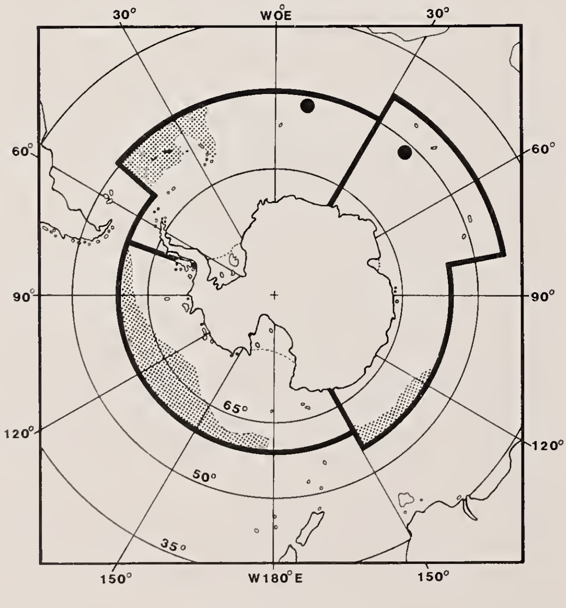
Gymnoscopelus (Nasolychnus) hintonoides Hulley, 1981

Fig. 22

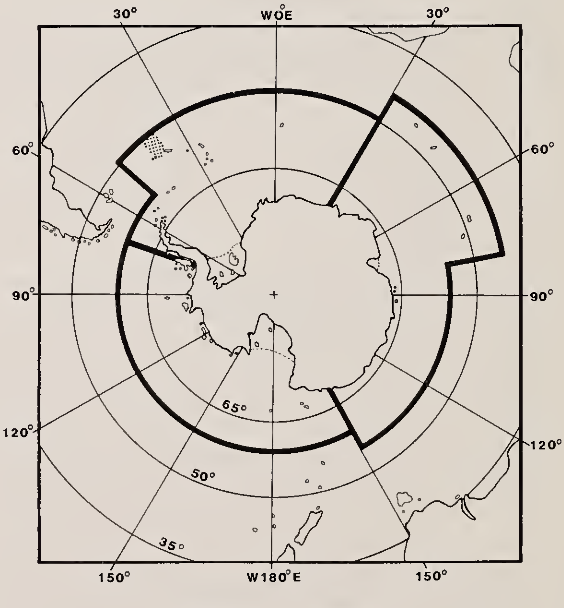
Gymnoscopelus (Nasolychnus) hintonoides Hulley, 1981: 262, figs. 125–126 (42°57.9′S, 39°53.2′W). Holotype: ISH 843/76a.

Diagnosis: D 17–19; A 17–20; P 12–15; GR (7–10)+(18–21); AO (8–11)+(6–10); Prc (3–4)+1.

Distribution: Generally, circumglobal between the STC and the APF. Mesopelagic: South Temperate (Holosubantarctic) Pattern (Hulley 1981): mainly below 800 m,



Distribution of *G. (N.) fraseri*



Distribution of *G. (N.) hintonoides*

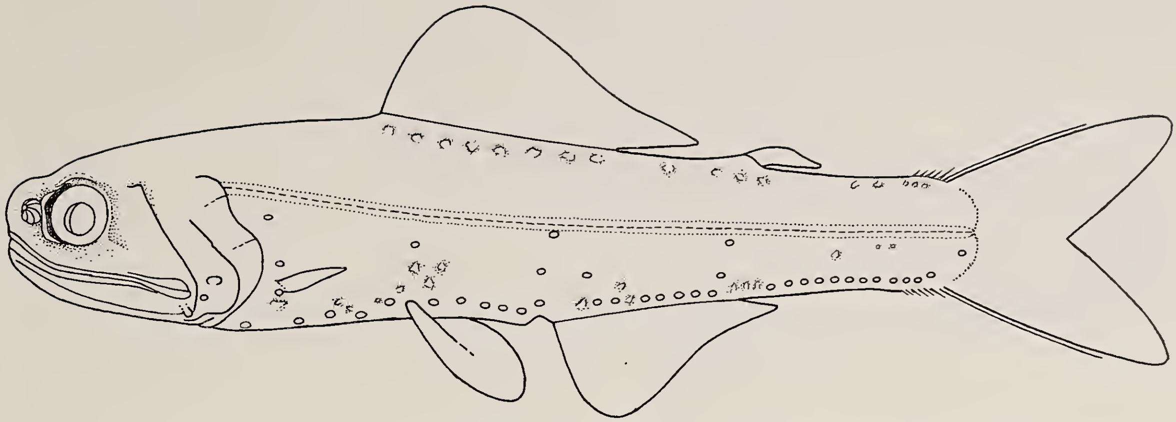


Fig. 22. *Gymnoscopelus (Nasolychnus) hintonoides*, 110 mm SL (from *Smiths' Sea Fishes*)

with shallowest depth of capture 328 m. Recorded from about 50°S to 54°S along 40°W; and between the STC and the APF at about 125°W (Bekker & Evseenko 1987).

Remarks: *G. hintonoides* matures at about 135 mm SL. It has been taken in bottom trawls.
Attains 140 mm SL.

Gymnoscopelus (Nasolychnus) microlampas Hulley, 1981

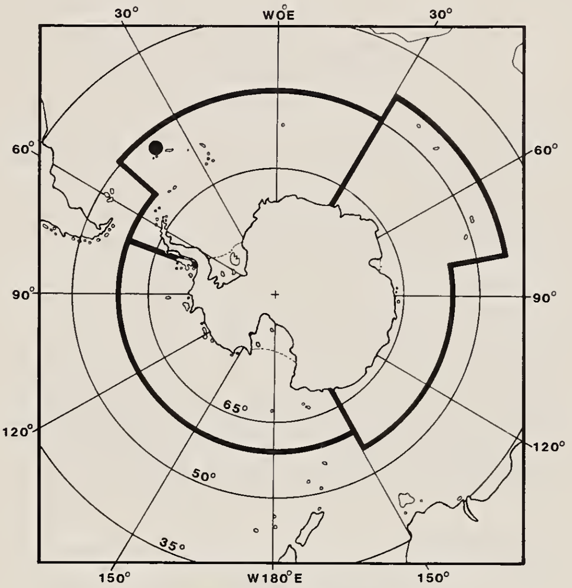
Fig. 23

Gymnoscopelus (Nasolychnus) microlampas Hulley, 1981: 226, figs. 125, 127 (41°46.6′S, 39°58.4′W). Holotype: ISH 551/76a.

Diagnosis: D 18–20; A 18–20; P 13–15; GR (9–11)+(21–24); AO (9–10)+(6–8); Prc (3–4)+1.

Distribution: Generally, circumglobal between STC and APF. Mesopelagic: South Temperate (Holosubantarctic) Pattern (Hulley 1981): below 210 m (night). Recorded from 54°07′S, 30°59′W (Hulley 1981).

Remarks: *G. microlampas* attains 117 mm SL.



Distribution of *G. N. microlampas*

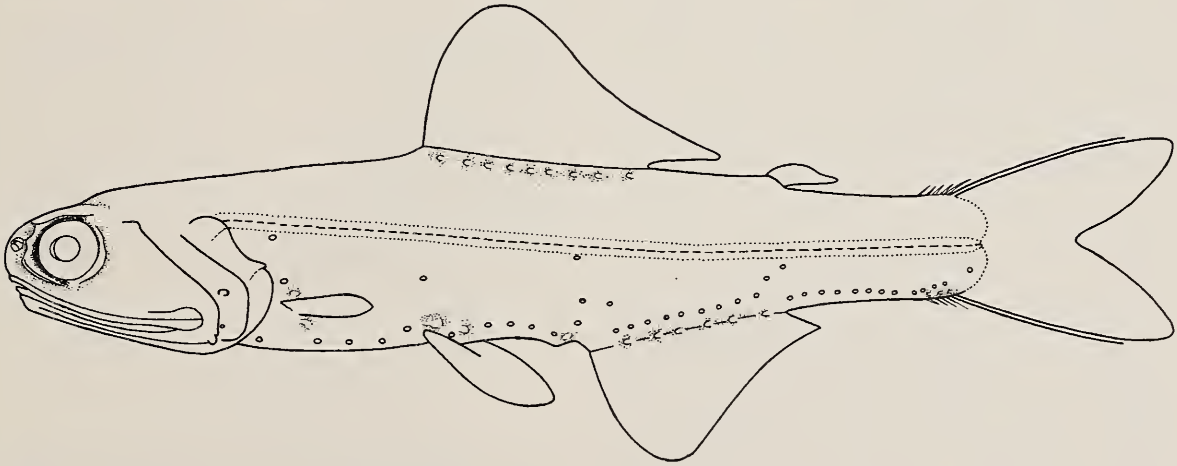


Fig. 23. *Gymnoscopelus (Nasolychnus) microlampas*, 110 mm SL (from *Smiths' Sea Fishes*)

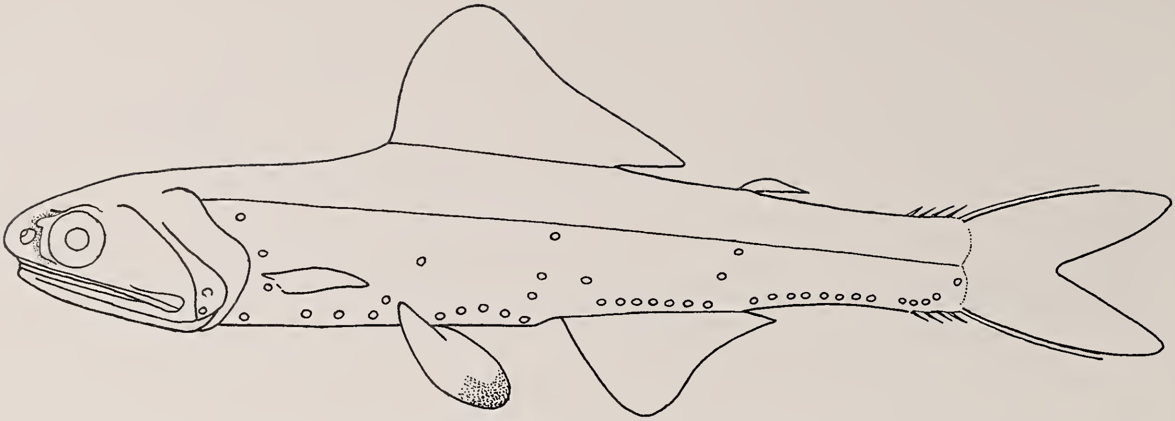


Fig. 24. *Gymnoscopelus (Nasolychnus) piabilis*, 105 mm SL (from *Smith's Sea Fishes*)

Gymnoscopelus (Nasolychnus) piabilis (Whitley, 1931)

Fig. 24

Lampanyctus piabilis Whitley, 1931: 103, fig. 1, Macquarie Island. Holotype: AMS IA.504.

Myctophum (Nasolychnus) florentii Smith, 1933: 126, pl. 9, near Port Alfred, South Africa.

Diagnosis: D 18–20; A 16–19; P 12–14; GR (9–12)+(20–25); AO (7–10)+(7–10); Prc (3–5)+1.

Colour: Tips of P and C rays darkly pigmented.

Otoliths

Diagnostic features: The oval shape with the small but distinct notch in the posterior margin, the smooth dorsal margin and the dentate ventral margin, the homosulcoid sulcus acusticus, the large anterior and small posterior colliculum, and the distally pointed antirostrum.

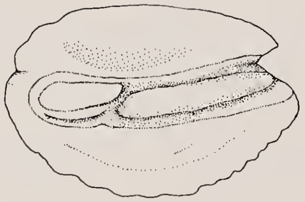
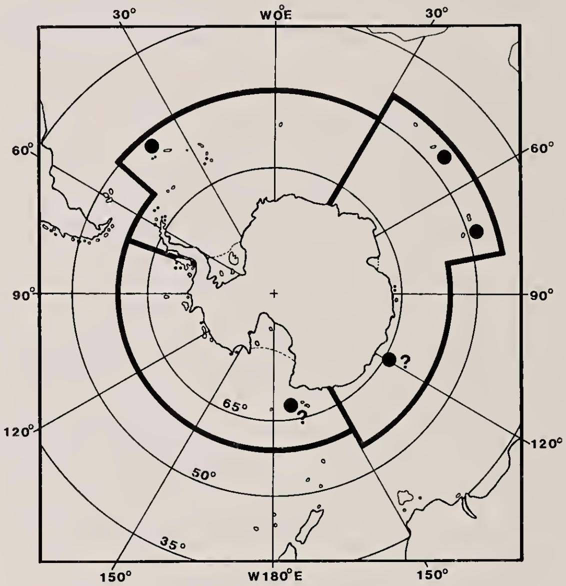


Fig. 25. Representative otolith of *G.* (*N.*) *piabilis*; fish length unknown

Distribution: Generally, between the STC and the APF (Atlantic Sector to south of Australia/New Zealand), but with northern extensions in eastern boundary currents; apparently absent in the sub-Antarctic region of the Pacific (McGinnis 1982; Bekker 1983). Mesopelagic/epibenthic: South Temperate (Semi-subantarctic) Pattern (Hulley 1981): below 100 m (night). In the Southern Ocean, recorded at about 51 °S, 40 °W and 46 °–48 °S, 51 °–71 °E. Two records given by Bekker (1983: fig. 89) from near the Antarctic Continent at about 120 °E and 170 °E may represent misidentifications.



Distribution of *G. (N.) piabilis*

Remarks: *G. piabilis* matures at about 99 mm. It is known from the stomach contents of *Dissostichus eleginoides*.

Attains 146 mm SL.

Genus *Hintonia* Fraser-Brunner, 1949

Maxilla extending beyond orbit. Dorsal-fin base slightly longer than anal-fin base. Dn and Vn present; 1 CP; 6 PO; 5 VO; AO series divided into AOa and AOp; 2 Pol; Prc in 2 groups; luminous tissue at cheek photophore, VLO and at base of dorsal, anal, and ventral fins. Monotypic.

Hintonia candens Fraser-Brunner, 1949

Fig. 26

Hintonia candens Fraser-Brunner, 1949: 1089, text-fig. 1104, pl. 18 (41 °50′S, 00 °01.7′E). Holotype: BMNH 1948.5.14.693.

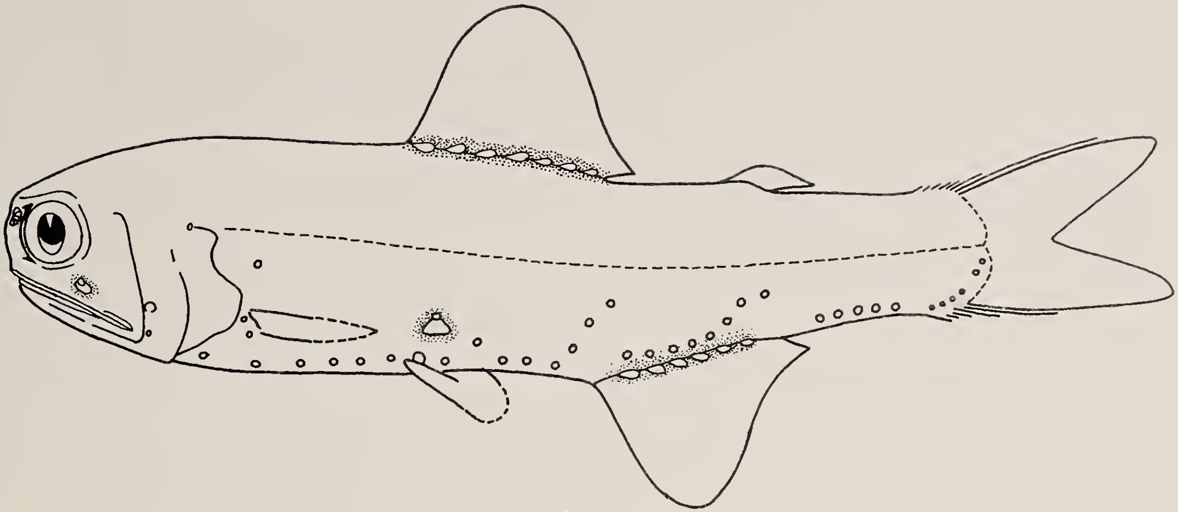
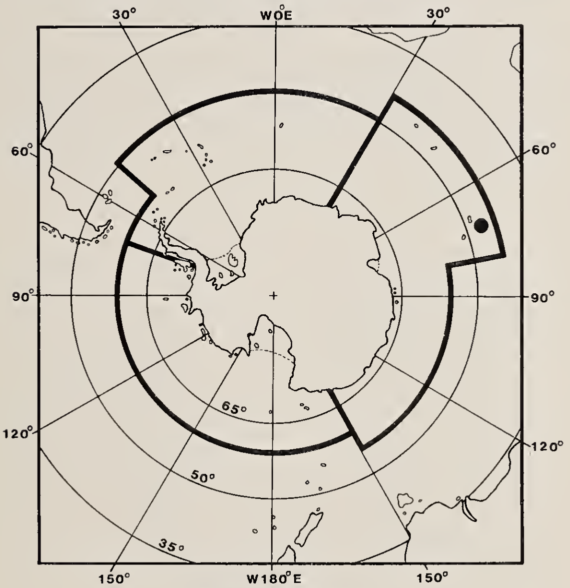


Fig. 26. *Hintonia candens*, 125 mm SL (from *Smiths' Sea Fishes*)

Diagnosis: D 14–16; A 12–14; P 13–15; GR (6–7)+(12–14); AO (5–7)+(5–6); Prc (3–4)+2.

Colour: Large golden-coloured luminous patch below cheek photophore.

Distribution: Generally, between about 40 °S and 50 °S. In the south-western Atlantic, the distribution can be correlated with $34.6^{0}/_{00}$ isohaline at 200 m. Mesopelagic: South Temperate (Convergence) Pattern (Hulley 1981): juveniles in upper 100 m (night), adults mainly below about 200 m (night). In the Southern Ocean, recorded from 45 °10′S, 69 °12′E (Bekker 1984).



Distribution of *H. candens*

Remarks: *H. candens* attains 130 mm SL.

Genus ***Krefftichthys*** Hulley, 1981

Maxilla greatly expanded posteriorly, extending to or a little behind vertical through posterior margin of orbit. Anal-fin base longer than dorsal-fin base. Dn absent; Vn poorly developed; 5 PO; 4 VO; 2 SAO almost horizontal. Monotypic.

Krefftichthys anderssoni (Lönnberg, 1905)
Fig. 27

Myctophum anderssoni Lönnberg, 1905a: 763 (48 °54′S, 51 °40′W). Lectotype: NRM SYD/1902265.3001; paralectotype: NRM SYD/1902265.3002.

Diagnosis: D 12–14; A 17–20; P 14–16; GR (6–8)+(19–22); AO 12–13. Mature males with 5–8 separate, individually complex, supracaudal glands; mature females with 2–4 separate, luminous glands infracaudally.

Otoliths

Diagnostic features: The discoid to sub-quadrate shape, the ostial and heterosulcoid sulcus acusticus, the distinctive myctophiform colliculi, plus the presence of a pseudo-colliculum in the cauda.

Distribution: Occurs throughout the region, from the Antarctic Divergence/Weddell-Scotia Confluence to the northern boundary limits, and further north in meridional currents: to 32 °–33 °S in Peruvian Current and to 34 °S in Falkland Current. Mesopelagic: Broadly Antarctic Pattern (Hulley 1981): upper 50–100 m (night) south of APF, but deeper (500–600 m) north of APF (Bekker 1983) and at depths greater than 1,000 m at STC (Hulley 1981). Also recorded from upper 200 m over Discovery Seamount (Lubimova *et al.* 1983). An upper limiting temperature of 2.6 °–5.6 °C has been postulated (Andriashev 1962; Hulley 1981). Known also from the STC zone of the south-west Indian Ocean (Bekker 1983).

Remarks: *K. anderssoni* matures at about 54 mm SL. The larvae occur in large quantities only north of the APF (Efremenko 1976). The diet in the Indian Ocean sector consists mainly of copepods (68% occurrence: *Calanoides acutus, Calanus propinquus*), with small euphausiids (50%: *Thysanoessa macrura* furcilia/adults) and amphipods (*Primno macropa, Hyperia* sp.) as alternatives (Williams 1985b), while in the Atlantic Ocean sector Rembiszewski *et al.* (1978) have recorded

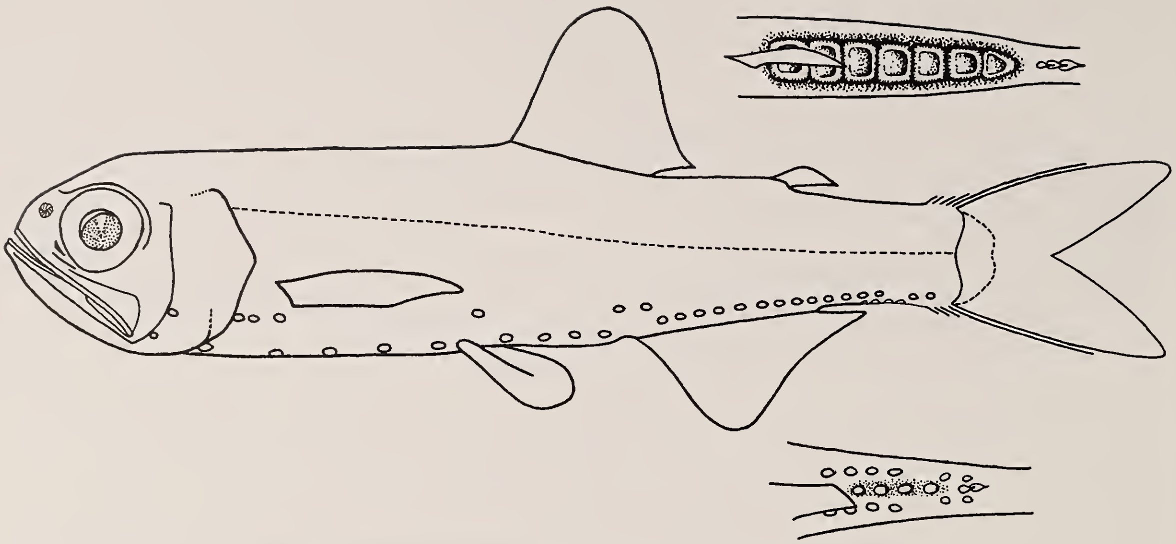
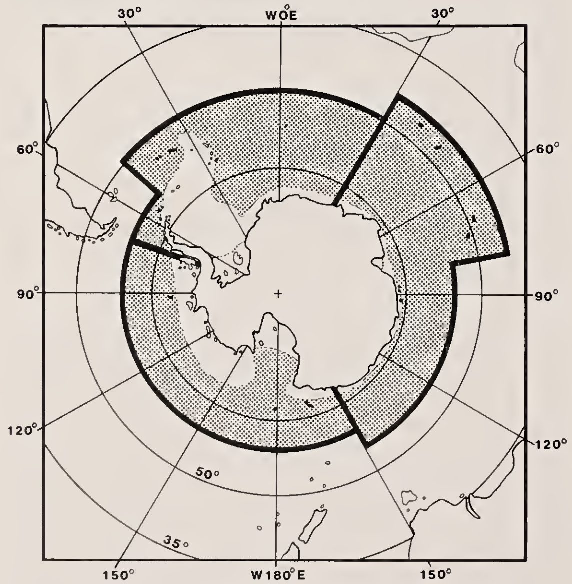


Fig. 27. *Krefftichthys anderssoni*, 55 mm SL (from *Smiths' Sea Fishes*)

Fig. 28. Representative otolith of *K. anderssoni*; fish length 71 mm TL; scale bar 1 mm



Distribution of *K. anderssoni*

Euphausia superba in 68% of stomachs. *K. anderssoni* was found in the stomach contents of *Champsocephalus gunnari* (Duhamel & Hureau 1982).

The larvae have been described by Moser & Ahlstrom (1974), Efremenko (1976, 1983), Belyanina & Kovalevskaya (1979), and Moser *et al.* (1984).

Attains 71 mm SL.

Genus *Lampanyctus* Bonaparte, 1840

Maxilla slightly expanded posteriorly, extending well behind orbit. Anal-fin base longer than dorsal-fin base. Dn absent; Vn small; 5 PO; 4 (rarely 5) VO; 3 SAO, usually angulate; AO series divided into AOa and AOp; 2 Pol, oblique; 4 Prc. Both sexes with supracaudal and infracaudal luminous glands, consisting of numerous, overlapping, scale-like structures; luminous scale(s) at adipose-fin origin present or absent. Cheek photophore (CP) and "secondary" photophores in some species.

More than 35 species of which 5 are recorded from the Southern Ocean.

KEY TO SPECIES

1a Branchiostegal membrane with small serial photophores between branchiostegal rays.................. *L. australis*
1b Branchiostegal membrane without serial photophores 2
2a One or more photophores on cheek.....................3
2b No photophores on cheek.............................4
3a Total GR 24–30; AOa series level or only slightly arched .... *L. macdonaldi*
3b Total GR 14–16; AOa^1 and/or AOa^2 depressed... *L. intricarius*
4a P fins weakly developed; Pol on or slightly before vertical at origin of adipose fin; origin of adipose fin well in advance of vertical at base of last A ray....................... *L. ater*
4b P fins absent (present in very small juveniles); Pol well in front of vertical at origin of adipose fin; origin of adipose fin on or slightly behind vertical at base of last A ray....... *L. achirus*

Lampanyctus achirus Andriashev, 1962

Fig. 29

Lampanyctus achirus Andriashev, 1962: 256, fig. 27 (64°36′S, 108°52′W). Holotype: ZIN 36111.

Diagnosis: D 14–16; A 16–20; P absent in adults; GR (5–6)+(12–14); AO (6–8)+(7–9).

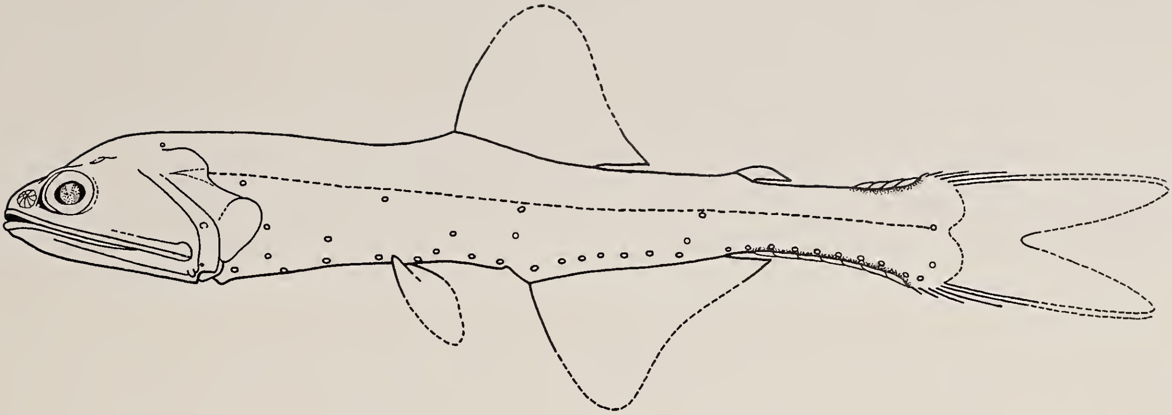


Fig. 29. *Lampanyctus achirus*, 70 mm SL (from *Smiths' Sea Fishes*)

Otoliths

Diagnostic features: Dorso-ventral rectangular shape with the mid-medially situated ostial and homosulcoid sulcus acusticus.

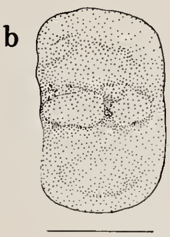


Fig. 30. Representative otolith of *L. achirus*; fish length 160 mm TL; scale bar 1 mm

Distribution: Circumglobal from the STC to south of the APF at Weddell-Scotia Confluence and northern reaches of Ross Sea, and with northern extensions to 21°S in meridional currents. Bathypelagic: South Temperate (Subantarctic) Pattern (Hulley 1981): usually below 500 m, shallower in upwelling regions.

Remarks: *L. achirus* matures at about 133 mm SL. The larvae have been described by Moser & Ahlstrom (1974) and Moser *et al.* (1984).

Attains 162 mm SL.

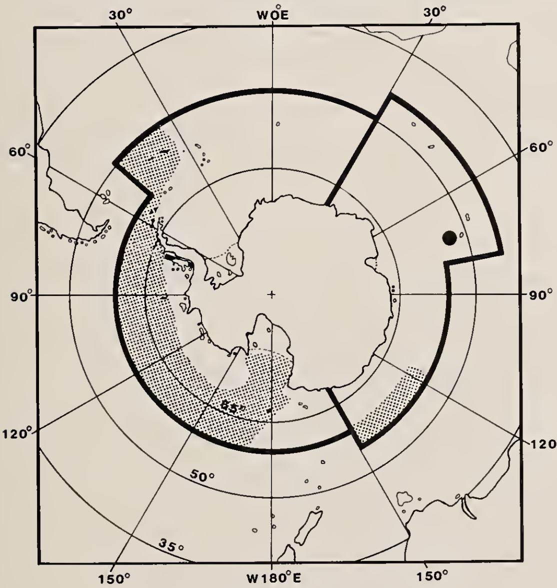
Lampanyctus ater Tåning, 1928

Fig. 31

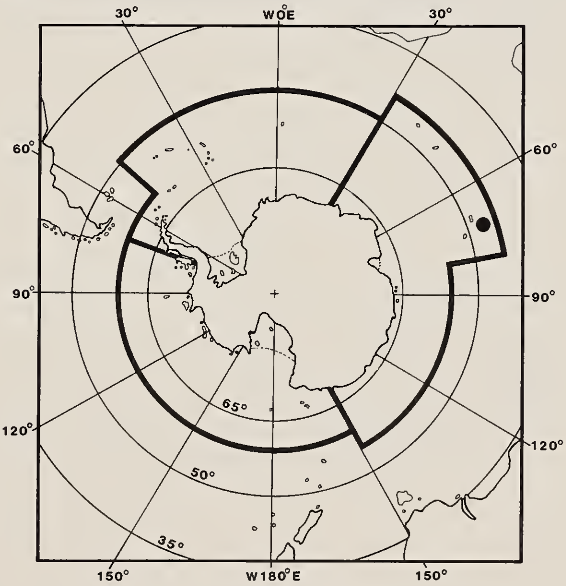
Lampanyctus ater Tåning, 1928: 67 (24°30′S, 80°00′W). Lectotype: ZMUC P2330212.

Diagnosis: D 14–16; A 16–20; P 11–12; GR (4–5)+(11–13); LL 36–39; AO (6–8)+(6–9).

Distribution: Generally, 58°–17°N and 15°–40°S (Atlantic), 12°–44°S (Indian), between Australia and New Zealand and in the Tasman Sea. Mesopelagic: Subtropical (Bisubtropical) Pattern (Hulley 1981): 550–750 m (day), 40–550 m (night). In the Southern Ocean, recorded from 45°10′S, 69°12′E (Bekker 1984).



Distribution of *L. achirus*



Distribution of *L. ater*

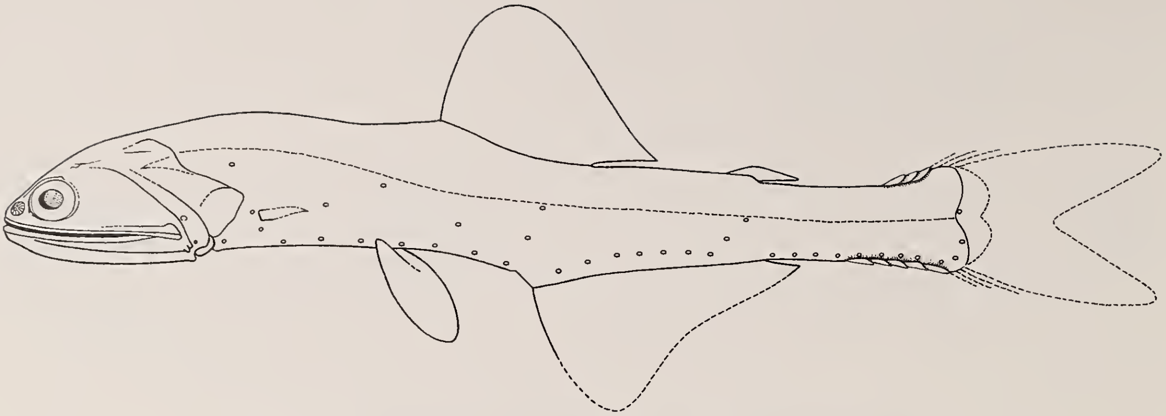


Fig. 31. *Lampanyctus ater*, 105 mm SL (from *Smiths' Sea Fishes*)

Remarks: *L. ater* attains 140 mm SL and is sexually mature from about 90 mm SL.

Lampanyctus australis Tåning, 1932
Fig. 32

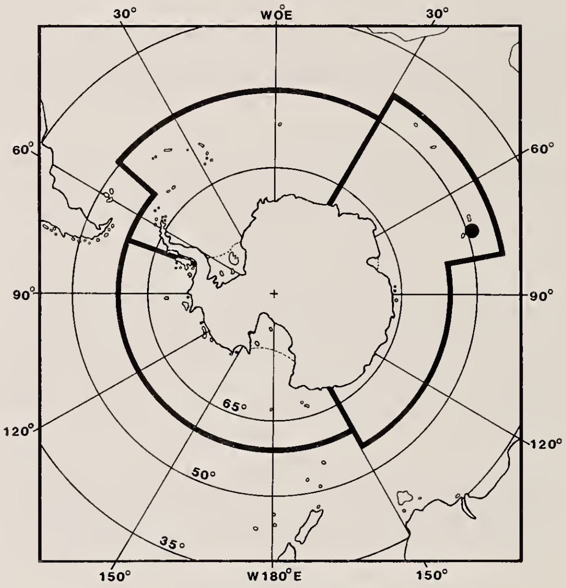
Lampanyctus alatus australis Tåning, 1932: 145 (41°47′S, 176°55′E). Lectotype: ZMUC P2330216.

Diagnosis: D 12–14; A 17–19; P 13–15; GR (5–7)+(13–16); AO (6–9)+(6–9).

Distribution: Generally, circumglobal between 33°S and 44°S, but with northern extensions in eastern boundary currents. Mesopelagic: South Temperate (Convergence) Pattern (Hulley 1981): adults mainly below 500 m (night) but juveniles less than 80 mm in upper 100 m (night). In the Southern Ocean, recorded from 45°10′S, 69°12′E (Bekker 1984).

Remarks: *L. australis* matures at about 95 mm SL. Gravid females have been taken in June.

Attains 131 mm SL.



Distribution of *L. australis*

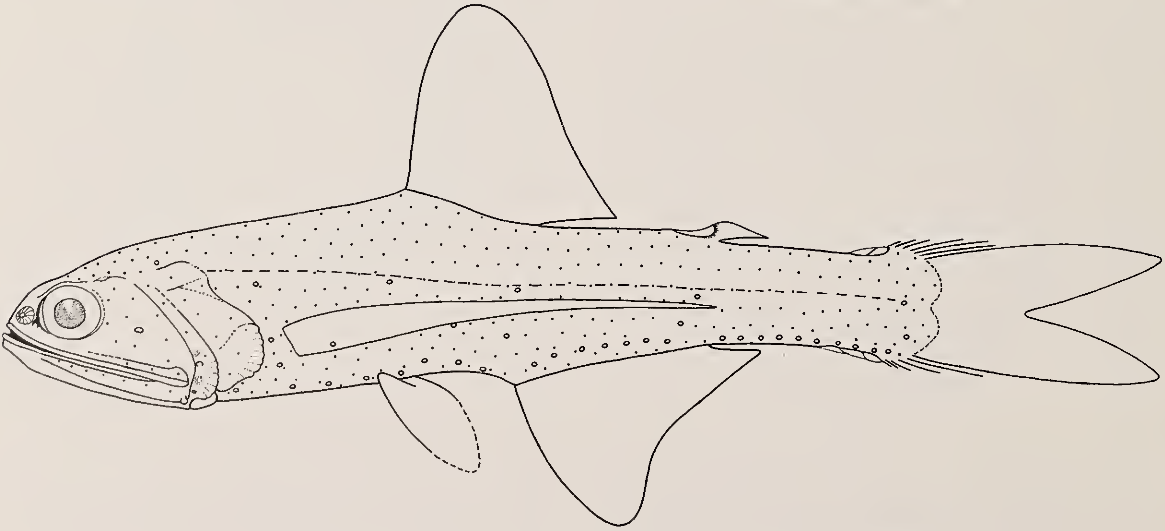


Fig. 32. *Lampanyctus australis*, 90 mm SL (from *Smiths' Sea Fishes*)

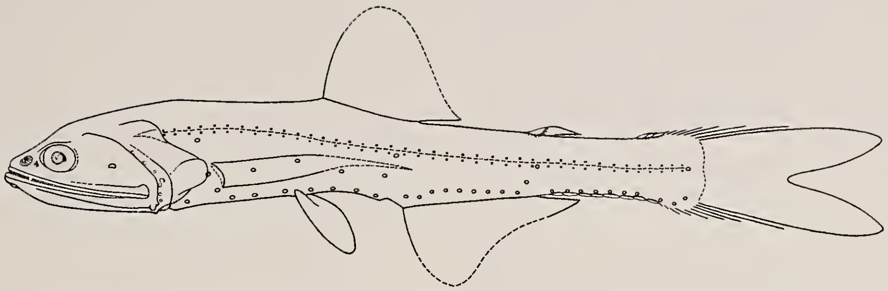


Fig. 33. *Lampanyctus intricarius*, 40 mm SL (from *Smiths' Sea Fishes*)

Lampanyctus intricarius Tåning, 1928
Fig. 33

Lampanyctus intricarius Tåning, 1928: 67 (38°10′N, 09°20′W). Lectotype: ZMUC P2330208.

Diagnosis: D 14–16; A 17–20; P 13–15; GR 4+(10–12); AO (8–10)+(7–9).

Otoliths

Diagnostic features: The oval to discoid shape, the ostial and homosulcoid sulcus acusticus, with no separation between ostium and cauda, the large ostium relative to the cauda (ca. 4×), the prominent pseudocolliculum, and the prominent and rounded rostrum.

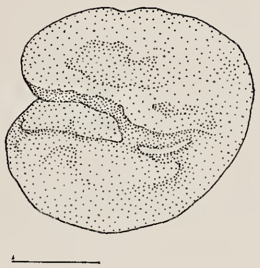
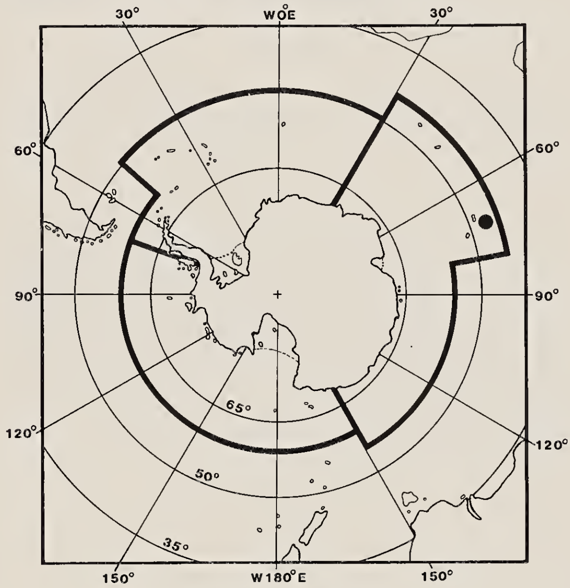


Fig. 34. Representative otolith of *L. intricarius*; fish length 163 mm SL; scale bar 1 mm

Distribution: Generally, 65°–32°N (North Atlantic) and in the STC zone in all three oceans, but with northern extensions to 18°S in eastern boundary currents. Mesopelagic: Bitemperate Pattern (Hulley 1981): 550–750 m (day) 40–550 m (night). In the Southern Ocean, recorded from 45°10′S, 69°12′E (Bekker 1984).

Remarks: *L. intricarius* attains 200 mm SL.



Distribution of *L. intricarius*

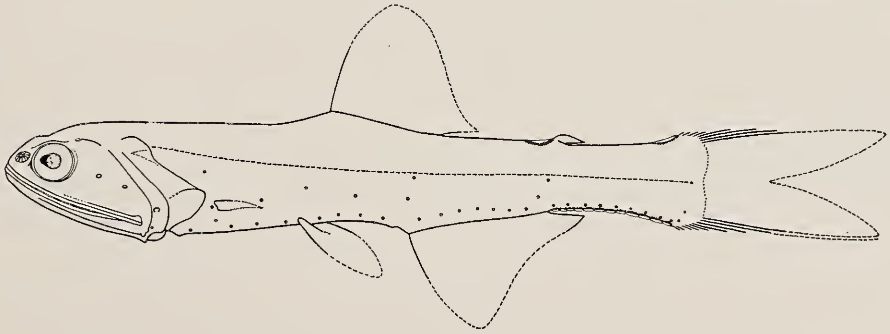


Fig. 35. *Lampanyctus macdonaldi*, 100 mm SL (from *Smiths' Sea Fishes*)

Lampanyctus macdonaldi (Goode & Bean, 1896)
Fig. 35

Nannobrachium macdonaldi Goode & Bean, 1896: 94, pl. 29, fig. 110 (39°48′N, 70°36′W). Holotype: USNM 39478.

Diagnosis: D 14–16; A 16–19; P 12–14; GR (8–10)+(16–21); AO (6–8)+(6–8).

Otoliths

Diagnostic features: The near dorsoventral rectangular shape, the ostial and homosulcoid sulcus acusticus with no distinction between ostium and cauda, the single colliculum and the absence of the rostrum, antirostrum and excisura ostii.

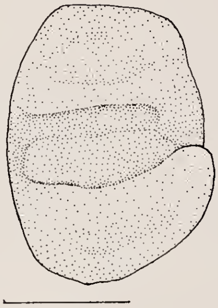
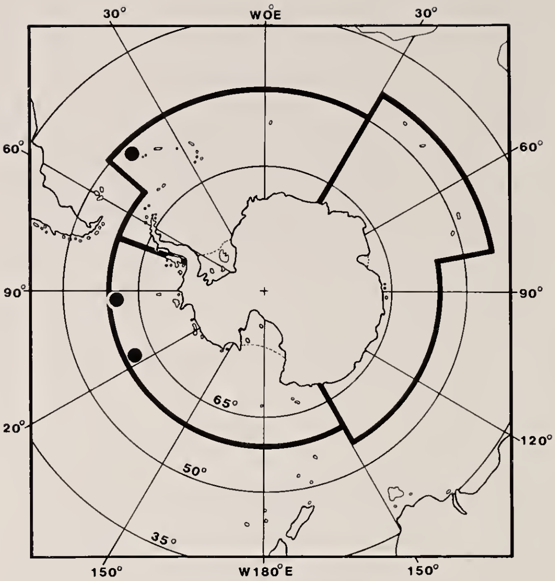


Fig. 36. Representative otolith of *L. macdonaldi*; fish length 122 mm SL; scale bar 1 mm

Distribution: Generally, 65°–47°N (Atlantic) and between the STC and the APF in all 3 sectors. Mesopelagic: Bitemperate Pattern (Hulley 1981): 550–1,000 m (day), 60–175 m (juveniles) and deeper than 250 m (adults) (night). In the Southern Ocean, recorded from 60°–63°S, 90°–120°W and in Falkland Current region at about 52°S, 43°W (McGinnis 1982).

Remarks: *L. macdonaldi* attains 160 mm SL.



Distribution of *L. macdonaldi*

Genus ***Lampichthys*** Fraser-Brunner, 1949

Maxilla slightly expanded posteriorly, extending well behind orbit. Anal-fin base slightly longer than dorsal-fin base. Dn and Vn present; 2–6 CP; 5 PO; 5 VO; SAO series markedly angulate; AO series divided into AOa and AOp; 3 Pol, forming right angle; "secondary" photophores on head and trunk; patches of luminous tissue of various shapes and sizes on body and 1 patch supracaudally. Monotypic.

Lampichthys procerus (Brauer, 1904)
Fig. 37

Myctophum (Lampanyctus) procerus Brauer, 1904: 402, fig. 9 (35°32′08″S, 18°20′01″E). Holotype(?): ZMB 17609.

Lampichthys rectangularis Fraser-Brunner, 1949: 1096, text-fig. 1003, fig. 14 (44°42′S, 53°32′W).

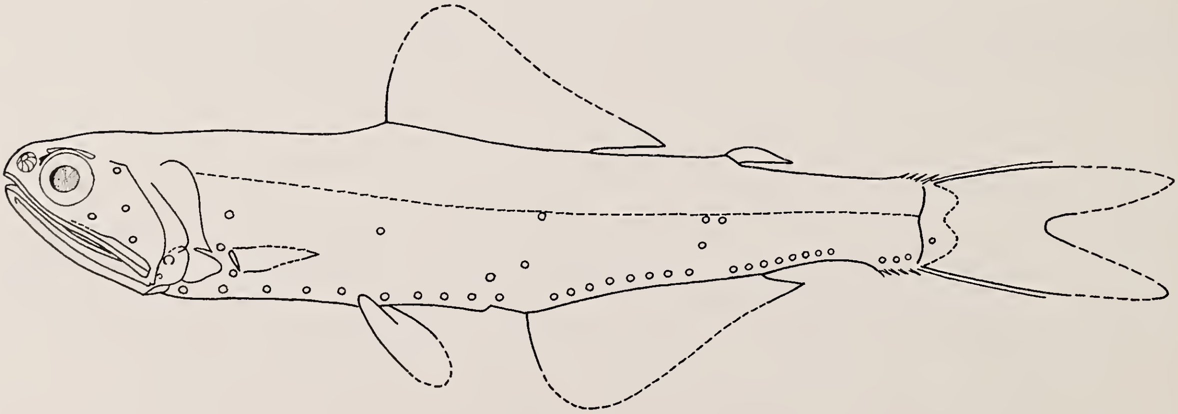
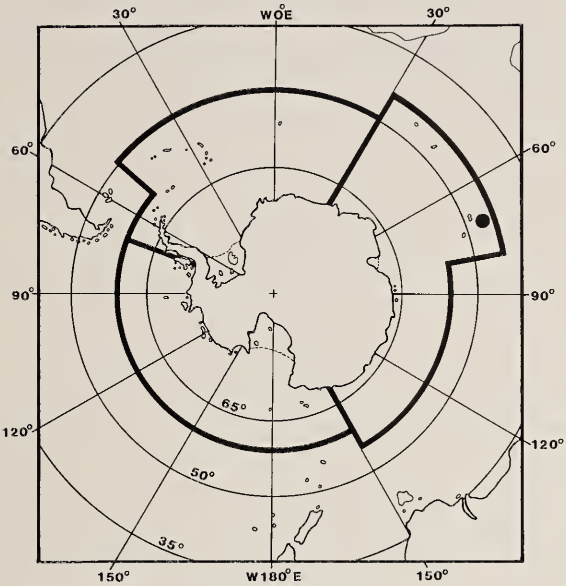


Fig. 37. *Lampichthys procerus*, 85 mm SL (from *Smiths' Sea Fishes*)

Lampichthys rutkovichi Linkowski, 1985: 319, figs. 1–2a (23°36′S, 06°13′E).

Diagnosis: D 16–18; A 21–23; P 13–15; GR (4–6)+(13–16); AO 8+8.

Distribution: Generally, in the STC zone in all 3 oceans, but with extensions into lower latitudes in eastern boundary currents. Mesopelagic: South Temperate (Convergence) Pattern (Hulley 1981): 700–1,200 m (day), 100–700 m (night). In the Southern Ocean, recorded from 45°10′S, 69°12′E (Bekker 1984).



Distribution of *L. procerus*

Remarks: *L. procerus* matures at about 80 mm SL. The larvae have been described by Moser & Ahlstrom (1972).

Attains 95 mm SL.

Genus *Metelectrona* Wisner, 1963

Maxilla greatly expanded posteriorly, extending to or only slightly behind vertical at posterior margin of orbit. Anal-fin base longer than dorsal-fin base. Dn and Vn present; 5 PO; 4 VO; SAO angulate; Pol absent, but AO series behind anal fin base markedly depressed, forming "Pol grouping". Both sexes with single luminous patch supracaudally and infracaudally.

Two species, of which 1 is recorded from the Southern Ocean.

Metelectrona ventralis (Bekker, 1963)

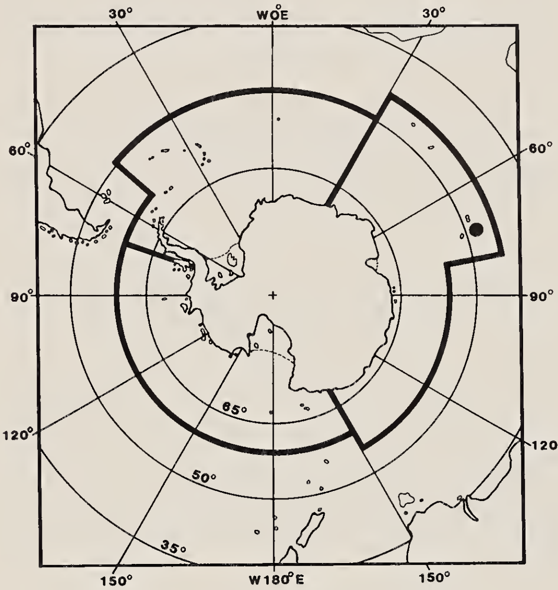
Fig. 38

Electrona ventralis Bekker, 1963: 26, fig. 5 (42°40′S, 39°07′W). Holotype: ZIN 36804.

Metelectrona ahlstromi Wisner, 1963: 25, fig. 1 (46°53′S, 179°48′W).

Diagnosis: D 13–15; A 20–22; P 14–16; GR (6–7)+(17–20); AO 13–17.

Distribution: Generally, circumglobal between 36° and 51°S. The most southerly records (50°40′S, 50°01′W;



Distribution of *M. ventralis*

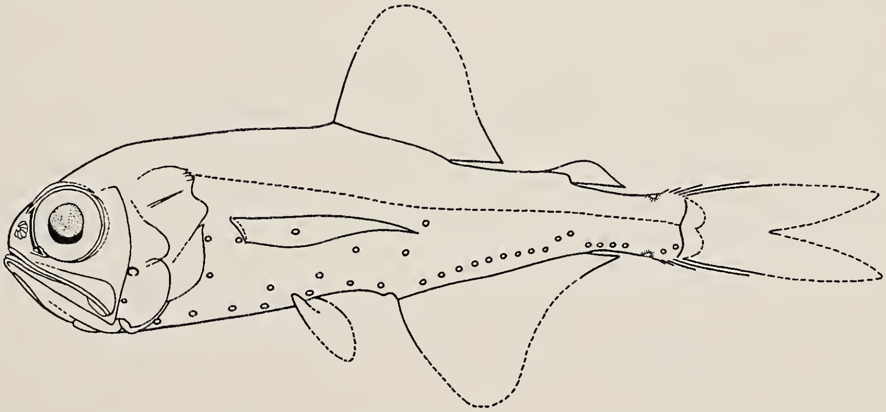


Fig. 38. *Metelectrona ventralis*, 40 mm SL (from *Smiths' Sea Fishes*)

47°50.6′S 40°00.8′W) in the south-west Atlantic lie outside the defined boundary limits. Mesopelagic: South Temperate (Semi-subantarctic) Pattern (Hulley 1981): from surface to 350 m (night). In the Southern Ocean, recorded only as stomach contents of fishes from 48°–50°S, 70°–71°E.

Remarks: *M. ventralis* matures at about 81 mm SL. It was found in the stomach contents of *Champsocephalus gunnari* and *Dissostichus eleginoides*.

Attains 107 mm SL.

Genus *Notoscopelus* Günther, 1864

Maxilla slightly expanded posteriorly, extending well past orbit. Dorsal-fin base longer than anal-fin base; pectoral fins short. Dn well developed; Vn small; 5 PO; 5 VO; SAO series obtusely angulate; AO series divided into AOa and AOp; 2 (sometimes 3) Pol, horizontally arranged; 2+1 Prc; large supracaudal luminous gland only in males; numerous patches of luminous tissue on trunk and at bases of procurrent caudal rays.

Two subgenera, of which 1 is recorded from the Southern Ocean.

Subgenus *Notoscopelus* Günther, 1864

Adult males with large supracaudal gland but without luminous tissue on cheek and above eye.

Five species, of which 1 is recorded from the Southern Ocean.

Notoscopelus (Notoscopelus) resplendens
(Richardson, 1845)
Fig. 39

Lampanyctus resplendens Richardson, 1845: 42, pl. 27, figs. 16–18, no type locality. Syntypes (3): BMNH 1843.3.16.

Notoscopellus brachychier Eigenmann & Eigenmann, 1889: 126, Cortez Banks off California. (Emended to *Notoscopelus brachychir* Eigenmann & Eigenmann, 1890.)

Notoscopelus ejectus Waite, 1904: 150, Lord Howe Island.

Serpa hoffmanni Fowler, 1934: 282, fig. 43 (36°45′N, 74°28′39″W).

Diagnosis: D 21–24; A 18–20; P 11–13; GR (5–7)+(13–16); AO (7–9)+(4–7).

Otoliths

Diagnostic features: The oval shape, the ostial and homosulcoid sulcus acusticus, the entire dorsal margin, the slightly serrate ventral margin, the sinuate posterior margin, the extremely short and distally blunt rostrum, and the distinct colliculi of which the anterior colliculum is approximately 4 times the size of the posterior colliculum.

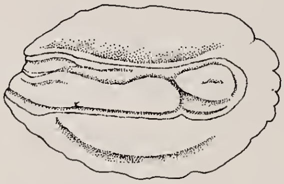


Fig. 40. Representative otolith of *N.* (*N.*) *resplendens*; fish length unknown

Distribution: Generally, 47°N to the STC (Atlantic), 24°–30°S (Indian), and 35°N–34°S (Pacific), but absent from western tropical Pacific and south-east Asian Seas (Bekker 1983). Mesopelagic: Broadly Tropical (Holo-eurytropical) Pattern (Hulley 1981): 651–2,000 m (day), 50–300 m and at surface in cooler waters (night). In the Southern Ocean, recorded from 60°58′S, 48°05′W (Andriashev 1962).

Remarks: *N. resplendens* matures at about 66 mm. The larvae have been described by Moser & Ahlstrom (1972, 1974), Badcock & Merrett (1976), and Shiganova (1977).

Attains 95 mm SL.

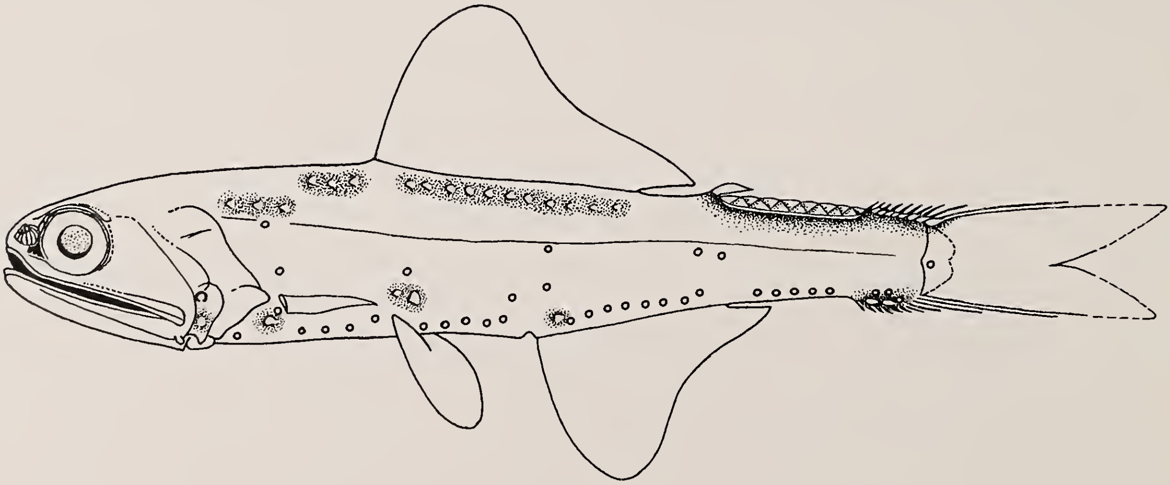
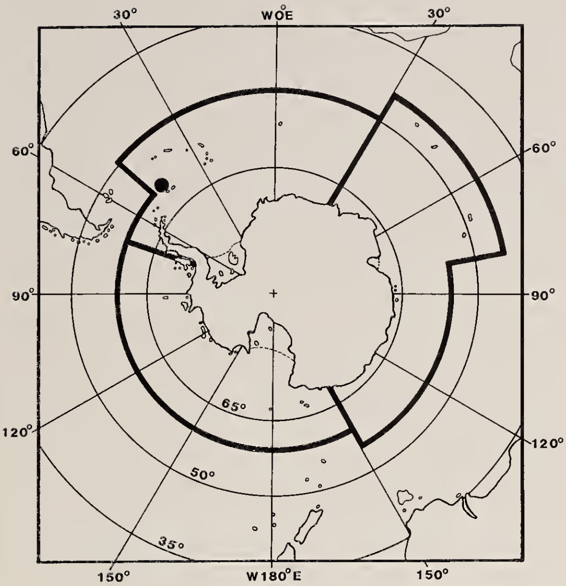


Fig. 39. *Notoscopelus (Notoscopelus) resplendens*, 60 mm SL (from *Smiths' Sea Fishes*)



Distribution of *N. (N.) resplendens*

Genus ***Protomyctophum*** Fraser-Brunner, 1949

Maxilla greatly expanded posteriorly, extending to or only slightly behind vertical through posterior margin of orbit. Anal-fin base longer than dorsal-fin base. Dn minute; Vn small; 5 PO; 4 VO; 3 SAO straight or weakly angulate; supracaudal and infracaudal glands present.

Two subgenera, both of which are recorded from the Southern Ocean.

KEY TO SUBGENERA

1a Eyes semi-telescopic; interorbital width less than expanded posterior end of maxilla .... *Hierops*
1b Eyes normal; interorbital width greater than expanded end of maxilla.............................. *Protomyctophum*

Subgenus ***Hierops*** Fraser-Brunner, 1949

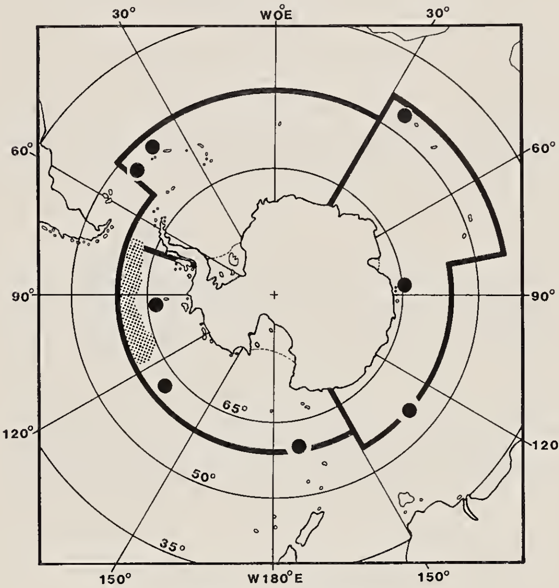
Seven species, of which 1 is recorded from the Southern Ocean. *Protomyctophum (Hierops) subparallelum* (Tåning, 1932) has been recorded from just outside the northern boundary limit at 80°W (McGinnis 1982).

Protomyctophum (Hierops) parallelum (Lönnberg, 1905)
Fig. 41

Myctophum parallelum Lönnberg, 1905a: 764 (48°27′S, 42°36′W). Holotype: NRM SYD/1902261.3003.

Diagnosis: D 10–13; A 23–27; P 14–15; GR (3–4)+(13–15); AO 17–19. Mature males with single, large, supracaudal luminous gland, outlined in black pigment; mature females with 1–3 infracaudal, luminous scales.

Distribution: Generally circumglobal between the STC and the APF with extensions to 35°S (Australian Bight) and 32°S (off Argentina and Chile). Mesopelagic: South Temperate (Holosubantarctic) Pattern (Hulley 1981): 150–450 m (night), nyctoepipelagic at surface in Pacific (Bekker 1983). In the Southern Ocean, recorded at 53°18′S, 49°57′W and 45°25′S, 36°32′E (Hulley 1981, 1986b).



Distribution of *P. (H.) parallelum*

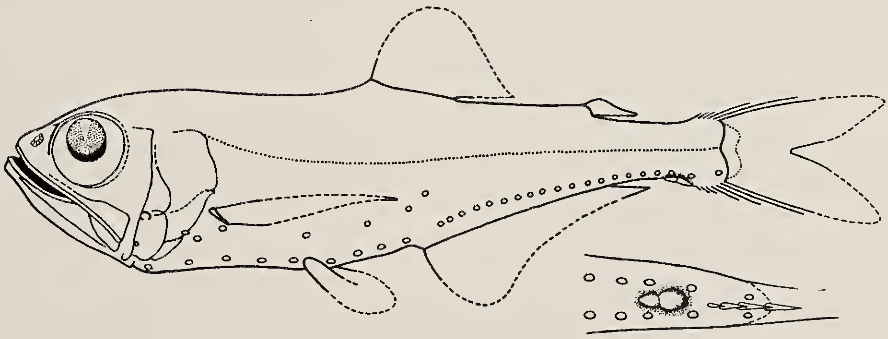


Fig. 41. *Protomyctophum (Hierops) parallelum,* 40 mm SL (from *Smiths' Sea Fishes*)

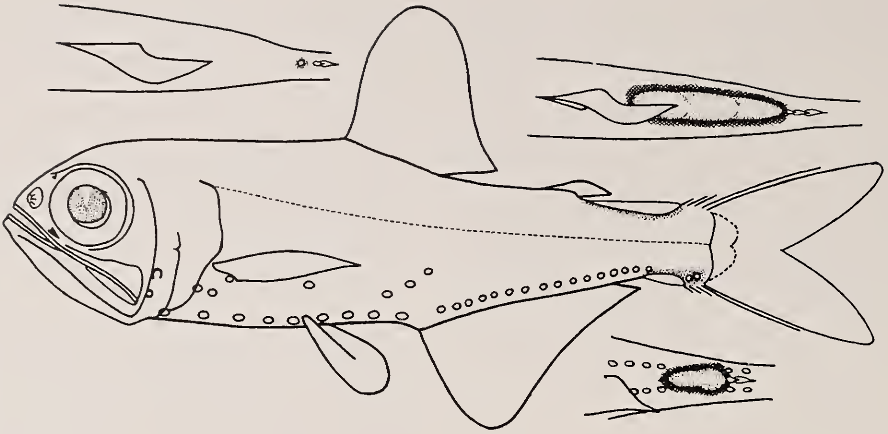


Fig. 42. *Protomyctophum (Protomyctophum) andriashevi*, 55 mm SL (from *Smiths' Sea Fishes*)

Remarks: *P. parallelum* matures at about 32–44 mm SL. The larvae have been described by Pertseva-Ostroumova (1967) and Belyanina & Kovalevskaya (1979).

Attains 50 mm SL.

Subgenus ***Protomyctophum*** Fraser-Brunner, 1949

More than 7 species. Seven species are recorded from the Southern Ocean.

KEY TO SPECIES

1a Distance Prc_1–Prc_2 greater than one photophore-diameter; males with single, medially constricted, black-edged supracaudal gland; females with 3–6 individual luminous scales infracaudally, or a single, coalesced infracaudal gland .... *P. (P.) bolini*

1b Distance Prc_1–Prc_2 about one-half photophore-diameter or less 2

2a Body depth less than 25% SL (usually 21–23%) 3

2b Body depth greater than 25% SL (usually 26–30%).......4

3a Palatine teeth in anterior group only; length of posterior ventral expansion of maxilla about equal to length of distal margin of maxilla; males with supracaudal gland only, comprising 6–8 partially coalesced luminous scales; females with infracaudal gland only, comprising 4–6 separate, luminous patches.................................. *P. (P.) tenisoni*

3b Teeth evenly spaced along entire length of palatine; length of posterior ventral expansion of maxilla greater than length of distal margin of maxilla; males with supracaudal gland only, comprising 5 or 6 black-edged, diamond-shaped, partially coalesced scales; females with infracaudal gland only, comprising 5–7 well-separated luminous patches .... *P. (P.) choriodon*

4a Total GR 18–21; males with single, large, supracaudal gland, extending from procurrent caudal rays to adipose base, and small infracaudal gland; females with single, minute, supracaudal gland only .... *P. (P.) andriashevi*

4b Total GR 22–28; males with supracaudal and infracaudal glands; females with or without supracaudal and infracaudal gland, or with infracaudal gland only 5

5a P rays 16–18; males with single supracaudal gland extending about 70% of distance between procurrent caudal rays and adipose base, and single (sometimes bifid) infracaudal gland; females with single small supracaudal gland and minute infracaudal gland .... *P. (P.) gemmatum*

5b P rays 13–15; males with supracaudal and infracaudal glands; females with well-developed infracaudal gland only, or with well-developed supracaudal and infracaudal gland 6

6a Males with single supracaudal gland, extending about 60% of distance from procurrent C rays to adipose base, and infracaudal gland of 2–4 separate, indistinct, luminous scales, the posteriormost being the best developed; females with infracaudal gland only, comprising 2–4 separate, luminous scales; total GR 25–28 (rarely 24)................. *P. (P.) normani*

6b Males with single supracaudal gland, extending about 50% of distance from procurrent C rays to adipose base, and single, coalesced infracaudal gland extending from procurrent C rays to A-fin base; females with single, minute, black-edged infracaudal gland; total GR 22–24 (rarely 25)... *P. (P.) luciferum*

Protomyctophum (Protomyctophum) andriashevi Bekker, 1963

Fig. 42

Protomyctophum andriashevi Bekker, 1963: 19, fig. 2 (42°16′S, 39°00′W). Holotype: ZIN 36803.

Diagnosis: D 13–14; A 22–25; P 15–17; GR (4–5)+(14–17); AO 15–17.

Otoliths

Diagnostic features: The generally discoid shape except for the prominent and rounded rostral projection, the

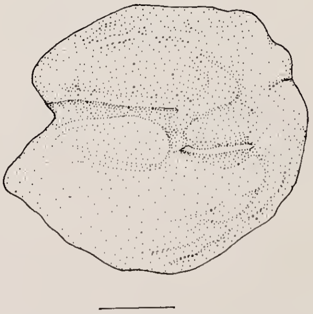
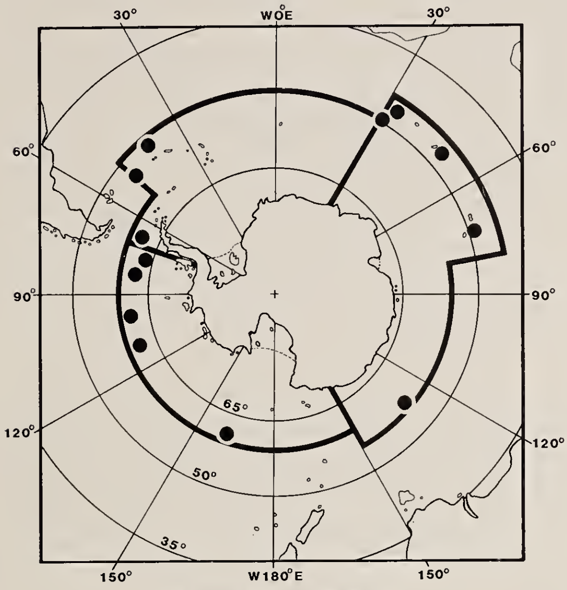


Fig. 43. Representative otolith of *P.* (*P.*) *andriashevi*; fish length 58 mm SL; scale bar 1 mm

oblique posteroventral margin, the ostio-pseudocaudal sulcus acusticus, the small ostium relative to the cauda, the typical myctophiform colliculi and the pseudocolliculum.

Distribution: Generally, circumglobal between the STC and the APF. Mesopelagic: South Temperate (Holosubantarctic) Pattern (Hulley 1981): 600 m (day), 50–200 m (night). Recorded from 53°18′S, 49°57′W and 51°05.5′S, 39°56.5′W in Atlantic Ocean sector (Hulley 1981), at 47°S, 31°E and 49°S, 71°E in Indian Ocean sector, and between 60°–65°S, 70°–165°W in Pacific Ocean sector.



Distribution of *P. (P.) andriashevi*

Remarks: *P. andriashevi* matures at about 47 mm SL. It was found in the stomach contents of *Champsocephalus gunnari*.

Attains 60 mm SL.

Protomyctophum (Protomyctophum) bolini
(Fraser-Brunner, 1949)
Fig. 44

Electrona (Protomyctophum) bolini Fraser-Brunner, 1949: 1045, 1099, fig. 12 (in part) (45°18′S, 18°58′E). Holotype: BMNH 1948.5.14.1.

Diagnosis: D 12–14; A 23–26; P 14–16; GR (4–6)+(15–18); AO 17–18.

Otoliths

Diagnostic features: The dorsoventral oval shape, the entire margin, the absence of the crista superior, the heteromorph colliculi and the presence of a pseudocolliculum in association with the notch in the posterior margin.

Fig. 45. Representative otolith of *P. (P.) bolini*; fish length 45 mm TL; scale bar 1 mm

Distribution: Circumpolar between Antarctic Divergence and northern boundary limits of region, and extending northwards to the STC zone. Mesopelagic: Broadly Antarctic Pattern (Hulley 1981): 608–728 m (day), 364–426 m (night).

Remarks: *P. bolini* matures at about 51 mm SL. The diet includes copepods and larval stages of krill, mainly calytopis and furcilia stages (Ascencio & Moreno 1983). Intramuscular lipid storage has been reported by Reinhardt & Van Vleet (1986a, b). This species was found in

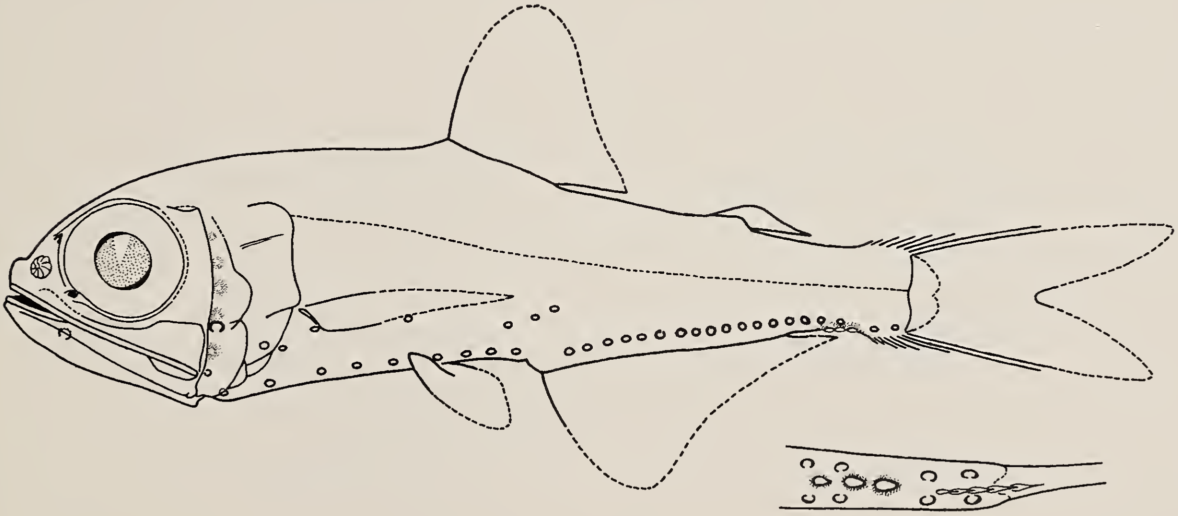
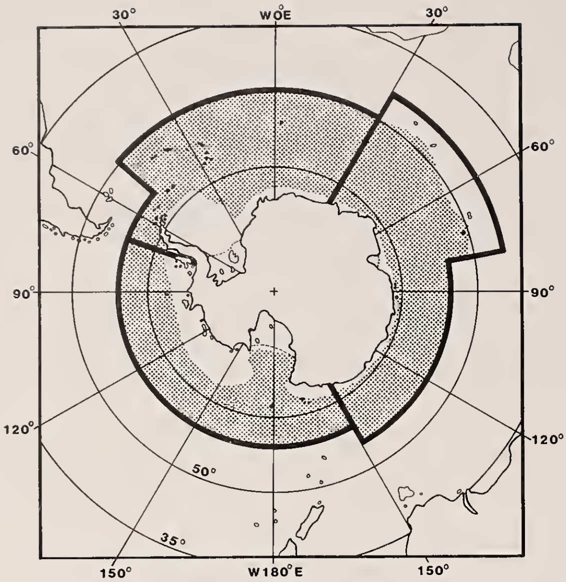


Fig. 44. *Protomyctophum (Protomyctophum) bolini*, 45 mm SL (from *Smiths' Sea Fishes*)



Distribution of *P. (P.) bolini*

the stomach contents of *Lepidonotothen squamifrons* (Duhamel & Hureau 1982).

The larvae have been described by Pertseva-Ostroumova (1967), and Belyanina & Kovalevskaya (1979).

Attains 67 mm SL.

Protomyctophum (Protomyctophum) choriodon
Hulley, 1981
Fig. 46

Protomyctophum (Protomyctophum) choriodon Hulley, 1981: 20, figs. 10, 12 (35°47′S, 52°52′W). Holotype: ISH 1541/66a.

Diagnosis: D 12–14; A 22–25; P 14–16; GR (6–7)+(18–21); AO 15–17.

Otoliths

Diagnostic features: The near discoid shape with the slightly triangular ventral margin, the near-equally sized rostrum and antirostrum, the homosulcoid sulcus acusticus, and the presence of a pseudo-rostrum, pseudo-antirostrum and pseudo-excisura ostii.

Fig. 47. Representative otolith of *P.* (*P.*) *choriodon*; fish length 76 mm SL

Distribution: Generally, circumglobal between 36°S and 51°S. Mesopelagic: South Temperate (Semi-subantarctic) Pattern (Hulley 1981): upper 100 m (night). In the Southern Ocean, recorded from 57°58′S, 50°00′W in Atlantic Ocean sector (Hulley 1981) and from 54°29′S, 74°00′E and 48°43′S, 70°58′E in Indian Ocean sector.

Remarks: *P. choriodon* matures at about 77 mm SL. It was found in the stomach contents of *Champsocephalus gunnari*.

Attains 95 mm SL.

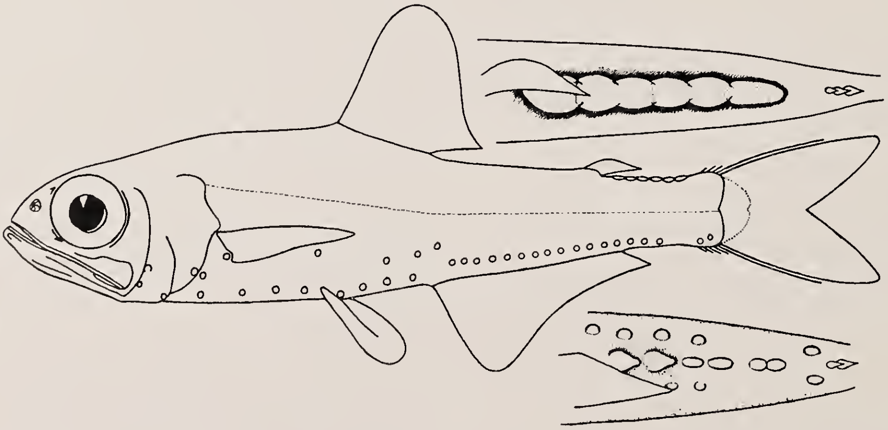
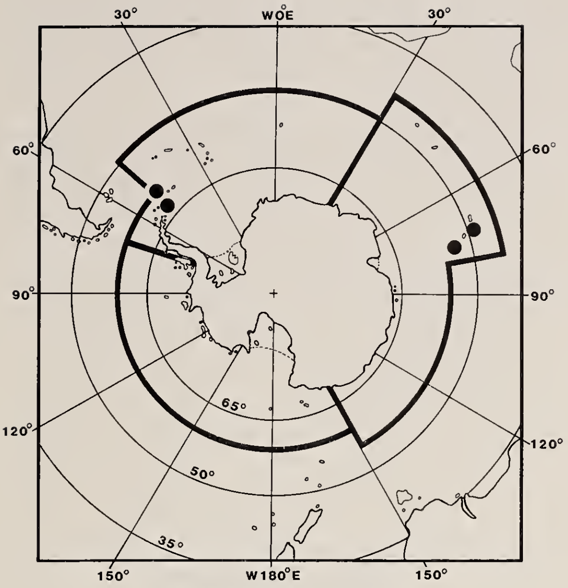


Fig. 46. *Protomyctophum (Protomyctophum) choriodon*, 80 mm SL (from *Smiths' Sea Fishes*)



Distribution of *P. P. choriodon*

Protomyctophum (Protomyctophum) gemmatum Hulley, 1981

Fig. 48

Protomyctophum (Protomyctophum) gemmatum Hulley, 1981: 23, figs. 13, 14 (40°18′S, 35°07′W). Holotype: ISH 734/71a.

Diagnosis: D 12–14; A 22–25; P 16–18; GR (5–7)+(17–20); AO 15–17.

Otoliths

Diagnostic features: The generally discoid shape and entire margin, the slightly smaller ostium relative to the cauda, the prominent anterior colliculum, the poorly developed posterior colliculum but the well developed pseudo-colliculum, and the dorsally recurved and distally rounded rostrum.

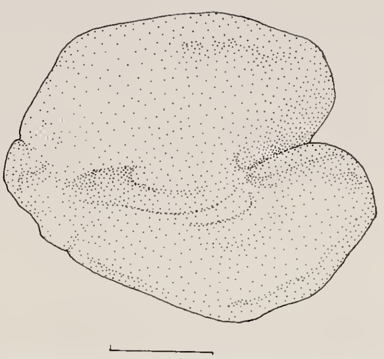
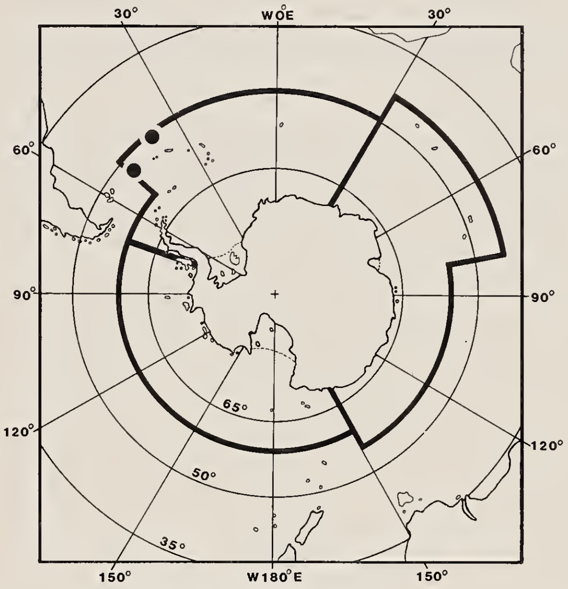


Fig. 49. Representative otolith of *P.* (*P.*) *gemmatum*; fish length 64 mm SL; scale bar 1 mm

Distribution: Generally, probably circumglobal between STC and APF. Mesopelagic: South Temperate (Holo-



Distribution of *P.* (*P.*) *gemmatum*

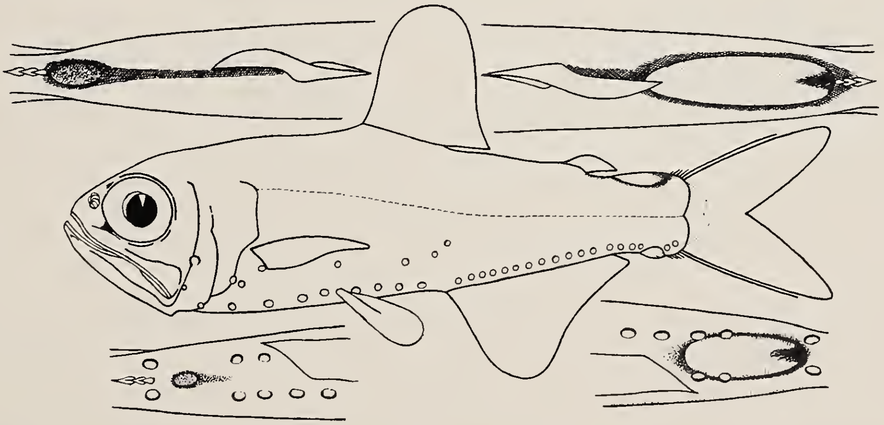


Fig. 48. *Protomyctophum (Protomyctophum) gemmatum*, 70 mm SL (from *Smiths' Sea Fishes*)

subantarctic) Pattern (Hulley 1981): 500 m (night). In the Southern Ocean, recorded from 53°18'S, 40°57'W and 51°05.5'S, 39°56.5'W (Hulley 1981).

Remarks: *P. gemmatum* matures at about 72 mm SL. Attains 86 mm SL.

Protomyctophum (Protomyctophum) luciferum Hulley, 1981

Fig. 50

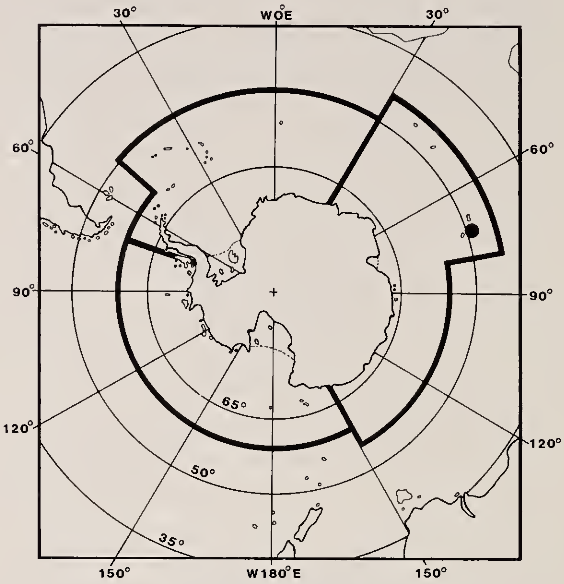
Protomyctophum (Protomyctophum) luciferum Hulley, 1981: 27, figs. 13, 15 (34°01'S, 47°39'W). Holotype: ISH 1564/68a.

Diagnosis: D 12–14; A 21–24; P 13–15; GR (5–6)+(16–19); AO 15–17.

Distribution: Generally, probably circumglobal between 34°S and 48°S. Mesopelagic: South Temperate (Convergence) Pattern (Hulley 1981): below 140 m (night). In the Southern Ocean, recorded from 49°–50°S, 70°–71°E.

Remarks: *P. luciferum* matures at about 54 mm SL. It was found in the stomach contents of *Champsocephalus gunnari.*

Attains 61 mm SL.



Distribution of *P. (P.) luciferum*

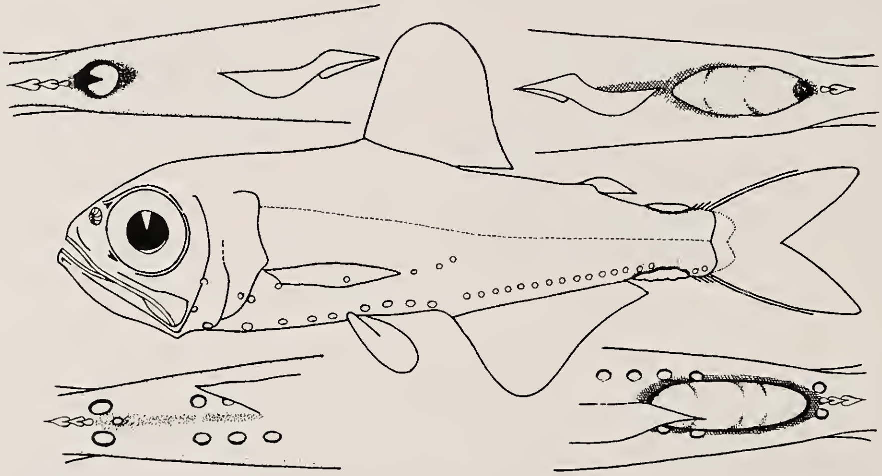


Fig. 50. *Protomyctophum (Protomyctophum) luciferum*, 55 mm SL (from *Smiths' Sea Fishes*)

Protomyctophum (Protomyctophum) normani (Tåning, 1932)

Fig. 51

Myctophum normani Tåning, 1932: 127, fig. 2 (41°47′S, 176°55′E). Holotype: ZMUC P2329231.

Diagnosis: D 12–13; A 21–24; P 13–15; GR (5–7)+(18–21); AO 15–17.

Otoliths

Diagnostic features: The generally discoid shape and the V-shaped ventral margin, in association with the typically myctophiform sulcus acusticus and colliculi.

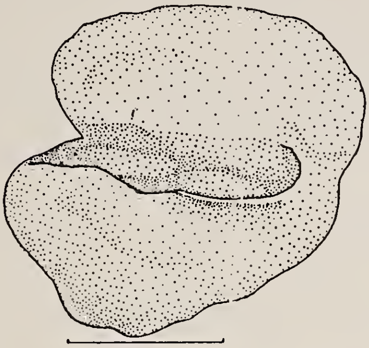
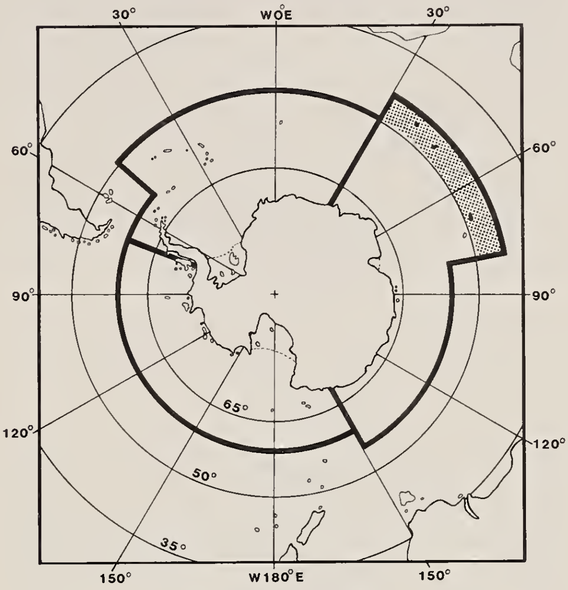


Fig. 52. Representative otolith of *P.* (*P.*) *normani*; fish length 70 mm SL; scale bar 1 mm

Distribution: Generally, circumglobal between 36°S and 43°S. Mesopelagic: South Temperate (Convergence) Pattern (Hulley 1981): upper 104 m (night). In the Southern Ocean, recorded from 45°10′S, 69°12′E (Bekker 1984) and 41°–48°S, 51°–71°E.

Remarks: *P. normani* matures at about 48 mm SL. It was found in the stomach contents of *Champsocephalus gunnari*.

The larvae have been described by Moser *et al.* (1984). Attains 56 mm SL.



Distribution of *P. (P.) normani*

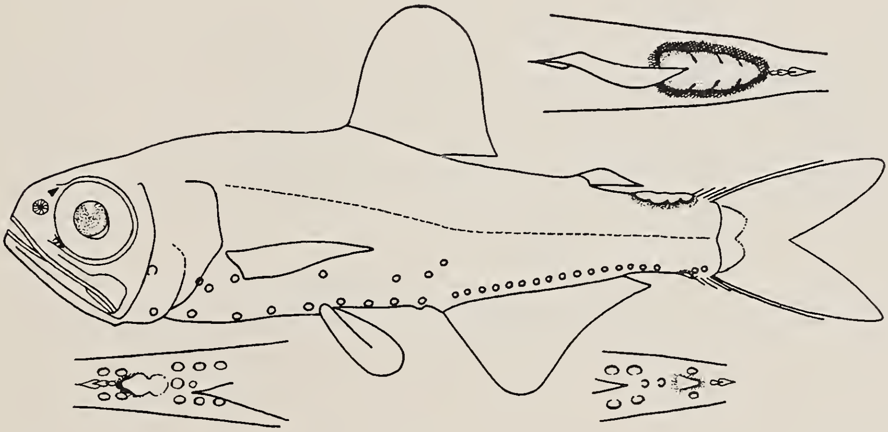


Fig. 51. *Protomyctophum (Protomyctophum) normani*, 50 mm SL (from *Smiths' Sea Fishes*)

Protomyctophum (Protomyctophum) tenisoni
(Norman, 1930)
Fig. 53

Myctophum tenisoni Norman, 1930: 321, fig. 27 (in part) (46°25′S, 15°30′E). Holotype: BMNH 1930.1.12.604.

Diagnosis: D 11–13; A 22–25; P 14–16; GR (5–7)+(16–19); AO 16–19.

Otoliths

Diagnostic features: The typically myctophiform sulcus acusticus with homomorph colliculi and, in particular, the dorsally constricted collum.

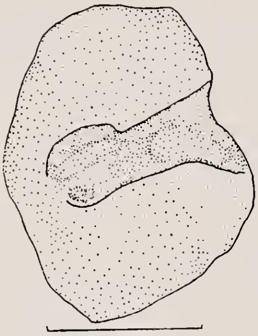
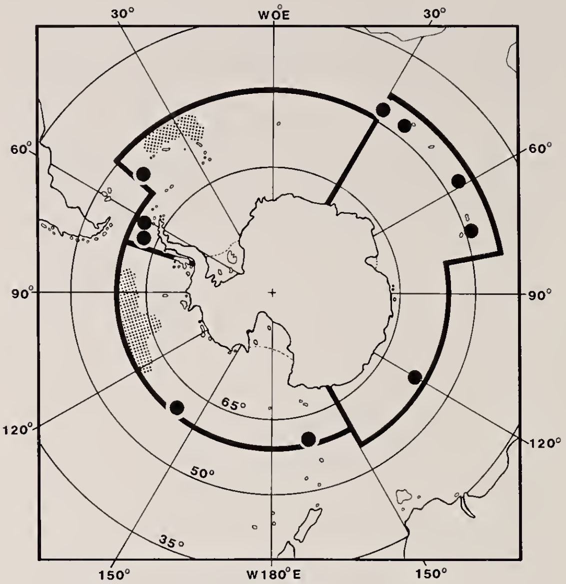


Fig. 54. Representative otolith of *P.* (*P.*) *tenisoni*; fish length 55 mm TL; scale bar 1 mm

Distribution: Generally, circumglobal between the STC and the APF, with northern boundary correlated with the 5°C isotherm at 200 m (Hulley 1981). Mesopelagic: Broadly Antarctic Pattern (Hulley 1981): upper 100–850 m (night). In region of the APF in all three ocean sectors.



Distribution of *P. (P.) tenisoni*

Remarks: *P. tenisoni* matures at about 45 mm SL. It was found in the stomach contents of *Champsocephalus gunnari*.

The larvae have been described by Moser *et al.* (1984). Attains 54 mm SL.

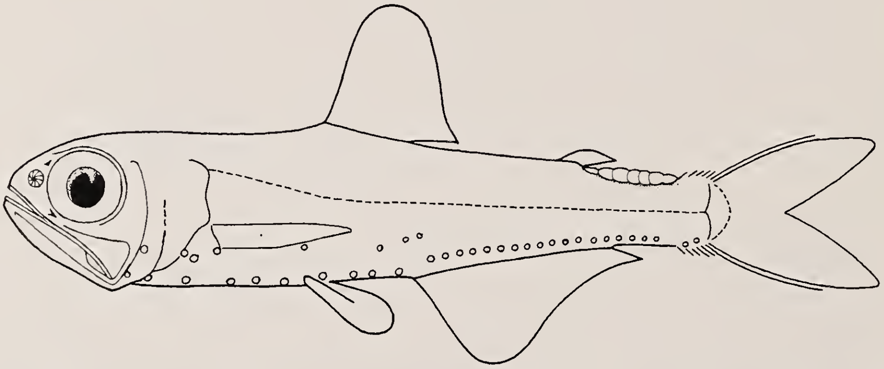


Fig. 53. *Protomyctophum (Protomyctophum) tenisoni*, 55 mm SL (from *Smiths' Sea Fishes*)

Genus *Symbolophorus* Bolin & Wisner, in Bolin, 1959

Maxilla moderately expanded posteriorly, extending well behind orbit. Anal-fin base longer than dorsal-fin base. Dn small; Vn larger; 5 PO; 4 VO; SAO series strongly angulate; AO series divided into AOa and AOp; 1 Pol. Supracaudal and/or infracaudal luminous glands present.

About 10 species, of which 1 is recorded from the Southern Ocean.

Symbolophorus boops (Richardson, 1845)

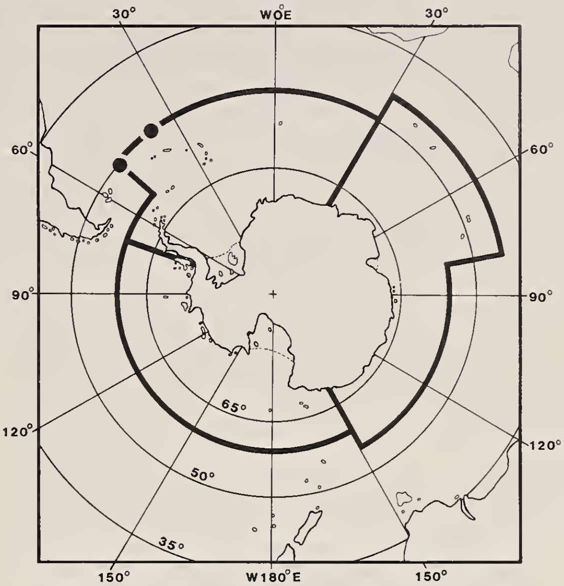
Fig. 55

Myctophum boops Richardson, 1845: 39, pl. 27, figs. 6–12, type locality erroneous—probably eastern South Atlantic. Syntype: BMNH 1948.1.12.1—specimen's status in doubt (Hulley 1981).

Diagnosis: D 13–15; A 20–23; P 12–14; GR (6–7) + (15–19); AO (7–9) + (6–8).

Colour: Pectoral fin with a darkly pigmented blotch; tips of caudal fin darkly pigmented.

Distribution: Not yet recorded in region as defined; 2 records (50°40′S, 50°01′W; 47°50.6′S, 40°00.8′W) just to the west and north of limits respectively. Mesopelagic: South Temperate (Semi-subantarctic) Pattern (Hulley 1981): nyctoepipelagic at surface.



Distribution of *S. boops*

Remarks: *S. boops* matures at about 114 mm SL. The larvae have been described by Pertseva-Ostroumova (1974).

Attains 157 mm SL.

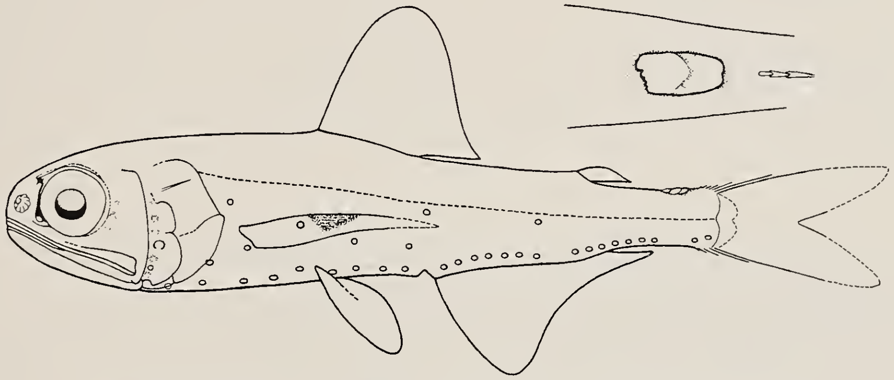


Fig. 55. *Symbolophorus boops*, 50 mm SL (from *Smiths' Sea Fishes*)

Genus *Taaningichthys* Bolin, 1959

Maxilla slightly expanded posteriorly, extending well past orbit. Anal-fin base equal to or slightly longer than dorsal-fin base. Dn absent; Vn present; body photophores present or absent; when present 5–7 PO; 3–10 VO; 1 SAO, at or slightly below horizontal septum; AO series divided into AOa and AOp; one Pol; 2+1 Prc. Both sexes with large, undivided supracaudal and infracaudal luminous gland.

Three species, of which 1 is recorded from the Southern Ocean.

Taaningichthys bathyphilus (Tåning, 1928)
Fig. 56

Lampadena bathyphila Tåning, 1928: 63 (25°11′N, 20°57′W). Lectotype: ZMUC P2329220.

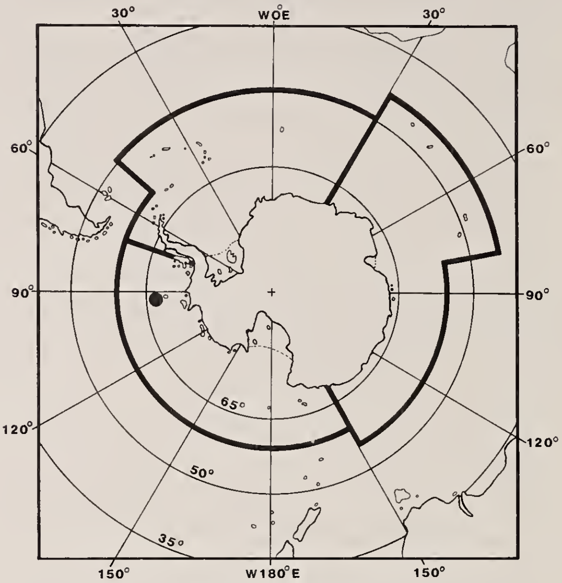
Diagnosis: D 11–14; A 12–14; P 12–13; GR (3–4)+(8–10); AO (2–3)+1.

Otoliths

Diagnostic features: The ovate to rhomboidal shape, the entire margin, the ostial and homosulcoid sulcus acusticus, the large ostium and anterior colliculum in comparison to the cauda and the posterior colliculum, the presence of the typical myctophiform pseudo-colliculum, the short rostrum and the minute antirostrum.

Fig. 57. Representative otolith of *T. bathyphilus*; fish length 73 mm SL; scale bar 1 mm

Distribution: Generally, widespread (43°N–40°S) in all 3 oceans. Bathypelagic: Widespread Pattern (Hulley 1981): below 675 m (night), shallowest depth of capture 400 m. In the Southern Ocean, recorded at about 67°S, 90°W (McGinnis 1982).



Distribution of *T. bathyphilus*

Remarks: *T. bathyphilus* matures at about 61 mm SL. Attains 80 mm SL.

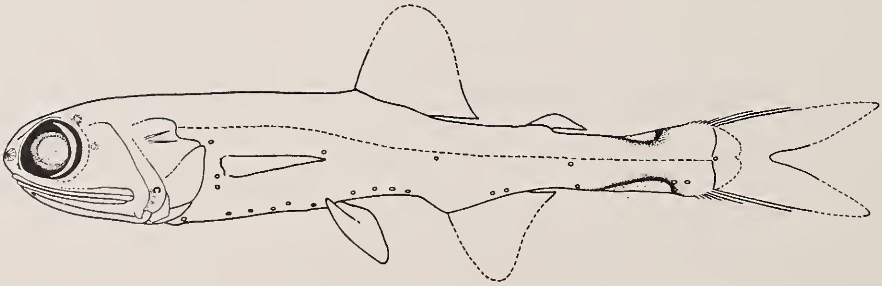


Fig. 56. *Taaningichthys bathyphilus*, 50 mm SL (from *Smiths' Sea Fishes*)

MURAENOLEPIDIDAE

Eel cods

by T.S. CHIU & D.F. MARKLE

Body elongate. Two dorsal fins, the first with 2 rays (1 reduced); second dorsal, caudal, and anal fins confluent; pelvic fins jugular, with 5 rays, the outer rays filamentous; no fin spines. Mouth terminal; chin barbel present; jaws with villiform teeth; head of vomer toothless. Gill openings restricted below pectoral fins. Lateral line only on anterior part of body. Scales oblong and embedded in skin.

Benthopelagic fishes found only in the Antarctic and sub-Antarctic; distributed from continental shelf to outer slope. One genus with 4 species. Andriashev (1965) considers this family as typically Antarctic, but DeWitt (1971) suggests that they may have invaded the Southern Ocean recently. Both reproductive and feeding biology are unknown.

The present work is based on specimens from LACM *Eltanin* collections and the types of *Muraenolepis microps*. Additional work on taxonomy and biology of *Muraenolepis* is clearly needed. No commercial utilisation is known at present.

Genus ***Muraenolepis*** Günther, 1880

Description same as family.

KEY TO SPECIES

1a LL a distinct, regularly spaced series of pores reaching about middle of D_2..2

1b LL of 2 pores located behind head or an irregularly arranged series of pores ending well before middle of D_2..........3

2a Vertebrae 67–71; D_2 128–147; A 89–108; mental barbel shorter than eye diameter; length of upper jaw 7.2–9.6% SL....................................*M. marmoratus*

2b Vertebrae 74–76; D_2 161–175; A 124–131; mental barbel almost equal to eye diameter; length of upper jaw 6.7–7.1% SL....................................*M. orangiensis*

3a Vertebrae 83–85; D_2 160–176; A 122–135; snout to anus length 40.2–43.7%, head length 13.1–17.7%; body depth 11.8–12.6% SL.......................*M. microcephalus*

3b Vertebrae 70–74; D_2 133–146; A 99–112; snout to anus length 44.1–52.5%; head length 18.7–23.9%; body depth 13.8–18.5% SL.............................*M. microps*

Muraenolepis marmoratus Günther, 1880

Fig. 1

Muraenolepis marmoratus Günther, 1880: 18, pl. VIII, fig. B, Kerguelen Islands. Holotype: BMNH 1879.5.14.640.

Muraenolepis microps (in part) Lönnberg, 1905b: 43 (paralectotype only, NRM SYD/1902 225.6364, 130 mm SL, from Boiler Harbor, Bay of Pots, Cumberland Bay, South Georgia, 20 m depth, 30 May 1902).

Diagnosis: D_2 128–147; A 89–108; vertebrae (20–22)+(46–51)=67–71. Body depth 13.9–20.6%, head length 16.8–23.9%, and upper jaw length 7.2–9.6% SL.

Colour: light brown or reddish on dorsum, grey ventrally with iridescent hues.

Otoliths

Diagnostic features: The otoliths of this species and *M. microps* are both typified by their characteristic hetero-

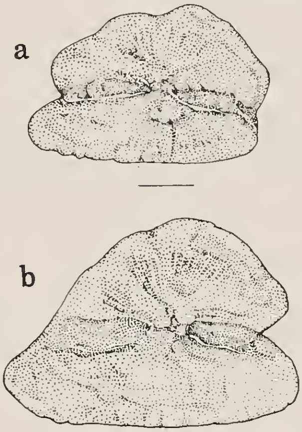


Fig. 2. Representative otoliths of *M. marmoratus*; fish lengths: (a) 28 cm and (b) 33 cm TL; scale bar 1 mm

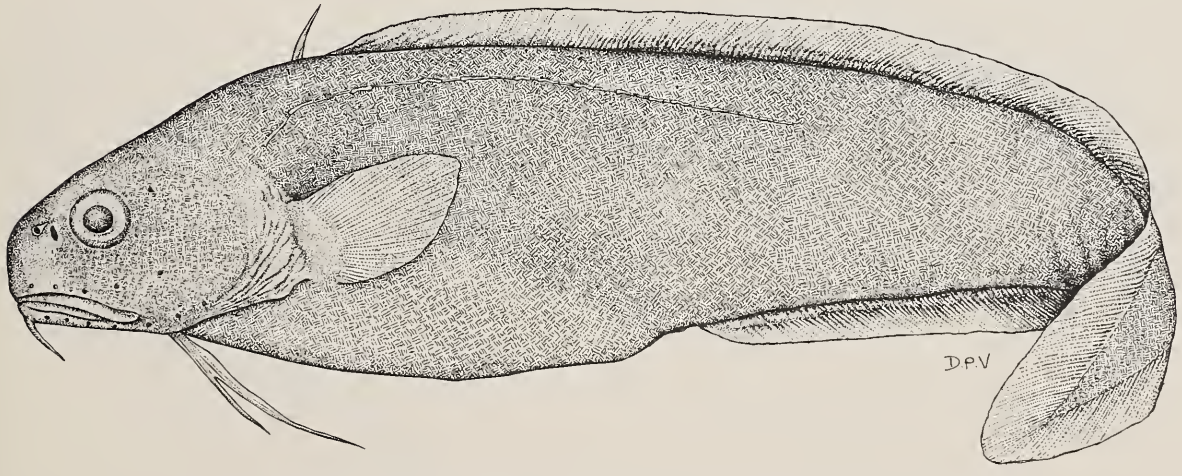


Fig. 1. *Muraenolepis marmoratus* LACM 10769-1, 28 cm TL (53°50′S, 37°25′W)

heteromorph gadiform colliculi and the equally sized ostium and cauda. The otoliths of *M. marmoratus* can be distinguished from those of *M. microps* by the presence of a clearly defined rostrum, antirostrum and excisura ostii.

Intraspecific variation: Geometric shape is variable, from oval to slightly triangular, otherwise negligible.

Distribution: Scotia Sea (LACM 10606, 10607, 10985, 10771, *Eltanin* station 1581), Prince Edward Islands, Crozet Islands, between Kerguelen and McDonald islands, and Macquarie Island. On continental and insular shelves and slopes at depths of 20–1,600 m.

Remarks: Attains 40 cm.

Muraenolepis microcephalus Norman, 1937

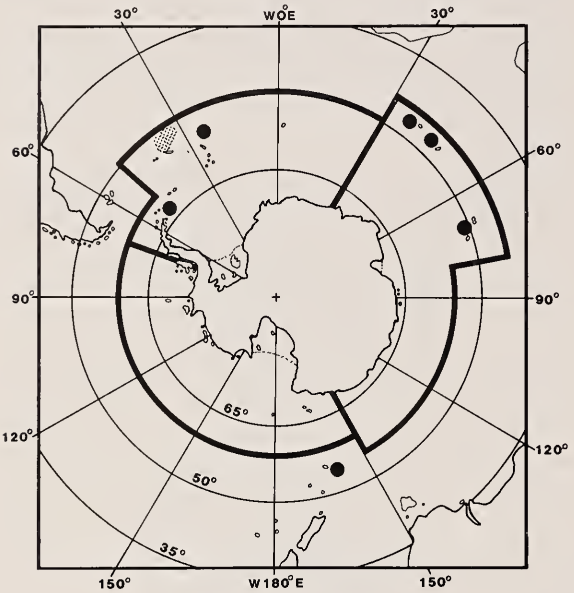
Fig. 3

Muraenolepis microcephalus Norman, 1937b: 68, fig. 5 (63°51′ S, 54°16′ E). Holotype: BMNH 1937.9.21.96.

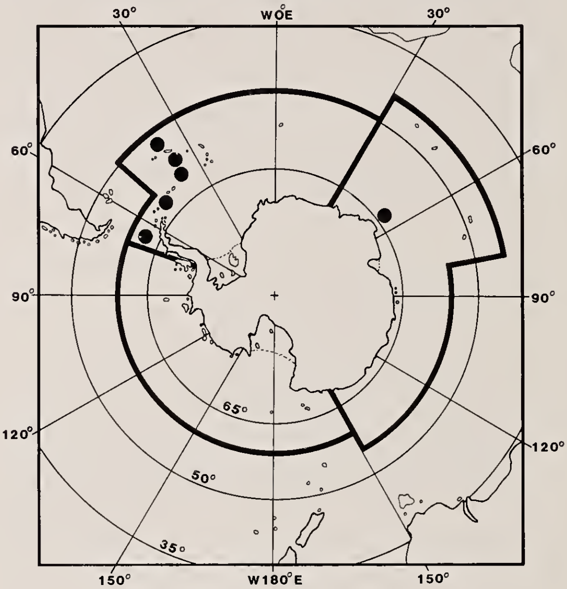
Diagnosis: D_2 160–176; A 122–135; vertebrae (22–23)+(60–63)=83–85. Body depth 11.8–12.6%, head length 13.1–17.7%, length of upper jaw 6.3%, and distance from snout to anus 40.2–43.7% SL.

Colour: Brown on dorsum, ventrum grey, with iridescent hues.

Distribution: Scotia Sea (South Georgia, South Sandwich, South Orkney, and South Shetland islands), north-



Distribution of *M. marmoratus*



Distribution of *M. microcephalus*

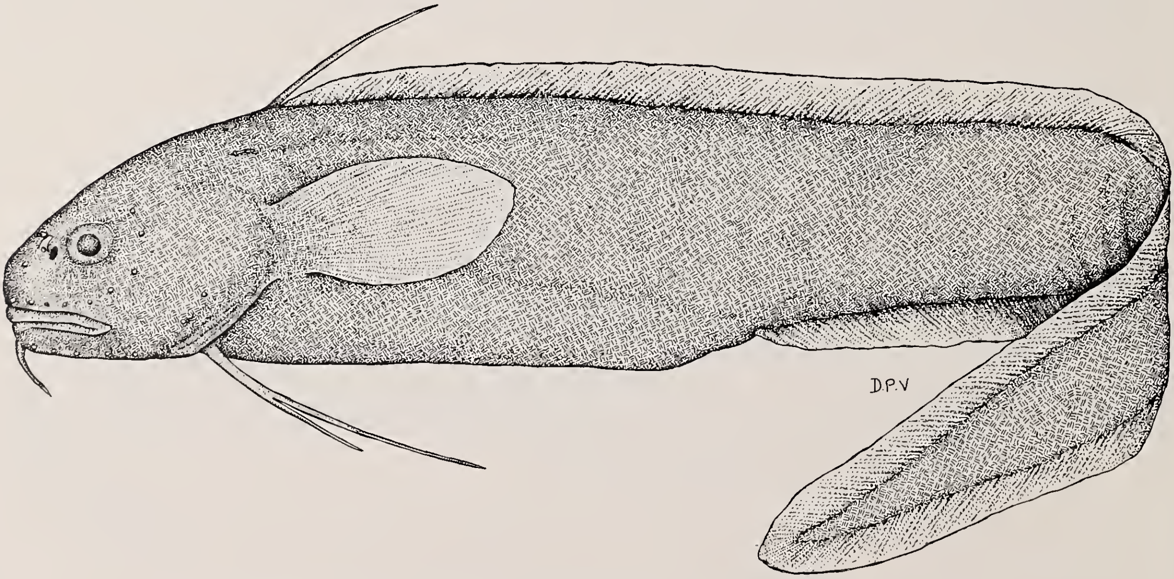


Fig. 3. *Muraenolepis microcephalus* LACM 10772–4, 21 cm TL (55°01′S, 39°55′W)

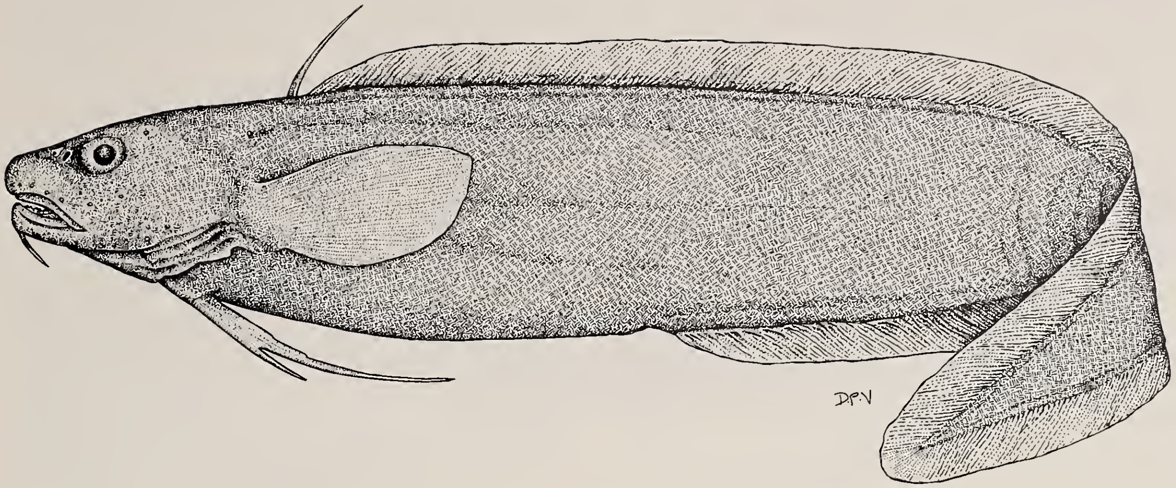


Fig. 4. *Muraenolepis microps* LACM 11469–1, 20 cm TL (72°28′S, 175°26′E)

ern part of Antarctic Peninsula, and Enderby coast. On continental slope at depths of 1,976–3,040 m.

Remarks: Attains 30 cm SL.

Muraenolepis microps Lönnberg, 1905
Fig. 4

Muraenolepis microps Lönnberg, 1905b: 9 and 43 (lectotype herein designated as NRM SYD/1902 212.4213, a female, 308 mm SL, 321 TL, from Cumberland Bay, South Georgia, 100 m depth, 20 May 1902, collected by Swedish South Polar Expedition 1901–1903; paralectotypes examined—NRM SYD/1902 381.4106 referred to *M. orangiensis*, NRM SYD/ 1902 225.6364 referred to *M. marmoratus*).

Diagnosis: D_2 133–146; A 99–112; vertebrae (21–23)+(49–51)=70–74. Body depth 13.8–18.4%, head length 18.7–23.9%, length of upper jaw 7.2–9.0%, distance from snout to anus 44.1–52.5% SL.

Colour: brown on dorsum, pale ventrally with iridescent hues.

Otoliths

Diagnostic features: The oval to triangular shape, the typical gadoid sulcus acusticus and colliculi and the broad ridge-like structure below the crista inferior.

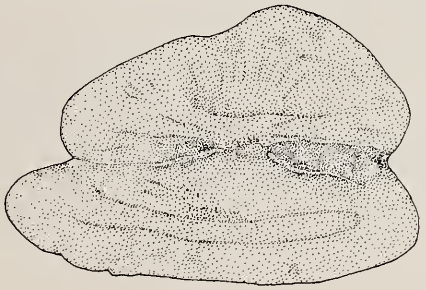
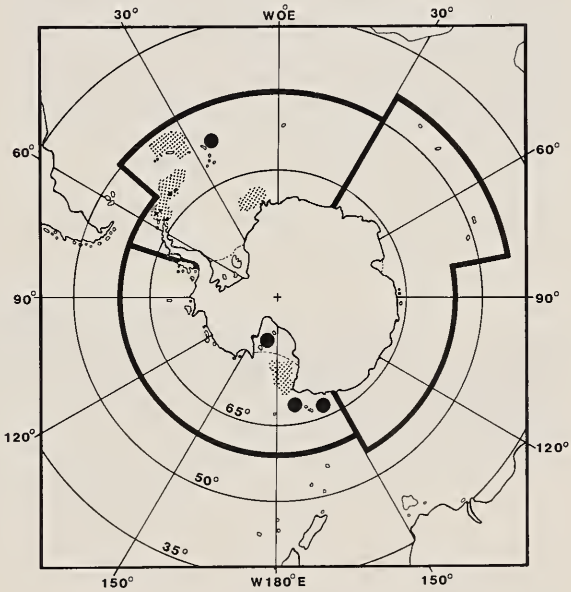


Fig. 5. Representative otolith of *M. microps*; fish length 34 cm TL; scale bar 1 mm

Intraspecific variation: Geometric shape variable, oval to triangular, otherwise negligible except for ontogenetic changes.

Ontogeny: The geometric shape changes from oval to generally triangular in fish 350 mm TL. Also in fish 350 mm TL the rostral and pseudo-rostral structures start to develop.

Distribution: Coasts of Antarctic Peninsula, Scotia Sea (South Georgia, South Sandwich, South Orkney and South Shetland islands), Victoria Land and Ross Sea. On continental and insular shelves and slopes at depths of 10–1,600 m (Tomo & Hureau 1985).



Distribution of *M. microps*

Remarks: Attains 35 cm.

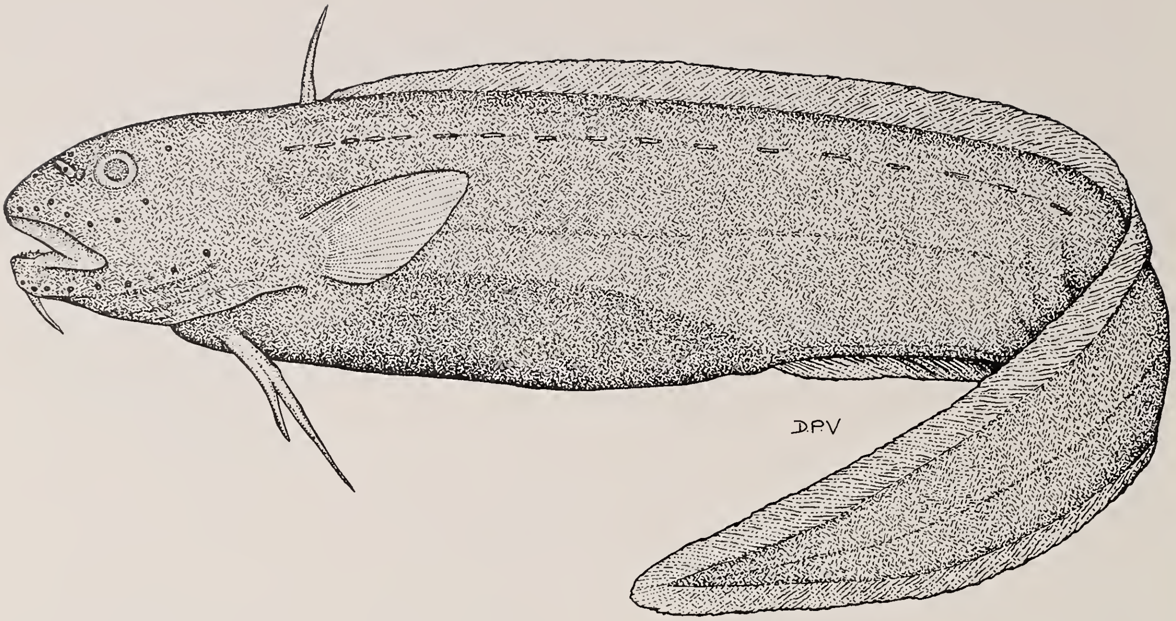


Fig. 6. *Muraenolepis orangiensis* MNHN 1985–897, 135 mm TL, Prince Edward Islands, N.E. Marion Island (46°50.6′S, 38°0.6′E)

Muraenolepis orangiensis Vaillant, 1888

Fig. 6

Muraenolepis orangiensis Vaillant, 1888a: c20, pl. 4, figs. 2, 2a, 2b, Cape Horn, Orange Bay. Holotype: MNHN 1884–819.

Muraenolepis microps (in part) Lönnberg, 1905b: 9 (paralectotype only, NRM SYD/1902 381.4106, 82 mm SL, from 55°12′ S, 66°18′ W, 100 m (level data), 15 Sept. 1902).

Diagnosis: D_2 161–175; A 124–131; vertebrae (21–22)+(53–54)=74–76. Body depth 14.9–17.7%, head length 18.3–19.6%, and upper jaw length 6.7–7.1% SL.

COLOUR: reddish on dorsum, grey on ventrum.

Otoliths

DIAGNOSTIC FEATURES: The near oval shape and the squared off anterior margin, the ostial and heterosulcoid sulcus acusticus, and the well developed colliculi in the near equal sized ostium and cauda.

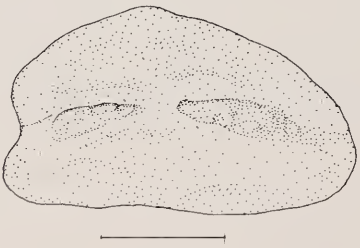
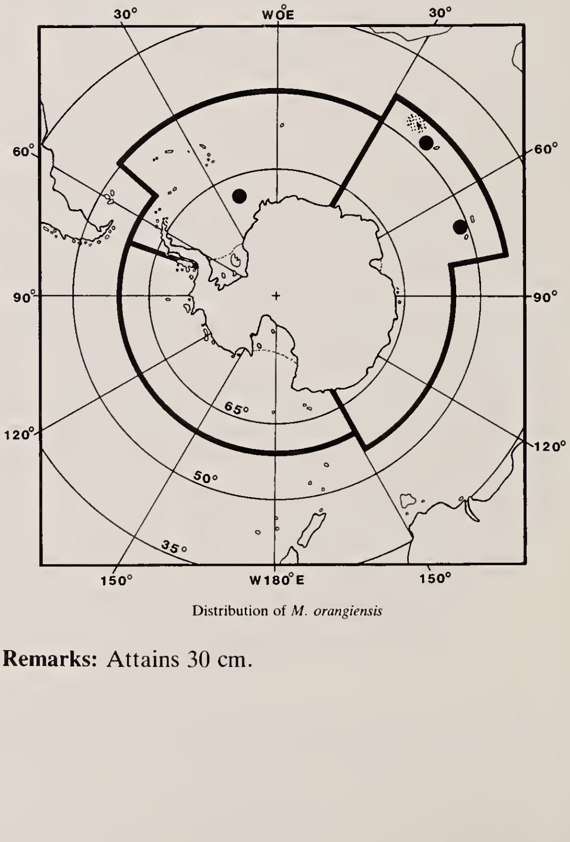


Fig. 7. Representative otolith of *M. orangiensis*; fish length 95 mm TL; scale bar 1 mm

Distribution: Sub-Antarctic Islands of the Indian Ocean sector; Patagonia and Discovery Seamount in the South Atlantic Ocean. On continental and insular shelves and slopes at depths of 140–600 m.



Distribution of *M. orangiensis*

Remarks: Attains 30 cm.

MORIDAE

Deepsea cods

by T.S. CHIU, D.F. MARKLE & R. MELÉNDEZ

Body fusiform to elongate with a narrow caudal peduncle. One or 2 dorsal fins, rarely 3, sometimes deeply notched; caudal fin separate, truncate or emarginate; pelvic fins jugular in adult with 1 to many rays, the outer ones may or may not be elongate, juveniles may have numerous rays; no fin spines. Mouth terminal or subterminal, chin barbel usually present; vomer toothless or with minute teeth. Eye size moderate. Scales cycloid. Swim-bladder connected to auditory capsules.

Small to medium size (reaching 70 cm), benthopelagic fishes distributed world-wide; ranging from outer continental shelf to the lower slope. Several species caught commercially in New Zealand and Australia. Seventeen genera and about 71 species around the world; 4 species in our area. Additional species likely to be discovered. Phylogenetic relationships and taxonomy of New Zealand species reviewed by Paulin (1983).

KEY TO GENERA

1a	Snout long, pointed, projecting in front of mouth	*Antimora*
1b	Snout short, round, mouth terminal	2
2a	V rays not elongated	*Halargyreus*
2b	V rays greatly elongated	3
3a	V with 5–7 visible rays, the outer 2 elongated	*Lepidion*
3b	V in adults with only 2 visible elongated rays	*Laemonema*

Genus ***Antimora*** Günther, 1878

Body fusiform. Protruding snout pointed. Two dorsal fins, first dorsal ray elongate; 1 notched anal fin; caudal fin emarginate. Chin barbel present. Weak teeth on jaws and vomer.

Recently reviewed by Small (1981); 2 species, 1 in our area.

Antimora rostrata (Günther, 1878)
Blue antimora
Fig. 1

Haloporphyrus (Antimora) rostrata Günther, 1878: 18; 1887: 93, pl. 16, fig. A, Marion Island (46°46′S, 45°31′E). Holotype: BMNH 1887.12.7.36.

Haloporphyrus viola Goode & Bean, 1878: 257, outer edge of Le Have Bank, north-western Atlantic.

Antimora rhina Garman, 1899: 185, Gulf of Panama.

Antimora australis Barnard, 1925: 499, off Cape Point, South Africa.

Antimora meadi Pequêno, 1970: 14, off Chile, South America.

Diagnosis: D_1 5–7; D_2 50–56; A 37–44; V 6; vertebrae (27–29)+(30–33)=58–60. Head length 23.7–25.9%, eye diameter 2.9–7.8%, barbel length 1.7–2.4%, first dorsal ray 11.7–19.8% SL. Teeth on jaws villiform, on vomer small.

Colour: In life, bluish-black.

Otoliths

Diagnostic features: The near pyriform shape, the caudal and heterosulcoid sulcus acusticus and the ridge-like posterior colliculum.

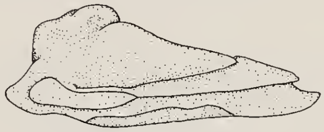


Fig. 2. Representative otolith of *A. rostrata*; fish length unknown

Distribution: Benthopelagic on continental slope and upper rise to depths of 3,000 m or more; world-wide at abyssal depth. In the Pacific Ocean from about 10°N to Tasmania; in the Atlantic Ocean from Davis Strait to South Georgia; and in the Indian Ocean south to Antarctica. Not in semi-closed basins such as Mediterranean Sea, Red Sea, Sulu Sea, Sea of Japan, Gulf of Mexico

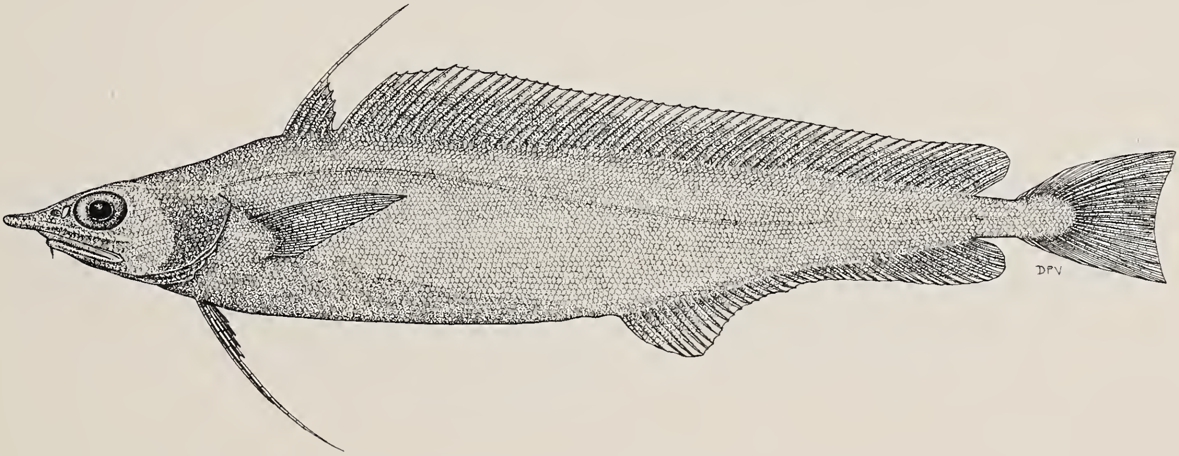
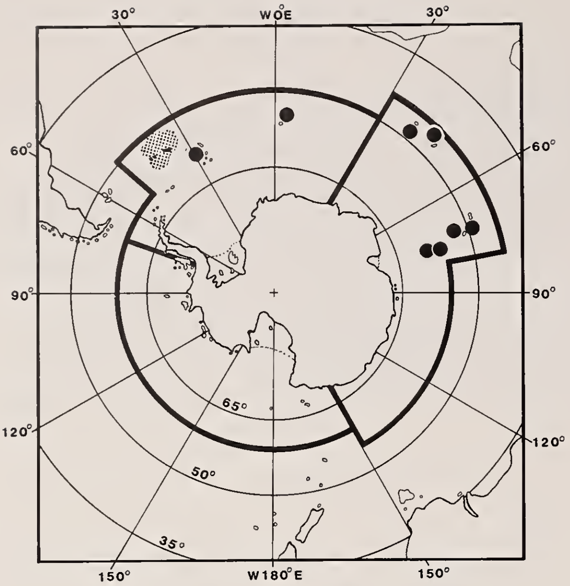


Fig. 1. *Antimora rostrata* LACM 10979–2, 22 cm SL (52°17′S, 160°40′E)



Distribution of *A. rostrata*

and Caribbean Sea. In the Antarctic: off South Georgia and South Sandwich Islands, and around Bouvet, Marion, Prince Edward, Crozet and Kerguelen islands (Iwamoto 1975).

Remarks: Iwamoto (1975) reports that 5 *Antimora* species other than *A. rostrata* had been described before 1970—*A. viola* (Goode & Bean), *A. microlepis* Bean, *A. rhina* Garman, *A. australis* Barnard, and *A. meadi* Pequêno. Excluding *A. meadi*, there are 2 opinions about the number of species in the genus. Schroeder (1940) and most recent workers have believed that there is only 1 valid species, *A. rostrata*. However, Small (1981) recognises 2 valid species: *A. microlepis* in the North Pacific, and *A. rostrata* from the south-eastern Pacific, Southern Ocean, and Atlantic Ocean. He reports differences as follows: first gill arch filaments 90–103 in *A. microlepis* versus 76–90 in *A. rostrata*, and different regression equations of gill filament length and HL on SL. The characteristics of *A. meadi* are within the range of variation of *A. rostrata*, and Paulin (1983) therefore considers it a synonym.

On the basis of strong mobility of *Antimora* (Cohen 1977), Small (1981) recognises 3 populations of *A. rostrata*: (1) North Atlantic, (2) south-eastern Pacific, (3) Southern Ocean, and one population of *A. microlepis* in the North Pacific. Reproductive biology is poorly known (Wenner & Musick 1977). Catch data indicate segregation of sexes at larger size (>322 mm) (Iwamoto 1975). The diet consists of free-living small animals, such as crustaceans and squids (Iwamoto 1975). This fish has been caught over a wide vertical range of 402–2,904 m, but it is abundant about 800–1,800 m (Grey 1956). No commercial fisheries utilize this species at present.

Attains about 75 cm SL.

Genus *Halargyreus* Günther, 1862

Body fusiform. Two dorsal fins, first dorsal ray not elongated; 1 notched anal fin; caudal fin emarginate. Chin barbel absent. Upper jaw with a notch, lower jaw extending beyond the upper; no teeth on vomer and palatines.

Recent reviews by Templeman (1968) and Cohen (1973). One valid species.

Halargyreus johnsonii Günther, 1862
Fig. 3

Halargyreus johnsonii Günther, 1862: 342, Madeira. Holotype: BMNH 1861.6.4.2.

Halargyreus breviceps Vaillant, 1888b: 295, off Morocco.

Halargyreus affinis Collett, 1904: 6, Faroe Slope.

Diagnosis: D_1 6–9; D_2 47–59; A 41–52; P 17–19; V 5–6; GR (lower first arch) 14–21; vertebrae (22–23)+(30–35)=52–57. Head length 23.6–26.2%, eye diameter 5.4–8.1%, first dorsal-fin ray 4.6–8.1% SL.

COLOUR: In life, reddish-brown on silvery background, silvery on belly and sides of head. Preserved specimens light brown to whitish-grey.

Distribution: Main centers of abundance in North Atlantic, from south and west of Iceland to Faroes Shelf and west Ireland; Japan; coast of New Zealand and South America (Templeman 1968); Scotia Sea, around South Georgia Island (Permitin 1969; ISH 331/76, ISH 319/76).

Remarks: Relatively broad range of counts (D, A) in this species are apparently due to pooling several geographical samples (western North Atlantic, eastern North Atlantic, Madeira and north-west Africa, western South Pacific, and eastern South Pacific and South Atlantic).

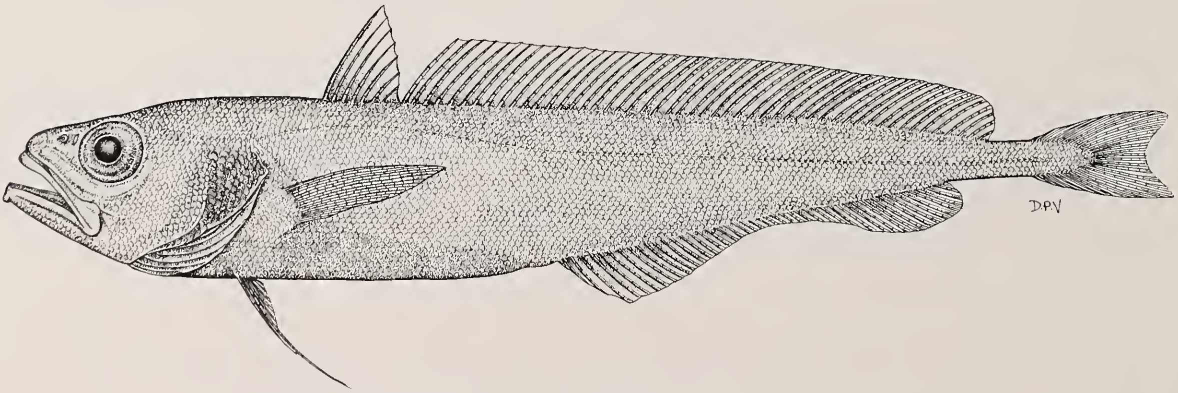
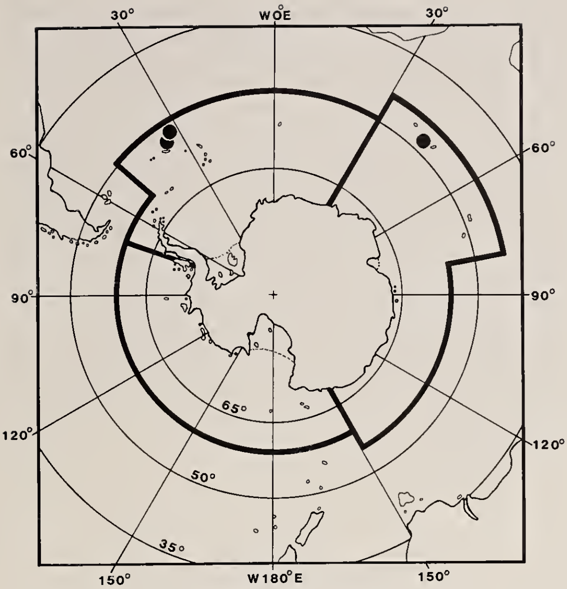


Fig. 3. *Halargyreus johnsonii* LACM 10985–4, 28 cm SL (52°20′S, 158°29′E)



Distribution of *H. johnsonii*

Differences between *H. johnsonii* from the Southern Hemisphere and the North Atlantic are (North Atlantic in parentheses): D_2 51–59 (49–54) and A 44–51 (41–47), and the mode of V 6 (5) (Cohen 1973). Reproductive biology is poorly known. The available male specimens, from 211 mm to 274 mm SL, and largest female, 432 mm, are immature (Templeman, 1968). Intestinal contents of single specimen from Icelandic slope indicates feeding on medium-sized pelagic shrimp (Templeman 1968).

Cohen (1973) comments that *H. johnsonii* might be similar to *Micromesistius* ecologically. Similarities include: structure of gill rakers, swimming and feeding habit, and pattern of distribution.

Genus **Laemonema** Johnson, 1862

Body length moderate to short, covered by small cycloid scales. D_1 4–7; D_2 48–74; A 45–71, usually 2 elongated V rays in adults. Lateral line continuous. Barbel usually present. Teeth in jaws villiform, small vomerine teeth generally present. Seven branchiostegal rays. No pseudobranchia. More than 20 species assigned to this genus. Holt & Byrne (1908) and Karrer (1971) have suggested that this genus needs a systematic study. Distributed in all oceans, one species known in our area.

Laemonema kongi Markle & Meléndez, 1988
Fig. 4, Pl. II, Fig. 1

Laemonema kongi Markle & Meléndez, 1988: 872, off Chile (34°51′ S, 72°56′ W), 640 m. Holotype: MNHNC P. 6438.

Laemonema ?multiradiatum: (*non* Thompson, 1916): Paulin, 1983: 115, fig. 22; Pavlov & Andrianov, 1986: 158.

Salilota sp. Nakamura, 1986b: 106,

Diagnosis: D_1 4–6; D_2 62–74; A 61–71; P 22–26; GR (6–9)+(14–22)=20–31; vertebrae (11–13)+(38–43)= 49–54; LL about 20–24. Snout short (0.23–0.28 HL), barbel small (0.04–0.15 HL), orbit large (0.28–0.37 HL), interorbital space broad (0.26–0.41 HL) and flat with weakly ossified ridges. Body short, head broad. Pelvic-fin rays reaching anal-fin origin. Mouth large, upper jaws ending at middle of orbit. Both jaws with 2 series of small caniniform teeth and inner rows of smaller villiform teeth; vomer with small patch of teeth.

Colour: Body brown if scales intact. Body of preserved, abraded specimens with pinkish-bluish cast. Snout, jaws, lips, orbit and edge of opercle dark. Peritoneum black and showing through as a bluish belly. Fins all with dark membranes.

Otoliths

Diagnostic features: The pyriform shape in association with the domed dorsal margin, the caudal and heterosulcoid sulcus acusticus, the pyriform ostium and the long

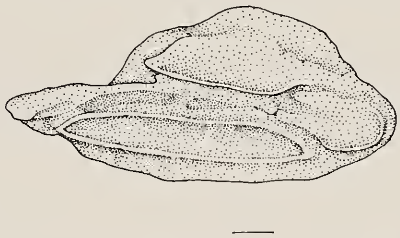


Fig. 5. Representative otolith of *L. kongi*; fish length 150 mm SL; scale bar 1 mm

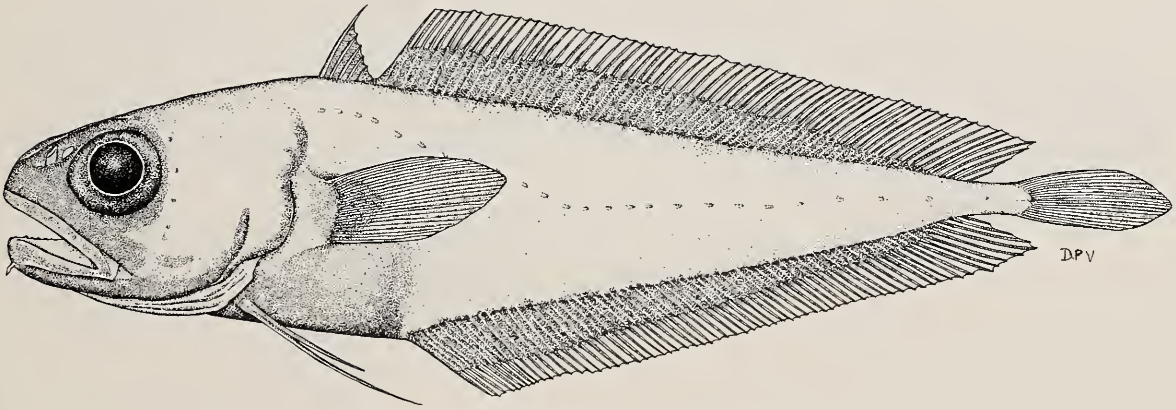
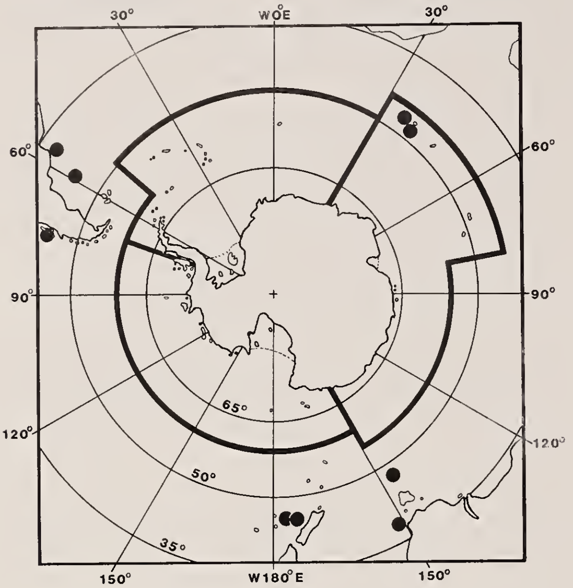


Fig. 4. *Laemonema kongi* RUSI 27490, 86.8 mm SL, Prince Edward Islands

and narrow cauda, the prominent anterior colliculum and the ridge-like posterior colliculum, and the absence of the rostrum, antirostrum and excisura ostii.

Distribution: Benthopelagic on continental and insular slopes of the Southern Ocean (sensu lato). Found from 55 to 1,070 m depth. Locally abundant off Chile, and in the South Atlantic off Argentina; also known from New Zealand and Australia. Recently found in the channel between Marion and Prince Edward islands of the Indian Ocean sector (46°40.55'S, 37°50.98'E), at 488 m (Gon & Klages 1988).



Distribution of *L. kongi*

Remarks: *Laemonema kongi* is very similar to the North Atlantic species, *Laemonema latifrons* Holt & Byrne, 1908, but they can be distinguished by the number of caudal vertebrae (38–43 in *L. kongi* and 45–49 in *L. latifrons*), larger orbit in *L. kongi* (0.30–0.37 HL) than in *L. latifrons* (0.25–0.30 HL), and mouth colour. The pale colour of the lips, floor of the mouth, roof of the mouth anterior and lateral to the palatines, inside surface of gill cover and branchiostegal membranes in *L. kongi* differs from the dark or densely pigmented mouth area of *L. latifrons*. *L. kongi* may also be confused with *L. gracillipes* Garman, 1899, but differs in number of body scales, ca. 125 deciduous scales in *L. gracillipes*. Other similar species are *L. nana* Taki, 1953, which has fewer rays in second dorsal (48) and anal (48) fins, and *Momonatira globosus* Paulin, 1985 which has more rays in pelvic (5–6), pectoral (28–30) and second dorsal (79–86) fins, and always lacks a barbel. Off Chile, south of Argentina and in New Zealand, *L. kongi* has been reported as sympatric with *L. globiceps* Gilchrist, 1906; the 2 species can be easily distinguished, as *L. globiceps* has a very elongated second ray of the first dorsal fin.

Attains 153 mm SL.

Genus *Lepidion* Swainson, 1839

Body fusiform. Two dorsal fins, first dorsal filamentous; 1 anal fin; caudal fin truncate or with slight notch. Chin barbel present. Snout not projecting in front of mouth; jaws and vomer with teeth (Paulin 1983).

About 10 species have been referred to this genus which is in need of revision, all found on continental slopes of Pacific, Atlantic and Indian oceans and Mediterranean Sea. At present one species occurs in our area.

Lepidion sp. (cf. *L. ensiferus* (Günther, 1887))

Fig. 6

Diagnosis: As for the genus above.

Colour: greyish.

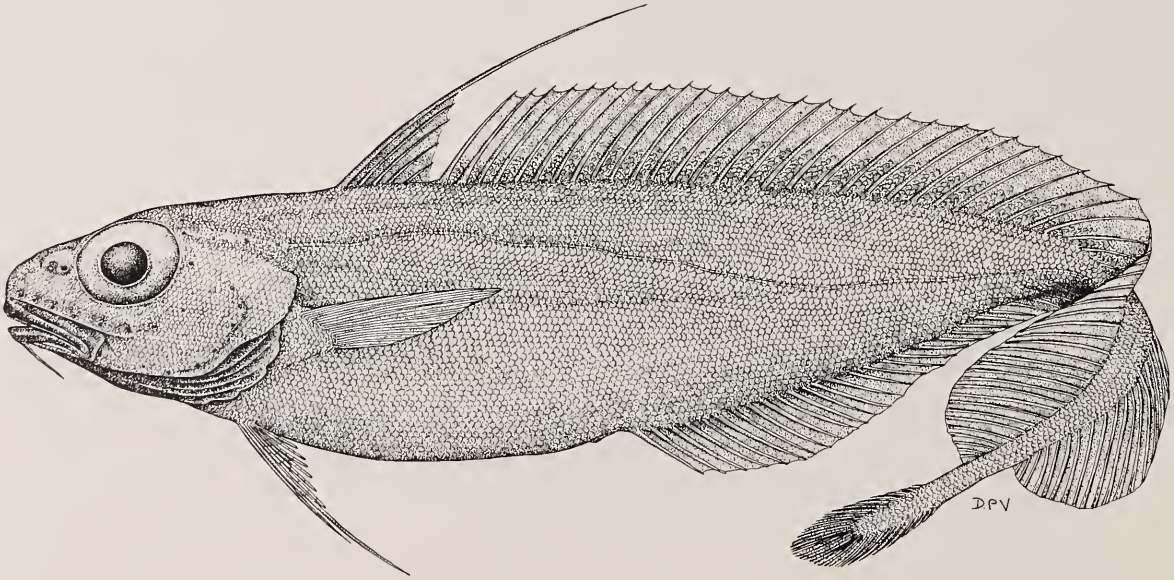
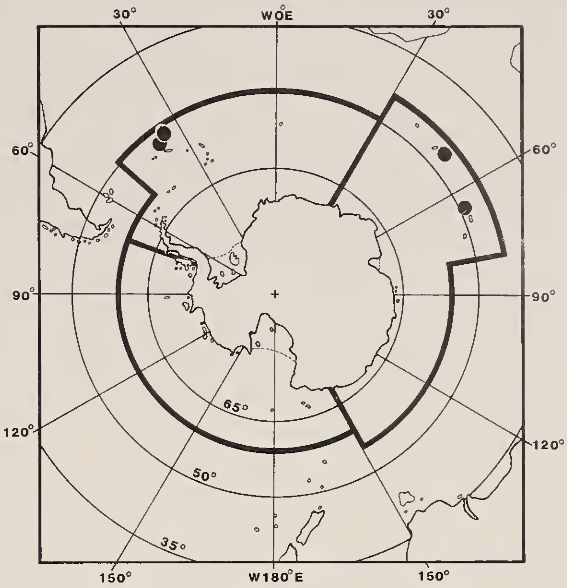


Fig. 6. *Lepidion* sp. MNHN 1988–76, 28 cm SL, Crozet Islands (46°14'S, 51°04'E)

Distribution: Benthopelagic in continental slope. Along the coast of South Africa, from the Cape to East London; in the Antarctic Ocean, at South Georgia Island and the sub-Antarctic islands of the Indian Ocean sector.

Remarks: Nine specimens of this genus from South Georgia Island are deposited at ISH (cat. no. ISH 320/76, ISH 332/76) as *Lepidion ensiferus.* As noted by Paulin (1983), "With the exception of Templeman (1970b) and Nakaya *et al.* (1980) who provided variational data for specimens examined, published descriptions of *Lepidion* refer only to a few type specimens or reiterate descriptions of earlier authors". The high number of species referred to in this genus and the rarity of material point to the need for a worldwide revision of this genus.



Distribution of *Lepidion sp.*

MELANONIDAE

Melanonids

by T.S. CHIU & D.F. MARKLE

Head and body compressed, terminating in a long tapering tail. One continuous dorsal fin (some authors mistakenly identifying 2); 1 long anal fin; caudal peduncle narrow and caudal fin small with numerous procurrent rays; pectoral fins midlateral; pelvic fins below pectorals; no fin spines. Head with numerous small soft ridges; chin barbel absent. Eye size moderate. Outer gill-rakers of first gill arch strong and long. Scales small and cycloid. Swim-bladder with no otophysic connection.

Meso- to bathypelagic fishes found worldwide, but nowhere common. One genus with 2 species of which 1 occurs in our area.

Genus *Melanonus* Günther, 1878

Diagnosis as for family.

Melanonus gracilis Günther, 1878

Fig. 1

Melanonus gracilis Günther, 1878: 19, pl. 16, fig. B (62°26′ S, 95°44′ W). Holotype: BMNH 1887.12.7.22.

Diagnosis: D 67–72; A 52–54; P 11–13; V 7; LSS about 70; vertebrae 13+44=57. Maxilla does not extend to vertical at posterior border of eye; uniform minute villiform teeth on jaws, vomer, palatines and pterygoids. Body depth 15.3–16%, head length 18.2–18.8%, and snout length 3.31–3.42% SL.

Colour: pale to dark brown.

Otoliths

Diagnostic features: The oval to subquadrate shape with the oblique anterior margin, the homomorph colliculum, the entire margin in association with the excisural projection.

Fig. 2. Representative otolith of *M. gracilis*; fish length 148.5 mm SL; scale bar 1 mm

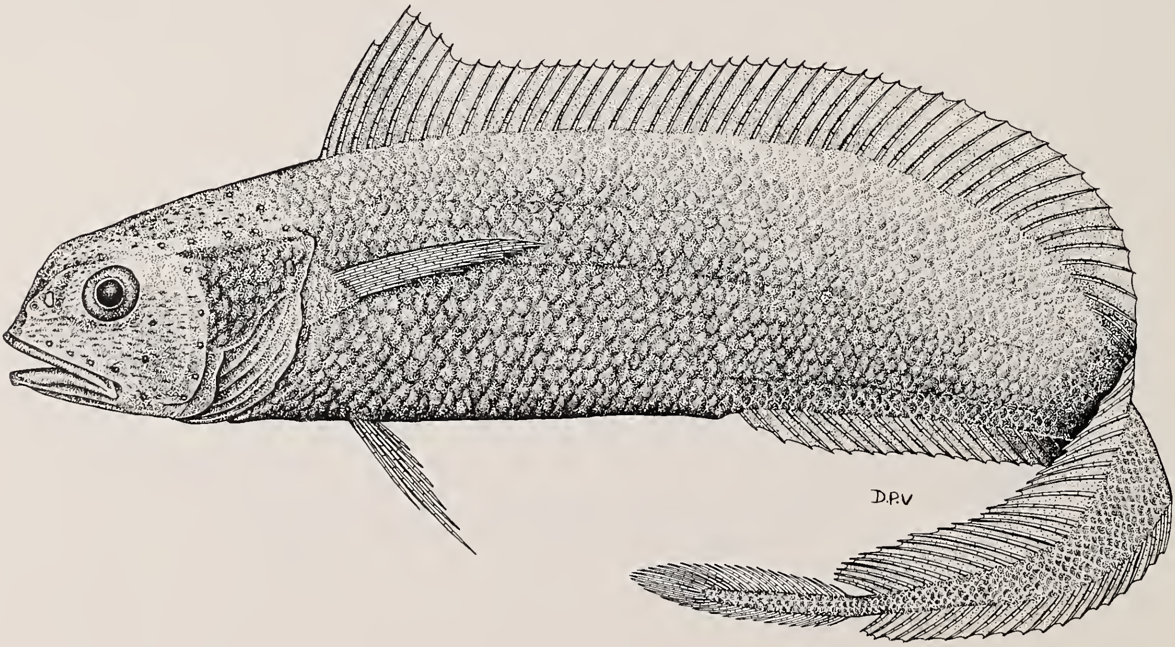
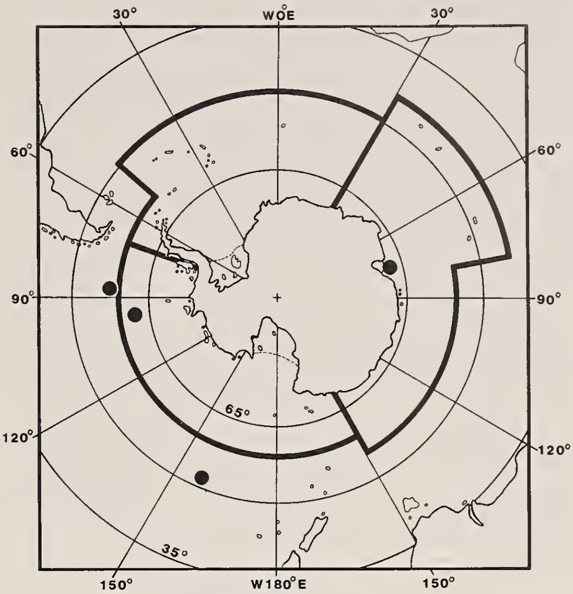


Fig. 1. *Melanonus gracilis* LACM 10838, 187 mm SL (59°37′S, 88°54′W)

Distribution: Off Chile and South Atlantic south of Subtropical Convergence. Rare in our area, known only from the holotype and a recent capture in Prydz Bay. The 2 other records on the map are specimens collected by the *Eltanin*. Reported from 600 to 3,500 m depth.

Remarks: The biology of this rare species is unknown. Attains 187 mm SL.



Distribution of *M. gracilis*

GADIDAE

Cods

by T.S. CHIU & D.F. MARKLE

Body subfusiform. Three dorsal fins and 2 anal fins; no fin spines. Pelvic fins small, thoracic; caudal fin truncate to slightly forked. Chin barbel absent in Southern Ocean representative. Swim-bladder with short, horn-like processes anteriorly, not in contact with auditory capsules.

Based on work by Markle (1989) the family is here restricted to the subfamily Gadinae of Nelson (1984) with 12 genera and about 25 species around the world. Demersal, benthopelagic or pelagic on continental shelves and upper slope regions. Extremely fecund fishes, producing moderate size (1–2 mm) pelagic eggs without oil globules. Omnivorous and voracious in feeding habits.

Mostly confined to north temperate and Arctic habitats; the basis of major fisheries in the North Atlantic and North Pacific. One genus and species known from our area. The major taxonomic review of the family was restricted to northern species (Svetovidov 1948).

Genus *Micromesistius* Gill, 1863

Anal fin origin slightly before dorsal origin. Caudal fin with a small notch. Lower jaw projects forward slightly. Chin barbel absent. Teeth present on premaxillary and dentary; vomerine teeth 1–2 on either side; no teeth on palatines. Pyloric caeca 8–13.

Two species; *Micromesistius poutassou* occurs in the North Atlantic and Mediterranean. *M. australis* has 2 separate populations in the Falkland-Patagonian and New Zealand regions.

Micromesistius australis Norman, 1937
Southern blue whiting
Fig. 1

Micromesistius australis Norman, 1937a: 51, fig. 22, off Patagonia and Falkland Islands (50°57′ S, 63°37′ 30″). Holotype: BMNH 1936.8.26.385.

Diagnosis: D_1 9–14, D_2 10–15, D_3 22–27; A_1 33–43, A_2 22–30; P 20–23; V 6; GR 38–49; vertebrae: precaudal 24–27, caudal 20–33, total 54–58. Depth of body 8.2–19.0%, length of head 19.1–28.5%, eye diameter 5.1–6.8%, length of upper jaw 9.1–10.8% SL.

Colour: Live, pale blackish on body with darker back, light sides and milky white belly. Numerous small black spots on scales and fin membranes. Iris gold, pupil blue-black. Tips of jaws and caudal fin blackish (Inada & Nakamura 1975).

Otoliths

Diagnostic features: The elongate oval shape, the homosulcoid sulcus acusticus, the horizontal ventral groove, with distinctly sinuate dorsal and ventral ridges.

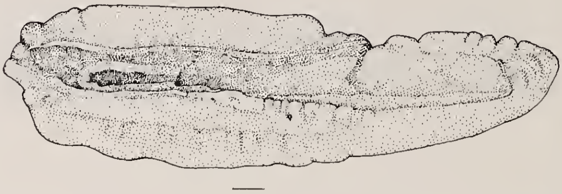


Fig. 2. Representative otolith of *M. australis*; fish length 50 cm TL; scale bar 1 mm

Distribution: The main areas of distribution of *M. australis* are: (1) Amphi-South America south of about 40°S to the Falkland Islands, Argentine and Chilean Patagonia, and the Scotia Sea (*M. australis australis*; Inada 1986); and (2) shelf areas of southern New Zealand, the Campbell and Auckland islands (*M. australis pallidus*; Inada & Nakamura 1975; Shpak 1975a, b; Shust 1978). The populations from these 2 areas are independent and recognized as sub-species (Inada & Nakamura 1975; Shust 1978). *M. a. australis* is found at depths of 50–900 m, but south of 50°S it is more abundant at 100–600 m (Inada 1986). In summer, *M. australis australis* is abundant in the southern part of the Scotia Sea, in the region of the South Orkney and the South Shetland islands (Kock 1975; Shust 1978), and is frequently caught by midwater trawls as shallow as 80 m (Barrera-Oro & Tomo 1988).

Remarks: *M. australis* and *M. poutassou* of the North Atlantic are closely related species. The only difference used to differentiate them is gill rakers: 27–33 in *M. poutassou*, and 40–49 in *M. australis* (Svetovidov 1948; Shapk 1975b). *M. australis* is larger and has a longer life cycle than *M. poutassou* (Shust 1978). Sexual maturity in *M. australis* is reached at a length of 35–40 cm and an age of 4–5 years. The main spawning

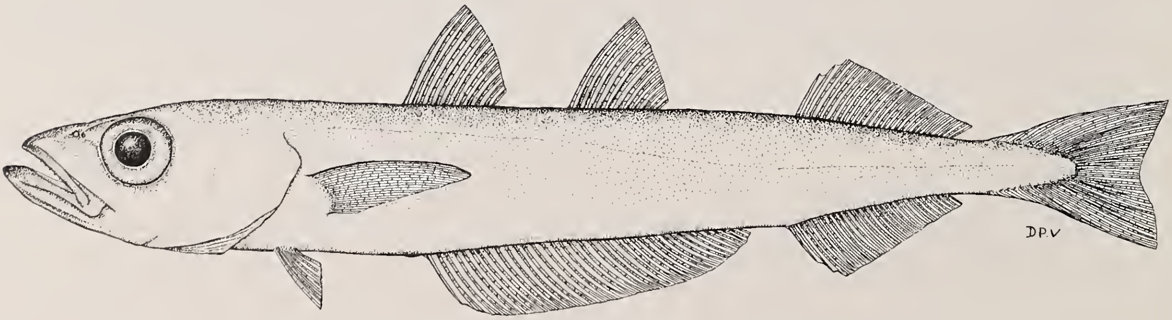
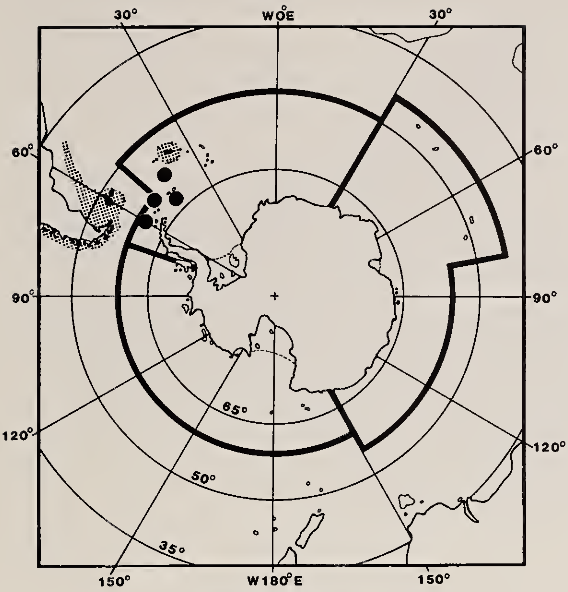


Fig. 1. *Micromesistius australis* LACM 10988–2, 97.7 mm SL, juvenile (50°52′S, 166°42′E)



Distribution of *M. australis*

population is composed of fishes about 45–52 cm, aged 5–8 years. The spawning season is August-September. The Falkland-Patagonian population has a greater fecundity than the New Zealand population (Lisovenko *et al.* 1982). The diet of fishes from the Falkland-Patagonian region is largely plankton and small pelagic nekton: Euphausiidae (50%) Hyperiidae (19.4%), Myctophidae (17.6%), *Sagitta* (6.7%), and Copepoda (6.3%) (Shust 1978). The New Zealand population also feeds on plankton and small fishes (Inada & Nakamura 1975). Shust (1978) reports daily vertical migration to the surface at night and to a depth of more than 200 m during the day. During winter and early spring adult *M. a. australis* form large and dense spawning schools in the waters south and east of the Falkland Islands (Inada 1986). After breeding, these fishes migrate to the Scotia Sea to feed on Antarctic krill (Barrera-Oro & Tomo 1988).

The 2 subspecies of *M. australis* differ in body proportions and meristics although there is much overlap. The head is relatively smaller in *M. australis australis* as are several other body proportions (Inada & Nakamura 1975). Evidence for the presence of this species in our area is based on Merrett (1963), Permitin (1969), Shubnikov *et al.* (1969), Shpak (1975b), and Shust (1978).

Attains about 90 cm FL.

MACROURIDAE
Grenadiers

by T. IWAMOTO

Body short, tail long and tapered, lacking a caudal fin. Head large, often cavernous with enlarged sensory canals. Snout often pointed. Two separate dorsal fins (except 1 in Macrouroidinae), the first short and high with a rudimentary splint adjoined to a long spinous ray; second dorsal fin long, low (much reduced in most Macrourinae), confluent with anal fin; pectoral fins well developed; pelvic fins thoracic to almost jugular, absent (1 genus), small, or well developed. Abdominal vertebrae 10–16. Mouth small to large, inferior to terminal; jaws bearing small to large conical teeth; palate toothless. Chin barbel usually present. Outer gill slit restricted in all Antarctic members; branchiostegal membranes with 6–8 rays, forming a narrow to broad fold across isthmus; gill rakers usually tubercular, but lathlike in some species (outer series of first arch absent in 2 genera). Swim-bladder usually well developed, with drumming muscles in males of many species. Scales cycloid but covered with spinules in most species. A ventral light organ in many species.

About 35 genera and 300 species of small to medium-sized (150 cm) exclusively deep-sea fishes, most of which are benthopelagic, but a few are bathypelagic, including 1 endemic Southern Ocean species. Family world-wide in all oceans, but species most numerous in tropical seas; some species extremely wide ranging, others confined to limited areas. Four of the 9 Southern Ocean species apparently endemic to this area. Recent revisions of family by Okamura (1970) and Marshall (1973).

Remarks: A controversy currently raging concerns the monophyletic versus polyphyletic nature of the group and whether or not 1 or more of the 4 subfamilies should be considered separate families. Okamura (1970) and Markle (1989) recognise Macrouroididae as well as Macrouridae; Okamura (1989) recognises Trachyrincidae, Macrouroididae, and Macrouridae, and Howes (1988, 1989) considers Trachyrincidae and Bathygadidae as families of the suborder Gadoidei; Iwamoto (1989) continues recognition of 4 subfamilies, with Bathygadinae representing the primitive sister group of the other 3 subfamilies.

Methods: Suborbital width is measured at the narrowest part of the suborbital region from the bony orbit to the lower edge of the infraorbital bones (it does not include the lips). The count of scales below the first dorsal fin stops at the scale row above the lateral line, lateral line scale is not included. The outer gill slit is the opening between the operculum and the first gill arch. Fish lengths are given as the total length (TL).

KEY TO GENERA

1a Large fang-like teeth in upper jaw; lateral line in 2 segments; snout not produced, jaws terminal; no chin barbel; bathypelagic .... *Cynomacrurus*

1b No fang-like teeth in jaws; lateral line single; snout variously produced beyond subterminal jaws; chin barbel present; benthopelagic 2

2a Outer GR on first arch absent; a stout, coarsely spined ridge from snout to preopercle, ending in a sharp point 3

2b Outer GR on first arch present; a spinous infra-orbital ridge present or absent, but never ending in a sharp point .... *Coryphaenoides*

3a Spinous second ray of D_1 smooth; spinules on body scales without an enlarged median series in Antarctic species .... *Coelorinchus*

3b Spinous second ray of D_1 serrated (sometimes weakly); spinules on body scales with an enlarged median series.... .... *Macrourus*

Genus *Coelorinchus* Giorna, 1809

Mouth subterminal, small to moderate sized; teeth small, in narrow to broad bands. Snout usually pointed and projecting; a strong spinous ridge between tip of snout and preopercle, the posterior end forming a sharp point. Branchiostegal rays 6. Outer gill rakers on first arch absent. Scales covered with small to large spinules, often in ridge-like rows. Spinous second ray of first dorsal fin smooth. Pelvic-fin rays 6 or 7. Ventral light organ rudimentary or well developed, often with one or 2 black fossae on ventral midline of trunk between anus and isthmus.

About 100 species, most of which are known from tropical and warm-temperate waters. Two species, 1 widespread in the Southern Hemisphere, the other known primarily from the Patagonian Shelf, have been reported from South Georgia (Hubbs 1934).

Coelorinchus fasciatus (Günther, 1878)
Fig. 1

Macrurus fasciatus Günther, 1878: 24, east coast of southern tip of South America, *Challenger* stations 305, 309, 311. Syntypes: BMNH 1887,12.7.73; BMNH 1898.12.30.1.

Coelorhynchus fasciatus Goode & Bean, 1896.

Coelorhynchus patagoniae Gilbert & Thompson, 1916.

Garichthys fasciatus Whitley, 1968.

Diagnosis: D II,9–10 + about 80; P i,15–i,19; V 7; total inner GR 7–9; scales below middle of first dorsal fin 4–5.5; pyloric caeca 15–19. Head length 4.2–5.0 in TL. Snout length 3.0–3.4, orbit diameter 2.2–2.6, upper jaw length 3.2–4.0, interorbital width 4.5–6.0, outer gill slit 5.4–8.2, barbel length 8.1–13.3, and dorsal interspace 3.7–6.3 in HL. Snout bluntly conical, anterolateral portion of ridge incompletely supported by bone. First dorsal fin high, more than postrostral length of head. Anus slightly removed from anal fin by 2 or 3 scale rows; black naked fossa of light organ immediately anterior to anus, its length about half pupil diameter, fossa extends about midway to pelvic-fin bases. Underside of head completely naked. Body scales with slender, reclined spinules arranged in discrete, parallel, longitudinal, ridge-like rows (as many as 15 or 16 rows in largest individuals). Swim-bladder deeply bilobed anteriorly; 4–6 retia. Teeth all small, in broad short bands.

Colour: In alcohol, brownish-black overall, paler ventrally; dorsally marked with 8–10 broad saddles (marks faint in some specimens). Outer pelvic-fin ray whitish, but fins generally blackish. Oral and branchial cavities blackish.

Distribution: Temperate waters of southern Africa, both sides of southernmost South America, New Zealand, Tasmania, and southern Australia. The species has been recorded from South Georgia and is therefore included among the Southern Ocean fauna, but it should be considered marginally of this fauna at most. (I have not seen any specimens from south of the Antarctic Polar

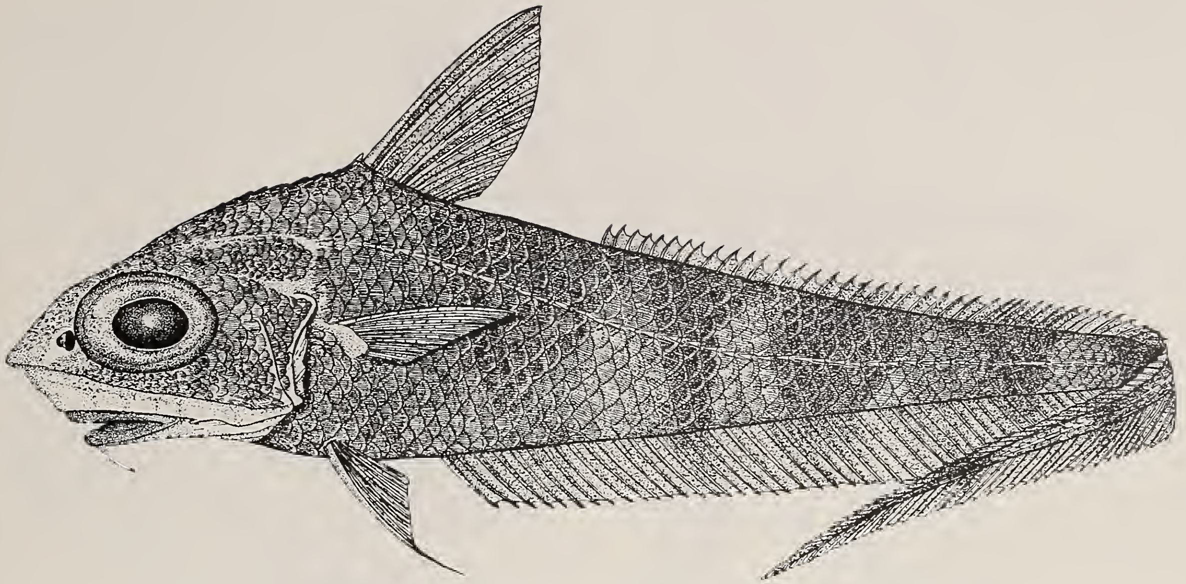
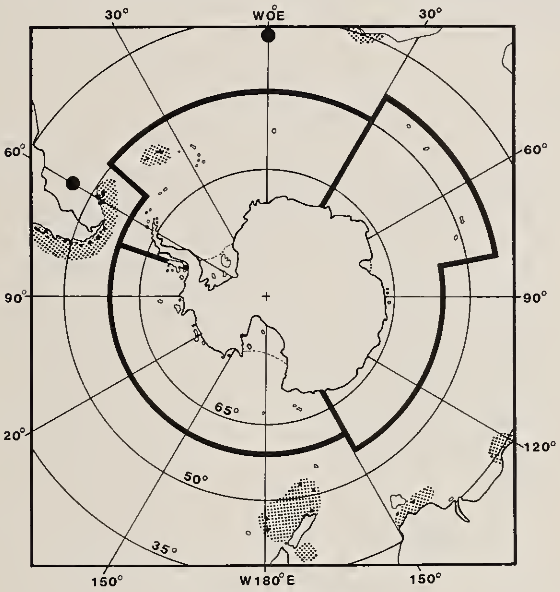


Fig. 1. *Coelorinchus fasciatus* RUSI 17851, 43 cm TL, Port Elizabeth, South Africa

Front). Hureau's (1979) record of this species from Crozet Islands is an error; the specimen (MNHN 1985–891) is a representative of *Coryphaenoides*. Depth range 155–1,086 m.



Distribution of *C. fasciatus*

Remarks: *C. fasciatus* is well known and sometimes taken in abundance in relatively shallow waters as shallow as 155 m. The broad distribution of this species and the several close relatives found in the New Zealand-Australian region have led to some identification problems. I am unable to differentiate *C. cookianus* McCann & McKnight, 1980, from *C. fasciatus,* based on the original description. It is possible that more than 1 species currently is being called *C. fasciatus*; for example, in a previous paper (Iwamoto 1978) I noted important differences in southern African populations examined, but did not think at that time that they warranted recognition of new species. After recent examination of additional South West African specimens in Soviet collections, however, I am convinced that at least that population should be considered a distinct species.

Food largely consists of copepods, polychaetes, benthic molluscs, and various other arthropods including decapods and amphipods.

Attains about 45 cm.

Coelorinchus marinii Hubbs, 1934

Fig. 2

Coelorhynchus marinii Hubbs, 1934: 1, pl. 1, off Province of Buenos Aires (38°52′S, 56°20′W). Holotype: MACN 357.

Coryphaenoides barattinii Fowler, 1943: 323, figs. 16–17, off Uruguay (35°08′S, 52°37′W).

Diagnosis: D II,8–10 + about 80–90; P i,17–i,20; total inner GR 13–14; scales below second dorsal fin 6–6.5. Head length 4.5–5.1 in TL. Body depth 1.25–1.50, snout length 2.9–3.2, orbit diameter 2.6–3.0, postorbital length 3.2–3.6, and upper jaw length 2.9–3.6 in HL. Height of first dorsal fin 1.2–1.4, pectoral fin length 1.6–1.8, and pelvic fin length 1.5–1.9 in HL. Outer gill slit 1.9–3.0, barbel length 3.9–4.6, and interorbital width 1.4–1.7 in orbit. Head mostly covered with scales, a narrow mid-ventral naked strip on snout, and lunate areas immediately behind dorsal leading edges of head naked or with thin scales; body scales covered with fine conical spinules in subparallel rows to somewhat quincunx pattern. Subopercle not produced into a slender flap. Upper jaw extends to somewhat beyond middle of orbit. First dorsal fin longer than postrostral length of head. Outer pelvic-fin ray extends to 4th-7th anal-fin ray. Ventral fossa long, pear-shaped, situated between and slightly ahead of pelvic-fin bases.

Colour: In alcohol, overall medium brown to swarthy, darker ventrally on trunk. Fins dusky to blackish, outer pelvic-fin ray whitish distally. Oral cavity pale, branchial cavity black.

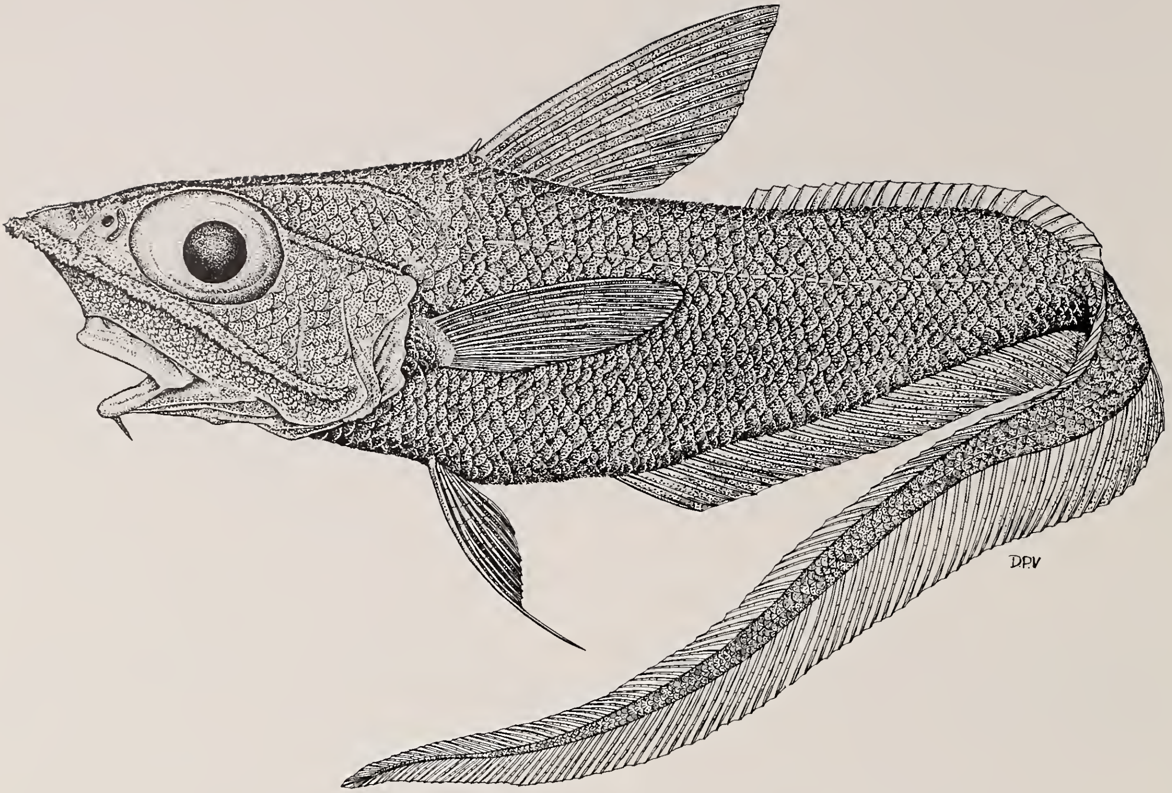


Fig. 2. *Coelorinchus marinii* ISH 1543/66, 27 cm TL (35°47′S, 52°52′W)

Otoliths

Diagnostic features: The oval to obovate shape, the ostial and homosulcoid sulcus acusticus, the clearly separated ostium and cauda, the homomorph colliculi and the short, distally rounded rostrum.

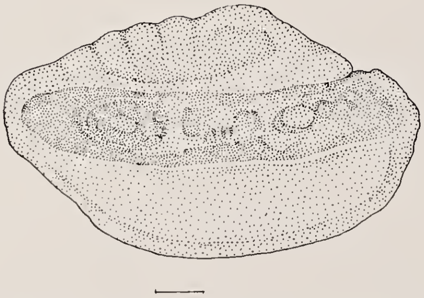
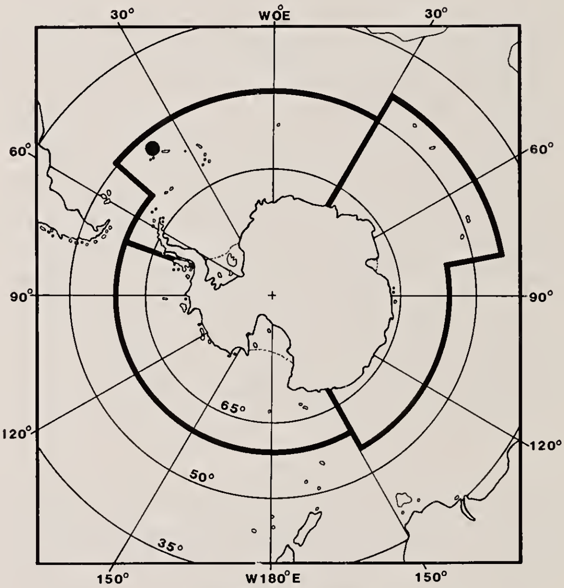


Fig. 3. Representative otolith of *C. marinii*; fish length unknown; scale bar 1 mm



Distribution of *C. marinii*

Distribution: Southern Brazil (28°43′S) to Argentina (38°52′S); 1 record from South Georgia (Hubbs 1934). Depth range 270–600 m.

Remarks: *Coelorinchus marinii* was treated as a subspecies of *C. coelorhincus* by Marshall & Iwamoto (in Marshall 1973), but the higher gill raker counts, the deeper body, and longer fins of *C. marinii* warrant recognition of this taxon. Published results of the extensive Japanese trawl survey off the Patagonian Shelf (Nakamura 1986a) did not report this species, although it should have been expected. *Coelorinchus fasciatus* is distinguished from *C. marinii* by its banded color pattern, naked underside of head, and scale spinules in numerous, discrete, parallel rows. Three other members of the genus, *C. chilensis* Gilbert & Thompson, 1916, *C. kaiyomaru* Arai & Iwamoto, 1979, and *C. matamua* (McCann & McKnight, 1980), are known from near the southern tip of South America, but have yet to be taken from the Southern Ocean.

Angelescu & Cousseau (1969) have reported *C. marinii* in the diet of the Argentine hake (*Merluccius hubbsi*).

Attains about 30 cm.

Genus ***Coryphaenoides*** Gunnerus, 1765

Mouth small to large, third to half of head length. Dentition highly variable within group, lower jaw teeth in Southern Ocean species in 1 row to a narrow band. Branchiostegal rays 6. Outer gill slit restricted. Outer gill rakers of first arch rudimentary, other rakers tubercular. Spinules on body scales few and weak to dense and strong, but lacking enlarged median series. Spinous second ray of first dorsal fin serrated (serrations greatly reduced in some). Anus at anal-fin origin. No light organ. Swim-bladder in Southern Ocean species with 5–7 long retia and without drumming muscles.

Remarks: Four benthopelagic Southern Ocean species, often placed in the genera *Nematonurus, Chalinura,* and *Lionurus*. For reasons discussed elsewhere (Iwamoto & Stein 1974; Iwamoto & Sazonov 1988), I prefer to recognise those taxa as subgenera of *Coryphaenoides*. Two species (*C. ferrieri, C. lecointei*) are apparently endemic to our area; *C. filicauda* is wide ranging in the Southern Hemisphere; *C. armatus* is world wide.

KEY TO SPECIES

1a Interorbital wide, 3.0–3.2 in HL; snout long, 2.6–3.0 in HL; barbel thin and short, less than half orbit diameter; scales thin, devoid of spinules or spinules few and very small. 2

1b Interorbital 3.6–4.8 in HL; snout 3.0–5.0 in HL; barbel rather stout at base, usually more than half orbit diameter (sometimes less in *C. lecointei*); scales thin to thick, spinules numerous, small to fairly large 3

2a Outer GR rudimentary prickles, 3–6 total; first gill slit 12–15% HL; interorbital width 29–32% HL . . . .*C. filicauda*

2b Outer GR shaped somewhat like a tab or flap, 10 total; first gill slit 22% HL; interorbital width 34% HL . . . .*Coryphaenoides* sp.

3a Upper jaw teeth relatively slender, conical, without arrowhead-like tips (Fig. 4a), arranged in an irregular narrow band; scales relatively firm, strongly adherent and coarsely spinulated. . . . .*C. ferrieri*

3b Upper jaw teeth stoutly conical, with arrowhead-like or spatulate tips (Fig. 4b), usually in 1 or 2 distinct rows; scales thin, deciduous, with small low spinules 4

4a Most ventral surfaces of head except snout, but including mandibular rami, uniformly scaled; snout rather narrow and pointed, with a broad spiny tubercle at tip . . . .*C. lecointei*

4b Ventral surfaces of head mostly naked; snout rather broad and blunt, without a distinct terminal tubercle . . . .*C. armatus*

Coryphaenoides armatus (Hector, 1875)

Fig. 5

Macrurus armatus Hector, 1875: 81, about 200 n mi. west of Cape Farewell, New Zealand. Holotype: BMNH 1982.6.8.1.

Coryphaenoides variabilis Günther, 1878: 27, Central North Pacific, (36°10′N, 178°00′E).

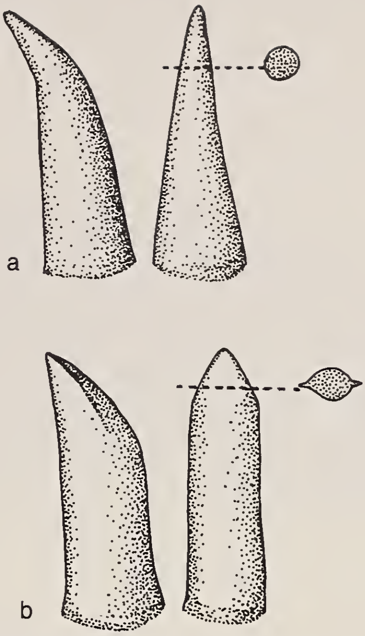


Fig. 4. Anterior and lateral views of right premaxillary teeth in *C. ferrieri* (a) and *C. armatus* (b)

Macrurus asper Goode & Bean, 1883: 196, Gulf Stream off New England (41°24.5′N, 65°35.5′W).

Macrurus goodei Günther, 1887: 136 (substitute name for *Macrurus asper* Goode & Bean, 1883, preoccupied).

Coryphaenoides gigas Vaillant, 1888b: 232, eastern North Atlantic (44°20′N, 17°11′W).

Nematonurus cyclolepis Gilbert, 1895: 458, off Queen Charlotte Island (52°39.5′N, 132°38′W).

Macrurus (Nematonurus) suborbitalis Gill & Townsend, 1897: 234, Bering Sea, south-west of Pribilof Island (55°23′N, 170°31′W).

Nematonurus abyssorum Gilbert, 1915: 374, off Santa Catalina Island, California (33°02′15′′N, 120°42′W).

Diagnosis: D II,8–10 + about 95–105; P i,17–i,21; V 10–12; total inner GR 11–14; scales below middle of first dorsal fin 6–8. Head length 4.9–5.8 in TL. Snout length 3.2–5.0, orbit diameter 3.7–5.6, upper jaw length 2.5–2.9, interorbital width 3.3–4.5, outer gill slit 5.6–8.3, and dorsal interspace 1.1–2.1 in HL. Barbel length 1.2–2.1 and suborbital width 1.5–2.6 in orbit. Head covered dorsally with small coarse scales; most ventral surfaces of snout, suborbital, ventral margins of preopercle, and mandible naked (narrow scaled strips often on suborbital and mandible); body scales deciduous, covered with small, fine spinules in parallel rows, the median row slightly larger. Teeth conical, relatively stout, with hastate or spatulate tips; 2 discrete rows of teeth in upper jaws (inner row of smaller teeth sometimes lost in larger individuals) and 1 row in lower jaw.

Colour: In alcohol, brown overall; fins darker, usually blackish.

Otoliths

Diagnostic features: The oval shape with the entire margin, the medial sulcus acusticus and the homomorph colliculi.

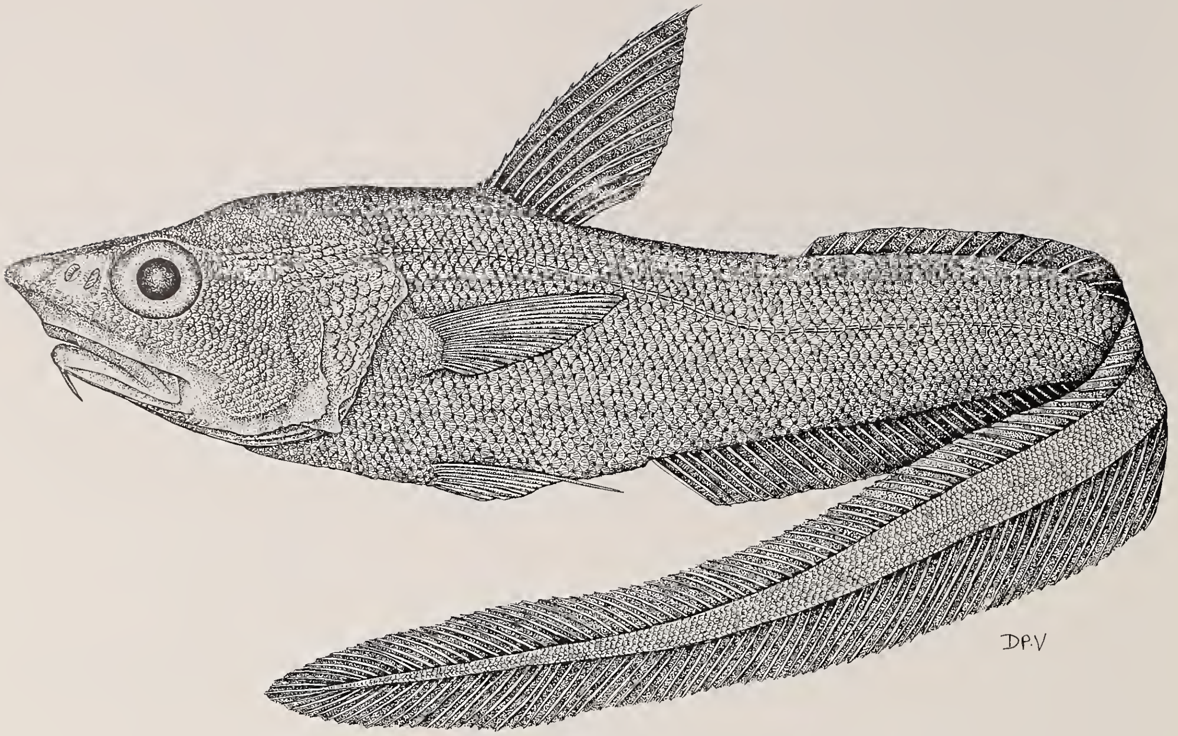


Fig. 5. *Coryphaenoides armatus* ISH 400/76, 26 cm TL (54°12′S, 40°02′W)

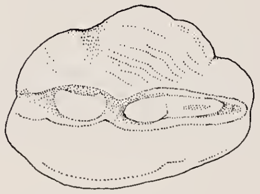
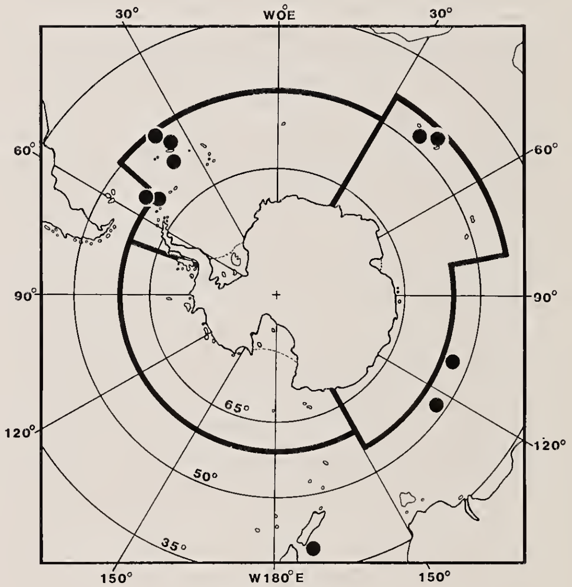


Fig. 6. Representative otolith of *C. armatus*; fish length unknown



Distribution of *C. armatus*

Distribution: Probably world-wide although not recorded from the central and western parts of the Pacific Basin and the Indian Ocean north of approximately 45°S. In the North Pacific the species is confined mostly to near the continental margins, but in the Atlantic, it is more widely distributed over the oceanic basin. The species is marginal to the Southern Ocean, never having been recorded from deep inside the Antarctic Polar Front. Depths most commonly between 2,000 and 4,300 m; shallowest record (732 m) at type locality off Cape Farewell, New Zealand.

Remarks: Wilson & Waples (1984) distinguished 2 subspecies, *C. armatus variabilis* (confined to the North Pacific) and *C. a. armatus* (everywhere else), based on differences in interorbital space, dorsal interspace, dorsal- and pectoral-fin ray counts, and in allelic frequencies at the phosphogluconate dehydrogenase locus. Food preferences change with size, the young feeding mainly on benthic invertebrates (especially crustaceans and holothuroids), the adults on mesopelagic fishes and cephalopods.

Attains over 87 cm.

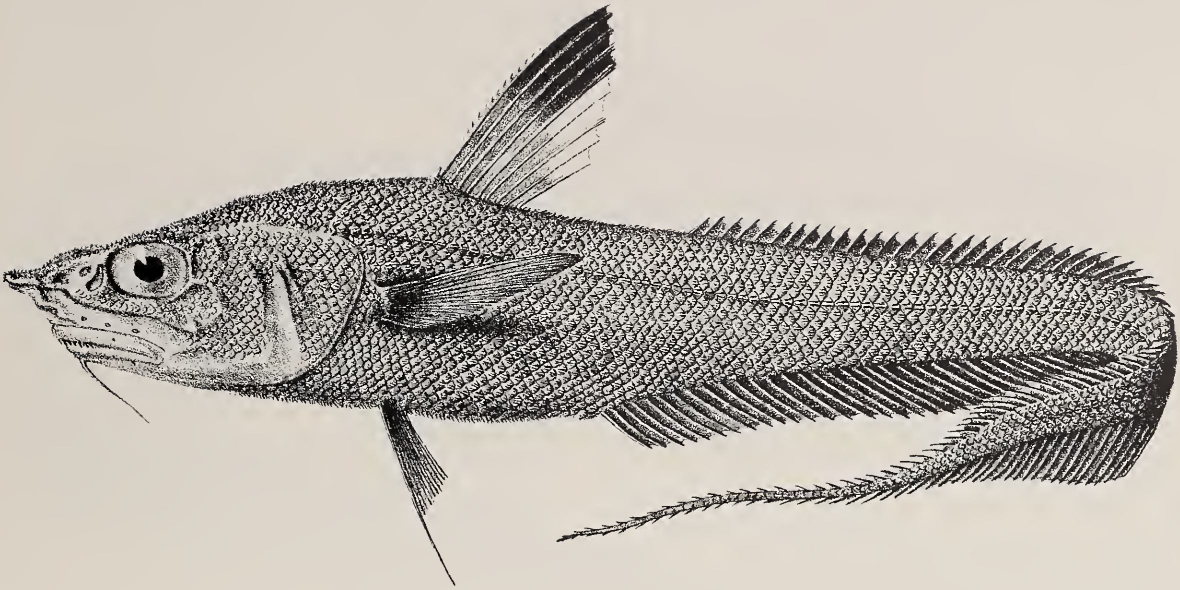


Fig. 7. *Coryphaenoides ferrieri* holotype, 23 cm TL (71°21'S, 16°34'W) (from Regan 1913)

Coryphaenoides ferrieri (Regan, 1913)
Fig. 7

Chalinura ferrieri Regan, 1913: 236, pl. 2, fig. 1, Coats Land (71°22'S, 16°34'W). Holotype: NMSZ 1921.143. 0356.

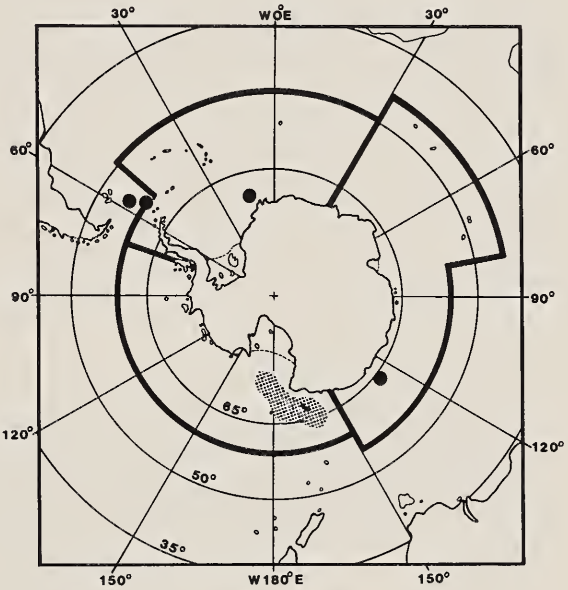
Diagnosis: D II,8–10 + about 100–110; P i,17–i,21; V 10–11; total inner GR 9–11; scales below middle of first dorsal fin 6–8. Head length 5.1–5.9 in TL. Snout 3.0–3.7, orbit diameter 4.5–5.9, upper jaw length 2.5–2.9, interorbital width 3.7–4.5, outer gill slit 5.3–6.7, and dorsal interspace 1.8–2.2 in HL. Barbel length 0.9–1.7 and suborbital width 1.5–2.1 in orbit. Snout rather long and pointed. Head pores large and prominent; head dorsally covered with small coarse scales, none particularly enlarged; ventral surfaces mostly naked including snout, most of suborbital, ventral margin of preopercle, and mandibles (some scattered small scales); body scales relatively adherent, coarsely spinulated, the spinules in 3–5 parallel, ridge-like rows. Teeth slender, conical, sharply pointed, in a narrow band on upper jaw with an outer enlarged series, in 1–2 irregular rows on mandible.

Colour: In alcohol, greyish-brown to dark brown overall. Fins darker.

Distribution: Endemic to the Southern Ocean (sensu lato). Depth range 2,525–3,931 m.

Remarks: A benthopelagic species of the continental rise.

Biology unknown. Attains about 60 cm.



Distribution of *C. ferrieri*

Coryphaenoides filicauda Günther, 1878
Fig. 8

Coryphaenoides filicauda Günther, 1878: 27. off Valparaiso, Chile (33°31'S, 74°43'W). Lectotype: BMNH 1887.12.7.96.

Diagnosis: D II,8–10 + about 100–110; P i,16–i,19; V 9–10; total inner GR 9–10; scales below middle of first

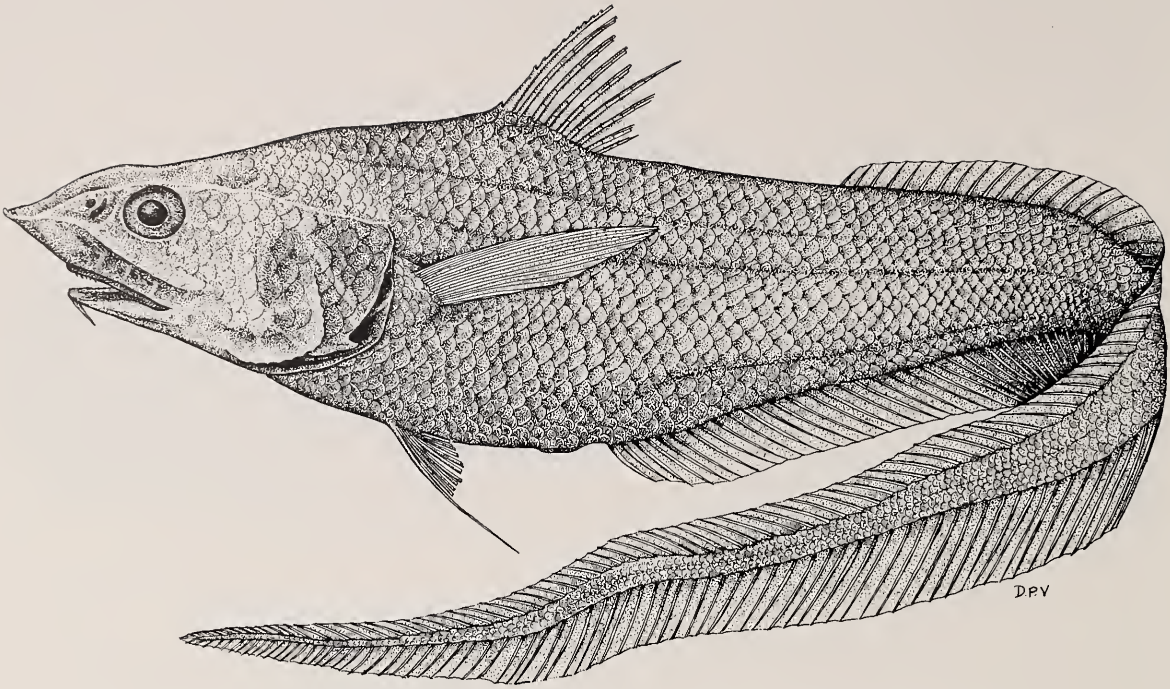


Fig. 8. *Coryphaenoides filicauda* MNHN 1987–210, 32 cm TL, Kerguelen Islands

dorsal fin about 5. Head length 5.7–6.2 in TL. Snout length 2.6–3.0, orbit diameter 5.3–6.4, upper jaw length 2.7–3.1, interorbital width 3.0–3.3, outer gill slit 5.7–10.0, and dorsal interspace 1.2–1.7 in HL. Barbel length 2.2–4.8 and suborbital width 1.2–1.5 in orbit. Snout rather long and pointed. Head pores large and prominent. Head and body covered with thin, fine deciduous scales, with a single median ridge of 1–3 greatly reclined spinules or surface entirely smooth. Teeth small, slender, conical, sharply pointed, in a narrow band on upper and lower jaws, a slightly enlarged outer series in upper jaw. Soft bodied, almost translucent flesh. Spinous ray of first dorsal fin smooth except for a few prickles distally.

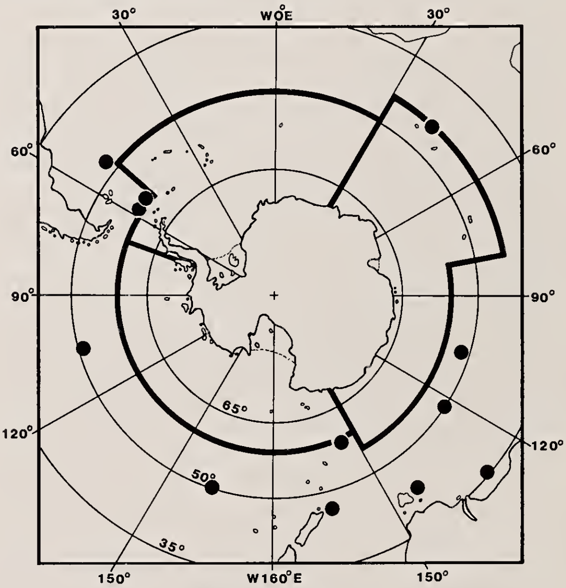
Colour: In alcohol, overall pale to whitish. Mouth dark grey, gill cavity and peritoneum black.

Otoliths

Diagnostic features: The generally oval shape, the entire margin, the ostio-caudal and heterosulcoid sulcus acusticus and the large heteromorph colliculi.

Fig. 9. Representative otolith of *C. filicauda*; fish length unknown

Distribution: Sub-Antarctic in continental rise to abyssal depths; not yet taken within CCAMLR area, but found almost within borders and may occur as strays. Depth range 2,470–5,070 m, but most often taken between 3,500 m and 5,000 m.



Distribution of *C. filicauda*

Remarks: Iwamoto & Sazonov (1988) have recently treated the species and compared it with its close relative *C. carapinus* (Goode & Bean 1883). These two species are the only representatives of the subgenus *Lionurus*, and these 2 species may be sympatric in sub-Antarctic waters. A related species of indeterminate status is recorded below from a juvenile taken off Crozet Islands.

Attains about 40 cm.

Coryphaenoides lecointei (Dollo, 1900)
Fig. 10

Macrurus lecointei Dollo, 1900d: 384, Antarctic, *Belgica* station 873 (70°40′S, 102°15′W). Holotype: IRSNB 4.

Diagnosis: D II,8–10 + about 100; P i,16–i,20; V 10–11; total inner GR 11–14; scales below middle of first dorsal fin 6–8. Head length 5.2–5.8 in TL. Snout length 3.4–4.0, orbit diameter 3.6–4.5, upper jaw length 2.3–2.6, interorbital width 3.6–4.2, outer gill slit 4.5–5.7, and dorsal interspace 1.3–1.9 in HL. Barbel length 1.5–3.3 and suborbital width 2.5–3.1 in orbit. Underside of snout naked, but head otherwise mostly covered with small, rather deciduous scales bearing 3–5 parallel rows of low weak spinules. Terminal snout scute broad and blunt. Teeth usually in 2 distinct rows on upper jaw, but occasionally with narrow band 3–4 teeth wide anteriorly; lower jaw teeth in 1 row.

Colour: In alcohol, overall brownish-grey to dirty whitish (especially when denuded of scales). Leading rays of first dorsal, pectoral, and pelvic fins usually blackish, the remainder of fins clear or dusky. Smaller Atlantic specimens appear to be somewhat darker overall.

Otoliths

Diagnostic features: The discoid shape, the ostio-caudal and homosulcoid sulcus acusticus, the crater-like ostium and cauda, and the absence of a rostrum, antirostrum and excisura ostii.

Fig. 11. Representative otolith of *C. lecointei*; fish length unknown; scale bar 1 mm

Distribution: Generally restricted to continental rise depths of Southern Ocean, although a few records occur outside boundaries. Depth range 2,154–3,931 m.

Remarks: Probably the most common deeper-living grenadier in the Southern Ocean, although no capture records were available from east of 175°E.

Coryphaenoides affinis (Günther, 1878), known from only 2 specimens taken off the Rio La Plata at 3,475 m (35°39′S, 50°47′W), may be a synonym of *C. lecointei*. Cursory examination of the type specimens showed virtually no differences of significance except outer gill slit length (25–29% HL in *affinis* vs 18–22% in *lecointei)* and suborbital width (3.3–3.4 in orbit vs 2.5–3.1). Closer comparisons of comparable-sized specimens of both species may reveal them to be conspecific. *Coryphaenoides lecointei* differs from *C. armatus* primarily in its sharper, more slender teeth, more extensive scale covering on the head, smaller, less prominent cephalic lateral line pores, relatively narrower and more pointed snout, and paler

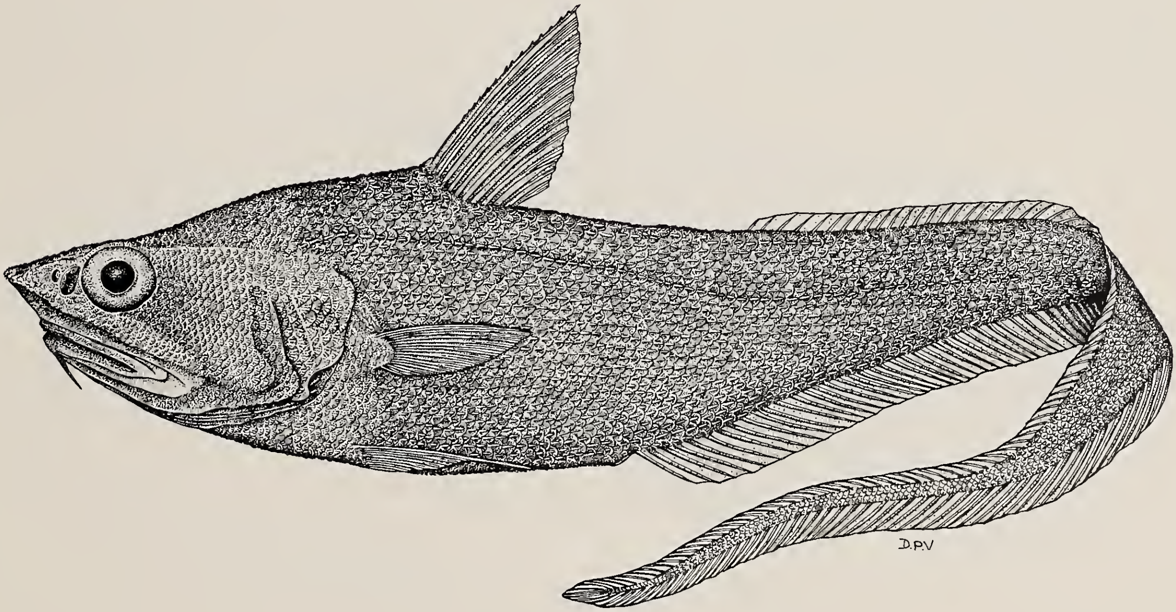
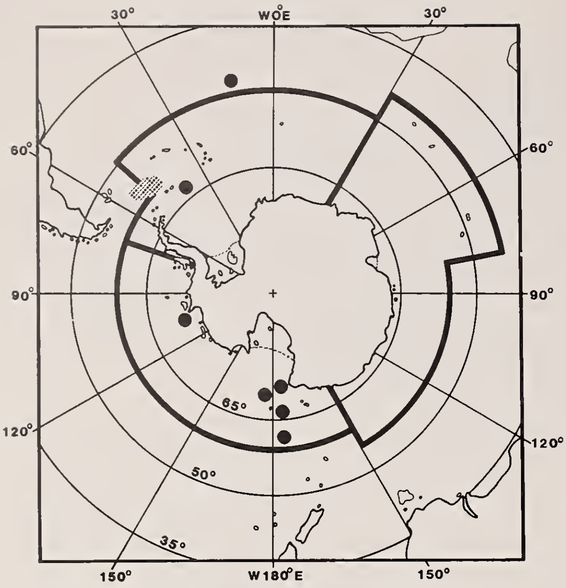


Fig. 10. *Coryphaenoides lecointei* MNHN 1987–208, 40 cm TL, Kerguelen Islands



Distribution of *C. lecointei*

fins. It differs from *C. ferrieri* in dentition pattern, squamation (much coarser and adherent in *ferrieri* and naked areas more extensive), in its paler colour, and its relatively less pointed snout.

Attains over 60 cm.

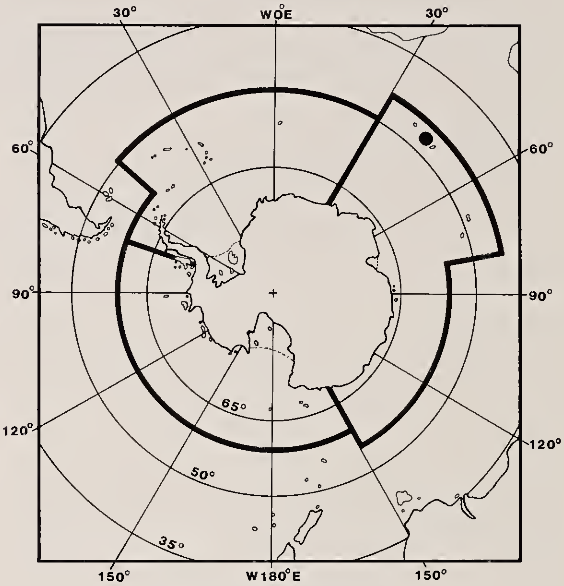
Coryphaenoides sp.
Fig. 12

Coelorhynchus fasciatus (*non* Günther, 1878): Hureau, 1979: 238, 245, Crozet Islands.

Diagnosis: D II,7; P i,18; V 9; total outer GR 10, inner GR 14. Head length 5.3 in TL. Snout length 2.9, orbit diameter 6.8, upper jaw length 2.4, interorbital width 2.9, outer gill slit 4.6, and dorsal interspace 1.9 in HL. Barbel length 2.2 and suborbital width 0.7 in orbit. Snout high, moderately pointed and protruding, broad, its width across supranarial ridges about three-quarters interorbital space. Orbit very small, greatest diameter much less than suborbital width. Teeth all small, those in upper jaw in a narrow band, those in lower jaw in about 3 irregular rows at symphysis, uniserial laterally. A single denticle on leading edge of incomplete spinous ray of first dorsal fin.

Colour: In alcohol, pale brownish overall, abdomen and gill covers dark, underside of head probably brownish in life. Mouth and gill cavities dark brownish grey.

Distribution: Known only from a single specimen captured at Crozet Island.



Distribution of *Coryphaenoides* sp

Remarks: This juvenile seems to agree in most respects with *Coryphaenoides carapinus,* but it has a longer upper jaw, somewhat smaller orbits, and more inner gill rakers on the first arch. Whether or not these differences may

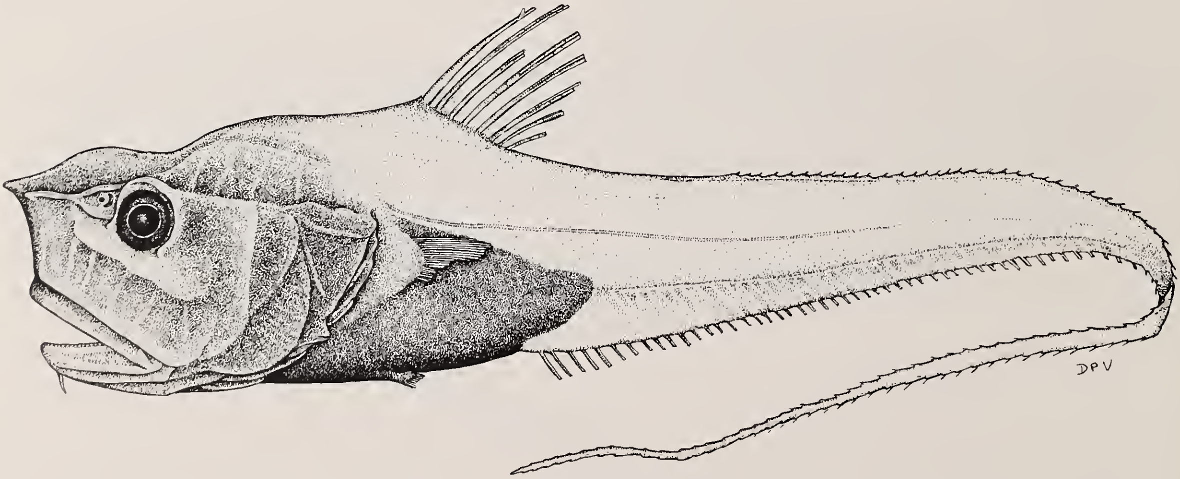


Fig. 12. *Coryphaenoides* sp. MNHN 1985–891, 127+ mm TL, Crozet Islands

be attributes of the juvenile stage or different species is not known. Until more specimens become available, the prudent course seems to be to leave it unnamed.

Genus *Cynomacrurus* Dollo, 1909

Large terminal mouth, the lower jaw bearing canine teeth in a single row, the upper jaw a band of small teeth and a pair of fang-like teeth anteriorly. Branchiostegal rays 6. Lateral-line canal in 2 sections. Anus at anal-fin origin. No light organ. Swim-bladder regressed. Monotypic.

Cynomacrurus piriei Dollo, 1909
Fig. 13

Cynomacrurus piriei Dollo 1909: 320, Weddell Sea, off Coats Land (71°50′S, 23°30′W). Holotype: NMSZ 1921.143.0358.

Diagnosis: D II,8–9 + about 100; P i,13–i,16; V 7–8; GR outer series 0+(8–9), GR inner series 2+(12–14); scales below first dorsal fin about 7; pyloric caeca 9–10. Head length 4.8–5.2 in TL. Orbit diameter 5.5–6.5 and interorbital width 3.1–3.4 in HL. Scales small, bearing needle-like spinules in 1–5 divergent rows; broad areas on head naked. Maxilla extends well beyond orbits; small teeth in narrow bands in premaxillae, with 1 or more pairs of fang-like teeth anteriorly; lower jaw with 4–11 canines in a single row. Large pores on head. Lateral-line scales large, anterior segment of lateral line terminates at about vertical through second dorsal-fin origin, the posterior (midlateral) segment begins at about same vertical.

Colour: In alcohol, dark brown to blackish overall, including fins.

Otoliths

Diagnostic features: The discoid geometric shape, the flat medial face, the strongly convex lateral face and the medial sulcus acusticus.

Intraspecific variation: Negligible except for the variability of the colliculi and the definition of the cristae.

Fig. 14. Representative otolith of *C. piriei*; fish length 21 cm TL; scale bar 1 mm

Distribution: A bathypelagic species, widespread in and endemic to the Southern Ocean; north of the Antarctic Polar Front in some areas. Captured at more than 150 midwater trawl stations of the USS *Eltanin*, at fishing depths (using open nets) ranging from about 300 m to more than 3,000 m; most, however, were made between 1,000 and 2,000 m.

Remarks: Common in 1,000–2,000 m, but seldom taken in quantity. Pelagic copepods were found in the throat of 1 specimen; probably also feeds on small fish and invertebrates. Marshall (1964) found well-developed eggs of 1.0–1.2 mm diameter in specimens of 373–445 mm TL. Evseenko & Efremenko (1988) described a 14.3 mm SL larva collected in the upper 100 m in the Ross Sea.

Attains 46 cm.

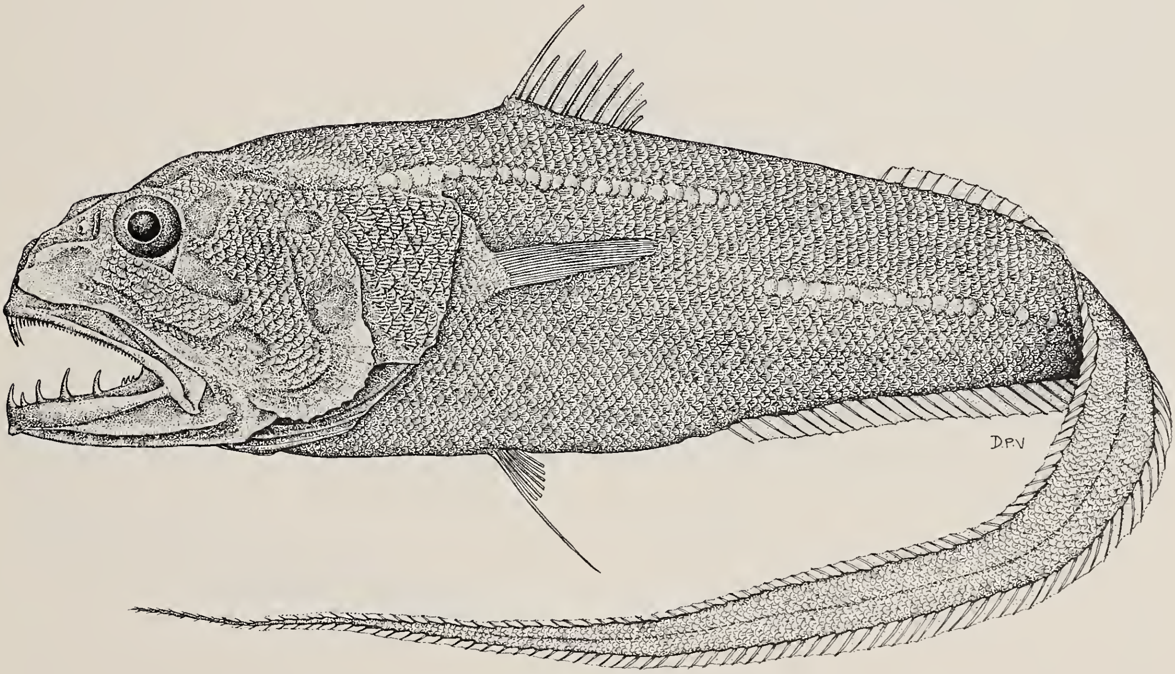
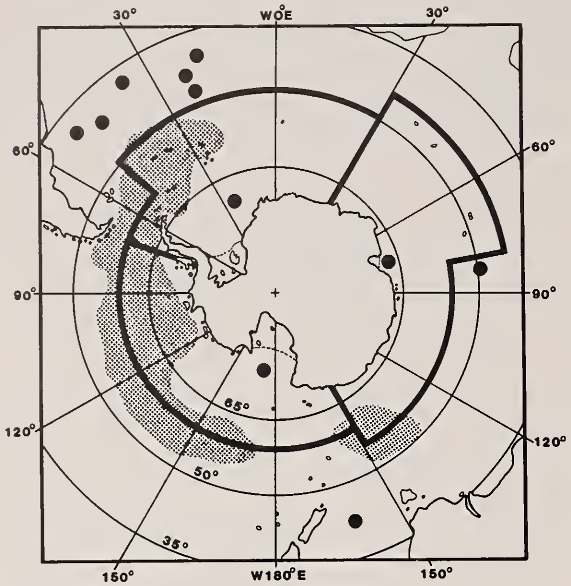


Fig. 13. *Cynomacrurus piriei* LACM 11687–7, 34 cm TL (60°03′S, 127°03′W)



Distribution of *C. piriei*

Genus *Macrourus* Bloch, 1786

Head large and broad, its depth 4.2–4.6 in TL. Snout rounded to bluntly pointed. Mouth subterminal, jaws extend beyond vertical through mid-orbit. Orbits large, about one third of head. Branchiostegal rays 6. Outer gill rakers on first arch absent. Body scales with enlarged median row of spinules flanked by parallel rows of much smaller spinules. Head with a strong suborbital ridge that extends posteriorly onto preopercle, ending in a sharp point. Dorsal fin spinous ray serrated. Pelvic-fin rays 7–9. Anus at anal-fin origin, no light organ. Swimbladder shallowly bilobed anteriorly, with 4 retia mirabilia. Teeth small, in moderate to broad bands in premaxilla, none much enlarged, the bands tapering posteriorly and ending well short of rictus, mandibular band about 3–4 teeth wide at symphysis, narrowing to 1 row posteriorly and extending to about end of rictus.

Four species; 1 in North Atlantic, 2 in temperate to sub-Antarctic waters, and 1 restricted to Southern Ocean. The following key to species was adapted from a key graciously provided by I.A. Trunov, July 1988.

KEY TO SPECIES

1a Underside of head without scales, or with only 1–3 scales above corner of mouth...................... *M. holotrachys*

1b Scales usually present between suborbital ridge and jaws, and on underside of lower jaw (scales sometimes small and thin, and scarcely visible without magnification)...........2

2a Scales in oblique row between A origin and lateral line more than 27; interorbital space 1.1–1.6 (1.7–1.9 in small specimens) in orbit; first gill slit usually 1.4–1.5 times length of last slit .... *M. whitsoni*

2b Scales in oblique row between A origin and lateral line fewer than 27; interorbital space 1.5–2.3 in orbit; first gill slit about equal to or slightly longer than last slit......... *M. carinatus*

Macrourus carinatus (Günther, 1878)
Fig. 15

Coryphaenoides carinatus Günther, 1878: 28, near Prince Edward Island, *Challenger* station 145A. Holotype: BMNH 1887.12.7.89.

Macrourus holotrachys (*non* Günther, 1878): Hureau, 1979: 238, 245; Golovan & Pakhorukov, 1983: 16;

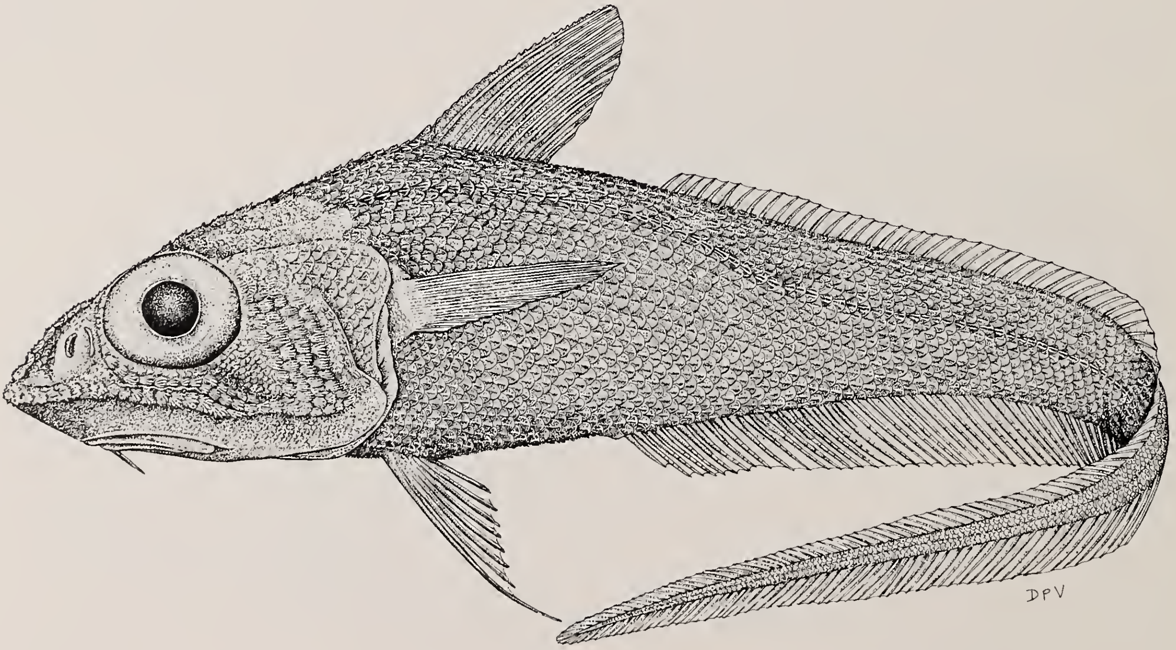


Fig. 15. *Macrourus carinatus* MNHN 1985–269, 28 cm TL, Kerguelen Islands

Trunov, 1982; Iwamoto & Geistdoerfer, 1985: 298 (in part); Iwamoto 1986: 336 (in part).

Coryphaenoides holotrachys (*non* Günther): Norman, 1937a: 41; Pequêno, 1971: 289; Nakamura, 1986c: 134 (?in part).

Diagnosis: D II,9–11; P i,17–i,20; V 8 (rarely 9); total inner GR 8–11; scales below middle of first dorsal fin usually 4.5–6.5. Head length 4.4–4.8 in TL. Snout length 2.8–3.5, orbit diameter 2.6–3.2, upper jaw length 2.6–3.7, interorbital width 5.0–6.9, outer gill slit 7.2–11.1, and dorsal interspace 4.5–7.2 in HL. Barbel length 2.2–3.9 and suborbital width 2.0–3.1 in orbit. Naked patches on dorsal surface of snout behind leading edges small. Underside of head posterior to snout moderately to extensively scaled, but sometimes only a file or narrow band of small scales below suborbital and preopercle ridges, and posteriorly on lower jaw. Body scales with enlarged spinules in median row compressed and bladelike, the tips overlapping to form a lightly serrated, continuous ridge much higher and longer than ridges on either side. Origins of anal and second dorsal fins more or less on same vertical.

Colour: In alcohol, medium brown to somewhat straw coloured. Fins darker, blackish in some; dorsal and pelvic fins in small specimens dark distally, paler basally. Mouth lining dark grey or brown.

Otoliths

Diagnostic features: The elongate oval shape, the sinuate mid-section of the dorsal margin, the ostio-caudal and homosulcoid sulcus acusticus and the homomorph colliculi.

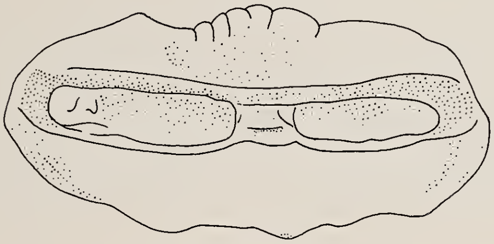
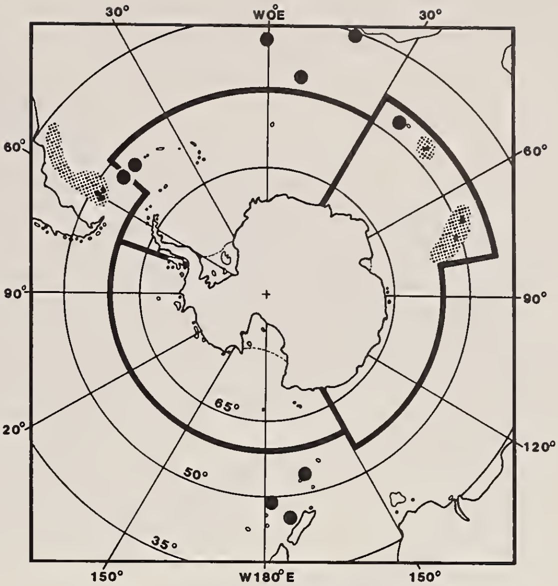


Fig. 16. Representative otolith of *M. carinatus*; fish length unknown

Distribution: Trunov & Konstantinov (1986) give the distribution as both sides of South America, Falkland (Malvinas) Islands, Discovery and Meteor seamounts, South Africa, off Crozet and Prince Edward islands, and off New Zealand. The depth distribution ranges from about 300 m to 1,100 m, although it is most often taken between 500 and 800 m.

Remarks: Trunov & Konstantinov (1986) clarified the differences between *M. carinatus* and *M. holotrachys* based on Soviet collections from the Argentine coast. They found the species to differ in: squamation on underside of head (more extensive in *M. carinatus*); lunate areas behind leading edges of snout (broader, more naked in *M. holotrachys*); pelvic-fin rays (usually 8 in *M. carinatus* vs 9); pyloric caeca (13–21 in *M. carinatus* vs 8–16); and relative positions of the origins of the second dorsal and anal fins (second dorsal origin in advance of anal fin in *M. holotrachys*, above anal fin in *M. carinatus*).



Distribution of *M. carinatus*

The difficulty of distinguishing *M. carinatus* from its sympatric congener *M. holotrachys* has led to much confusion in the literature. Trunov & Konstantinov's (1986) paper, from which the above synonymy was taken, provides concrete means by which the two can be distinguished. Caution should be exercised, however, in judging the extent of squamation on the underside of the head, as considerable variation exists in this character. In some specimens of *M. carinatus*, scales densely cover most of the underside, whereas in others, only a file or narrow patch of small thin scales can be found above the jaws. The distributional limits of both species have yet to be properly assessed, and the apparent overlap in distributions along the Patagonian slope should be carefully studied to determine the factors effecting separation of the species.

Macrourus carinatus is an abundant slope species off the Patagonian coast of Argentina and Chile and is currently being harvested by the Argentines. Some of the catch is being imported into the United States and sold under the name Grenadero.

Attains over 70 cm.

Macrourus holotrachys Günther, 1878

Fig. 17

Macrurus holotrachys Günther, 1878: 24, east of mouth of Rio de la Plata, *Challenger* station 320. Holotype: BMNH 1887.12.7.87.

Diagnosis: D II,9–11; P i,17–i,19; V 9 (rarely 8); total inner GR 8–11; scales below middle of first dorsal fin usually 4.5–6.5, diagonal scale rows from anal-fin origin to lateral line fewer than 27. Head length 4.4–4.6 in TL. Snout length 2.7–3.4, orbit diameter 2.5–3.0, upper jaw length 2.4–4.2, interorbital width 4.8–6.4, outer gill slit 8.5–12.8, and dorsal interspace 4.1–8.1 in HL. Barbel length 3.3–4.5 and suborbital width 2.4–2.5 in orbit. Upper side of snout with a broad naked patch on either side behind anterolateral margins; underside of head entirely naked, or at most, only 1–3 small scales just above corner of mouth. Body scales as described for

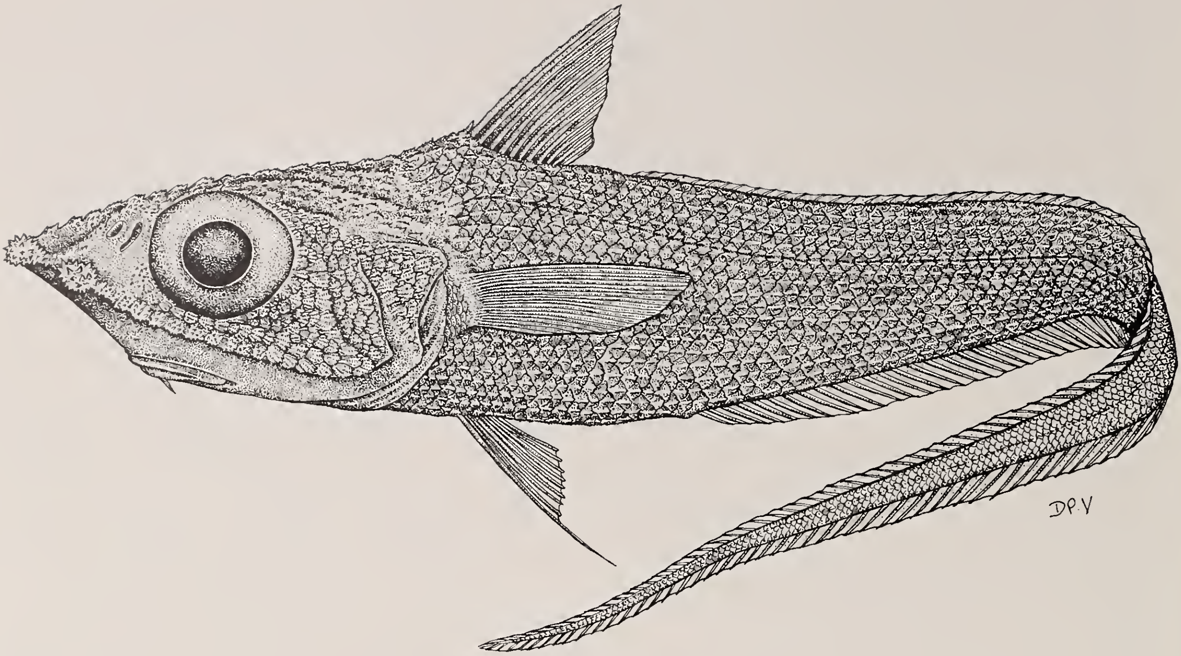
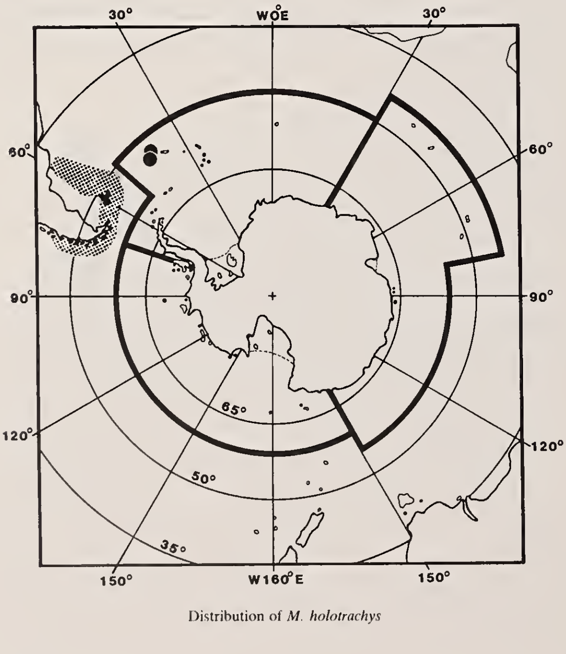


Fig. 17. *Macrourus holotrachys* holotype, 22+ cm TL

M. carinatus. Anal-fin origin behind that of second dorsal fin, usually on a vertical below 2nd to 4th ray of latter.

Colour: In alcohol, pale brown without markings.

Distribution: Generally Magellanic in distribution, from Uruguay to Falkland (Malvinas) Islands, but 2 specimens from Shag Rock (ZIN 48719, 295 mm, 620–635 m; ZIN 48365, 420 mm, 512–597 m) were brought to my attention by Dr. Trunov. Depth range about 150–1,100 m.



Distribution of *M. holotrachys*

Remarks: The extensive collections of *Macrourus* made by Japanese exploratory fishing vessels off the southern tip of South America and reported by Nakamura (1986c) should be re-examined in view of the currently recognised differences between *M. carinatus* and *M. holotrachys*. It is likely that the 2 species are represented in those collections, and their study may uncover new aspects of the distribution and ecology of the 2 species.

Attains over 80 cm.

Macrourus whitsoni (Regan, 1913)

Fig. 18

Chalinura whitsoni Regan, 1913: 236, pl. 2, fig. 2, off Coats Land (71°22′S, 16°34′W). Holotype: BMNH 1912.7.1.87.

Macrourus holotrachys (*non* Günther): Iwamoto & Geistdoerfer, 1985: 298 (in part).

Diagnosis: D II,8–11 + about 100–110; P i,17-i,20; V 7–9 (usually 8); total inner GR 10–12; scales below middle of first dorsal fin usually 6.5–7.5 (rarely 5.5). Head length 4.2–5.0 in TL. Snout length 3.7–5.2, orbit diameter 2.6–3.1, upper jaw length 2.3–3.1, interorbital width 3.7–4.5, outer gill slit 4.5–7.1, and dorsal interspace 3.6–7.1 in HL. Barbel length 2.8–5.2 and suborbital width 2.2–2.9 in orbit. Snout tipped with a stout spiny tubercle. Underside of head generally covered with small scales below suborbital, preopercle, and posteriorly on mandible, but scales sparse in some individuals; underside of snout and mandible often covered with hair-like papillae in large specimens. Body scales with short, rather slender spinules in longitudinal rows, the median row forming a spiked ridge much larger than the 2–4 short lateral rows on each side. Anal-fin origin usually below or anterior to that of second dorsal fin.

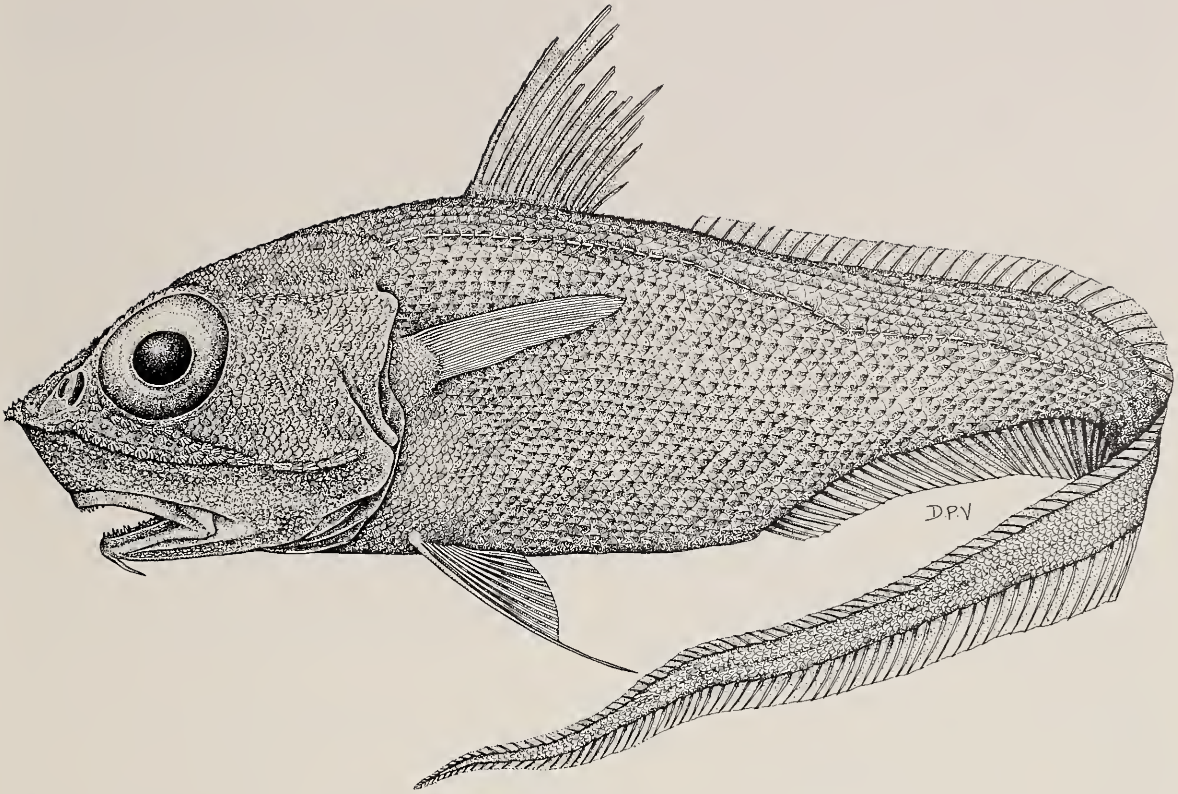


Fig. 18. *Macrourus whitsoni* LACM 11048–1, 33 cm TL (59°34′S, 27°18′W–59°37′S, 27°16′W)

Colour: In alcohol, dark brown to swarthy overall. Fins and lips blackish.

Otoliths

Diagnostic features: The oval shape, the ostio-caudal and homosulcoid sulcus acusticus and the homomorph colliculi.

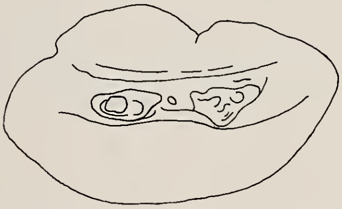
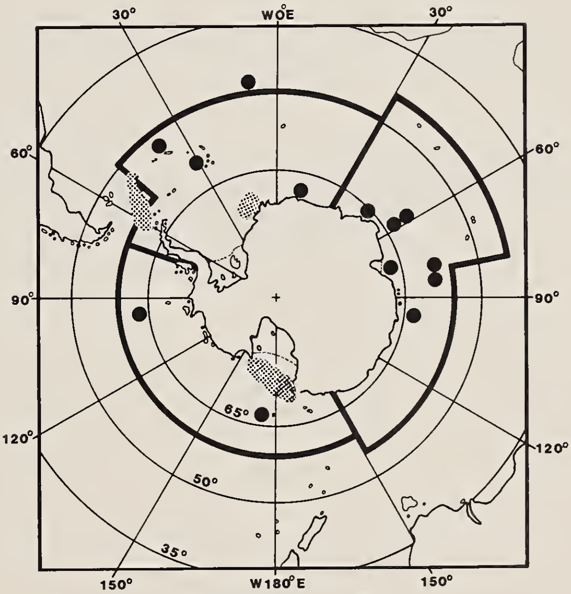


Fig. 19. Representative otolith of *M. whitsoni*; fish length unknown

Distribution: Found throughout the Southern Ocean and on to the continental slopes of Antarctica; generally does not occur north of the Convergence except in the Falkland (Malvinas) Islands–Burdwood Bank area. Depth range from about 400 m to 3,185 m, although it is most often found in depths of 600–1,500 m.



Distribution of *M. whitsoni*

Remarks: *Macrourus whitsoni* can be distinguished from *M. carinatus* by characters given in the key and the combination of slightly more gill rakers, more scales below second dorsal fin (6.5–7.5 vs 4.5–6.5), broader interorbital space (21–28% vs 14.5–20% HL), longer outer gill slit (15–22% vs 9–14% HL) (Fig. 20), and overall darker colour.

Feeds on pelagic crustaceans (especially euphausiids), small fish, and polychaetes. A large species of some potential, if not actual, commercial value, along with its close relatives to the north, *Macrourus holotrachys* and *M. carinatus*. Their North Atlantic congener, *M. berglax* is currently heavily fished.

Attains about 75 cm.

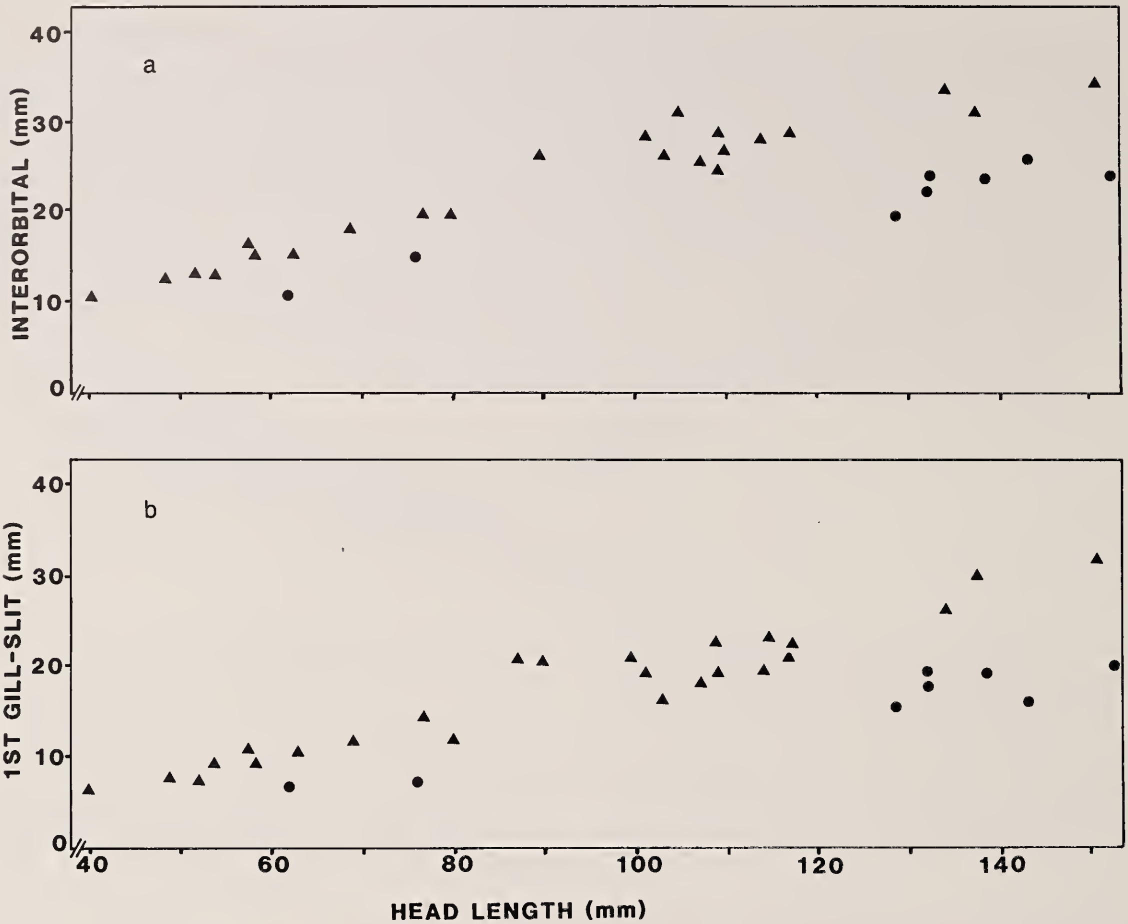


Fig. 20. Scatter diagrams comparing interorbital width (a) and length of first gill slit (b) to length of head in *M. whitsoni* (triangles) and *M. carinatus* (circles)

OPHIDIIDAE

Cuskeels

by J.G. NIELSEN

Body more or less elongate. Dorsal and anal fins long-based, joined to caudal fin. Ventral fins absent or with 1–2 slender rays. Scales small and cycloid. Developed gill rakers on first arch 3 or more. All ophidiids are oviparous.

Predominantly found in the tropical area and in the deep sea. About 40 genera with 135 species and still many to be described. The genera have been reviewed by Cohen & Nielsen (1978). Sizes range from about 15 cm in some shallow water forms to more than a metre in certain deep sea species. One genus represented in Southern Ocean.

Genus ***Holcomycteronus*** Garman, 1899

Snout longer than eye. Opercular spine strong. Basibranchial with 2 median and 1 pair of tooth patches. Vomer with a V-shaped tooth patch. Developed gill rakers on first gill arch 7–10. Pectoral-fin rays 15–21, the ventral ones more or less free. Pelvic fins with 2 rays in each, flattened distally. Six species are recognised, of which 1 is found in our area. The genus is in need of a revision.

Holcomycteronus brucei (Dollo, 1906)

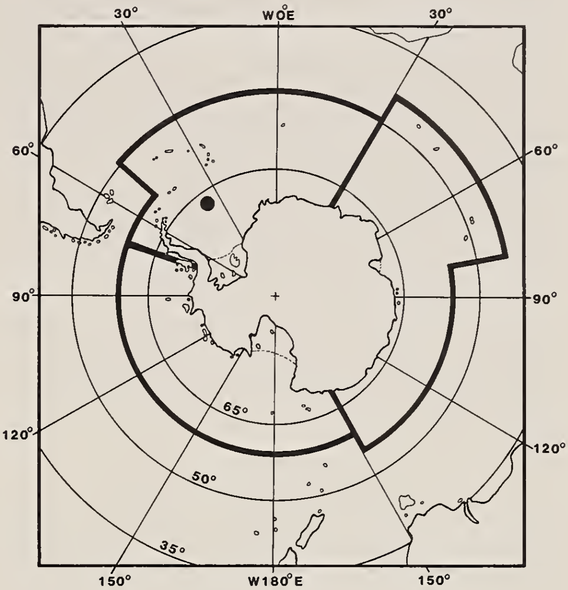
Fig. 1

Neobythites brucei Dollo, 1906a: 117 (67°33′S, 36°35′W). Holotype: NMSZ 1921.143.0484.

Diagnosis: D 104; A 83; C 8; P 18; GR 4+16 (8 well-developed); pseudobranchial filaments 2; LSS about 125; vertebrae 20+49=69. Anterior dorsal-fin ray above vertebra no. 7; anterior anal-fin ray below vertebra no. 22 and dorsal-fin ray no. 27. Body and head covered with small cycloid scales. Lateral line indistinct. Diameter of eye about 5 in snout length and 15 in HL. Maxilla ends well behind eye. Paired basibranchial tooth patches almost as large as posterior, median patch.

Colour: Whitish-brown after 82 years of preservation. No colour notes in original description.

Distribution: Only known from the type locality in the Weddell Abyssal Plain. The holotype was collected at 4,500 m.



Distribution of *H. brucei*

Remarks: Biology unknown. The length of the holotype is 307 mm SL.

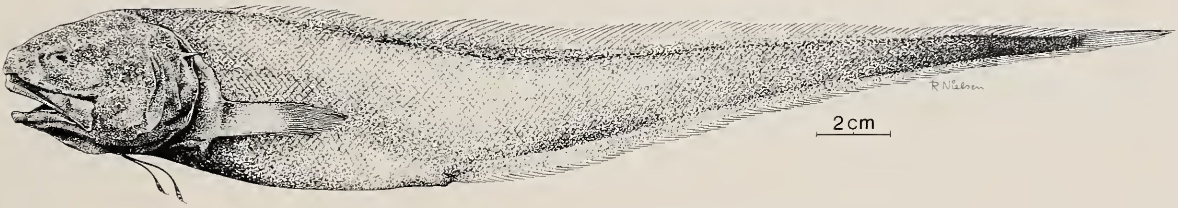


Fig. 1. *Holcomycteronus brucei* NMSZ 1921.143.0484, holotype, male, 31 cm SL

CARAPIDAE

Pearlfishes

by R. MELÉNDEZ & D.F. MARKLE

Naked eel-like fishes with slender body tapering to a long tail. Mouth large, with small teeth and sometimes with large fang-like teeth. Gill membrane free from isthmus. Supramaxillary absent. Pectoral fin usually present, may be reduced or even absent (in some *Encheliophis*). Pelvic fins usually absent (present in *Pyramodon*). Life history complex, with a very specialized pelagic larval stage, the vexillifer, which has a long and variously ornamented first dorsal-fin ray (Olney & Markle 1979, 1986; Markle & Olney 1980, 1990).

The pearlfishes are distributed world-wide principally in tropical waters, from shallow to upper continental slope depths. Some species are free-living (*Echiodon)* and others live inside invertebrate hosts like sea cucumbers, starfishes, and molluscs (Trott 1981; Olney & Markle 1986; Markle & Olney 1990).

The family has been partly reviewed by Arnold (1956), Trott (1981) and Williams (1983, 1984). Markle & Olney (1990) recently completed an extensive revision and cladistic analysis of Carapidae.

According to Markle & Olney (1990), there are 7 genera and 31 species including 1 unnamed form. One genus and 1 species in our area. It should be noted that 3 additional, rare species of *Echiodon* occur off New Zealand and might be encountered in our area (Markle & Olney 1990).

Genus *Echiodon* Thompson, 1837

Carapids with elongate, cylindrical body, and without pelvic fins. Maxillary free. Anus posterior to a vertical through the pectoral-fin base. Symphyseal fangs on the dentary and premaxillary. Numerous small distal radials supporting pectoral-fin rays. Posterior swim-bladder with a ventral patch of tunic ridges. In larvae the vexillum origin is posterior to a vertical through the first anal-fin ray. Markle & Olney (1990) recognise 11 species; 1 in our area.

Echiodon cryomargarites
Markle, Williams & Olney, 1983
Fig. 1

Echiodon cryomargarites Markle, Williams & Olney, 1983: 647, fig. 1a, b, off New Zealand. Holotype: LACM 10985–6.

Echiodon specimens: Markle, Williams & Olney, 1983: 654, fig. 1c, d (53°13′–16′S, 75°41′W).

Diagnosis: D rays anterior to 30th vertebra 36–40 (in larvae 34–40); A rays anterior to 30th vertebra 46–50 (in larvae 45–48); P 19–21; developed GR 3; A rays anterior to dorsal-fin origin 9–12; precaudal vertebrae 25–29. Dorsal-fin origin over vertebrae 11–12; anal-fin origin under vertebrae 6–8. Body firm to soft, each premaxillary and dentary with 1–2 large canines anteriorly. Two pores in the preopercular canal.

Colour: In alcohol, body completely tan with a more or less uniform distribution of small melanophores, slightly more concentrated along myosepta and bases of dorsal and anal fins. Interior of the mouth to branchial cavity from light tan to uniform brown. Outer surface of stomach black, peritoneum tan.

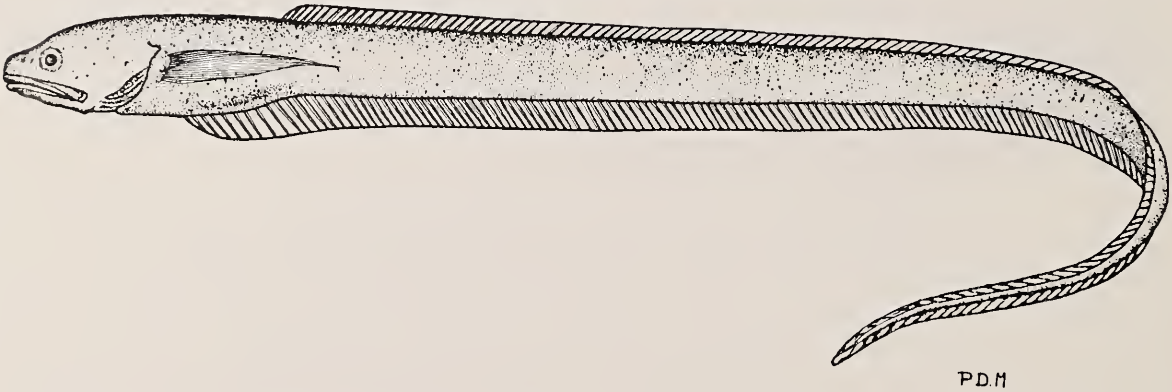
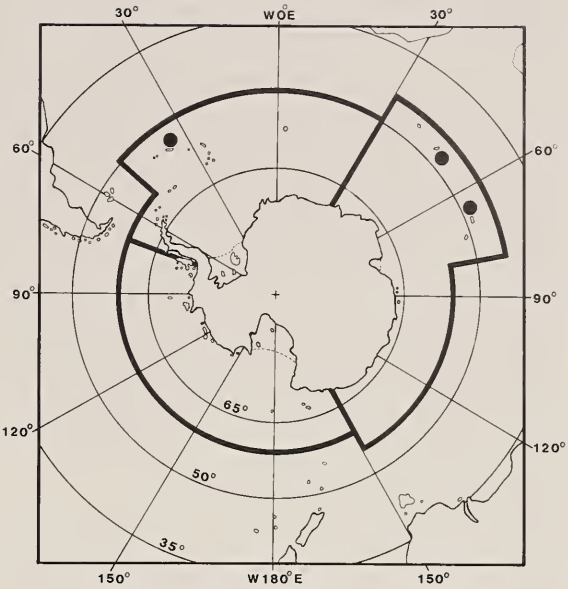


Fig. 1. *Echiodon cryomargarites* LACM 42953–001, 30.8 mm HL, 34 cm TL, female (53°13′–16′S, 75°41′W)

Distribution: Widespread in the subtropical and temperate waters of the Southern Hemisphere, off New Zealand, south of Australia, off Southern Chile, off Argentina and Falkland Islands and southern Brazil. Recently cited by Stehmann (1987) from 53°56′S, 35°40′W, eastern slope off South Georgia Island, at 800 m depth. According to Markle *et al.* (1983), the majority of the adults were caught in bottom trawls on continental or insular slopes.

Remarks: Markle *et al.* (1983), considered that *Echiodon cryomargarites* and *Echiodon* specimens differed slightly in geographic distribution and morphology. Markle & Olney (1990) stated the *Echiodon* specimens are simply a regional variant. *E. cryomargarites* differs from *E. exsilium* and *E. dawsoni* in its low number of precaudal vertebrae (25–29 vs 21–25) and from *E. dentatus* and *E. drummondii* in its high number of pectoral-fin rays (19–21 vs 15–17). There is no evidence of commensalism and it is considered a free living species.

Attains 41 cm TL.



Distribution of *E. cryomargarites*

CERATIIDAE
Seadevils

by T.W. PIETSCH

Metamorphosed females with elongate body; head length approximately 40% SL; greatest body depth about 50% SL. Mouth large, vertical to strongly oblique, not extending past eye; jaw teeth slender, recurved, and depressible, those in lower jaw considerably larger and slightly more numerous than those in upper. Eye small, subcutaneous. Gill opening oval, situated posterior to pectoral fin base. Two or 3 caruncles (modified dorsal rays, each bearing a bioluminescent gland) on dorsal midline of trunk just anterior to dorsal fin. Illicium (fishing apparatus) exposed, emerging on head from between frontal bones just posterior to eye, posterior end protruding on dorsal midline of trunk just anterior to caruncles; escal bulb (bait) oval, with or without 1 or 2 distal appendages. Skin everywhere covered with close-set dermal spines. Swim-bladder absent.

Free-living adolescent males with a pair of large denticular teeth on snout, fused at base and articulating with pterygiophore of illicium. Two pairs of denticular teeth on tip of lower jaw; premaxillae degenerate; jaw teeth absent. Eyes large, bowl-shaped, directed laterally, and pupil much larger than lens. Olfactory organs minute. Caruncles absent. Skin naked. Swim-bladder absent. Adult males parasitic. Skin spinulose. Denticles, eyes, and gut degenerate.

Dorsal fin I+3–5, but nearly always 4; anal fin with 4 soft-rays; pectoral-fin rays 14–19; pelvic fins absent; caudal-fin rays 8–9, the 4 innermost rays bifurcate; branchiostegal rays 6.

Colour: Females in preservative dark red-brown to black over entire surface of body (except for distal portion of escal bulb) and oral cavity. Skin unpigmented in adolescent males, darkly pigmented in parasitic stages. Subdermal pigment present or absent (in *Ceratias*).

This family comprises 2 genera and 4 species (Pietsch 1986). Females represent the largest known ceratioids, attaining a standard length of at least 77 cm. All known free-living males (approximately 75 known specimens) measure less than 12 mm SL, whereas parasitically attached males (about 20 known specimens) range from 9.8–118 mm SL (Pietsch 1976).

Ceratiids are nearly cosmopolitan at depths ranging from approximately 100–4,000 m, but most commonly taken between about 400 and 2,000 m. Taxonomic revisions of the Ceratiidae were done by Regan (1926), Regan & Trewavas (1932), Bertelsen (1943, 1951), and Pietsch (1986). Of the 2 recognized genera, only 1 is present in the Southern Ocean.

Genus ***Ceratias*** Kröyer, 1845

Subopercle without spine on anterodorsal margin. Caudal-fin rays 9, the lowermost ray reduced to a small remnant. Females with illicium long, 19.0–28.2% SL. Two club-shaped caruncles (minute in specimens greater than 40 cm SL) on the dorsal midline of trunk just anterior to origin of soft-dorsal fin.

Males with 2 pairs of lower denticular teeth nearly equal in size.

Three species are recognised, but only 1 is known from the Southern Ocean (Pietsch 1986).

Ceratias tentaculatus (Norman, 1930)
Fig. 1

Mancalias tentaculatus Norman, 1930: 355, fig. 45 (52°25′S, 9°50′E). Holotype: BMNH 1930.1.12.1100.

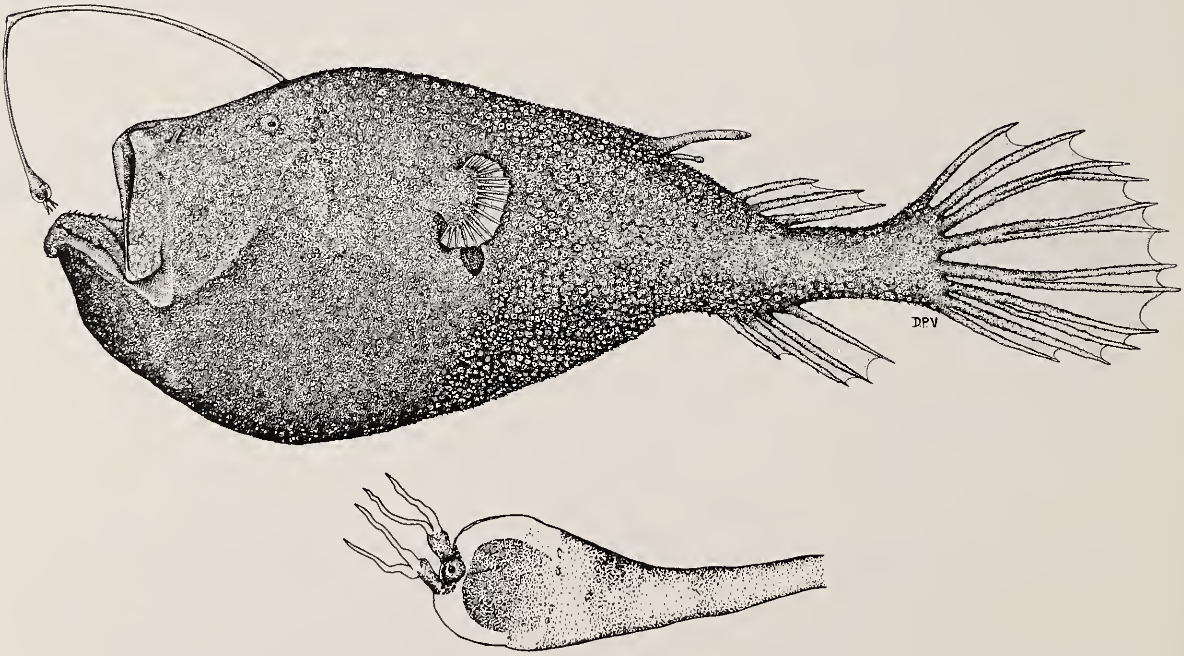


Fig. 1. *Ceratias tentaculatus* LACM 10466–7, 163 mm SL (58°10′S, 59°13′W)

Mancalias bifilis Regan and Trewavas, 1932: 100, pl. 6, fig. 1, east of New Zealand (46°43′S, 176°08′E).

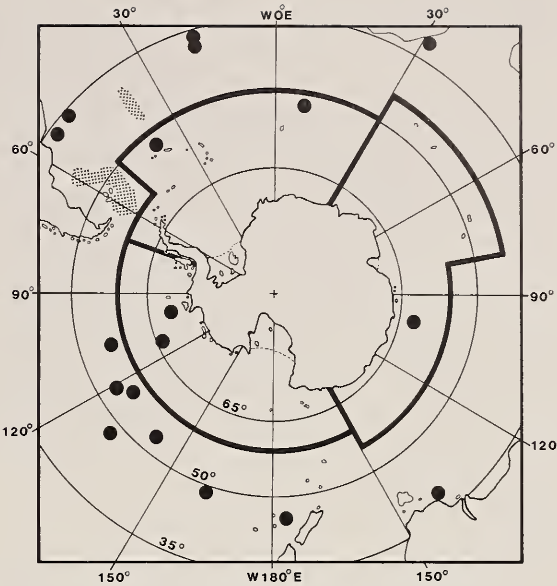
Ceratias holboelli tentaculatus: Bertelsen, 1951: 133, footnote (southern subspecies).

Diagnosis: (see also genus and family diagnoses). Esca with a pair of distal appendages; illicium length 19.1–28.2% SL. Caruncles greater than 6% SL (in specimens 20–150 mm SL). Vomerine teeth present in all known material.

Distribution: Except for 2 small specimens from off Durban and Delagoa Bay (6.2–15 mm SL), and a 534-mm SL specimen from off Saldanha Bay, Southern Africa (Penrith 1967), the known material of *C. tentaculatus* has all been collected within the Southern Ocean between approximately 35° and 68°S.

Although this species may be taken anywhere between approximately 100 and 2,900 m, the majority of specimens have been captured between 650 and 1,500 m (Pietsch 1986).

Remarks: Despite the fact that nearly all recent authors have treated *Ceratias* as a monotypic genus, the possibility of the existence of a northern and southern species has remained. Bertelsen (1943) was able to show that the isolated, so-called free, dorsal-fin ray of *Ceratias* is the posterior end of the movable pterygiophore of the illicium, which when pulled forward lies hidden under the skin of the back, and that the presence or relative length of this structure could therefore not be used to distinguish species. Mainly on this ground, the nominal genus *Mancalias* Gill (1879) was synonymised with *Ceratias,* and the nominal species of these genera were reduced to 2: *C. holboelli* Kröyer (1845) and *C. tentaculatus* (Norman 1930). The separation of these 2 forms was based on differences in the morphology of the esca, coupled with geographic distribution: the 2 adult *C. holboelli* with well-preserved escae known at that time had a single appendage and were collected from the North Atlantic; whereas the 2, or possibly 3 known *C. tentaculatus* had 2 escal appendages and were taken in southern waters beyond the tropics. By 1951, additional material led Bertelsen (1951) to conclude that the number and composition of the escal appendages were more variable and of less taxonomic value than previously supposed. Furthermore, since the distribution of the larvae did not seem to support a separate southern species, Bertelsen (1951) synonymised the 2. In the same publication, however, hearing of 2 additional specimens, 1 from the North Atlantic with a single escal appendage and 1 from the Southern Ocean having 2 (Clarke 1950), Bertelsen (1951: 133) made a final recommendation in a footnote that until further material is available, 2 subspecies should be recognised, a northern *C. h. holboelli* and a southern *C. h. tentaculatus.*



Distribution of *C. tentaculatus*

Since Bertelsen's (1951) monograph, the number of specimens of Southern Ocean *Ceratias* with 2 escal appendages has increased some seven-fold. Twelve specimens (90–470 mm SL) recently obtained during the South Atlantic cruises of the FRV *Walther Herwig,* have provided the primary basis for the resurrection of *C. tentaculatus* from the synonymy of *C. holboelli* (Bertelsen & Pietsch 1984). The validity of this Southern Ocean (sensu lato) endemic is further supported by 10 additional specimens reported by Pietsch (1986), 1 from off Cape Town, South Africa, and 9 collected from the Pacific sector of the Southern Ocean, as well as distinguishing features of the caruncles (those of *C. tentaculatus* slightly larger) and spinulose scales (those of *C. tentaculatus* smaller and more thinly distributed over the body) described by Tarakanov & Balushkin (1988).

Largest known female *C. tentaculatus*: 53 cm SL (Penrith 1967).

ONEIRODIDAE

Dreamers

by T.W. PIETSCH

Metamorphosed females with body relatively short and stout, globose; greatest body depth 50–75% SL. Mouth large, horizontal to somewhat oblique, extending past eye in some genera; jaw teeth slender, recurved, and depressible, those in lower jaw considerably larger and more numerous than those in upper. Eye small, subcutaneous. Gill opening oval, situated posterior to pectoral-fin base. Caruncles absent. Illicium (fishing apparatus) exposed, emerging on head from between frontal bones just posterior to eyes (posterior end protruding on dorsal midline of trunk just anterior to soft dorsal fin in *Oneirodes*); escal bulb (bait) highly variable in morphology. Skin spines usually absent (minute dermal spines present in *Oneirodes*). Swim-bladder absent.

Males free-living. Dermal spines of snout absent; upper denticular bone remote from anterior end of illicial pterygiophore. Jaw teeth absent. Eyes elliptical, directed anteriorly; diameter of pupil larger than that of lens. Olfactory organs large, anterior nostrils close together and opening anteriorly; posterior nostrils lateral, usually larger than eye. Caruncles absent. Skin naked. Swim-bladder absent.

Dorsal-fin rays I+4–8; anal-fin rays 4–7; pectoral-fin rays 14–30; pelvic fins absent; caudal-fin rays 9; branchiostegal rays 6.

Colour: In preservative, dark chocolate-brown to black over entire surface of body (except for distal portion of escal bulb) and oral cavity; nostril area unpigmented in some males. Subdermal pigment present or absent.

The family comprises 15 genera and 54 species. Females of some genera attain a standard length of 213 mm; the largest known metamorphosed male measures 16.5 mm SL (Pietsch 1976).

Nearly cosmopolitan in distribution; may be collected at depths ranging from approximately 300–3,000 m, but most commonly taken between about 800 and 1,500 m. Taxonomic revisions of the Oneirodidae were done by Regan (1926), Regan & Trewavas (1932), Bertelsen (1951), and Pietsch (1974). Only 1 genus is present in the Southern Ocean.

Genus **Oneirodes** Lütken, 1871

Mouth large, cleft extending past eye. Frontal bones convex along entire dorsolateral margin. Vomerine teeth present. Illicium length greater than 13% SL. Sphenotic spine well developed. Articular spine present; quadrate spine larger than mandibular spine; angular spine present. Pharyngobranchial of first arch present. Pectoral lobe short and broad, shorter than longest pectoral-fin rays. Posterior margin of opercle deeply notched; subopercle short and broad; upper portion rounded to bluntly pointed, lower portion semicircular, without anterior spine. Coracoid with a posteroventral process. Skin covered with minute, scattered dermal spines (visible microscopically in cleared and stained specimens); pigmented skin not extending past base of caudal fin.

Of 31 recognised species, only 1 is known from the Southern Ocean (Pietsch 1974).

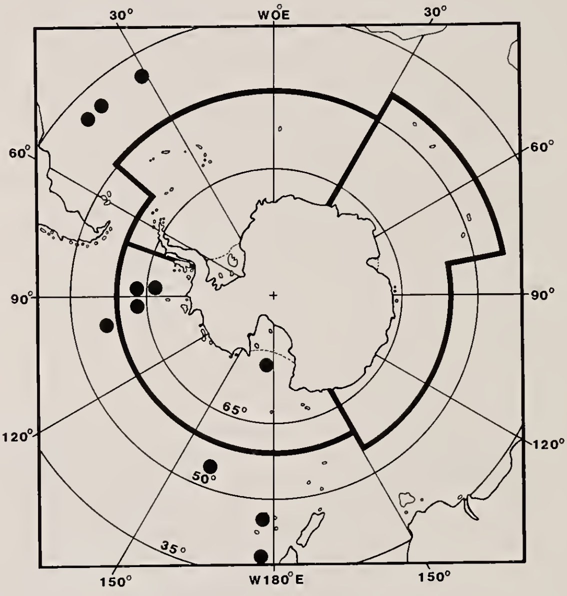
Oneirodes notius Pietsch, 1974

Fig. 1

Oneirodes notius Pietsch, 1974: 70, figs. 30B, 60B, 89, 90, 106 (62°13′S, 95°39′W). Holotype: LACM 111659.

Diagnosis: (see also genus and family diagnoses). D I+5–7; A 4; P 17–19. Esca with anterior appendage bearing a compressed papilla and several smaller papillae on distal tip, papillae darkly pigmented in specimens larger than about 40 mm SL. Posterior margin of upper portion of subopercle indented to deeply notched; ratio of lengths of upper and lower forks of opercle 0.42–0.54.

Distribution: Known only from sub-Antarctic and Antarctic waters: 3 stations from the Atlantic sector of the Southern Ocean along the 40th parallel between 30°30′W and 48°02′W, and 8 from the Pacific sector extending from off New Zealand (at 46°53′S, 179°48′W) south-east to 65°47′S, 88°48′W. Vertical distribution is rather wide, about 700–2,000 m, with the greatest concentration between 800 and 1,100 m (Pietsch 1974).



Distribution of *O. notius*

Remarks: Despite the disjunct distribution pattern shown by the known material of this species, no geographic variation was noted between the Atlantic and Pacific populations.

Largest known female is 150 mm SL.

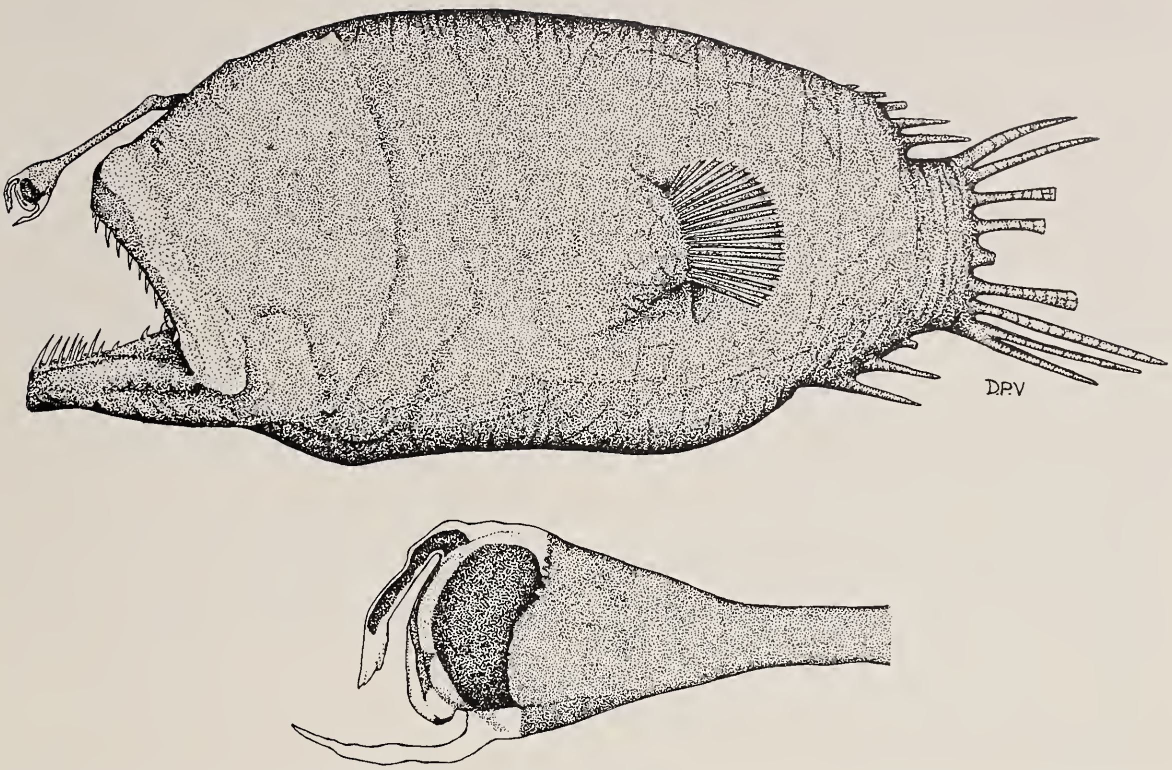


Fig. 1. *Oneirodes notius* LACM 10841–4, 60 mm SL, paratype, female, Pacific sector of the Southern Ocean (62°05′S, 89°56′W to 62°14′S, 89°55′W)

MELANOCETIDAE

Devil-anglers

by T.W. PIETSCH

Metamorphosed females with body relatively short and deep, globose (but often appearing highly compressed apparently due to deformation upon capture); greatest body depth 50–80% SL. Mouth large, cleft oblique to almost vertical, not extending past eye; jaw teeth slender, recurved, and depressible, some slightly hooked distally, those in lower jaw less numerous, but slightly longer, than those in upper jaw. Eye small, subcutaneous. Gill opening oval in shape, situated posterior to pectoral lobe. Caruncles absent. Illicium (fishing apparatus) exposed, emerging on head from between eyes (posterior end concealed under skin); escal bulb (bait) simple, usually with a rounded or conical, distal prolongation, and often with posterior and anterior crests; elongate escal appendages and filaments absent. Minute, widely spaced skin spines present in some species. Swim-bladder absent.

Males free-living. Upper denticular bone with 2–3 semicircular series of strong, recurved denticles, fused with a median series of 3–9 enlarged dermal spines that articulate with illicial pterygiophore; lower denticular with 10–23 recurved denticles, fused into a median and 2 lateral groups; jaw teeth absent. Eyes elliptical, directed laterally, diameter of pupil larger than that of lens. Olfactory organs large, nostrils lateral, nasal area unpigmented, inflated. Caruncles absent. Skin spinulose or naked. Swim-bladder absent.

Dorsal-fin rays I+13–17; anal-fin rays 3–5; pectoral-fin rays 15–23; pelvic fin absent; caudal-fin rays 9; branchiostegal rays 6.

Colour: In preservative, dark chocolate-brown to black over entire surface of body (except for distal portion of escal bulb) and oral cavity. All fins colourless in specimens less than about 40 mm SL (except for caudal rays in adolescent specimens of some species). Nostril area unpigmented in males. Subdermal pigment present or absent.

A single genus and 6 species. Females attain a standard length of 120 mm; the largest known metamorphosed male measures 27 mm SL (Pietsch & Van Duzer 1979).

Nearly cosmopolitan in distribution; may be collected at depths ranging from approximately 250–3,000 m, but most commonly taken between about 500 and 2,500 m. Taxonomic revisions of the Melanocetidae were done by Regan (1926), Regan & Trewavas (1932), Bertelsen (1951), and Pietsch & Van Duzer (1979).

Genus *Melanocetus* Günther, 1864

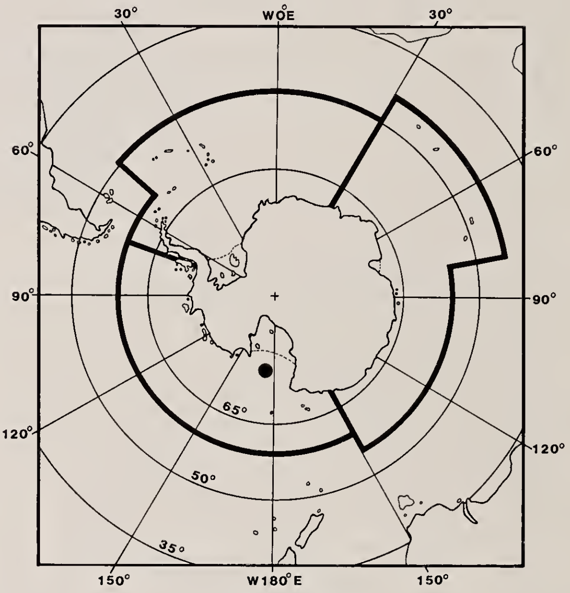
Description as for the family. Of 6 recognised species, only 1 is known from the Southern Ocean (Pietsch & Van Duzer 1979; Balushkin & Fedorov 1981).

Melanocetus rossi Balushkin & Fedorov, 1981

Melanocetus rossi Balushkin & Fedorov, 1981: 79, figs. 1–2 (74°46'S, 177°35'W). Holotype: ZIN 45349.

Diagnosis: D I+14; A 15; P 20. Anterior margin of vomer nearly straight. Illicial length 29.2% SL; esca (bait) laterally compressed, with a distinct, unpigmented median crest, but without anterior or posterior crests; escal bulb width 3.7% of SL. Longest tooth in lower jaw 8.6% SL.

Distribution: Known only from the holotype collected in the Ross Sea, Antarctica, by variable-depth otter trawl in 390 m over a bottom depth of 420 m (Balushkin & Fedorov 1981: 79).



Distribution of *M. rossi*

Remarks: *Melanocetus rossi* is most similar to *M. johnsoni,* but differs from the latter in lacking anterior and posterior escal crests, and in having a considerably smaller escal bulb (width 3.7% SL vs 4.3–8.6% SL for *M. johnsoni)* and a shorter illicium (29.2% SL vs 32.4–60.8% SL for *M. johnsoni*).

Unfortunately, the holotype (118 mm SL) is unsuitable for illustration.

LAMPRIDAE

Opahs

by O. GON

Body oval and compressed. Head large, with a blunt snout and a moderate eye. Nostrils small, contiguous and closer to upper jaw than to eye. Mouth small, with a unique arrangement of protrusible maxillae; teeth present in juveniles but absent in adults. No true spines in fins. Dorsal-fin origin above or slightly behind posterior end of pectoral-fin base. Anterior dorsal-fin rays elongate. Pectoral-fin base horizontal and inserted on upper third of body. Pelvic fins thoracic to abdominal, reaching posteriorly beyond anal-fin origin. Anal-fin base shorter than dorsal-fin base. Caudal fin forked. Body covered with small, cycloid and deciduous scales. Lateral line arched anterior to and level with pelvic-fin insertion, but straightening posteriorly. Swim-bladder large, physoclistic. Branchiostegal rays 6. Vertebrae 43–46.

A single genus *Lampris* Retzius, 1799, with circumglobal distribution except for polar seas. Two species, both in our area. Rare fishes usually found in the lower epipelagic zone. Specialised pelagic larvae. Embryonic development probably precocious (Olney 1984). Recent taxonomic treatment by Palmer & Oelschläger (1976) and Parin & Kukuyev (1983). The key and diagnoses below refer to specimens larger than 50 cm SL.

KEY TO SPECIES

1a Large, pale spots on body; ventral body contour much steeper than dorsal contour; P length 29–35 and greatest body depth 58–68% SL; V inserted under or slightly behind level of rear P base .... *L. guttatus*

1b No pale spots on body; ventral and dorsal contours of body similar; P length 19–21 and greatest body depth 43–53% SL; V inserted well behind P.................... *L. immaculatus*

Lampris guttatus (Brünnich, 1788)

Spotted opah

Fig. 1; Pl 2, Fig. 2

Zeus guttatus Brünnich, 1788: 398, pl. A, Elsinore, Denmark. No type specimens were preserved.

Zeus regius Bonnaterre, 1788: 72, pl. 39 (fig. 155), English Channel.

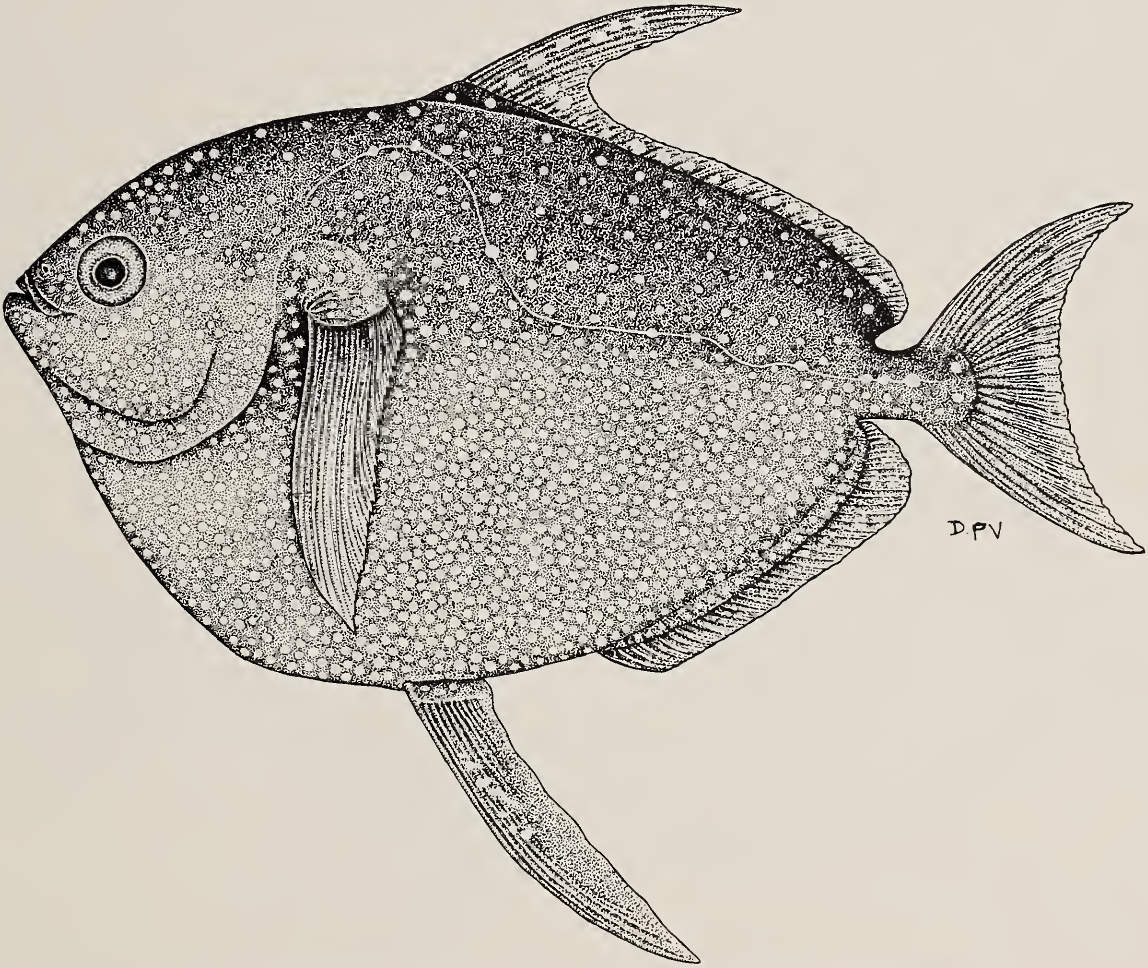


Fig. 1. *Lampris guttatus*, 95 cm, off Cape Town (from *Smiths' Sea Fishes*)

Zeus luna Gmelin, 1788: 1225, "Mari Normanniam alluente".

Lampris guttatus: Müller, 1806: 27, pl. 144.

Lampris lauta Lowe, 1841: 183, Madeira.

Diagnosis: D 48–55; A 33–42; P 20–25; V 13–17; GR 2+14; vertebrae 21+25. Body depth 1.5–1.6 and head length 2.7–3.1 in SL. Snout length 2.6–3.1, eye diameter 4.1–5.3, interorbital space 1.8–2.7 and upper jaw length (maxilla) 3.0–3.1 in HL. Body width 2.7–3.6 in body depth. Caudal peduncle depth 1.3–1.4 in its length and the length 9.1–10.5 in SL. Pectro-ventral distance (between vertical at origins of fins) 7.0–7.2, pectoral fin length 2.8–3.4 and pelvic fin length 2.3–2.5 in SL.

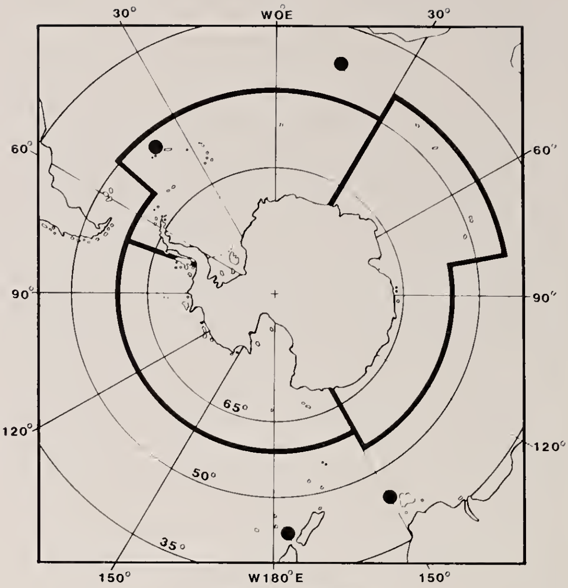
Colour: In life, body silvery-grey with reddish hue showing strongly above anal and pelvic fins. Body covered with large, pale spots, more crowded and numerous on its lower half. Tip of snout and jaws reddish. Fins bright orange with paler distal margins.

Distribution: Occurs in all oceans, including Mediterranean and Caribbean seas, from 140 to about 450 m. It appears to be absent from the Southern Ocean and the single capture near South Georgia (Parin & Kukuyev 1983) may be regarded as incidental.

Remarks: Early life history stages of *L. guttatus* were described by Oelschläger (1974) and Olney (1984). *L. guttatus* goes through radical morphological changes during its development. Most notable are the rapid increase in body depth and the decrease in length of pelvic and anterior dorsal-fin rays.

Excluding the South Georgia record, *Lampris guttatus* reaches its southernmost limit at about 42°S. However, the compilation of distribution records by Parin & Kukuyev (1983) shows that it occurs in sub-Arctic waters in the North Atlantic and Pacific oceans. This implies that the absence of *L. guttatus* from sub-Antarctic waters may be attributed to spatial habitat partitioning, possibly due to biotic factors and the high degree of specialisation of these species. *L. guttatus* feeds on squid and fish.

Attains 200 cm and 270 kg.



Distribution of *L. guttatus*

Lampris immaculatus Gilchrist, 1904

Southern opah

Fig. 2; Pl. 3, Fig. 1

Lampris immaculata Gilchrist, 1904: 4, pl. 22, False Bay, South Africa. Holotype: SAM 11765 (dried specimen).

Lampris guttatus (*non* Brünnich, 1788): Prut'ko, 1979: 140, Kerguelen Islands; Duhamel & Hureau, 1982: 74, Kerguelen Islands.

Diagnosis: D 49–56; A 32–40; P 21–24; V 12–15; GR 13–14; vertebrae 43. Body depth 1.9–2.3 and head length 2.9–3.6 in SL. Snout length 2.7–3.4, eye diameter 4.9–6.6 and interorbital space 1.9–2.4 in HL. Body

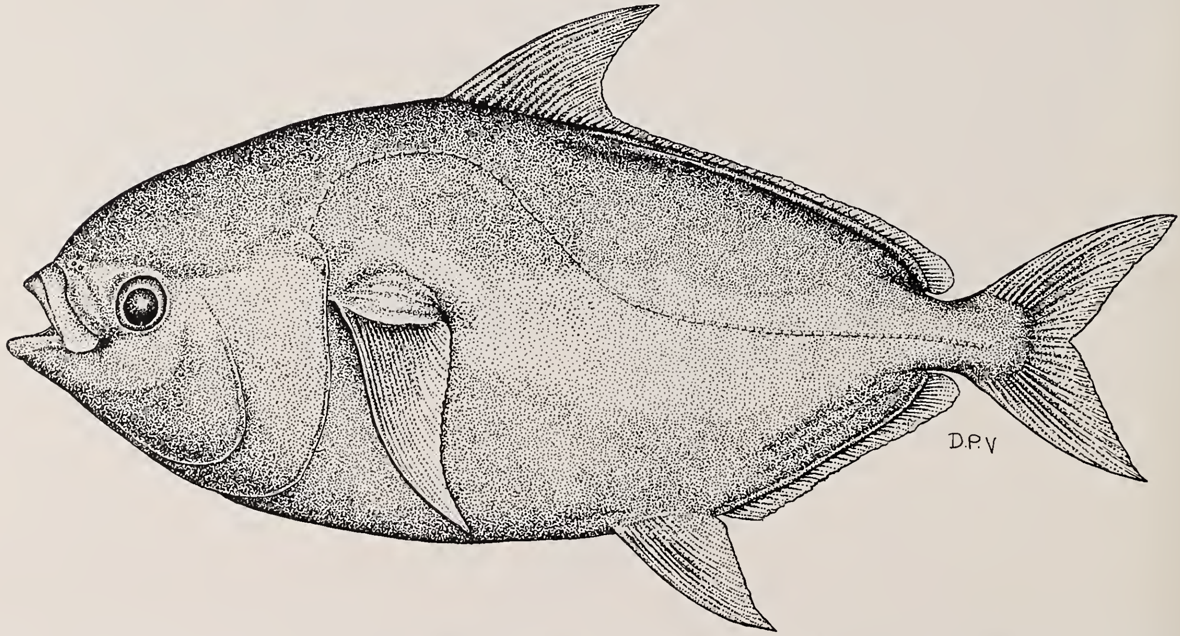


Fig. 2. *Lampris immaculatus*, 82 cm SL, Kerguelen Islands (from a slide by G. Duhamel published in Duhamel & Hureau 1982)

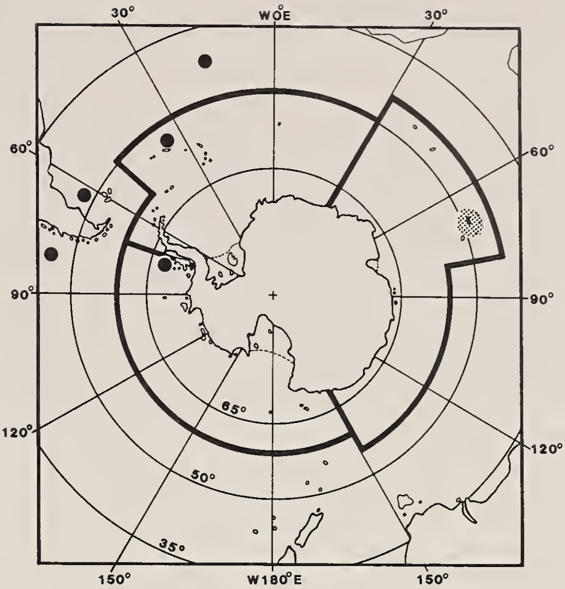
width 2.0–2.6 in its depth. Caudal peduncle depth 1.3–1.7 in its length and the length 8.2–9.6 in SL. Pectro-ventral distance 4.3–5.5, pectoral fin length 4.8–5.4 and pelvic fin length 4.1–6.6 in SL.

Colour: In life, body dark greyish-blue with metallic sheen above level of pectoral fin, grading into silvery-grey below it with reddish hue between lateral line, and anal and pelvic fins. Jaws and snout reddish. Fins bright orange with paler distal margins.

Distribution: Circumglobal in the Southern Hemisphere between 34 °S and the Antarctic Polar Front. One record from the Bellingshausen Sea (Parin & Kukuyev 1983). As most of the captures are between 40 °S and the Antarctic Polar Front, I agree with Parin & Kukuyev (1983) that *L. immaculatus* is essentially a sub-Antarctic species occasionally migrating farther north or south. Vertical distribution 50–485 m.

Remarks: In addition to differences in body depth, pectro-ventral, dorso-ventral and predorsal distances shown by Parin & Kukuyev (1983), *L. immaculatus* differs from *L. guttatus* in having shorter pectoral and pelvic fins (see above). Unusually high variation in pelvic-fin length seems to exist in *L. immaculatus*. The lower value given above was reported by Prut'ko (1979) for a 79.5 cm SL specimen and the higher value was found by Parin & Kukuyev (1983) for a 98 cm SL specimen.

Lampris immaculatus feeds on krill, squid and fish. Prut'ko (1979) found 18 specimens of the gempylid species *Paradiplospinus gracilis* 28.0–29.0 cm TL in the stomach of a single southern opah. Larvae unknown, but a 115 mm SL juvenile was described by Parin & Kukuyev (1983).



Distribution of *L. immaculatus*

Attains about 100 cm SL and over 30 kg.

MELAMPHAIDAE

Bigscale fishes

by O. GON

Beryciform fishes with compressed and oblong to elongate body, somewhat robust in appearance, and a relatively long and slender caudal peduncle. Head large, cavernous and weakly ossified. Frontal bones with thin, delicate ridges (inconspicuous or absent in *Scopelogadus* and *Melamphaes*). Snout short and blunt. A medial internarial spine or ridge in front of eyes, sometimes poorly developed. Circumorbital bones enlarged. Eyes moderate to small. Opercular bones vary from smooth to serrate. Supramaxilla present (except *Scopelogadus*). A single continuous dorsal fin with 1–3 weak, slender spines. A single anal-fin spine. Pelvic fin with 1 spine and 6–8 rays. Caudal-fin base with 3–4 dorsal and ventral procurrent spines. Head sensory canals well developed, covered by thin epidermis with sensory structures in the form of embossed lines. Scales thin, cycloid, moderate to large and usually deciduous. Opercle and cheek (except *Scopelogadus)* scaled. Lateral line reduced to at most 2 pored scales. Teeth villiform, in single to polyserial bands in both jaws. Palate toothless. Pseudobranch varies from poorly to well developed. Branchiostegal rays 7–8. Pyloric caeca 5–8. Vertebrae 24–31 including terminal vertebral element.

Five genera and 33 species of small, rare meso- and bathypelagic fishes with no commercial value. Melamphaid fishes occur in all oceans except the Arctic Ocean and Mediterranean Sea (Ebeling 1986). Recent revisions by Ebeling & Weed (1973), Ebeling (1986) and Maul (1986). Lateral scale series counted from rear end of posttemporal bone to caudal-fin base. Pectoral-fin ray count includes uppermost rudimentary ray. Species diagnoses below are based on Southern Ocean specimens.

KEY TO SPECIES

1a Frontal ridges crestlike and serrate; a sharp, slender internarial spine in front of eyes; preopercle edge serrate; D III,13–16 .... *Poromitra crassiceps*
1b Frontal ridges smooth and not crestlike (may appear crestlike if skin damaged); internarial spine, if present, blunt, short and inconspicuous; preopercle edge smooth or with minute serrae 2
2a D III, 17–18; branchiostegal rays 8; upper jaw teeth polyserial; total GR 23–24 .... *Melamphaes microps*
2b D III, 9; branchiostegal rays 7; upper jaw teeth uniserial; total GR 28 .... *Sio nordenskjöldii*

Genus ***Melamphaes*** Günther, 1864

Melamphaids with smooth frontal ridges and no stout rostral spine. Dorsal-fin rays 17 or more (including spines). Two cheek scales, the anterior 1 small and modified to fit the rear end of maxilla. Three or 4 scales (except *M. lugubris)* covering opercle, subopercle and interopercle. Lateral scale series 24–31. Pyloric caeca 7–8. Head sensory canal pores small and usually in groups of 2–4.

Twenty-one species found mostly in tropical seas, but with some species in peripherial areas of high productivity regions (Ebeling 1986; Ebeling & Weed 1973). One species in our area.

Melamphaes microps (Günther, 1878)

Fig. 1

Scopelus microps Günther, 1878: 186, between Cape of Good Hope and Kerguelen Islands (46°46′S, 45°31′E). Holotype: BMNH 1887.12.7.5.

Diagnosis: D III,18; A I,8; P 16; V I,8; GR 6+18; LSS about 30 (based on scale pocket count); scales from dorsal-fin origin to anus 8; vertebrae 13+18. Body depth 3.6 and head length 3.1 in SL. Body width 1.5 in its depth. Snout short and blunt 5.3, eye diameter 4.9, interorbital width 2.8, and lower jaw length 1.9 in HL. Pectoral fin relatively short, 5.0 in SL, not reaching anal-fin origin. Caudal peduncle length 4.4 in SL and its depth 2.3 in the length. Pelvic fins inserted slightly behind level of pectoral-fin base. Anal-fin origin at level of last dorsal-fin ray. Distances from snout to dorsal-fin origin 2.5, to upper pectoral-fin base 2.8, to pelvic-fin insertion 2.6, and to anal-fin origin 1.4 in SL. Both jaws with narrow polyserial bands of small conical teeth. Preopercle edge and ridge smooth except for a small spine or two at their angle.

Colour: In alcohol, the holotype of *M. microps* is pale with no trace of colour pattern, except for greyish margin of scale pockets.

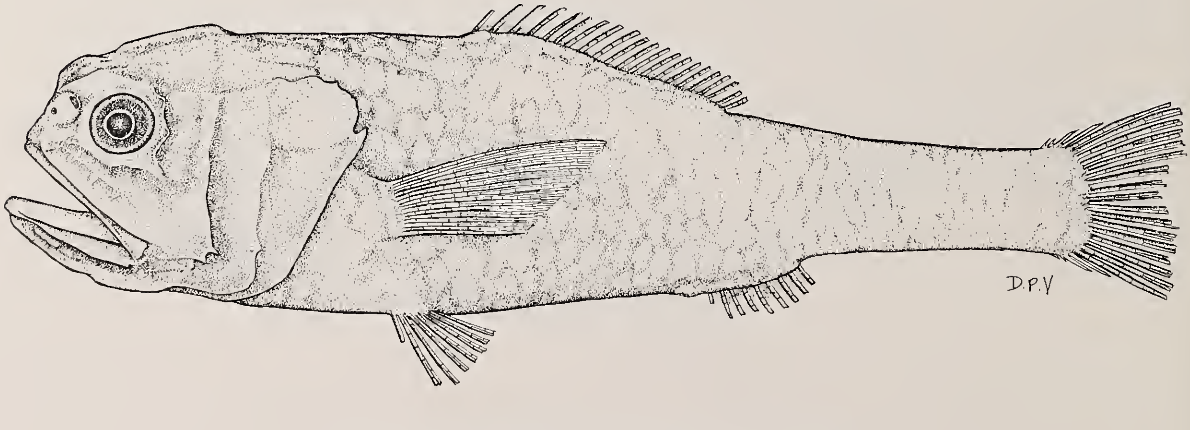
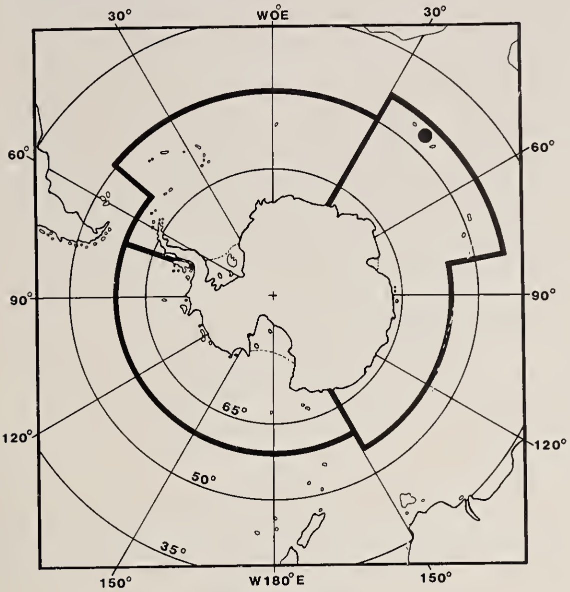


Fig. 1. *Melamphaes microps*, 96.4 mm SL, holotype

Distribution: Antitropical and bathypelagic (Ebeling 1962). A single specimen in our area, the holotype, was caught in the sub-Antarctic Indian Ocean east of the Kara Dag Seamount, at about 2,500 m. Two postlarval specimens were taken in the Southern Hemisphere (300–500 m), 1 in South Africa and another in New Zealand. In the north Atlantic Ocean, both juveniles and adults were collected in deep water, between 32–58 °N (Ebeling 1962).



Distribution of *M. microps*

Remarks: The pelvic-fin ray count of I,8 is diagnostic for *M. microps*. All other conjeners have a count of I,7 (Ebeling & Weed 1973). Ebeling (1962) showed that small meristic differences exist between north Atlantic and sub-Antarctic specimens. Counts were slightly higher in specimens from the Southern Hemisphere. The higher number of vertebrae of the holotype, 31 versus 28–30 (Ebeling & Weed 1973), is due to an extra precaudal vertebrae.

Very rare in the Southern Hemisphere. Attains about 10 cm (the holotype, 96.4 mm SL, is the largest known specimen).

Genus *Poromitra* Goode & Bean, 1883

Melamphaids with strong, crestlike, serrate frontal ridges. A stout, sharp internarial spine in front of eyes. Preopercle edge and ridge with strong and distinct serrae. Cheek scales 3–4, the anterior one not modified (except *P. capito*). Dorsal-fin rays 12–17 (including spines). Pyloric caeca 5–8. Lateral scale series 23–32. Head sensory canal pores moderate to large, usually single.

Five species of which 1 is restricted to the Atlantic Ocean (*P. capito)* and another known only from off New Guinea (*P. crassa*). One species in our area.

Poromitra crassiceps (Günther, 1878)

Fig. 2

Scopelus crassiceps Günther, 1878: 185, mid-Atlantic Ocean, *Challenger* station 107. Holotype BMNH 1887.12.7.7.

Melamphaes cristiceps Gilbert, 1890: 50 (27°09′N, 111°42′W).

Melamphaes nigrofulvus Garman, 1899: 64, pl. D, fig. 2 (6°21′N, 80°41′W).

Melamphaes frontosus Garman, 1899: 67, entrance to Gulf of California.

Melamphaes unicornis Gilbert, 1905: 615, pl. 17, Hawaiian Islands, near Kauai.

Poromitrella nigriceps Zugmayer, 1911: 7 (37°04′N, 28°01′W).

Plectromus coronatus Gilchrist & von Bonde, 1924: 14, off South Africa.

Melamphaes atlanticus Norman, 1929: 165, South Atlantic.

Melamphaes rugosus Chapman, 1939: 535, fig. 69 (55°32′N, 136°25′W).

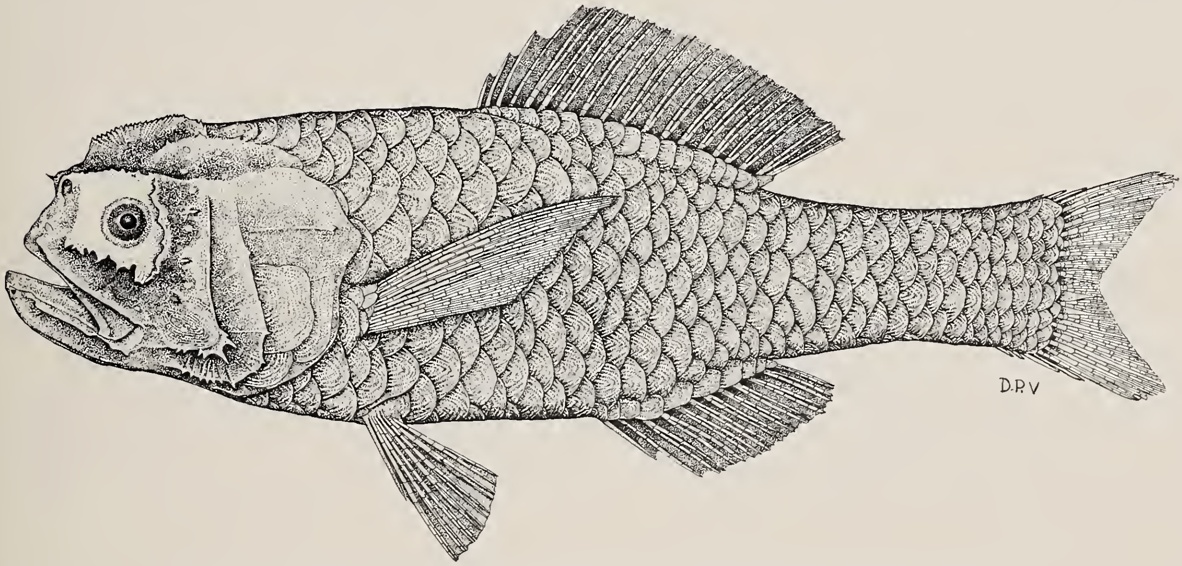
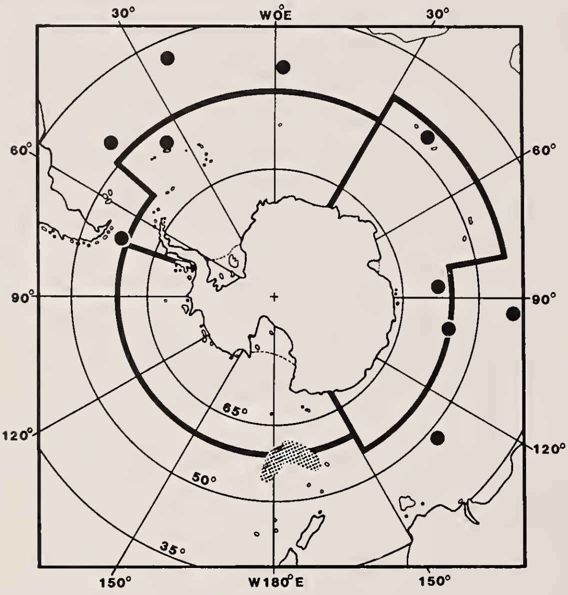


Fig. 2. *Poromitra crassiceps* ADH S85/0386, 103 mm SL (60°00.6′S, 88°01.3′E)

Diagnosis: D III,13–16; A I,9–11; P 14–15; V I,7; GR (9–10)+(19–22); LSS 25–28; predorsal scales 7–8; scales from dorsal-fin origin to anus 10–11; vertebrae 10+(18–19). Body depth 3.2–3.8 and head length 3.0 in SL. Body width 1.9 in its depth. Snout blunt 4.0–4.2, eye small 5.6–6.4, interorbital space 2.6–3.2, and upper jaw length 2.3 in HL. Pectoral fin length 3.2 in SL, reaching posteriorly to level of third anal-fin ray. Caudal peduncle length 3.4–3.9 in SL and its depth 2.0–2.6 in the length. Distances from snout to dorsal-fin origin 2.3, to upper pectoral-fin base 2.9, to pelvic-fin insertion 2.8, and to anal-fin origin 1.6–1.7 in SL. Both jaws with a single series of minute teeth. Preopercle ridge slightly slanting forward, forming an 80° angle with the horizontal, and has 2 strong retrorse spines at its angle. Anal-fin origin under middle of dorsal-fin base. Scales large, with widely spaced, thickened and raised circuli.

COLOUR: In alcohol, dark brown all over except for a whitish area around eye. Scale pockets with black margin visible through scales.

Distribution: World-wide except Arctic and Mediterranean seas. Circum-Antarctic on the margin of the Southern Ocean, mostly in sub-Antarctic water. Adults usually caught below 600 m and postlarvae and juveniles somewhat shallower (Ebeling & Weed 1973). Southern Ocean specimens were captured below 1,000 m.



Distribution of *P. crassiceps*

Remarks: Parin & Ebeling (1980) gave a range of 11–15 soft dorsal-fin rays for *P. crassiceps* and pointed out that sub-Antarctic specimens were on the higher end of this range. One of the specimens I examined had 16 soft dorsal-fin rays. The illustration of *P. crassiceps* in Ebeling & Weed (1973) shows the posterior end of the maxilla well behind the eye whereas in my specimen it reached only to the level of the rear margin of the eye. However, the length of the upper jaw (about 15.0% SL) is within the range given by Parin & Ebeling (1980) for sub-Antarctic *P. crassiceps*. I have also examined a juvenile, 44.5 mm SL, caught at 55°07.9′S, 99°53.7′E. The pectoral fin of this fish was longer, 2.8 in SL, reaching beyond the base of last anal-fin ray. Unlike the adult, the juvenile had a pale yellow body (in alcohol) with distinct brown scale pocket margin. The upper half of the head was translucent and the lower half appears dark due to the black lining of the mouth cavity and gill chamber. On a world-wide basis Parin & Ebeling (1980) found that sub-Antarctic specimens (south of 40°S) have higher counts and are usually on the extremes regarding body proportions.

Attains 18 cm SL.

Genus *Sio* Moss, 1962

Monotypic.

Sio nordenskjöldii (Lönnberg, 1905)

Fig. 3

Melamphaës nordenskjöldii Lönnberg, 1905a: 765; 1905b: 58 (49°56′S, 49°56′W). Holotype: NRM SYD/1902381.4106.

Diagnosis: Based on a single Antartic specimen, 72.2 mm SL. D III,9; A I,8; P 14; V I,7; GR 8+20; LSS 27; predorsal scales 10; scales from dorsal-fin origin to anus 10; pyloric caeca 7; branchiostegal rays 7; vertebrae 10+16. Body depth 3.8 and head length 2.8 in SL. Body width 1.4 in its depth. Snout length 5.3, eye diameter 5.2, interorbital space 2.8, and upper jaw length 2.8 in HL. Pectoral fin length 3.4 in SL, reaching slightly behind anal-fin origin. Caudal peduncle long and slender, its length 3.6 in SL and its depth 2.8 in the length. Distances from snout to dorsal-fin origin 2.1, to upper pectoral-fin base 2.6, to pelvic-fin insertion 2.5 and to anal-fin origin 1.5 in SL. Teeth minute, arranged in a single series in upper jaw and 1–2 series in lower jaw.

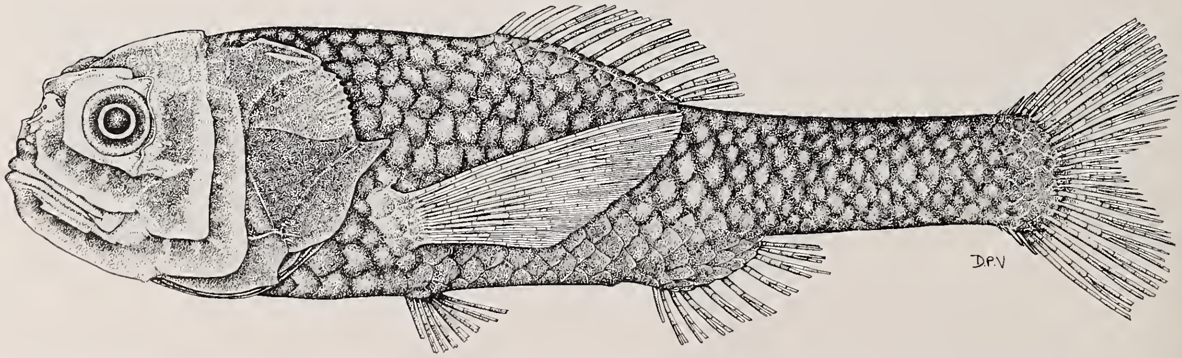


Fig. 3. *Sio nordenskjöldii* BMNH 1986.12.31.54, 72.2 mm SL, Amundsen Sea (69°15.7′S, 125°56.3′W to 69°16.2′S, 125°36.3′W)

Colour: In alcohol, dark brown all over. Fins dusky, but proximal half of caudal fin as dark as body.

Otoliths:

Diagnostic features: The generally ovate shape, the irregular sculpture of the margin in association with the large and prominent anterior colliculum.

Intraspecific variation: Irregular sculpture of margin and the variable ovate shape.

Ontogeny: Otoliths of fish smaller than 80 mm SL are greater in height than in length, whereafter they become ovate.

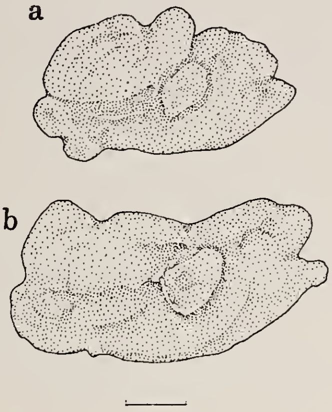
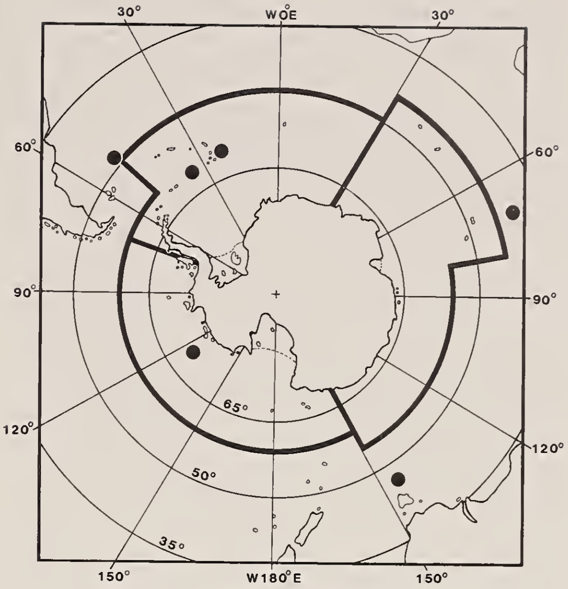


Fig. 4. Representative otoliths of *Sio nordenskjöldii*; fish lengths: (a) 88 mm and (b) 102 mm TL; scale bar 1 mm

Distribution: Besides a single record from the central north Pacific Ocean, *S. nordenskjöldii* occurs in the Southern Hemisphere south of 20 °S and is trawled below 200 m (Ebeling 1986; Moss 1962). Moss (1962) associated the occurrence of adults with the subtropical convergence. Young fishes were found mostly in more northern and warmer waters.



Distribution of *S. nordenskjöldii*

Remarks: In its general form, *S. nordenskjöldii* closely resembles members of the genus *Melamphaes* from which it can be separated by its higher number of gill rakers (24–29 vs 14–25) and lower number of soft dorsal-fin rays (9 vs 14–18) and branchiostegal rays (7 vs 8). The latter 2 characters will distinguish *Sio* from all other melamphaid genera (Moss 1962). Unlike the description of Moss (1962) and Ebeling (1986), the preopercle edge in my Antarctic specimen (south of APF) is smooth. It should be noted that Lönnberg (1905a, b) published 2 descriptions of *S. nordenskjöldii* with conflicting localities. The footnote in the description of *Bathylagus gracilis* (Lönnberg 1905a: 762) apparently applies to the present case as well (see remarks for *B. gracilis* above).

Attains 123 mm SL.

CETOMIMIDAE

Whalefishes

by J.R. PAXTON & O. GON

Body soft and flabby, elongate and compressed, whale-like in shape. Head large. Eyes small to rudimentary, closer to upper jaw than to dorsal profile of body. Mouth enormous, maxilla reaching far beyond eye; teeth small. Pelvic fins, fin spines and abdominal ribs absent. Stomach and abdomen greatly distensible. Dorsal and anal fins placed opposite each other on posterior half of body. Pectoral fins small, in a ventrolateral position. Body and head scaleless, but large lateral-line scales embedded in lateral-line canal. Lateralis sensory system usually cavernous on head and body, with large pores, rarely of papillate neuromasts. Swim-bladder and pyloric caeca absent. Gill openings large, gill membranes free from isthmus. Gill rakers club-shaped or reduced to bony plates covered with minute teeth. Photophores absent. Cavernous tissue usually present around anus, sometimes also along dorsal- and anal-fin bases.

Rare meso- and bathypelagic fishes found in all oceans. Nine genera and about 35 species (Paxton 1989). Two genera and 3 species in our area. Revisions by Parr (1934), Harry (1952) and Paxton (1989), regional treatments by Paxton (1986) and Paxton & Bray (1986).

Remarks: The small number of Antarctic cetomimids (15 specimens of 3 species) and their complete absence from the Indian Ocean sector is at least partially attributable to the paucity of midwater trawls taken below 1,500 m in the Southern Ocean. The first step in studying this second largest of bathypelagic families is to undertake a midwater sampling programme in deep water, particularly in the Indian Ocean sector. With 2 of the 3 Antarctic species known only from 2 specimens each, the most basic studies on reproduction, feeding and migration require more study material.

KEY TO GENERA

1a Jaw teeth short, in indistinct oblique rows; no vomerine, palatine or ectopterygoid teeth; free gill arches 4, with slit behind ventral arm of fourth gill arch; gill rakers as very short knobs covered with tiny teeth, 2+8 on first gill arch; LL scales round and flat, without dorsal and ventral projections; 5–7 oblique skin ridges passing over middle LL scales .... *Notocetichthys*

1b Jaw teeth elongate, in distinct longitudinal rows; vomerine, palatine and ectopterygoid teeth present; free gill arches 3, no slit behind ventral arm of fourth gill arch; gill rakers as flattened tooth plates, separate in small individuals, coalescing with increasing size; LL scales elongate to rectangular and curved with 1–3 dorsal and ventral projections or spines; no oblique skin ridges on middle of body......... *Gyrinomimus*

Genus *Gyrinomimus* Parr, 1934

Teeth present on jaws, vomer, palatine, ectopterygoid, tongue, gill arches and dorsal pharyngeals; jaw teeth small, elongate, closely-set, in distinct longitudinal rows (except in juveniles of 2 non-Antarctic species); vomerine tooth patch rectangular or oval and flat; copular tooth patch large, in front of level of eye; no ventral pharyngeal tooth plates. Gill rakers as bony plates bearing small teeth. Three free gill arches. Supraorbital and main head canals of lateralis system separate. Anus close to anal-fin origin. Dorsal- and anal-fin rays 14–21. Lateral-line scales rectangular or strap-like and curved, 12–23. Vertebrae 47–59. About 12 species, 2 in our area.

KEY TO SPECIES

1a No tooth plates on medial side of first gill arch; gill filaments of fourth arch large, longer than bony width of arch.. *G. andriashevi*

1b Tooth plates on medial side of first gill arch 2–5; gill filaments of fourth gill arch small to moderate, shorter than bony width of arch...................................... *G. grahami*

Gyrinomimus andriashevi Fedorov, Balushkin & Trunov, 1987

Fig. 1

Gyrinomimus andriashevi Fedorov, Balushkin & Trunov, 1987: 47, fig. 1, Lazarev Sea (65°20′S, 02°34′E). Holotype ZIN 47725.

Gyrinomimus sp. Trunov, 1985: 296, 305, Lazarev Sea.

Diagnosis: Based on re-examination of holotype. D 14; A 14; P 19?; LL pores 17?; vertebrae 58. Head length 27.6%, snout length 8.8%, upper jaw length 26.1%, and head width at rear end of upper jaws 7.4% SL. Distance from end of upper jaw to opercular margin 5.1%, and from snout to anal-fin origin 78.8% SL. Length of anal-fin base 12.4%, distance from dorsal-fin origin to anal-fin origin 12.7%, and caudal peduncle length 10.6% SL. Length of copular tooth plate 8.5% SL, copular tooth plate length/width 3.4. Head sensory pores arranged as follows (terminology after Paxton 1989): supraorbital 6; main 3–4; supratemporal off main 2–3; infraorbital 8; mandibular 7?; preopercular 3? All jaw teeth elongate, in distinct longitudinal rows (although additional teeth occur in groups of curved rows); vomerine teeth ca. 60 in 5 rows. First gill arch with 1+(3–4)

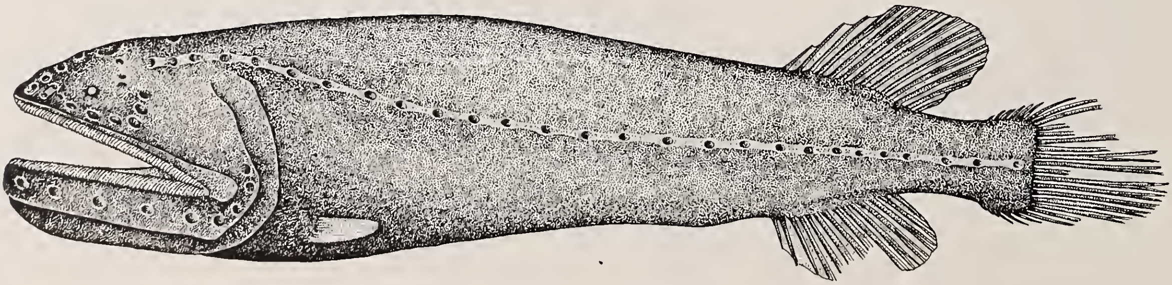
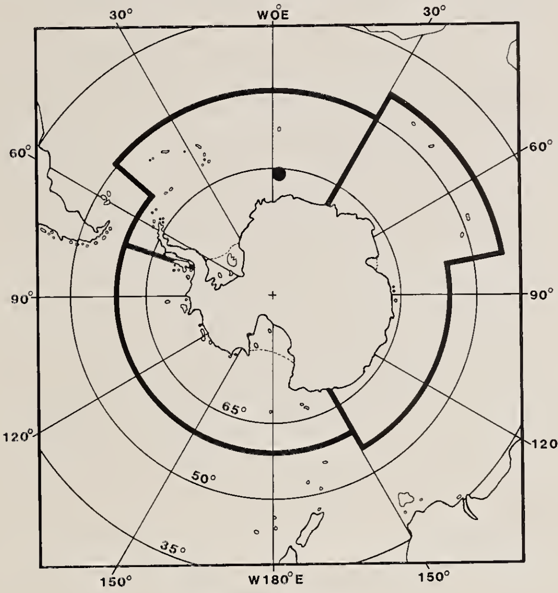


Fig. 1. *Gyrinomimus andriashevi*, 25 cm SL, holotype (based on Fedorov *et al.* 1987)

lateral tooth plates, no medial tooth plates; fourth gill arch with long gill filaments, longer than bony width of arch. Posterior lateral line without elongate flaps or keels; lateral-line scales narrow, with single dorsal and ventral projections. Presence or absence of skin ridges and/or anal lappets over anal-fin base unknown. Cavernous tissue around anterior 3/4 of anus and apparently in separate patch anterolateral to base of first anal-fin ray.

Colour: In life, head dark red and body black with reddish hue. Vertical fins orange. Mouth cavity, gill chamber and gill filaments yellowish orange. Peritoneum black (Fedorov *et al.* 1987). In preservative, all red and orange lost, body dark brown.

Distribution: Lazarev Sea. Collected between surface and 1,360 m; bottom depth at collection site 1,370–1,400 m (Fedorov *et al.* 1987).



Distribution of *G. andriashevi*

Remarks: *Gyrinomimus andriashevi* is known only from the 232 mm SL holotype. The specimen is mostly skinned on the body, although the lateral line remains on one side. The lateral line pore count of 17? (vs 23 in the original description) is based on the number of lateral-line scales present on the holotype. With only 14 dorsal- and anal-fin rays, *G. andriashevi* is similar only to *G. grahami,* but differs from this species in having large gill filaments on the fourth gill arch (vs small to moderate) and in lacking medial tooth plates on the first gill arch. A second 274 mm SL specimen from 2,000 m in the South Atlantic Ocean (39°45′S) is similar to *G. andriashevi* in having low dorsal and anal fin counts (14–15) and lacking tooth plates on the medial side of the first gill arch. However, this specimen has only moderate gill filaments on the fourth gill arch and, while in poor condition, apparently lacks the separate patch of cavernous tissue between the anus and anal-fin origin. This specimen is provisionally identified as *G. andriashevi* (although its counts and measurements are not included in the diagnosis above) until more specimens become available to determine the range of variation for this species (i.e. the 24 available specimens of *G. grahami* all have the separate patch of cavernous tissue present).

The biology of *G. andriashevi* is unknown; the larger South Atlantic specimen has large ovaries with eggs about 1.25 mm diameter, as well as smaller eggs. With the trawl fishing within 60 m of the bottom, the species may be benthopelagic. The holotype of *G. andriashevi* was taken in the same trawl as that of *Notocetichthys trunovi*.

Gyrinomimus grahami Richardson & Garrick, 1964

Fig. 2

Gyrinomimus grahami Richardson & Garrick, 1964: 523, fig. 1, off Cape Palliser, New Zealand (42°07′S, 174°57′E). Holotype: NMNZ 3744.

Gyrinomimus notius Fedorov & Balushkin, 1983: 739, fig. 1, Ross Sea (72°26′S, 175°10.8′E).

Diagnosis: Based on re-examination of both holotypes and 22 other specimens 66.4–310 mm SL. D 14–16; A 14–16; P 21–22 (n=5); LL pores 13–18 (usually 14–17); vertebrae 51–57 (usually 53–55). Head length 25.8–33.7%, snout length 7.9–12.3%, upper jaw length 21.9–30.7%, and head width at rear end of upper jaws 10.3–18.2% SL. Distance from end of upper jaw to opercular margin 3.5–7.0%, and from snout to anal-fin origin 71.6–78.6% SL. Length of anal-fin base 11.0–13.7%, distance from dorsal-fin origin to anal-fin origin 9.3–14.8%, and caudal peduncle length 9.0–14.2% SL. Length of copular tooth plate 7.2–10.3% SL, copular tooth plate length/width 3.0–4.4. Head sensory pores arranged as follows: supraorbital 6–7 (usually 7); main 4–5 (usually 4); supratemporal off main 3–4; infraorbital 7–8 (usually 8); mandibular 5–7; preopercular 3–4. All jaw teeth elongate, in distinct longitudinal rows (although additional teeth occur in groups of curved rows); vomerine teeth 10–81 in 2–8 rows,

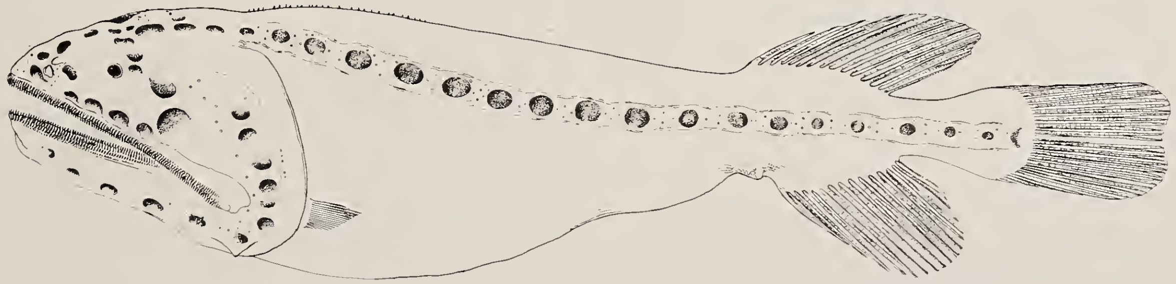
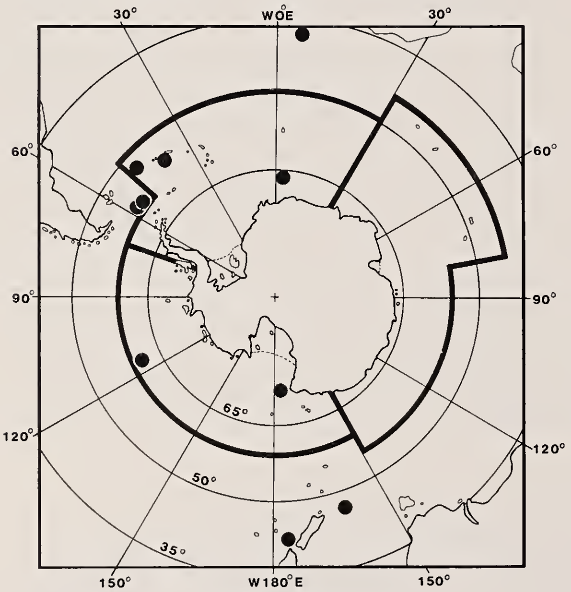


Fig. 2. *Gyrinomimus grahami*, 66.8 mm SL, holotype (revised from Richardson & Garrick 1964, drawn by D. Bürkel, ZMH)

increasing with age. First gill arch with (1–2)+(3–5) lateral tooth plates and 0+(2–5) medial tooth plates, both decreasing with age as individual plates coalesce; fourth gill arch with small to moderate gill filaments, shorter than bony width of arch. Posterior lateral line without elongate flaps or keels, small flaps and keels present in specimens larger than 200 mm SL; lateral-line scales narrow, with single dorsal and ventral projections. No skin ridges or anal lappets above anal fin. Cavernous tissue around anterior 3/4 of anus and in a small, separate patch over anal-fin origin or base of 1–2 anal-fin rays, most distinct in small specimens.

COLOUR: In life, dark red (Fedorov & Balushkin 1983). In preservative, blackish-brown becoming lighter with time.

Distribution: Probably circumglobal in the Southern Hemisphere; the lack of Indian Ocean sector specimens is most likely due to the paucity of deep water trawling in the area. Of the 24 known specimens, 12 have been taken within the Antarctic region, including the holotype of *G. notius*. The most northerly captures include 4 specimens off the west coast of South America (to 34°05′S) and 2 captures off the west coast of South Africa (to 33°00′S), both areas under the influence of cold water currents moving equatorward along the eastern side of the Pacific and Atlantic Oceans. Away from these eastern boundary currents, the species has not been taken north of the subtropical convergence. All but 3 of the 15 captures of *G. grahami* were made with gear fishing to at least 2,000 m. The extraordinary capture of the holotype of *G. notius* at 470 m is due to the hydrological conditions of the Ross Sea, allowing deep water fishes to penetrate into shallower slope waters (Fedorov & Balushkin 1983).



Distribution of *G. grahami*

Remarks: *Gyrinomimus grahami* differs from all its congeners except *G. andriashevi* in having cavernous tissue around the anterior 3/4 of the anus and in a separate patch over the anal-fin origin (all other species have cavernous tissue restricted to around the anus or in additional areas along the anal-fin base and more rarely predorsally and behind the pectoral-fin base) and in having only 5–7 mandibular pores (vs 7–11 pores); both species have fewer dorsal- and anal-fin rays (14–16) than most other species (15–21).

The great difference in size between the holotypes of the 2 nominal species (*G. grahami* 66.8 mm SL, *G. notius* 174.3 mm SL) accounts for such differences as the number of teeth on the jaws and vomer noted in the respective descriptions, as tooth rows are added with increasing size. The cavernous tissue around the anus and in a separate patch above the anal-fin origin becomes less conspicuous with increasing size, but is faintly visible on the holotype of *G. notius*. The cavernous tissue above the lateral line and on the caudal peduncle and fins mentioned by Fedorov & Balushkin (1983) is unlike that found in other members of the genus and family and is perhaps an artifact of preservation. Other slight differences in the morphometrics and meristics of the 2 holotypes are probably due to differences in their size and the latitudinal extremes at which they were captured (42°–72°S). Based on the variation seen in the 24 specimens, *G. notius* is here considered a synonym of *G. grahami*.

In one extraordinary trawl made by the German FRV *Walther Herwig* at 2,600 m, 8 specimens of *G. grahami* were caught. The size range was 139–310 mm SL, none of the specimens were ripe and no type of breeding aggregation was indicated. As this was the deepest trawl made by the 300 square metre net of the FRV *Walther Herwig* on its Antarctic cruise, *G. grahami* may be relatively common in southern waters below 2,000 m. Only the largest 2 fishes (283 and 310 mm SL) had egg diameters over 0.1 mm; all others had smaller eggs or were immature. No males were found. As other cetomimids are known to have larger eggs (*G. andriashevi*? 1.0 mm+, *Procetichthys* 2.0 mm), it seems likely that the maximum size of *G. grahami* is larger than 31 cm SL.

Genus *Notocetichthys* Balushkin, Fedorov & Paxton, 1989

Monotypic.

Notocetichthys trunovi Balushkin, Fedorov & Paxton, 1989

Fig. 3

Notocetichthys trunovi Balushkin, Fedorov & Paxton, 1989: 156, fig. 1, Lazarev Sea (65°20′S, 02°34′E). Holotype: ZIN 47696.

Ditropichthys sp. Trunov, 1985: 296, 305, listed from Lazarev Sea.

Diagnosis: Based on holotype and paratype description (Paxton 1989). D 13; A 11–13; P 17?-19; LL pores 16–17; vertebrae 39–41. Head length 31.3–31.9%, snout length 10.8–12.5%, upper jaw length 21.1–22.3%, and head width at rear end of upper jaws 10.7–13.8% SL. Distance from end of upper jaw to opercular margin 8.3–9.8%, and from snout to anal-fin origin 71.0–74.3% SL. Length of anal-fin base 9.9–10.6%, distance from dorsal-fin origin to anal-fin origin 19.8–20.5%, and caudal peduncle length 18.2–20.2% SL. Length of copular tooth plate 0.9–1.1% SL, copular tooth plate length/width 1.1–2.4. Teeth absent on vomer, palatine and ectopterygoid, present only on jaws, tongue, gill arches and dorsal pharyngeals. Jaw teeth tiny, triangular, closely set in approximate oblique rows. Copular tooth plate tiny, behind level of eye. Gill rakers as small knobs bearing minute teeth on arches 1–4. Four free gill arches. Gill filaments of all gill arches long and closely

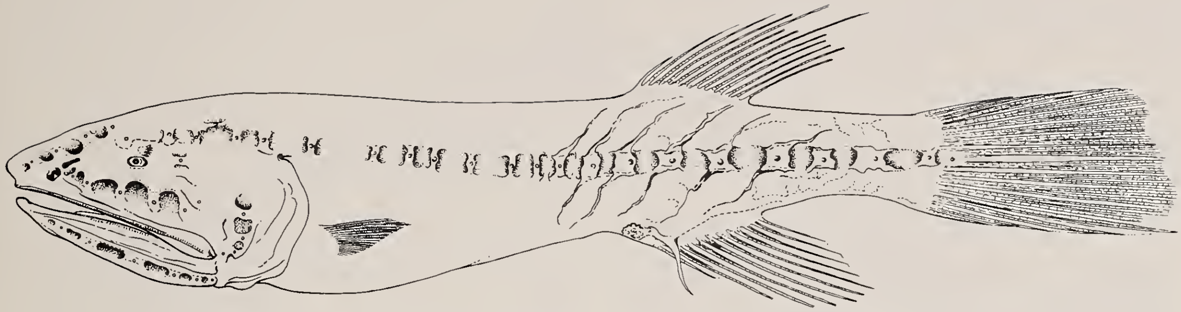


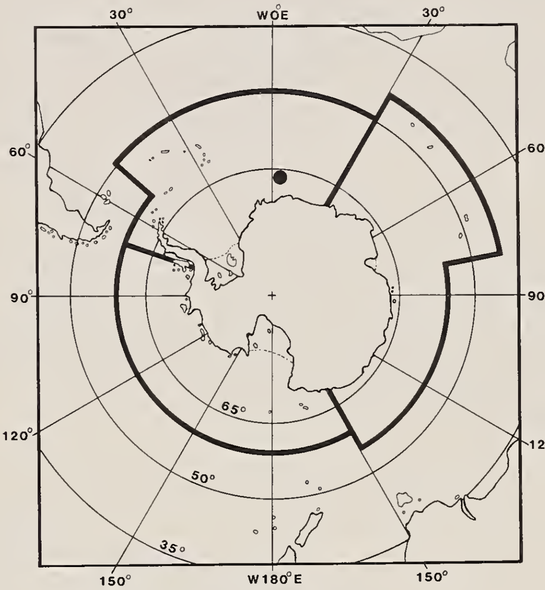
Fig. 3. *Notocetichthys trunovi*, 107.5 mm SL, holotype (from Paxton 1989)

spaced. Supraorbital and main canals of head lateralis system apparently joined; head sensory canals mostly damaged. Lateral line a broad shallow tube with overlying skin lost, pore shape unknown; lateral-line scales round and flat, without projections; 6–7 unique diagonal ridges with internal white vessels centred on midbody lateral-line scales. No skin ridges and anal lappets over anal-fin base. Cavernous tissue in small area behind anus with posterior free edge and thin flap-like extension over anal-fin base. Anus anterior to anal-fin origin about distance of caudal peduncle depth. Dorsal- and anal-fin rays exceptionally long.

Colour: In life, body claret-coloured, tips of fins bright orange. Opercle brown, thorax and belly dark with blueish tinge. Lining of mouth and gill cavity pink, gill arches and gill filaments light (Balushkin *et al.* 1989). Red and orange lost in preservative, body light brown.

Distribution: Known only from the 2 type specimens taken in bathypelagic waters at 65°17′–20′S, 02°42′–34′E. The 2 trawls, at 0–1,285 m and 0–1,360 m, fished within 100 m of the bottom, indicating that this species may be benthopelagic.

Remarks: *Notocetichthys trunovi* is unique among cetomimids in lacking vomerine and ectopterygoid teeth, in having a tiny copular tooth plate behind the level of the eye, cavernous tissue in an area with a free posterior edge and a long free flap, diagonal ridges centred on the lateral-line scales, and greatly elongate dorsal- and anal-fin rays. The biology of *N. trunovi* is unknown. The holotype of *N. trunovi* was taken in the same trawl as that of *G. andriashevi*.



Distribution of *N. trunovi*

OREOSOMATIDAE
Oreos

by P.C. HEEMSTRA

Body deep and compressed. Head broad, interorbital area flat. Eyes huge, their diameter greater than snout length. Jaws with 1 or 2 rows of tiny teeth; upper jaw protrusile. Fin spines longitudinally grooved; dorsal, anal and pectoral fin rays unbranched. Gills three and a half (no slit behind last hemibranch).

The pelagic prejuvenile stage is quite different in shape from the adult and has large bony excrescences or warty protuberances on the flanks and lower part of the enlarged belly.

Oreos occur in temperate waters of all oceans, but they are more common in the Southern Hemisphere and of commercial importance off New Zealand. Adults are benthopelagic on the continental slope in depths of 200 to 1,500 m, and they are also found in similar depths at seamounts and oceanic islands.

Four genera with 10 species, of which 2 are undescribed. One species is known from Antarctic waters. Recent taxonomic revision of Southern Hemisphere species by James *et al.* (1988).

Genus ***Pseudocyttus*** Gilchrist, 1906

Pelvic fins with 1 spine and 5 branched rays. First dorsal spine longer than or subequal to (more than 0.7) second spine. Fin spines weak. Scales on sides of body cycloid, deciduous; adults with a band of rough scales or tubercles (each with 1–3 little spines) along dorsal and ventral margins of body from head to caudal peduncle; spiny scales in 2 rows along base of dorsal and anal fins; operculum fully scaled. Monotypic.

Pseudocyttus maculatus Gilchrist, 1906
Round oreo
Figs 1, 2

Pseudocyttus maculatus Gilchrist, 1906: 153, pl. 41, off Cape Point, South Africa. Holotype: SAM 17938 (now lost).

Xenocyttus nemotoi Abe, 1957: 228, pls. 1–2, East Antarctica (64°32′S, 115°25′E).

Diagnosis: D V–VI, 34–36; A II–III, 31–34; P 19–21; LL about 98–110; GR (6–7)+(17–21); branchiostegal rays 7; vertebrae ca. 43; pyloric caeca numerous. Depth 1.35–2.1, head 2.6–3.2 in SL (for fish 14–50 cm SL). Predorsal body profile convex. Eyes enormous, the orbit diameter 2.7–3.1 in HL. Interorbital space broad, its least width subequal to or greater than orbit.

Colour: In life, juveniles (less than 20 cm SL) silvery, covered with numerous, various-sized dark spots; fins darker. Adults dark brownish grey; fins darker. In alcohol, adults generally slightly paler.

Otoliths

Diagnostic features: The dorso-ventrally oval shape and the deep constrictions in the mid-anterior and posterior margins.

Distribution: The round oreo is known in the Southern Hemisphere from off Argentina, Namibia and west coast of South Africa (Karrer 1968, 1973, 1986), off southern Chile and north-east of the Falklands (Nakamura 1986), New Zealand, Australia and the Kerguelen Islands

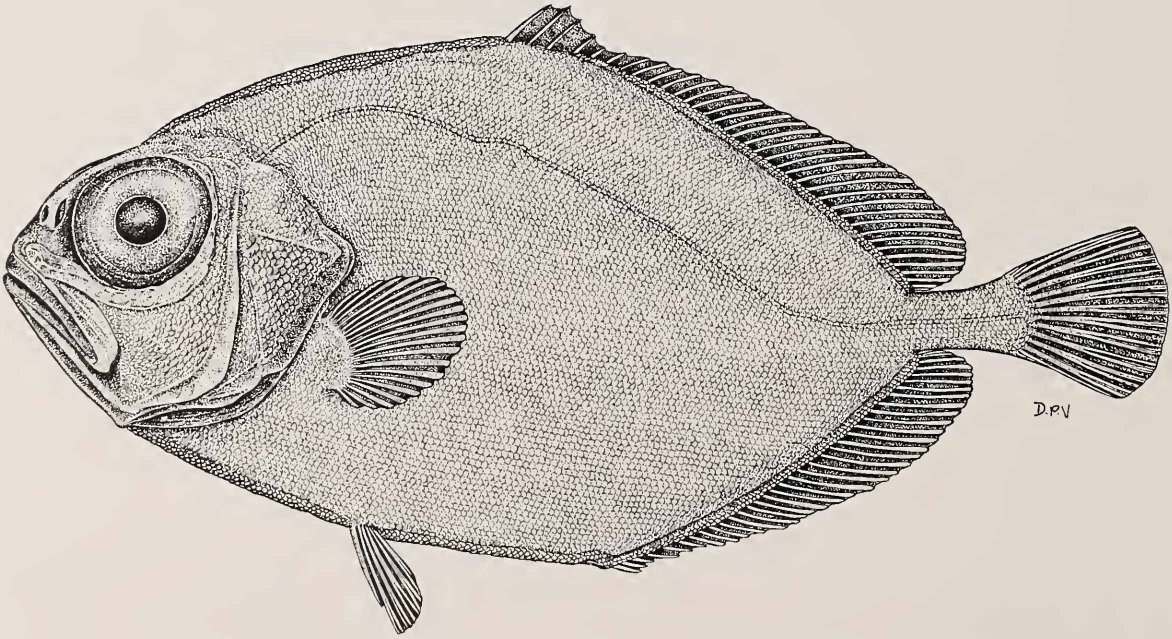


Fig. 1. *Pseudocyttus maculatus* RUSI 28137, 31 cm SL, west Cape Coast (32°25′S, 16°17.6′E)

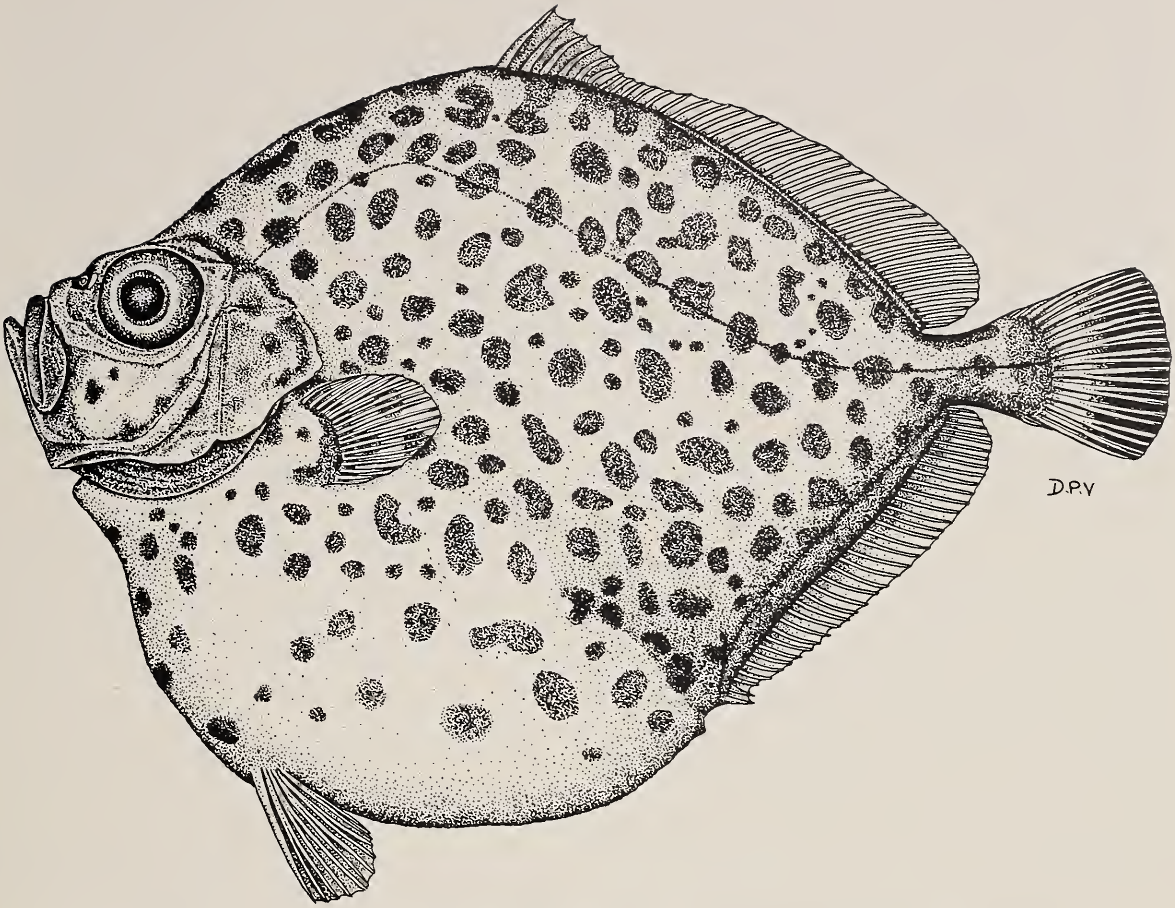


Fig. 2. *Pseudocyttus maculatus* 160 mm SL, juvenile, Balleny Islands (from a slide by W. Slosarczyk)

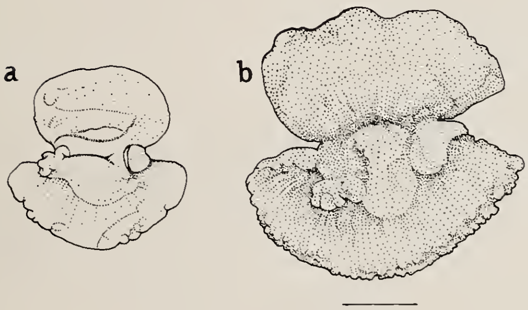
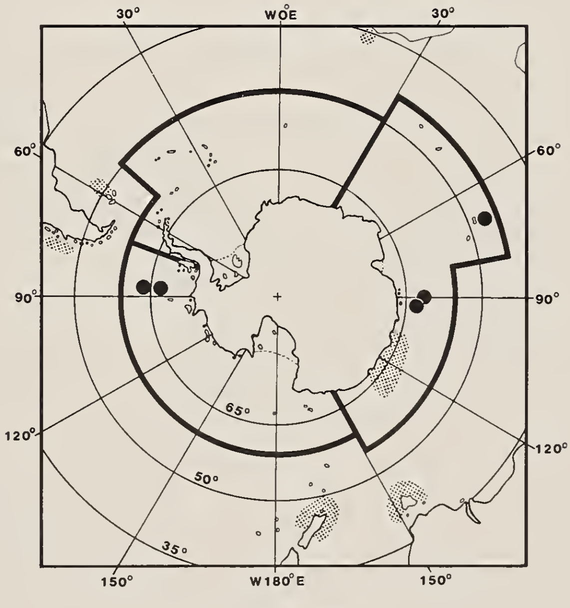


Fig. 3. Representative otoliths of *Pseudocyttus maculatus*; fish length: (a) unknown and (b) 162 mm SL; scale bar 1 mm

(James *et al.* 1988) and Antarctica (Abe 1957; Svetlov 1978a; Abe & Suzuki 1981). *P. maculatus* has also been reported from the western North Atlantic off Surinam (Shimizu 1983). Adults are taken in trawls near the



Distribution of *P. maculatus*

bottom in 460–1,160 m; juveniles are found near the surface, usually in association with krill (James *et al.* 1988).

Remarks: Abe & Suzuki (1981) reported on 29 prejuveniles (11–18 cm SL) caught with krill in the Southern Ocean. These fish had fed heavily on copepods (*Calanus* spp.).

Karrer (1986) considered *Xenocyttus nemotoi* Abe, 1957, a synonym of *P. maculatus,* and I can find no signficant differences in published descriptions of specimens from South America, South Africa, Australia and Antarctica. Hecht (1987 and pers. comm.) also found no differences in the otolith of specimens from New Zealand, South Africa and that illustrated by Abe & Suzuki (1981) from Antarctic specimens.

In addition to the original descriptions, specimens have also been illustrated by Karrer (1968, 1973), Abe & Suzuki (1981), Shimizu (1983), Nakamura (1986), and James *et al.* (1988). The Australian and New Zealand common name "smooth oreo" for this species is a misnomer as the dorsal and ventral margins of the body are covered with prickly scales or tubercles. A better name is "round oreo" in reference to the oval or round shape of the body with evenly convex dorsal and ventral profiles.

The holotype of *Xenocyttus nemotoi* was found amongst krill in the stomach of a whale. It was probably taken inadvertently by the whale while feeding on krill. Biology poorly known.

Attains 50 cm TL.

CONGIOPODIDAE

Horsefishes

by P.C. HEEMSTRA & G. DUHAMEL

Body oblong, compressed, smooth or covered with small, embedded, spiny scales. Snout produced; mouth small, protrusile; a single nostril on each side of snout. Gill opening restricted to a slit above pectoral-fin base. Dorsal fin spines strong, the longest subequal to body depth; pelvic fins with 1 spine and 5 unbranched rays. See diagnoses of the genus and species below for additional characters of the single species represented in the Southern Ocean.

About 10 species arranged in 4 genera; restricted to cool waters of the Southern Hemisphere. One species represented at sub-Antarctic islands and some oceanic seamounts of the Indian and Pacific sectors of the Southern Ocean.

Genus *Zanclorhynchus* Günther, 1880

Head with large spines. Dorsal fin with 8–10 spines and 12–15 soft-rays, the fin margin deeply divided before the soft-rayed part; dorsal fin origin over opercle; no anal-fin spines; pelvic fins abdominal, their origin about midway between anus and anterior end of isthmus; all fin rays unbranched. Scales on body with an embedded radially-ridged base and an erect, curved, central spine.

This genus comprises a single species.

Zanclorhynchus spinifer Günther, 1880
Spiny horsefish
Fig. 1; Pl. 3, Fig. 2

Zanclorhynchus spinifer Günther 1880: 15, pl. 8, fig. A, Kerguelen Islands. Holotype: BMNH 1879.5.14.197.

Diagnosis: D VIII–X/12–15; A 10–11; P 9; C 10 (principal rays); LL 11–15; vertebrae (14–15)+(20–21). Body depth 3.0–3.4, head length 2.7–3.0 in SL. Eye 3.0–4.8 in HL. Minute teeth on jaws; teeth have been reported on the vomer, but they could not be found in the specimens that we examined. A spine on each side of snout above nostril; supraorbital ridge ends posteriorly in a prominent spine; another strong spine behind eye and a greatly elongated spine above opercle. Opercle with 3 flat radiating ridges ending in 3 points posteriorly; a prominent, recurved subocular spine on cheek below rear margin of eye, and a few specimens with another smaller spine on middle of preopercle behind this subocular spine. A large spine on body above pectoral-fin base. Third dorsal-fin spine longest, about as long as body depth or head in adults. Scales scattered over dorsolateral parts of body, absent from chest, belly and ventral parts of peduncle.

Colour: Head and body brownish, purple, or ochre; head and anterior part of body with small dark spots or mottling. Black bar from soft dorsal fin to anal fin and another at base of caudal fin; black spot at base of first 2 or 3 dorsal-fin spines and a black bar at base of 6th to 7th dorsal spines extending to ventral part of body; fins yellow; black bar at middle of caudal fin and on paired fins. Post-larvae of 21 mm total length (Fig. 2) have a uniformly silver-coloured body and a characteristic black blotch on the pectoral fins.

Otoliths

Diagnostic features: The slender elongate shape with the prominent and slender rostrum and the up-turned and rounded posterodorsal corner.

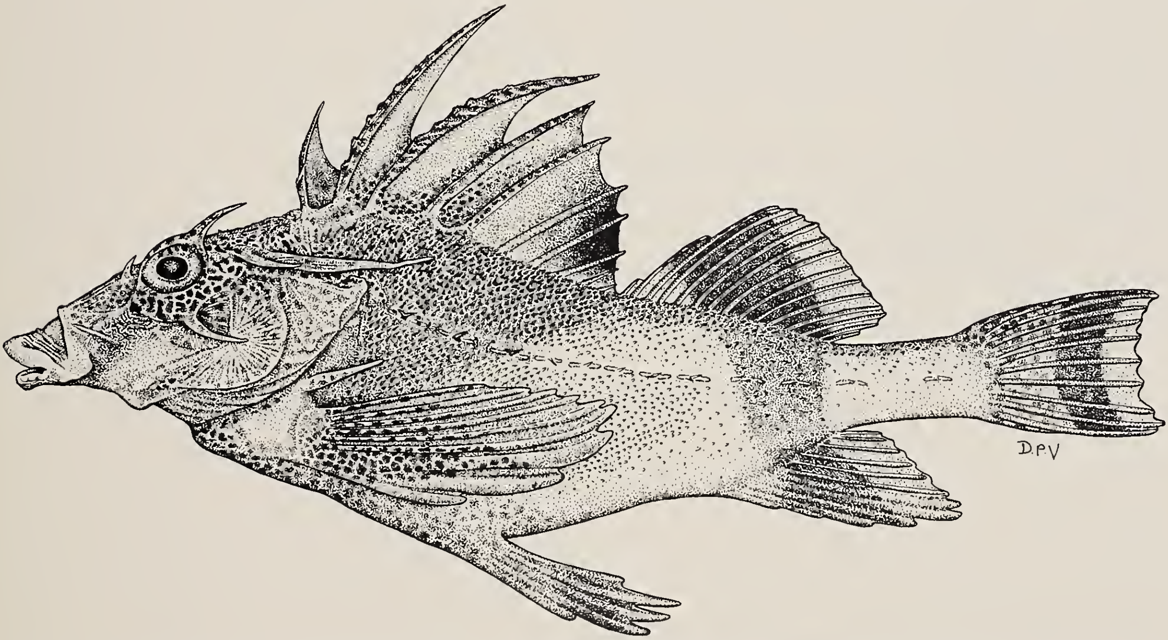


Fig. 1. *Zanclorhynchus spinifer* NMVA 5997, 190 mm SL, adult, west of Judge Clarke Rocks, Macquarie Island (54°23.6′S, 158°59.3′E)

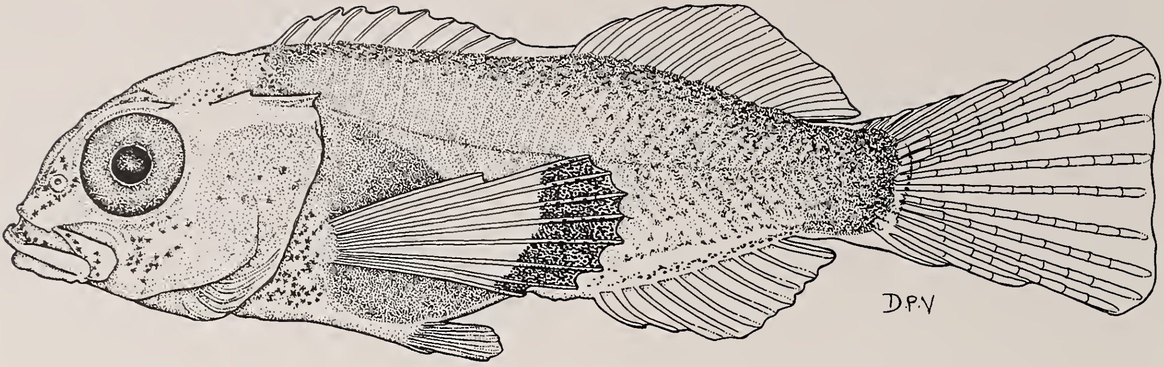
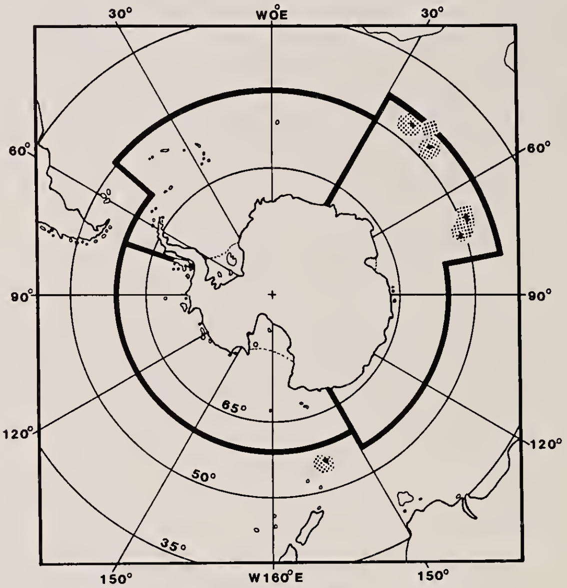


Fig. 2. *Z. spinifer* post-larva, 16.7 mm SL, MNHN 1989–1210, Kerguelen Islands shelf

Fig. 3. Representative otolith of *Z. spinifer*; fish length unknown



Distribution of *Z. spinifer*

Distribution: *Zanclorhynchus spinifer* is known from Prince Edward, Crozet, Kerguelen, Heard, and Macquarie islands and the Kara-Dag Seamount north-east of the Prince Edward Islands. It is a benthic species taken in trawls from depths of 5–400 m. According to Williams (1988b), *Z. spinifer* is the second most abundant fish species at Macquarie Island. Gon & Klages (1988) described a 42 mm SL juvenile and reported that a benthos survey using an underwater camera at Marion Island "implies that this species may be abundant in deeper water". *Z. spinifer* is also abundant on the Crozet shelf (Duhamel & Pletikosic 1983) and in the northern part of the Kerguelen shelf.

Remarks: The description above is based on Waite (1916), Slack-Smith (1962), Hureau (1971, 1985d) and examination of a few specimens from Macquarie Island. *Z. spinifer* feeds on benthic invertebrates, mainly amphipods (Arnaud 1972; Hureau 1985d). The stomach and intestine of a 197 mm SL specimen from Macquarie Island contained 5 whole sea urchin tests, 4 whole pelecypods, 1 whole gastropod, and some large pebbles.

Post-larvae (Fig. 2) are pelagic and have been collected in the Kerguelen Islands area over the shelf and also offshore (bottom depth 1,500 m) during summer and autumn.

Attains 40 cm.

LIPARIDIDAE

Snailfishes

by D.L. STEIN & A.P. ANDRIASHEV

Body tear-drop shaped, flattened to various degrees depending on species. Dorsal and anal fins single, continuous, joined to caudal fin; no fin spines; all fin rays unbranched. Pectoral fins often deeply divided, lower lobe easily mistaken for pelvic fin; pectoral-fin notch formed by shorter rays in mid-fin; rudimentary (unsegmented) rays occasionally present, difficult to determine. Pelvic fins (if present) forming ventral sucking disc. Vertebrae about 40–80. Nostril single or double. Mouth relatively small to large; teeth usually present, rarely absent, trilobed to simple, blunt or sharp, small or large, uniserial or in multiple rows often forming broad bands. Gill opening completely above pectoral-fin base or extending some distance ventrally in front of it; branchiostegal rays 5–6. Skin usually loose, always scaleless (prickles occasionally present), often with a gelatinous subcutaneous layer; lateral line absent.

About 17 genera presently recognised and about 170 species distributed predominantly in North Pacific, North Atlantic, and Southern Ocean but occurring in all oceans. Known from estuarine and intertidal zones to over 7,000 m; mostly benthic or benthopelagic, but a few holopelagic; life histories poorly known for almost all species. Fecundity generally low (fewer than 10–10,000 eggs), eggs large to very large, 1.0–8.0 mm diameter.

Southern Ocean with about 31 valid species, predominantly on continental slope. No commercial value. Taxonomic reviews by Burke (1930), Stein (1978), Able & McAllister (1980), Andriashev (1986) and Kido (1988).

Methods: Terminology of the head sensory canals and the pores they include has varied with different authors (e.g. Burke 1930; Stein 1978; Andriashev 1986). Most authors (except for Andriashev) have followed Burke (1930) and listed nasal, maxillary, mandibular, and suprabranchial pores (Fig. 1a). In order to reduce confusion and to standardise pore and canal nomenclature with that used for other families, we here adopt the canal terminology used throughout this book, but include the following changes and conventions for counting pores (Figs. 1b,c).

The supraorbital canal begins at the snout and arches over the orbit. In all Antarctic liparidids (except *Notoliparis)* this canal includes only 2 pores anteriorly, the nasal pores (Fig. 1b). In *Notoliparis,* in addition to the nasal pores, the postcoronal section of the supraorbital canal has 1 pore, the postcoronal pore (Fig. 2b). In *Notoliparis* and some Antarctic *Paraliparis* the coronal commissure across the interorbital region connects the left and right supraorbital canals and includes a median coronal pore (Fig. 2b).

The infraorbital canal ("maxillary canal" of other authors) extends from anterior to the orbit, curves below it and then dorsally to join the supraorbital and temporal canals above and behind the orbit (Fig. 1); usually, it includes 5–6 pores; the pore that typically occurs at the junction of these 3 canals has traditionally been counted as part of the infraorbital series (except for Andriashev (1986 and previous work), who counted it as the first temporal pore, t_1). This pore, here termed the junction pore (Figs. 1, 2), is included in the infraorbital pore count. Therefore, in this account the number of infraorbital pores in *Notoliparis,* as given by Andriashev (1975, 1978), is increased by 1 and the number of temporal pores is reduced by 1.

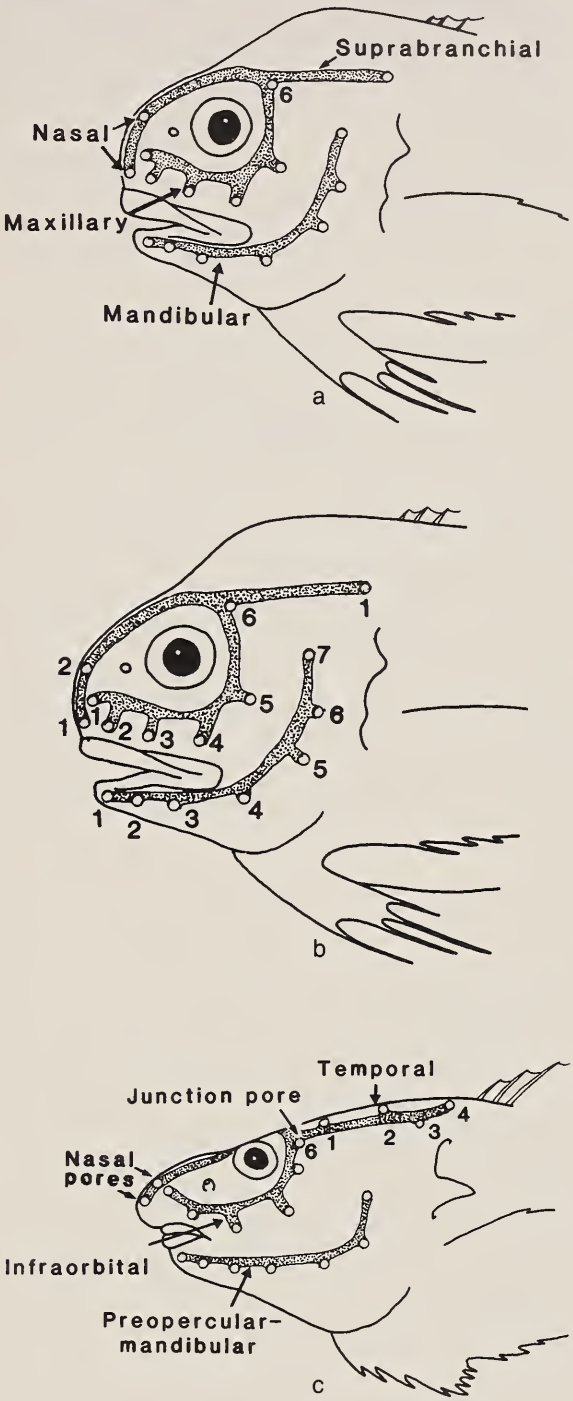


Fig. 1. Lateral view of head sensory canals of Antarctic liparidid fishes: (a) terminology of Burke (1930); (b) pattern of pores in *Careproctus, Genioliparis,* and *Paraliparis*; (c) pattern of pores in *Notoliparis* and new terminology (also applies to (b))

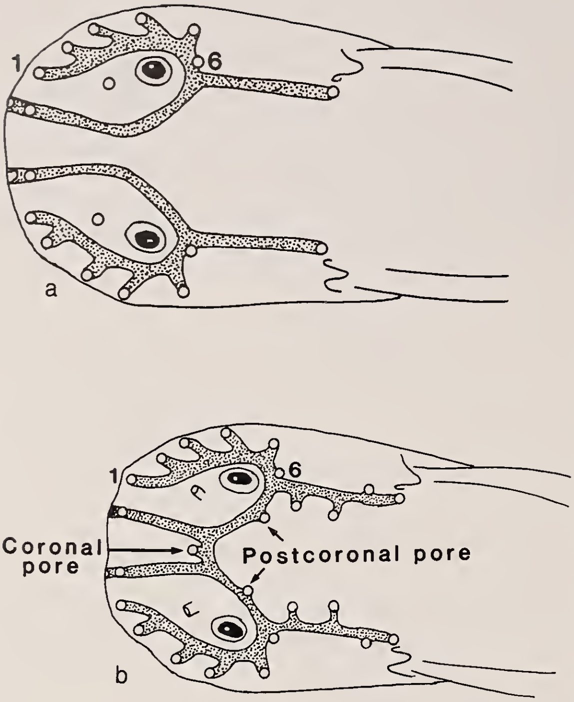


Fig. 2. Dorsal view of head sensory canals of Antarctic liparidid fishes: (a) pattern of pores in *Careproctus*, *Genioliparis*, and *Paraliparis*; (b) pattern of pores in *Notoliparis*. Note: the coronal pore is also present in some Antarctic *Paraliparis*

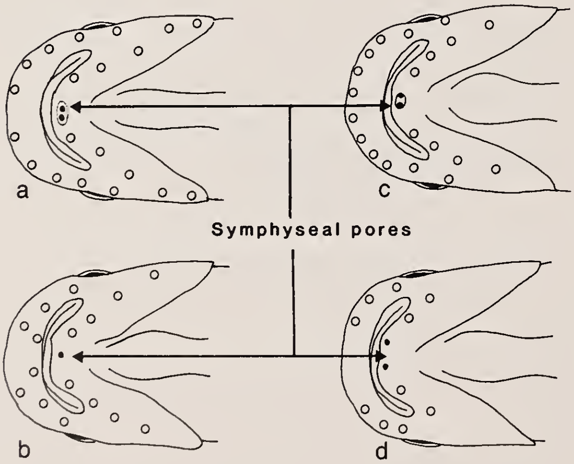


Fig. 3. Various conditions of the preopercular-mandibular symphyseal pores in Antarctic liparidid fishes: *Careproctus* (a); *Genioliparis* and *Notoliparis* (d); *Paraliparis* (a-d)

The temporal canal extends from the junction with the infra- and supraorbital canals posteriorly to just above the gill opening or the opercular flap (Figs. 1, 2). The pore (or 2 pores close together) near the end of the temporal canal above the gill opening is termed the suprabranchial pore (terminal pores of Andriashev 1986). In all Antarctic liparidids (except *Notoliparis)* this is the only pore in the temporal canal (Figs. 1b, 2a). *Notoliparis* has 4 temporal pores (Figs. 1c, 2b).

The preopercular-mandibular canal ("mandibular canal" of others) extends from the tip of the lower jaw posteriorly to the cheek, then dorsally to end before reaching the temporal canal. The right and left preopercular-mandibular canals each bear a pore at the anterior end, the symphyseal pore (Fig. 3); the position of these pores in relation to each other and their morphology are important taxonomic characters in some species.

Dorsal-, anal-, and pectoral-fin ray counts include all rays, rudimentary or not. Rudimentary pectoral-fin rays are very small (often not discernible without dissection or clearing and staining), and lack segmentation, but are composed of 2 longitudinally symmetrical halves. Caudal-fin ray counts are of principal (not procurrent, auxiliary or secondary) rays, those resting on the hypural plate. The length of the ventral disk is measured between the outside edges on the longitudinal axis, unfolding the edges if they are folded or curled, but making no attempt to flatten the disk if it is cupped. Vertebral counts include the urostyle and the hypural plate. In liparidid fishes, there are 1 or 2 hypural plates; 1 if all the caudal skeleton elements are fused together; 2 if a slit is present between the hypural and parhypural, representing an incomplete fusion. The entire unit (whether fused or not) is counted as a single vertebra. For more extensive discussion of important characters, see Burke (1930), Stein (1978), Andriashev (1986) and Kido (1988).

KEY TO GENERA

1a Pelvic sucking disk present............................2
1b Pelvic sucking disk absent............................3
2a Coronal and postcoronal supraorbital pores present (Fig. 2b) ....*Notoliparis*
2b Coronal and postcoronal supraorbital pores absent (Fig. 2a) ....*Careproctus*
3a Mouth very large; teeth large, sharp slender depressible canines; barbel-like snout projections present...*Genioliparis*
3b Not as above...............................*Paraliparis*

Genus *Careproctus* Kröyer, 1861

Cephalic sensory canals lacking coronal pore; 1 or 2 temporal pores present. Nostrils single, unpaired. Number of pectoral-fin rays generally fewer than number of dorsal-fin rays. Ventral sucking disk present, ranging from large and functional to tiny and probably disfunctional. Anus located posterior to disk, near to or distant from it.

Remarks: More than 60 species are known, many more probably remain to be described. Only 1 species has been described from the Southern Ocean.* However, specimens now in collections suggest that at least 17 more species exist in the area. Therefore, no key to *Careproctus* is provided here; a description of the single described species is included. Most specimens will not fit this description, and should be deposited in an appropriate museum or other repository for future study.

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* Andriashev (pers. comm.) is describing 4 new species of Antarctic *Careproctus*.

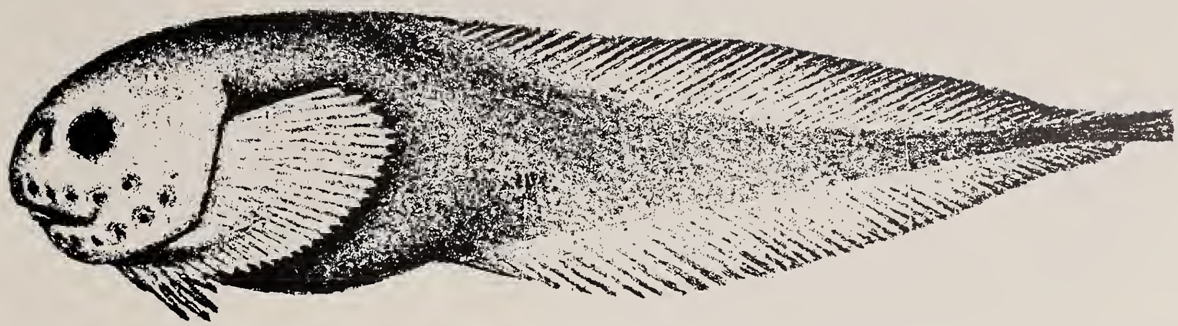


Fig. 4. *Careproctus georgianus*, 63 mm TL (from Lönnberg 1905: pl. 3, fig. 11)

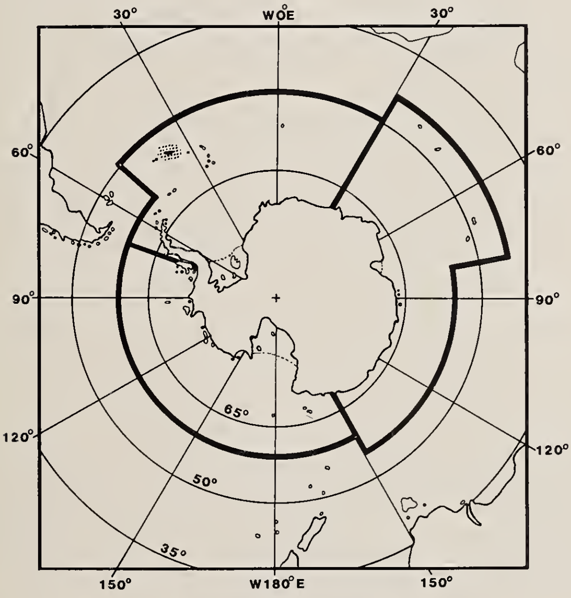
Careproctus georgianus Lönnberg, 1905
Fig. 4

Careproctus georgianus Lönnberg, 1905b: 41, pl. 3, fig. 11, South Fjord, Cumberland Bay, South Georgia Island. Syntypes: NRM SYD/1902224.1090 and SYD/1902224.3058.

Diagnosis: D 45–53; A 42–48; C 10; P 30, upper lobe rays 25, lower lobe rays 4–5. Head length 20.3%, body depth 16.8%, and distance from snout to anus 23.3% SL. Teeth simple, conical, forming bands in both jaws. Uppermost pectoral-fin ray level with lower margin of eye. Gill opening completely above pectoral-fin base. Upper pectoral-fin lobe somewhat shorter than head, notch shallow; distal end of lower lobe rays free from fin membrane. Anus slightly closer to anal-fin origin than to mouth.

Colour: In life, greyish, darker in large individuals; in preservation, pale, dotted with melanophores. Oral and branchial cavities pale, peritoneum pale.

Distribution: South Georgia Island, at 88–273 m.



Distribution of *C. georgianus*

Remarks: This is a poorly-known species. Given the range of dorsal- and anal-fin ray counts, it is possible that 2 or more species are confused in existing descriptions. Efremenko (1983) described 12.5–14.5 mm SL postlarvae of *C. georgianus*.

Biology unknown. The syntypes measure 63 and 105 mm TL.

Genus *Genioliparis* Andriashev & Neelov, 1976

Ventral sucking disk absent. One pore in temporal canal (Figs. 1b, 2a). Nostrils single. Mouth large, terminal, lower jaw massive. Snout with 5 fleshy barbels. Teeth large sharp canines. Gill opening above pectoral fin and extending ventrally in front of dorsal pectoral-fin rays. Pseudobranchs absent. Branchiostegal rays 6. Skin loose, thick, covered with small, sharp spinous prickles. Pectoral fin deeply notched. Four pectoral radials present, the dorsal pair notched. A single species known.

Genioliparis lindbergi Andriashev & Neelov, 1976
Fig. 5

Genioliparis lindbergi Andriashev & Neelov, 1976: 68, figs. 1–5, Bransfield Strait, Weddell Sea (61°39′S, 55°39′W). Holotype: ZIN 42511.

Diagnosis: D 53; A 49; P 19; C 6; vertebrae 62; P radials 4. Ventral sucking disk absent. Nostrils single. Head length 30.0% and head width 29.0% SL. Mouth very large, terminal. Teeth slender, sharp fang-like canines, forming bands in jaws, and enlarging towards inside of mouth. Snout with 5 barbels, median longest. Pectoral fin deeply notched, intermediate rays not rudimentary, 13+3+3 rays. Hypurals unfused, procurrent caudal rays absent.

Colour: In formalin, body, oral, and branchial cavities uniformly light. Peritoneum blackish, visible through body wall. Stomach and pyloric caeca pale.

Distribution: Known from 2 specimens; the holotype caught in the easternmost Bransfield Strait (Elephant Id) at a depth of 750–850 m, and another from the South Shetland Islands at a similar depth. Probably pelagic or benthopelagic.

Remarks: This species is very distinctive. It cannot be mistaken for any other liparidid known from the Southern Hemisphere, although it might be identified to the wrong family because of its dissimilarity to the "usual" liparidid. Its most similar relative is *Odontoliparis ferox* Stein (1978), from the north-eastern Pacific.

Biology unknown. The length of the holotype is 276 mm SL.

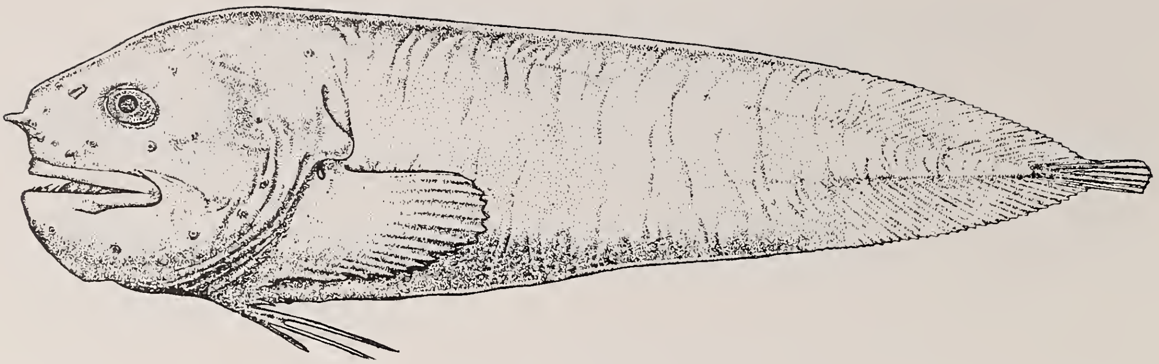
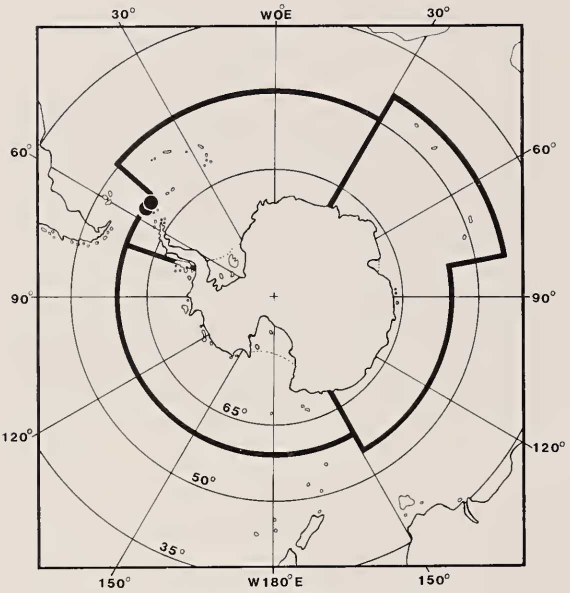


Fig. 5. *Genioliparis lindbergi* ZIN 42511, 276 mm SL, holotype (redrawn from from Andriashev & Neelov, 1976)



Distribution of *G. lindbergi*

Genus ***Notoliparis*** Andriashev, 1975

Cephalic sensory canals including an unpaired coronal pore, paired postcoronal pores, and 4 pairs of temporal pores (Figs. 1c, 2b). Nostrils single. Teeth simple, small. Eyes reduced to about 2.5% SL. Gill opening completely above pectoral-fin base. Pectoral fin with 4 un-notched radials. Ventral sucking disk present, not rudimentary. Anus located posteriorly, distant from disk. Two unfused hypurals present. Caudal-fin rays 13–14.

Three species of which 2 occur in our area, 1 in the Antarctic and another in the sub-Antarctic. The biology of *Notoliparis* species is unknown.

KEY TO SPECIES

1a D 41; A 38; vertebrae about 50; posterior margin of disk below gill opening; disk length 35% HL, and 21–22% distance from mandible to A origin .... *N. kurchatovi*

1b D 49–53; A 44–46; vertebrae 56–58; posterior margin of disk behind a vertical through tip of opercular flap; disk length 40–42% SL, and 28–29% distance from mandible to A origin .... *N. macquariensis*

Notoliparis kurchatovi Andriashev, 1975

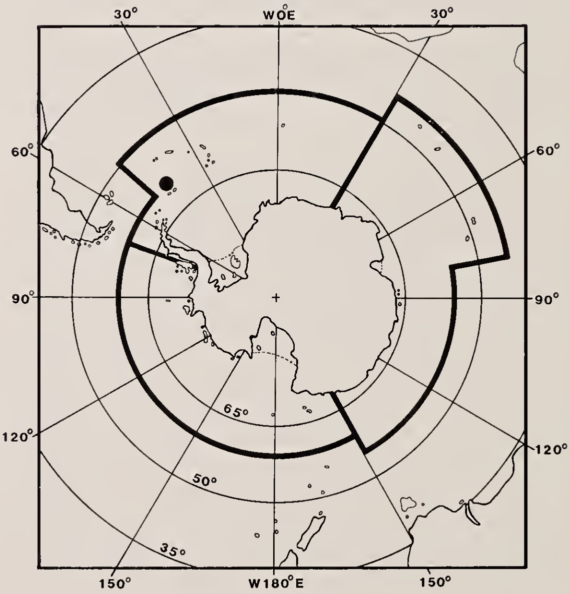
Fig. 6

Notoliparis kurchatovi Andriashev, 1975: 315, figs. 1–2, South Orkney Trench (60°13′S, 44°11′W). Holotype: ZIN 41755.

Diagnosis: D 41; A 38; P 31; C 13; vertebrae 50. Teeth simple, conical forming many rows. Pores of cephalic sensory canals very small. Disk length 8.8% SL, shorter than distance from premaxillary symphysis to anterior edge of disk. Preanal distance 42% SL.

COLOUR: In life, body pale rosy grey. Oral and branchial cavities and stomach pale. Peritoneum slightly rosy grey.

Distribution: Known only from the type locality at 5,474–5,465 m. Probably benthic.



Distribution of *N. kurchatovi*

Remarks: The length of the holotype is 108 mm SL.

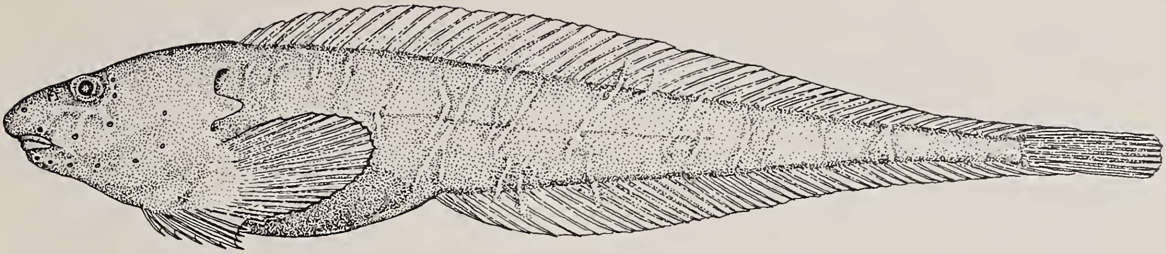


Fig. 6. *Notoliparis kurchatovi*, 126 mm TL (redrawn from Andriashev, 1975)

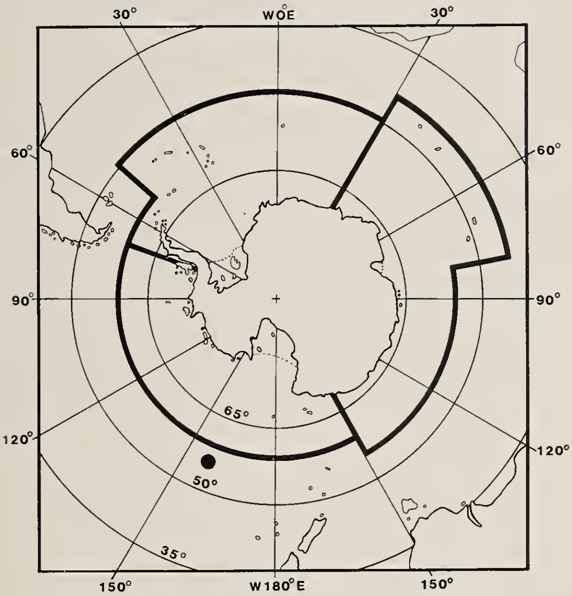
Notoliparis macquariensis Andriashev, 1978
Fig. 7

Notoliparis macquariensis Andriashev, 1978a: 152, figs. 1–2, Macquarie Trench (54°59'S, 159°21'W). Holotype: ZIN 43160.

Diagnosis: D 49–53; A 44–46; P 31; C 12; vertebrae 56–58. Teeth simple, small, conical, forming a few irregular rows. Disk length 9.5–9.9% SL, about equal to distance from mandible to anterior edge of disk. Dorsal-fin origin above anterior or middle of pectoral fin length. Preanal distance 37–38% SL.

COLOUR: In life, body pale pinkish-grey. Branchial and body cavities pale. Stomach pale. In alcohol, pale.

Distribution: Known only from the Macquarie Trench east of Macquarie Island, at depths of 5,400–5,410 m. Probably benthic.



Distribution of *N. macquariensis*

Remarks: Although the only captures of this species have been just outside the limits of the Southern Ocean, distribution within these limits seems likely.

Attains 88.0 mm SL.

Genus ***Paraliparis*** Collett, 1879

Ventral sucking disk absent. Nostrils single; snout barbels absent. One posterior (suprabranchial) pore present in temporal canal (Figs. 1b, 2a). Pseudobranchs absent. Branchiostegal rays 6. Pectoral-fin notch shallow or absent to very deep.

Remarks: Twenty-seven species have been described from the Southern Ocean, but these probably do not represent all the species present. Considering the established diversity of the genus in the region, more species will probably be described in the future. The majority of the species are benthic and inhabit deep water. Many are represented by a small number of specimens and nothing is known of their biology.

KEY TO SPECIES

1a Vertebrae fewer than 63 (rarely 64); D 35–60 (35–57 in most species, 58–60 in *eltanini*) 2

1b Vertebrae more than 65 (rarely 64); D 58–73 (rarely 57) 15

2a D and A rays unsegmented except for a few segments distally on posterior rays; D 38–41 ....*P. anarthractae*

2b D and A rays segmented except for anterior rudimentary rays if present..3

3a P 13–21 4

3b P 22–27 (very rarely 21)...............................7

4a Teeth completely absent in both jaws and pharyngeals; gill opening extending ventrally in front of 6–7 P, more than 33% HL; P 13–16 ....*P. terraenovae*

4b Teeth present in both jaws, forming bands composed of oblique rows; gill opening completely above P or extending ventrally in front of 1–5 rays, less than 33% HL 5

5a C 4–5; P distinctly notched, of 15–21 rays; opercular flap small, not overlapping anterior of P 6

5b C 9–10; P unnotched or shallowly notched, with 19–21 rays; opercular flap well developed, extending distinctly posterior to bases of dorsal P; opercle length more than 33% HL; stomach dark brown to black ....*P. operculosus*

6a Teeth shouldered; gill opening completely above P or extending ventrally in front of 1–2 rays; D 49–53; A 44–47; upper P lobe not reaching behind A origin ......*P. thalassobathyalis*

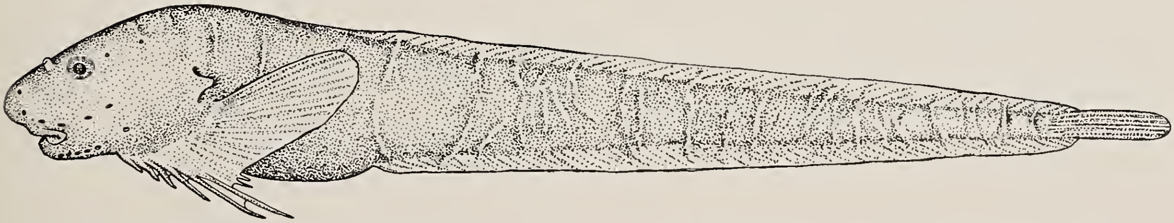


Fig. 7. *Notoliparis macquariensis* ZIN 43160, 100 mm TL, holotype (redrawn from Andriashev, 1978)

6b Teeth simple small canines; gill opening above P and extending ventrally in front of about 5 rays; D 58–60; A 51–52; upper P lobe reaching to or behind A origin .... *P. eltanini*

7a Gill opening very long, extending ventrally in front of 16–20 P rays, its length about 50% HL or more....... *P. meganchus*

7b Gill opening short or moderately long, extending ventrally in front of fewer than 10 P rays, less than 50% HL.........8

8a P very deeply notched, 2–3 rays rudimentary; notch rays 10–15% of upper P lobe length; gill opening extending ventrally in front of 1–3 P; oral and branchial cavities pale; peritoneum pale.............................. *P. leobergi*

8b P notch variable, rudimentary rays absent; notch rays more than 25% length of upper P lobe; gill opening extending ventrally in front of 1–8 P rays.........................9

9a Snout bilobed; 2 tubercular prominences present, on each of which an upper nasal pore opens; teeth in both jaws relatively large, flattened, some with shoulders, very closely set, forming a pavement-like surface; branchial cavity black; preanal distance about 33% SL..................... *P. diploprora*

9b Snout not bilobed; nasal pores not as above; teeth tricuspid or conical, sharp or blunt, usually tips only visible, not so closely set as to form a pavement 10

10a Mouth distinctly terminal, with the anterior part of snout not visible from below; P 22–23; C 10; pyloric caeca 6; stomach pale...................................... *P. incognita*

10b Mouth inferior or subterminal, with the anterior part of snout visible from below; P 21–27..........................11

11a Inner teeth clearly tricusped; A 41–43; vertebrae 51–55; oral and branchial cavities pale; stomach pale; pyloric caeca 3–6 12

11b Teeth simple; A 49–53; vertebrae 59–63; oral cavity pale or dark grey, branchial cavity black; stomach pale or reticulated black; pyloric caeca 6–10............................13

12a Premaxillary teeth strongly tricusped, in about 6–8 oblique rows; distance between mandibular symphyseal pores (Fig. 3) about equal to distance to next most posterior pores; peritoneum completely pale; hypural plate fused .... *P. leucogaster*

12b Premaxillary teeth weakly tricusped, in 15 or more oblique rows; mandibular symphyseal pores closer to each other than either is to more posterior pores; peritoneum mottled and reticulated with brown; hypural plate with a slit .*P. trilobodon*

13a P not reaching A origin; D and A rays black, fin membranes pale (in life red); snout dark; mandibular symphyseal pore pair very closely set; anus below preopercle....... *P. valentinae*

13b P reaching behind A origin; D and A pale; snout pale 14

14a Mandibular symphyseal pore pair close together, distance less than 4% HL; eye less than 26% HL; pyloric caeca 9–11, not unusually large; stomach pale........... P. *andriashevi*

14b Mandibular symphyseal pore pair well separated, distance more than 6% HL; eye more than 30% HL; pyloric caeca 6–9, large; stomach blackish or dusky, with black blood vessels.. .... *P. somovi*

15a P 15–17; stomach dark brown or black.................16

15b P 19–31; stomach pale, rarely dark dorsally 17

16a P notch absent or very shallow; length of intermediate P rays equal to or slightly shorter than upper P lobe length; pyloric caeca absent; C 8............................ *P. gracilis*

16b P notch moderately deep; length of intermediate P rays about 50% of upper P lobe length; pyloric caeca about 9, evenly short, black with pale tips; C 4 .... *P. kreffti*

17a Gill opening very long, extending ventrally in front of 15–20 P rays, its length more than 33% HL; C 9–10; head large, 25–26% SL; peritoneum pale to light brown, sparsely dotted; oral and branchial cavities pale; stomach ventrally pale, dorsally black............................. *P. antarcticus*

17b Gill opening short or moderately long, extending ventrally in front of 6 or fewer rays, its length equal to or less than 33% HL; C 8 or fewer; head length less than 24% SL; peritoneum dark brown or black, stomach pale.....................18

18a Mandibular symphyseal pore pair reduced to a single median pore or opening in a common pore or deep pit; branchial cavity pale; anus below rear half of eye; C 7...........19

18b Mandibular symphyseal pore pair not opening in a common pore or deep pit; branchial cavity dusky, grey or black; anus below preopercle or posterior to it; C 6–8...............20

19a Symphyseal pore pair opening into a transversely oval pit, larger than other preopercular-mandibular pores; P rays 26–31, 4–5 intermediate rays rudimentary; preanal distance 27–30% SL; gill opening 20–24% HL .... *P. tetrapteryx*

19b Unpaired symphyseal pore present, round, about equal to size of other preopercular-mandibular pores; P 22–25; no intermediate rays rudimentary; preanal distance 42–43% SL; gill opening 10–11% HL.................... *P. monoporus*

20a Mandibular symphyseal pore pair widely separated; P not deeply notched 21

20b Symphyseal pore pair closely set; P deeply notched; oral cavity and tongue similar in colour 22

21a Oral cavity dark, with the tongue pale; mandible to anus distance equal to or greater than anus to A origin distance; gill opening extending ventrally in front of 5–6 P rays, its length about 7% SL; P weakly notched .... *P. leucoglossus*

21b Oral cavity and tongue similar in colour; anus closer to mandibular symphysis than to A origin; gill opening above or in front of 1–2 P rays; P notch moderately deep .... *P. fuscolingua*

22a Teeth in one or both jaws mostly or completely uniserial, not in bands of oblique tooth rows; opercular flap present or absent..23

22b Teeth in both jaws in bands of oblique rows; opercular flap present 26

23a Intermediate P rays rudimentary, less than 10% of upper P lobe length; predorsal distance 27–30% SL; P radials 4, the dorsal 3 each with at least one semi-circular notch .... *P. stehmanni*

23b Intermediate P not rudimentary, more than 25% of upper P lobe length; P radials 3 or 4, un-notched................24

24a Opercular flap present, small; gill opening not pore-like, longer than 2.0% SL; C 6; D 61–64; head length 16.1–19.1 and preanal distance 41–45% SL .... *P. neelovi*

24b Opercular flap absent; gill opening pore-like, 1.0–2.1% SL; C 8; D 57–61; head length 14.9–17.5 and preanal distance 33–37% SL 25

25a Vertebrae 67–71; distances from snout to anus 15.0–16.9%; from snout to A origin 32.9–34.5%, and from anus to A origin 15.5–18.2% SL; gill opening length 1.0–1.4% SL.......... .... *P. copei gibbericeps*

25b Vertebrae 64–67; distances from snout to anus 13.4–15.0%, from snout to A origin 35.8–37.1%, and from anus to A origin 19.5–22.7% SL; gill opening length 1.3–2.1% SL.......... .... *P. copei kerguelensis*

26a P radials 2; intermediate P rays rudimentary, less than 10% of upper P lobe length; D 69; A 63; P 26–27; head length about 17% SL.................................. *P. cerasinus*

26b P radials 3 (rarely 2 or 4); intermediate P rays not rudimentary, more than 10% of upper P lobe length; D 61–65; A 55–59 27

27a Gill opening completely above P; mouth inferior, snout markedly extending anterior to mouth; preanal distance 33–37%, predorsal distance 23–26%, and head length 20–23% SL; C 7 .... *P. devriesi*

27b Gill opening extending in front of 2 P; mouth subterminal, snout extending only slightly in front of mouth; preanal distance 30.7%, predorsal distance about 21%, and head length 18.6% SL; C 6 .... *P. mawsoni*

Paraliparis anarthractae Stein & Tompkins, 1989
Fig. 8

Paraliparis anarthractae Stein & Tompkins, 1989: 1, fig. 1, Strait of Magellan (53°28.5′S, 70°46′W). Holotype: LACM 10727-5.

Diagnosis: D 38–41; A 37–39; P 14–16; C 8; vertebrae 45–48; P radials 3. Head length 28.6–32.8% SL. Mouth large, terminal, with small, sharp canines forming narrow band in each jaw. Coronal pore present. Gill opening starting above pectoral-fin base and extending ventrally in front of 11–12 rays. Dorsal- and anal-fin rays almost completely unsegmented.

Colour: In alcohol pale, skin transparent with scattered melanophores dorsally. Oral and branchial cavities pale. Peritoneum silver, visible through body wall, internally

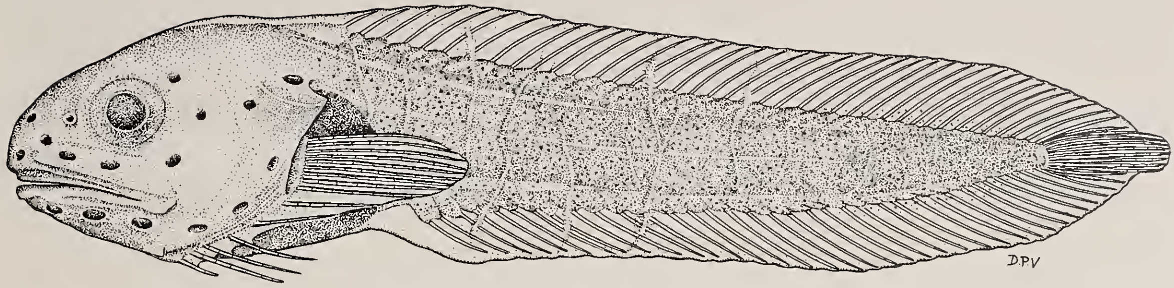
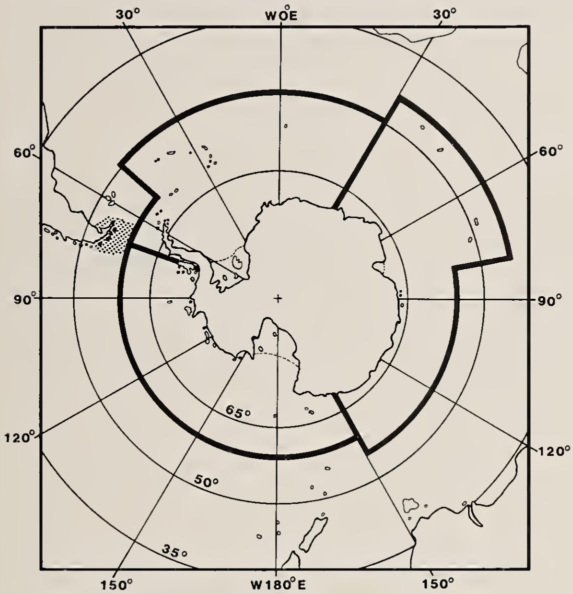


Fig. 8. *Paraliparis anarthractae* LACM 10727–5, 57 mm SL, holotype, female (from Stein & Tompkins, 1989)

black; a narrow mid-ventral black line surrounding anus and extending posteriorly, dividing body cavity into 2 silvery clamshell-like halves. Stomach and pyloric caeca black.

Distribution: Strait of Magellan and south of Cape Horn. Probably pelagic between surface and 485 m. It may occur within CCAMLR area.



Distribution of *P. anarthractae*

Remarks: Females appear to reach greater lengths than males (69 vs 57 mm SL). With increasing length, eye diameter becomes relatively larger (less than 13% to almost 20% HL), the anus is much farther anterior (snout-anus distance almost halves), and the upper pectoral-fin lobe is relatively longer. Females longer than 54 mm SL had apparently ripe eggs up to 2.0 mm diameter; 2 had 59 and 67 eggs.

Paraliparis andriashevi Stein & Tompkins, 1989

Fig. 9

Paraliparis andriashevi Stein & Tompkins, 1989: 4, fig. 5, Ross Sea (72°26.5'S, 177°08'E). Holotype: LACM 11467–2.

Diagnosis: D 57–58; A 52; P about 24; C 9; vertebrae 60–63; P radials 4; pyloric caeca 9–11. Head length 20–22% SL. Mouth inferior. Teeth mostly simple, blunt, but a few inner teeth with small shoulders, more obvious in smaller individuals. Mandibular symphyseal interpore space 2.5–4.0% HL. Dorsal pectoral-fin ray above level of posterior corner of maxilla. Pectoral-fin notch shallow, with lower lobe rays greatly exserted. Anus about midway between gill opening and orbit.

Colour: In alcohol, pale, abdominal region slightly rosy. Oral cavity pale anteriorly, dusky posteriorly. Branchial cavity dark. Peritoneum dark brown, stomach and caeca pale.

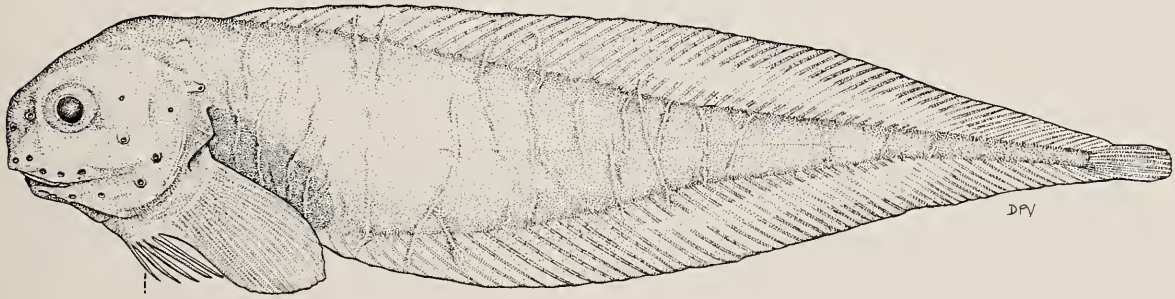
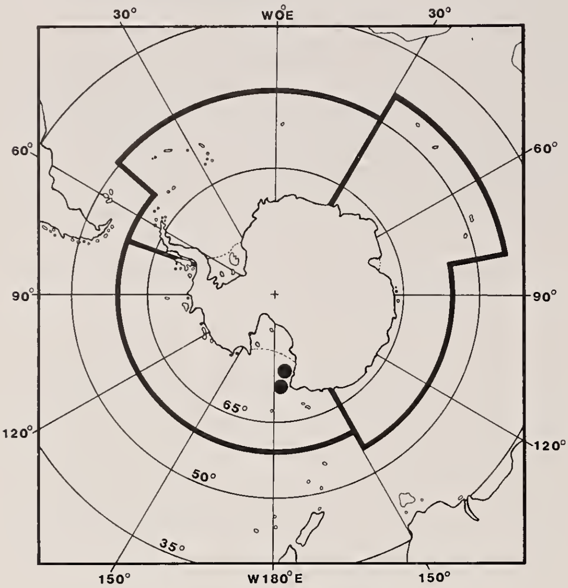


Fig. 9. *Paraliapris andriashevi* LACM 11467–2, 181 mm SL, holotype, male (from Stein & Tompkins, 1989)

Distribution: Ross Sea between 1,883–2,306 m. Apparently benthic or epibenthic.



Distribution of *P. andriashevi*

Remarks: The change in tooth characteristics appears to be size-related.

Attains 181 mm SL.

Paraliparis antarcticus Regan, 1914

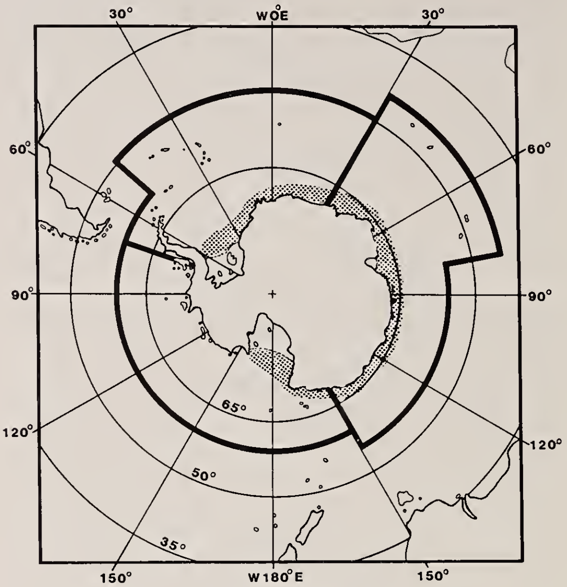
Fig. 10

Paraliparis antarcticus Regan, 1914a: 11, south of Balleny Islands. Lectotype: BMNH 1913.12.04.58–60.

Diagnosis: D 61–64; A 55-about 60; P 23–28; C 9–10; vertebrae 67–74; P radials 4 (rarely 3). Head length 25–26% and preanal distance 33–42% SL. Teeth simple, forming bands in both jaws. Seismosensory pores large; mandibular symphyseal pore pair distinctly separated, but only about 33% as far apart as distance between first and second pores in series. Gill opening greater than 33% HL, extending ventrally in front of 15–20 pectoral-fin rays.

Colour: In life, body pinkish, semi-transparent, tail orange-red. In alcohol, body, oral and branchial cavities, peritoneum, and ventral part of stomach pale. Dark dorsal portion of stomach sometimes visible through abdominal wall.

Distribution: East Antarctic shelf, including Ross Sea, Shackleton Ice Shelf, Enderby Land, and southernmost Weddell Sea. Probably benthic or epibenthic at depths of 300–782 m.



Distribution of *P. antarcticus*

Remarks: Allometry exists in preanal distance, which increases disproportionately with increasing size. Spawning probably occurs in late summer or early fall. Females captured in February and March had 40–80 nearly ripe eggs 3.5–5.6 mm diameter (Andriashev 1986). Juveniles 80 mm SL have been captured with midwater trawls at less than 100 m over a 580 m bottom depth.

Attains 23 cm SL.

Paraliparis cerasinus Andriashev, 1986

Fig. 11

Paraliparis cerasinus Andriashev, 1986: 40, fig. 13, Princess Astrid Coast, East Antarctica (69°14′S, 12°35′E). Holotype: ZIN 46808.

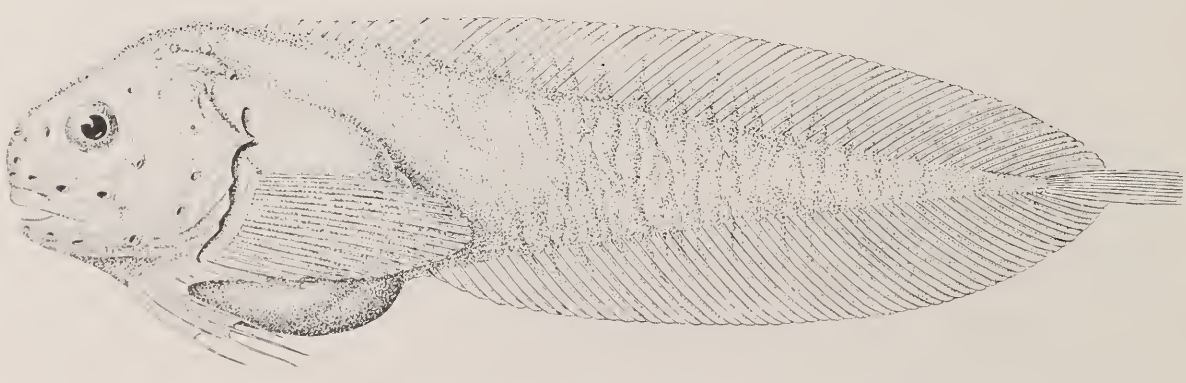


Fig. 10. *Paraliparis antarcticus* NMNZ-P 12008, 203 mm SL, female, Ross Sea (from Andriashev 1986)

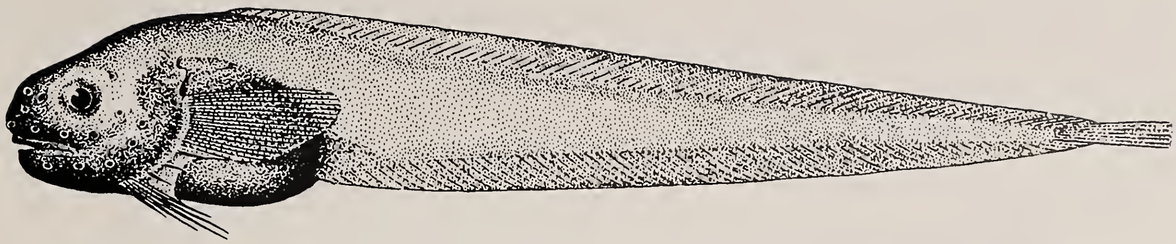


Fig. 11. *Paraliparis cerasinus* ZIN 46808, 87 mm SL, holotype, male (from Andriashev, 1986)

Diagnosis: D 69; A 63; P 26–27; C 7; vertebrae 76; P radials 2. Head small, about 17%, and preanal distance about 29% SL. Teeth very small, forming bands in both jaws. Cephalic pores very small; mandibular symphyseal pore pair nearly touching, but not in common pit. Gill opening short, 2.3–2.9% SL, completely above pectoral fin. Pectoral fin reaching posterior to anal-fin origin, deeply notched; several notch rays rudimentary.

Colour: In life, body cherry red; in alcohol, head and fins blackish, trunk grey. Oral cavity blue-grey, branchial cavity and peritoneum black, stomach pale.

Distribution: Known only from the holotype collected off east Antarctica in the Riiser-Larsen Sea at a depth of 950–1,100 m. Probably benthic or epibenthic.

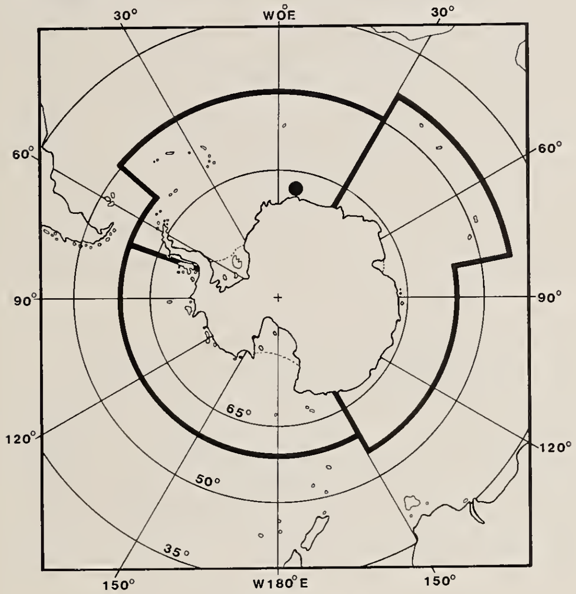
Remarks: Holotype (adult?) male 87 mm SL.

Paraliparis copei gibbericeps Andriashev, 1982

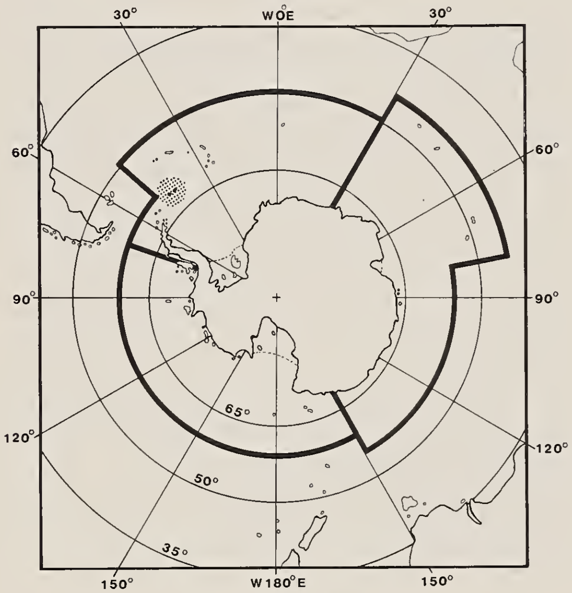
Fig. 12

Paraliparis copei gibbericeps Andriashev, 1982a: 182, figs. 2–3, South Georgia (53°39′S, 36°20′W). Holotype: ZIN 45711.

Diagnosis: D 59–61; A 52–56; P 21–22; C 8; vertebrae 67–71; P radials 4. Head length 14.9–17.5% and preanal distance 32.9–34.5% SL. Lower jaw included in upper. Teeth on premaxillary uniserial; teeth on dentary biserial near symphysis and in both jaws smaller anteriorly. Cephalic pores small; mandibular symphyseal pore pair close together, in a common transverse pit. Opercular flap absent. Gill opening completely above pectoral-fin base, pore-like.



Distribution of *P. cerasinus*



Distribution of *P. copei gibbericeps*

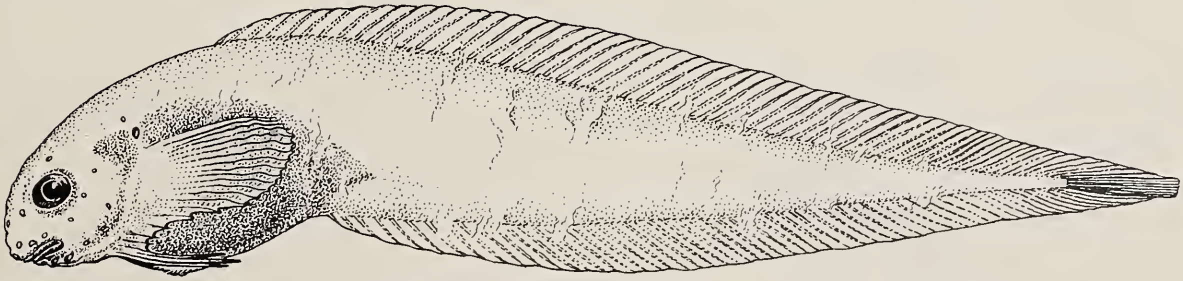


Fig. 12. *Paraliparis copei gibbericeps* ZIN 45711, holotype, 112 mm SL (from Andriashev, 1986)

Fig. 13. *Paraliparis copei kerguelensis* ZIN 45825, holotype, 123 mm SL (from Andriashev, 1986)

Colour: In life, snout blackish, body white; in alcohol, lips and skin around mouth brownish-black, body light, unpigmented. Oral cavity blackish-brown, branchial cavity and peritoneum black. Stomach light.

Distribution: Off South Georgia at depths of 400–1,000 m. Probably benthic or epibenthic.

Remarks: Attains 167 mm SL.

Paraliparis copei kerguelensis Andriashev, 1982
Fig. 13

Paraliparis copei kerguelensis Andriashev, 1982b: 722, figs. 1–2, Kerguelen Islands (50°01′S, 70°48′E). Holotype: ZIN 45825.

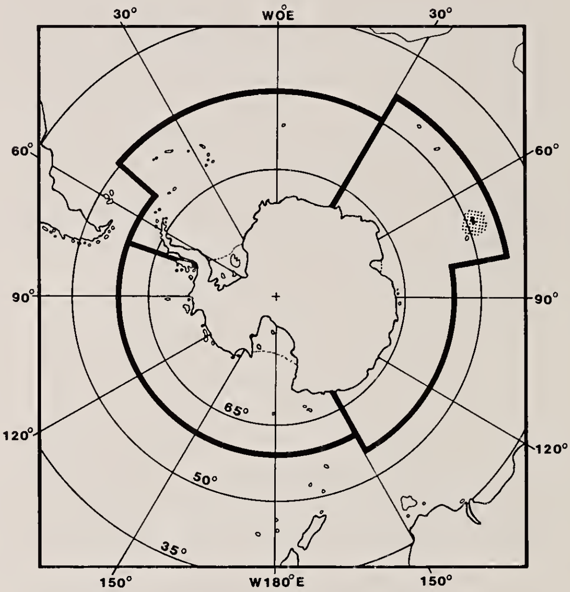
Diagnosis: D 57–61; A 50–54; P 20–22; C 8; vertebrae 64–67; P radials 4. Head length 15–16% and preanal distance 35.8–37.1% SL. Teeth on premaxillary uniserial; on dentary, biserial near symphysis. Cephalic pores small; mandibular symphyseal pore pair closely set, not in a common pit. Opercular flap absent. Gill opening completely above pectoral-fin base, pore-like.

Colour: In life, body pinkish-lilac, more intense caudally; in alcohol, body pale, lips and snout blackish. Oral cavity dark grey, gill cavity and peritoneum black. Stomach pale.

Distribution: Known from the Kerguelen Islands at depths of 580–820 m, and from the Kerguelen Ridge southward to about 52°S at depths of 510–1,050 m. Probably benthic or epibenthic.

Remarks: Spawning probably occurs in summer; a single large female had 216 ripe eggs 2–3.5 mm diameter. Juveniles 44–60 mm SL were captured in October.

Attains 194 mm SL.



Distribution of *P. copei kerguelensis*

Paraliparis devriesi Andriashev, 1980
Fig. 14

Paraliparis devriesi Andriashev, 1980a: 150, text figure, Ross Sea, near McMurdo Observatory. Holotype: ZIN 43577.

Diagnosis: D 61–65; A 55–59; P 22–25; C 7; vertebrae 68–72; P radials 3 (rarely 2 or 4). Head length

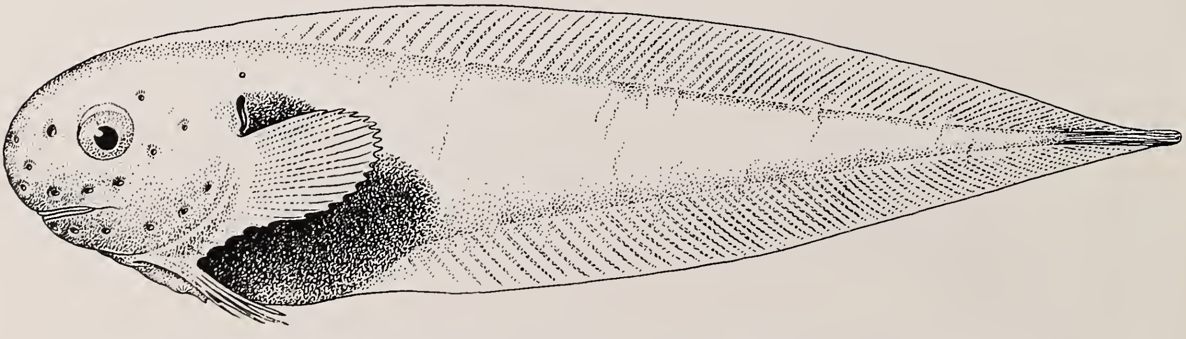
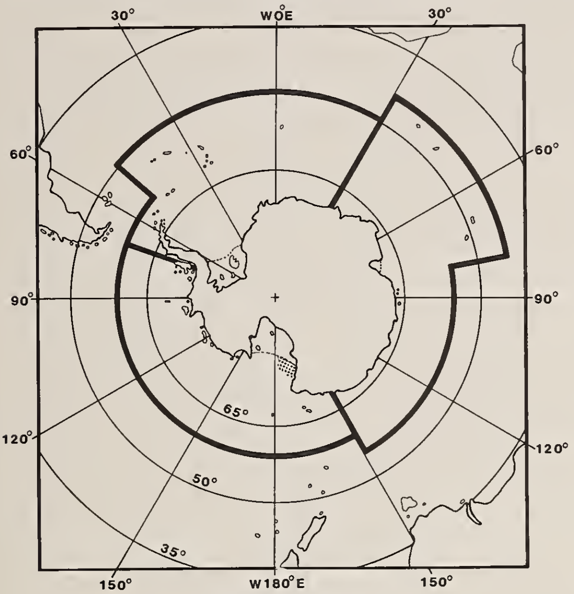


Fig. 14. *Paraliparis devriesi* ZIN 43577, 170 mm SL, holotype, female (from Andriashev, 1986)

19.8–22.6% and preanal distance 33.3–36.9% SL. Mouth inferior, with canines forming bands in both jaws. Mandibular symphyseal pore pair closely set in a common transverse pit. Gill opening above pectoral-fin base, its length 3.0–3.8% SL. Opercular flap small. Pectoral fin deeply notched, intermediate rays rudimentary or nearly so. Anus closer to snout than to anal-fin origin.

Colour: In life, pale pink, more intense on snout and tail, abdomen bluish; in alcohol, uniformly pale except for grey branchial cavity and black peritoneum.

Distribution: Known only from the Ross Sea near McMurdo Observatory, at depths of 500–700 m.



Distribution of *P. devriesi*

Remarks: Spawning probably occurs in summer. One almost ripe female had 57 eggs of about 3.7 mm diameter. Stomach contents included specimens of the amphipod *Orchomene plebs,* but these may have been eaten in fish traps by the individuals collected and thus may not be a usual food item.

Attains 178 mm SL.

Paraliparis diploprora Andriashev, 1986
Fig. 15

Paraliparis diploprora Andriashev, 1986: 65, figs 25–27, near South Georgia Island (54°12′S, 40°02′W). Holotype: ISH 407/76.

Diagnosis: D 54; A 50; P 25; C 10; vertebrae 60; P radials 4. Head length about 21% and head width about 10% SL. Snout bilobed from a pair of tubercular prominences, each terminating in a pore. Teeth relatively large, wide, and flattened; some with lateral shoulders, forming pavement-like bands in jaws. Mandibular symphyseal pore pair widely spaced. Gill opening less than 50% HL, extending ventrally in front of 7–10 pectoral-fin rays. Pectoral-fin notch shallow, rudimentary rays absent. Anus slightly closer to snout than to anal-fin origin.

Colour: In life, probably pinkish, more intense on snout and dorsal- and anal-fin bases. Oral cavity blackish, branchial cavity and peritoneum black. Stomach pale.

Distribution: Known only from the north Scotia Sea between South Georgia and the Shag Rocks. Probably epibenthic at depths of about 2,600 m.

Remarks: Holotype, adult female, 133 mm SL.

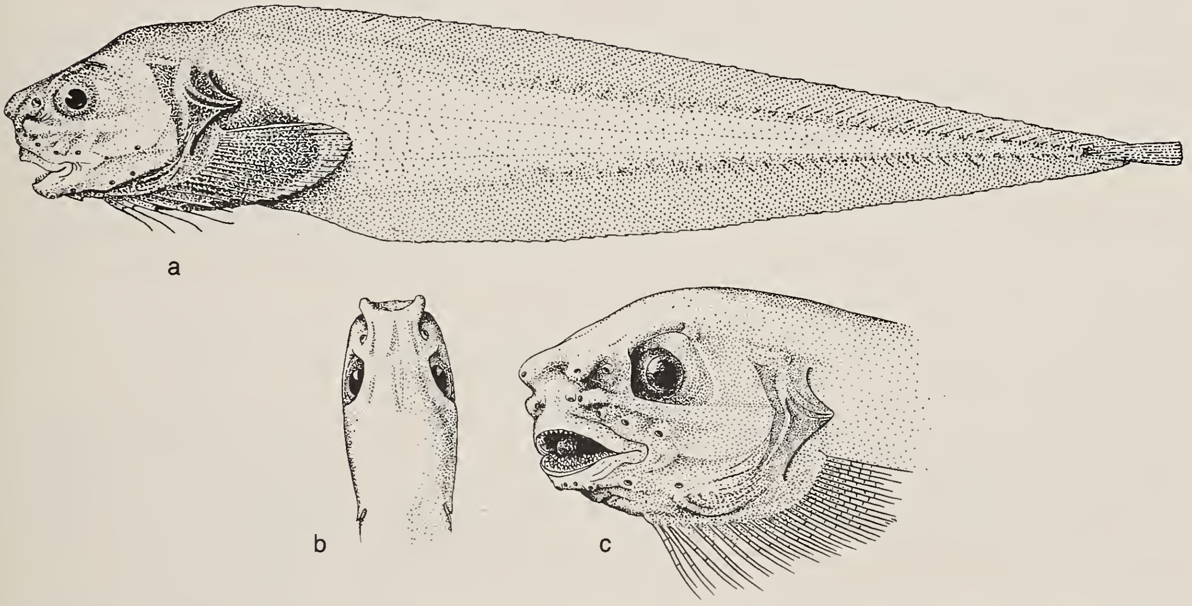


Fig. 15. (a) *Paraliparis diploprora* ISH 406/76, 133 mm SL, holotype, female; (b) dorsal view of head; (c) anterolateral view of head (from Andriashev, 1986)

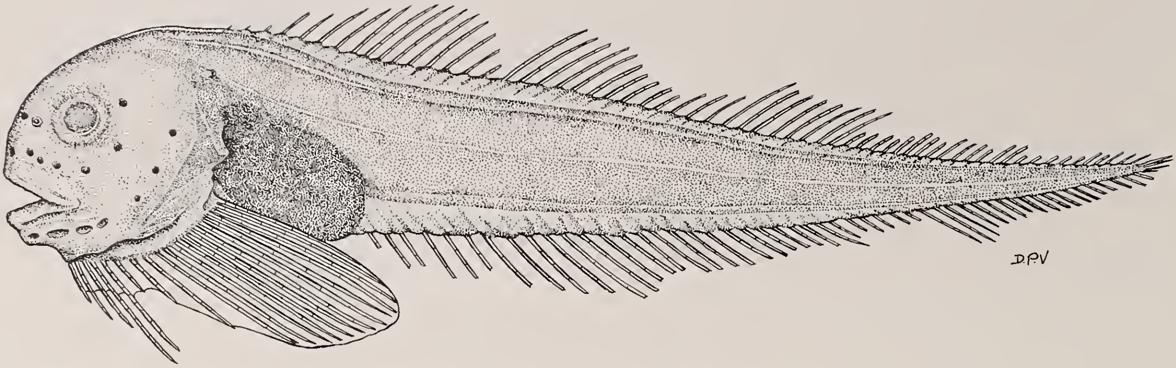
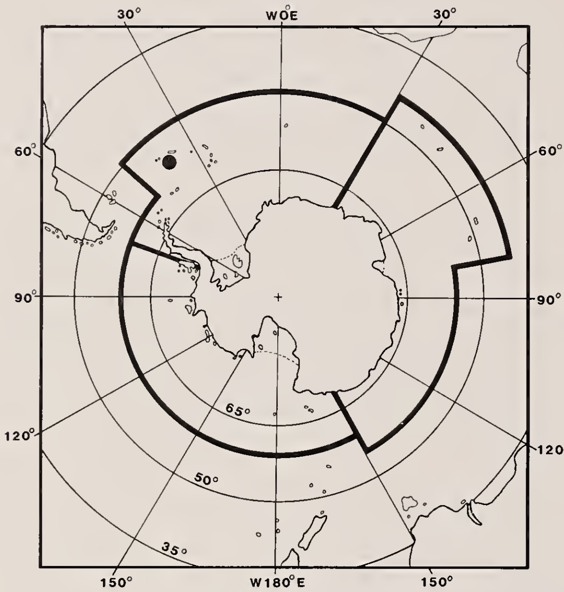
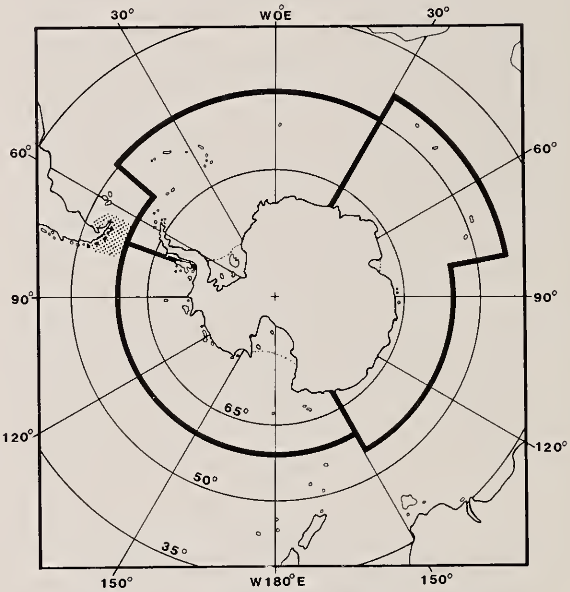


Fig. 16. *Paraliparis eltanini* LACM 10450–3, 84 mm SL, holotype, female (from Stein & Tompkins, 1989)



Distribution of *P. diploprora*



Distribution of *P. eltanini*

Paraliparis eltanini Stein & Tompkins, 1989
Fig. 16

Paraliparis eltanini Stein & Tompkins, 1989: 3, fig. 3, Strait of Magellan (53°46.5′S, 70°53′W). Holotype: LACM 10450–3.

Diagnosis: D 58–60; A 51–52; P 18–21; C 4; vertebrae 64–65; P radials 4. Head length 19.3–21.8% SL. Mouth terminal, with tiny canines, in narrow bands in both jaws. Coronal pore present. Gill opening starting above pectoral-fin base and extending ventrally in front of about 5 rays. Dorsal pectoral-fin ray level with or below posterior corner of maxilla.

COLOUR: In alcohol, pale, skin transparent with scattered dorsal melanophores. Oral and branchial cavities dusky; peritoneum dark brown, the stomach blackish and pyloric caeca pale.

Distribution: Strait of Magellan at less than 500 m. Likely to occur farther south, as in *P. anarthractae*. Probably pelagic or benthopelagic.

Remarks: Ripe or ripening eggs from fish collected in February were 2.3–2.5 mm in diameter.

Attains 88 mm SL.

Paraliparis fuscolingua Stein & Tompkins, 1989
Fig. 17

Paraliparis fuscolingua Stein & Tompkins, 1989: 5, fig. 7, off Cape Adare, Ross Sea (70°55′S, 172°00′E). Holotype: LACM 11351–4.

Diagnosis: D 61–63; A 54–57; P 24–25; C 8; vertebrae 68–69; P radials 4. Head length 19.4–19.6% SL. Mouth subterminal, snout slightly protruding. Teeth sharp, recurved canines, forming narrow band in each jaw. Gill opening apparently above pectoral-fin base. Anus below interopercle, distinctly closer to mandibular symphysis than to anal-fin origin.

COLOUR: In alcohol, body colour unknown, probably dusky at least anteriorly. Oral cavity, tongue, and branchial cavity dusky. Peritoneum dark brown or black. Stomach and pyloric caeca pale.

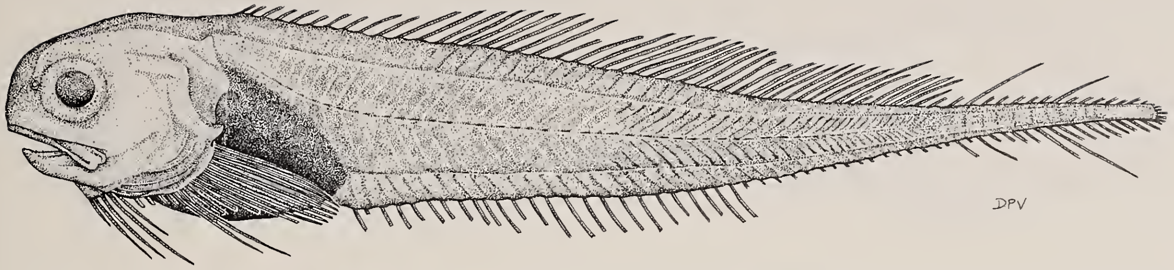
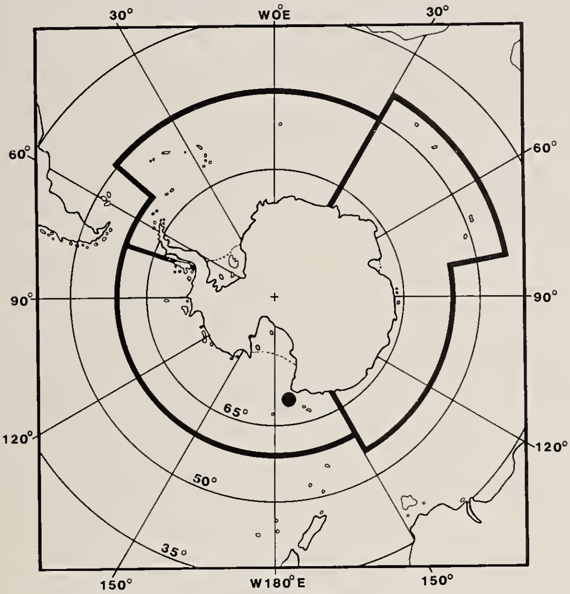


Fig. 17. *Paraliparis fuscolingua* LACM 11351–4, 115 mm SL, holotype, female (from Stein & Tompkins, 1989)

Distribution: Known only from the type locality, at 2,273 m. Probably benthic.



Distribution of *P. fuscolingua*

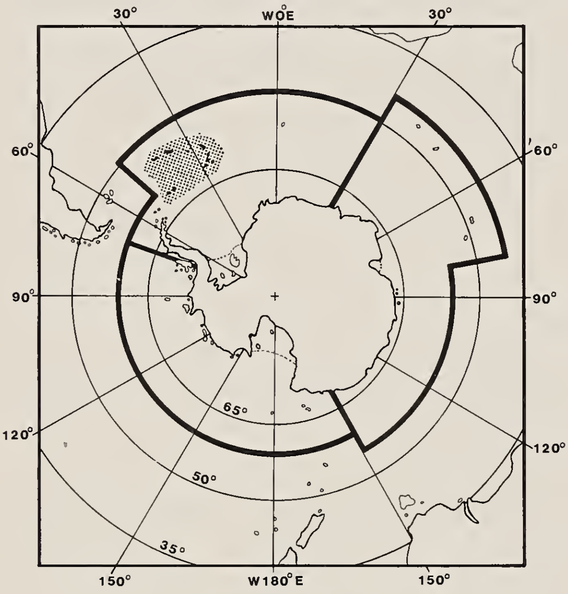
Remarks: Known only from 2 damaged female specimens, the larger 115 mm SL.

Paraliparis gracilis Norman, 1930
Fig. 18

Paraliparis gracilis Norman, 1930: 352, fig. 42, north of South Georgia Island (53°48′S, 35°37′30″W). Holotype: BMNH 1930.1.12.1077.

Diagnosis: D 58–66; A 56–63; P 15–17; C 8; vertebrae 68–74; P radials 4. Head length 18.4–19.9% and head width 10.9–12.8% SL. Teeth small canines in bands in both jaws. Gill opening starting above pectoral-fin base and extending ventrally in front of 1–3 rays. Pectoral-fin notch absent or very shallow; a single rudimentary ray frequently present in lowermost position on pectoral girdle, clearly evident only upon clearing and staining; remaining 2–4 ventral rays greatly exserted. Anus usually below anterior of preopercle, but in gravid females it protrudes ventrally below front of eye. Pyloric caeca absent.

Colour: In life, body colourless, abdominal cavity



Distribution of *P. gracilis*

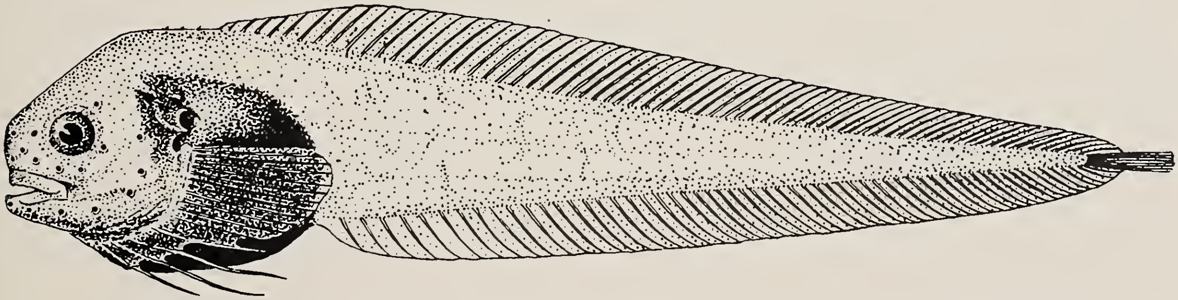


Fig. 18. *Paraliparis gracilis* ZIN 46825, 109 mm SL, female, South Georgia (from Andriashev, 1986)

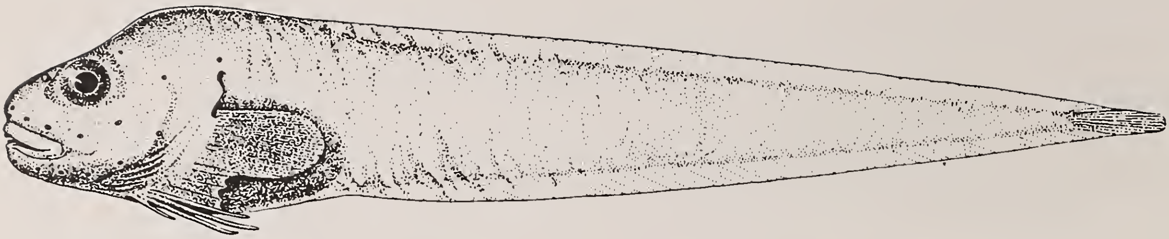


Fig. 19. *Paraliparis incognita* ZIN 45935, 80 mm SL, female, East Antarctica, off Shackleton Ice Shelf (from Andriashev, 1986)

bluish-black externally; in alcohol, body pale; oral cavity blackish-grey; branchial cavity and peritoneum black, the stomach and anterior part of intestine dark brown.

Distribution: South Georgia and South Orkney islands, from bottom and midwater trawls at depths of 217–830 m. Likely to occur near the South Sandwich Islands. Probably benthopelagic.

Remarks: Norman (1938) reported dorsal-fin ray counts of 58–66 and anal-fin ray counts of 56–63. Although the 42 specimens examined by Andriashev (1986) do not exhibit this range, the former's counts have been included in the diagnosis. Two females, captured in late February and early March, contained up to 47 eggs of 2.8–3.0 mm diameter, suggesting that spawning occurs about that time. Stomachs of some specimens contained sponge spicules.

Attains about 114 mm SL.

Paraliparis incognita Stein & Tompkins, 1989

Fig. 19

Paraliparis terraenovae (*non* Regan): Andriashev, 1986: 135, figs. 59–60.

Paraliparis incognita Stein & Tompkins, 1989: 6, Davis Sea, off Shackleton Ice Shelf (64°06′S, 98°27′E). Holotype: ZIN 45935.

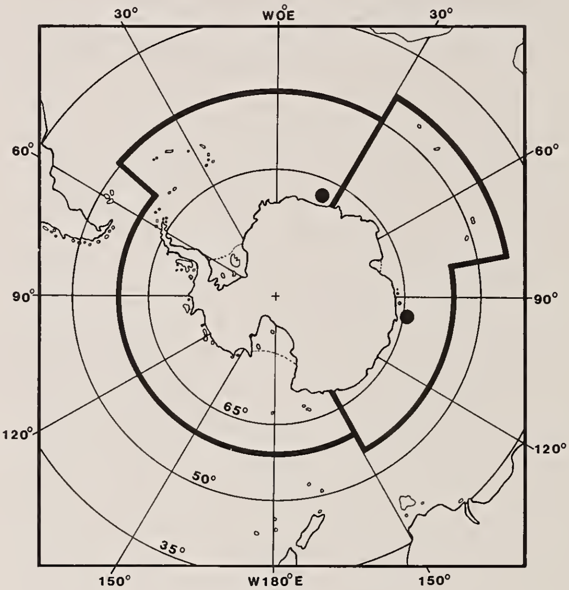
Diagnosis: D 48–50; A 43–45; P 22–23; C 10; vertebrae 54–58; pyloric caeca 6; P radials 3. Head large, 23.1–27.2% SL. Mouth distinctly terminal; teeth simple, in bands in both jaws. Gill opening extending ventrally in front of 2–4 pectoral-fin rays, its length 5.0–5.3% SL. Pectoral-fin notch moderately deep; rudimentary rays absent; anteriormost pectoral-fin ray behind a vertical through pupil.

Colour: In life, body pinkish-violet or reddish-brown. In alcohol, body pale or dusky. Oral and branchial cavities dark grey. Peritoneum dark brown and stomach pale.

Distribution: Known from the type locality and the Riiser-Larsen Sea (Princess Ragnhild Coast) at less than 560 m depth. Probably pelagic.

Remarks: This species was misidentified as *P. terraenovae* Regan, 1916, and was used as the basis for a rediscription of the species by Andriashev (1986). Stein & Tompkins (1989) examined Regan's holotype, discovered the error and named the species. A full description of the differences is included therein.

Attains about 80 mm SL.



Distribution of *P. incognita*

Paraliparis kreffti Andriashev, 1986

Fig. 20

Paraliparis kreffti Andriashev, 1986: 83, figs. 35–36, between South Georgia Island and Shag Rocks (54°12′S, 40°02′W). Holotype: ISH 405/76.

Diagnosis: D 66; A 59; P 16; C 4; vertebrae 73-about 77; pyloric caeca 9; P radials 2. Head length about 21% SL. Mouth terminal; jaws with bands of canines; a toothless, darkly pigmented gap at premaxillary symphysis. Gill opening starting above pectoral-fin base and extending ventrally in front of 1–3 rays. Pectoral fin moderately notched, rudimentary rays absent; lowest 3–4 rays free for at least 75% of their length, the longest exceeding length of upper pectoral-fin lobe. Anus distinctly closer to anal-fin origin than to snout.

Colour: In life, probably pinkish. In alcohol, body pale except for blackish snout, lips, lower part of head, and branchial area. Body cavity externally bluish-black. Oral cavity greyish-black; branchial cavity, stomach, and pyloric caeca (except for tips) black.

Distribution: Known only from the type locality; 2 specimens captured at about 2,600 m. Probably benthopelagic.

Remarks: The largest of the 2 known specimens is 114 mm SL.

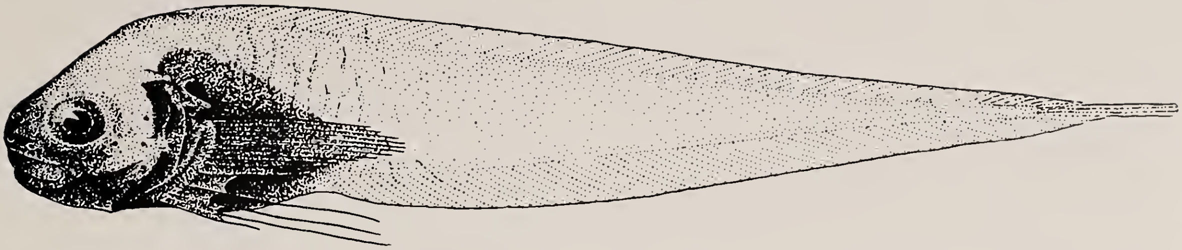
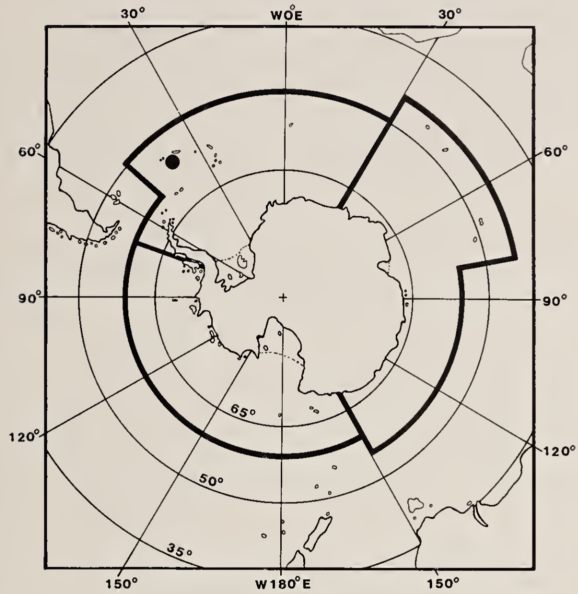


Fig. 20. *Paraliparis kreffti* ISH 405/76, 114 mm SL, holotype (from Andriashev, 1986)



Distribution of *P. kreffti*

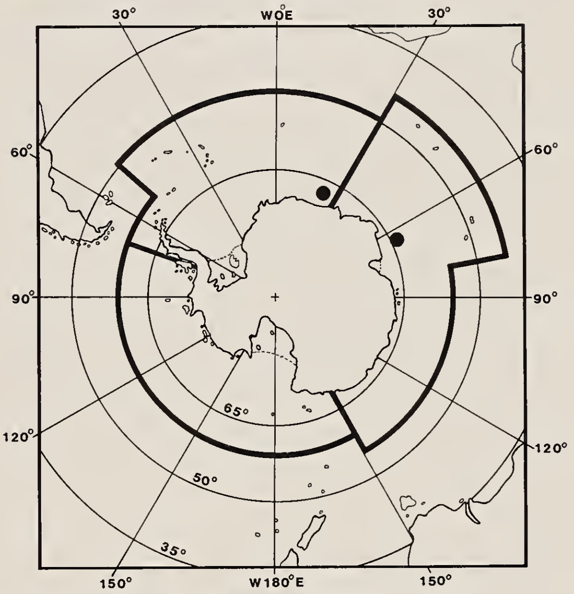
Paraliparis leobergi Andriashev, 1982
Fig. 21

Paraliparis leobergi Andriashev, 1982c: 534, figs. 2, 5, Princess Ragnhild Coast, East Antarctica (64°48′S, 63°50′E). Holotype: ZIN 45936.

Diagnosis: D 48–50; A 43–45; P 23–27; C 10; vertebrae 55–57; P radials 4. Head length about 25%, head width 15.3–16.3%, and preanal distance 36–42% SL. Bands of canines in both jaws. Mandibular symphyseal pores half as far apart as other pores in series. Gill opening starting above pectoral-fin base and extending ventrally in front of 1–3 P rays. Pectoral fin deeply notched, 3 intermediate rays rudimentary; upper and lower pectoral-fin lobes appear almost to be separate fins. Anus about midway between snout and anal-fin origin, closer to the latter in young specimens.

Colour: In life, body semi-transparent with pinkish to pale yellow regions. In alcohol, body, fins, oral and branchial cavities, peritoneum, and stomach pale.

Distribution: The 4 known specimens are from the Co-operation Sea, MacRobertson Land, Cosmonaut Sea near Enderby Land, and the type locality, at 165–450 m depth. Probably benthic or epibenthic.



Distribution of *P. leobergi*

Remarks; Attains 130 mm SL.

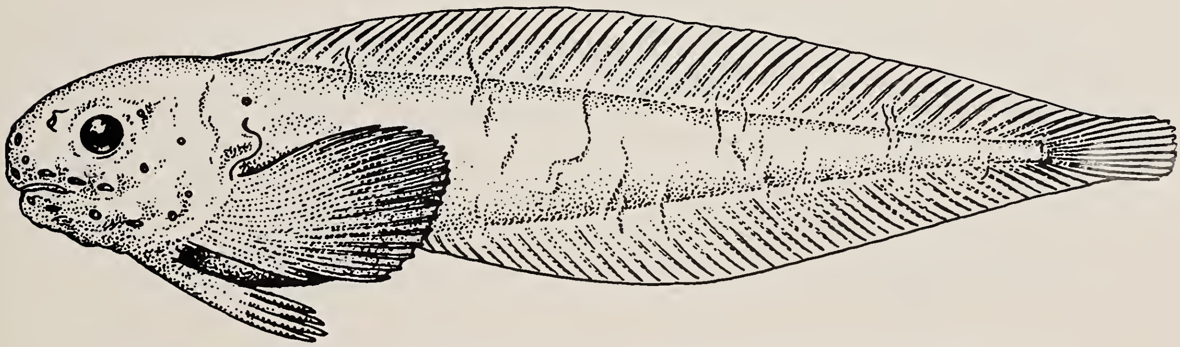


Fig. 21. *Paraliparis leobergi* ZIN 45936, 75 mm SL, holotype, female (from Andriashev, 1986)

Paraliparis leucogaster Andriashev, 1986

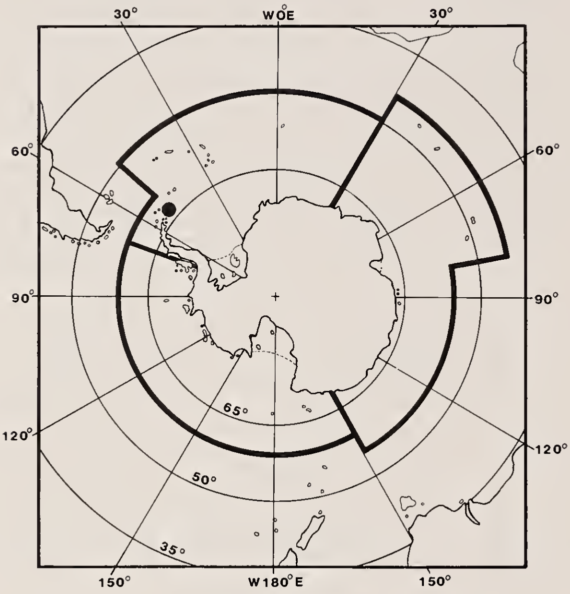
Fig. 22

Paraliparis leucogaster Andriashev, 1986: 91, figs. 39–40, Bransfield Strait, near Trinity Penninsula (63°56′S, 61°47′W). Holotype: ISH 914/76.

Diagnosis: D 48; A 42; P 25; C 10; vertebrae 54; P radials 4. Head length about 25% SL; preanal distance about 23% SL, about equal to distance between anus and anal-fin origin. Mouth terminal; teeth clearly shouldered, forming band in each jaw. Mandibular symphyseal pores as far apart from each other as from more posterior pores. Gill opening starting above pectoral-fin base and extending ventrally in front of 1–5 rays. Pectoral fin lacking rudimentary rays. Anus below gill opening. Hypural plate completely fused.

Colour: In life, as well as in alcohol, completely pale including peritoneum, stomach, and caeca.

Distribution: Known only from the type locality, at 210–260 m depth. Probably benthic or bentho-pelagic.



Distribution of *P. leucogaster*

Remarks: The holotype, a female of 95 mm SL collected in February, had 27 eggs 3.9–4.0 mm diameter.

Paraliparis leucoglossus Andriashev, 1986

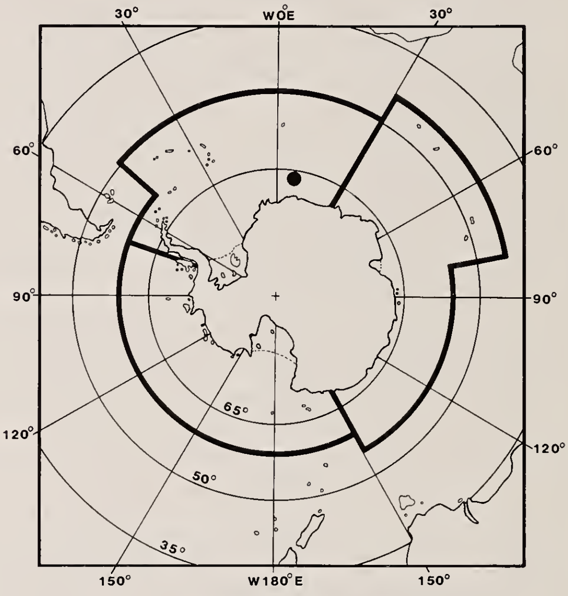
Fig. 23

Paraliparis leucoglossus Andriashev, 1986: 95, figs. 41–42, south-eastern Lazarev Sea, Princess Astrid Coast (59°23′S, 11°04′E). Holotype: ZIN 47176.

Diagnosis: D 62; A 56; P 22; C 8; vertebrae 68; P radials 4. Head length about 21% SL. Teeth small, simple, compressed and sharpened at tips, forming bands in both jaws. Mandibular symphyseal pore pair widely separated. Gill opening large, about 33% HL, extending ventrally in front of 5–6 pectoral-fin rays. Pectoral-fin notch shallow, lower lobe rays nearly completely free, fingerlike.

Colour: In alcohol, head, back, and pectoral fin dark bluish-black; body skinned, but probably dark. Oral cavity dark blue-grey; the tongue strikingly pale. Branchial cavity dark; peritoneum black, the stomach pale.

Distribution: Known only from the holotype collected at 900–960 m depth. Probably benthic or epibenthic.



Distribution of *P. leucoglossus*

Remarks: The holotype, a female of 99 mm SL, contained eggs of 4 mm diameter.

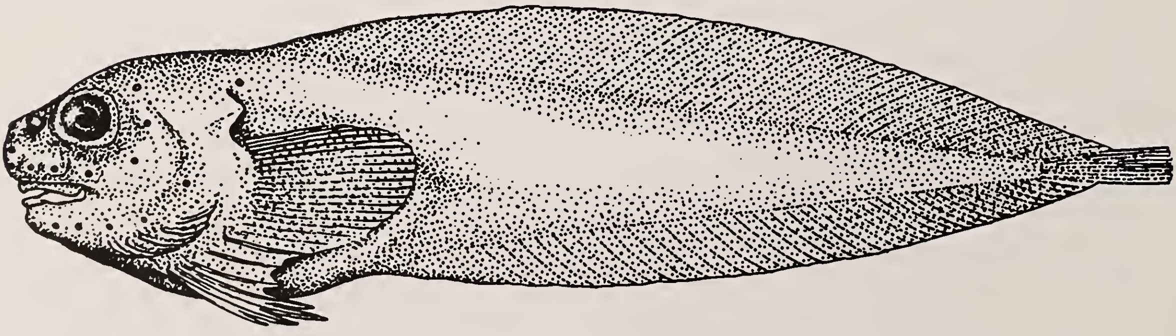


Fig. 22. *Paraliparis leucogaster* ISH 914/76, 95 mm SL, holotype, female (from Andriashev, 1986)

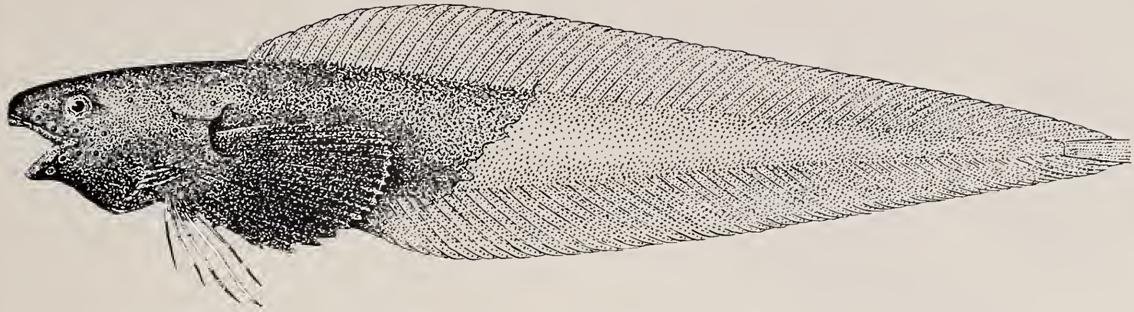


Fig. 23. *Paraliparis leucoglossus* ZIN 47176, 99 mm SL, holotype, female (from Andriashev, 1986)

Paraliparis mawsoni Andriashev, 1986

Fig. 24

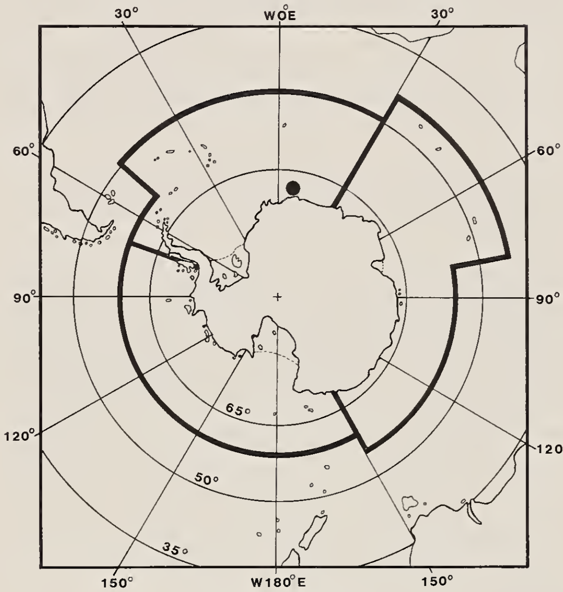
Paraliparis mawsoni Andriashev, 1986: 99, figs. 43–44, Princess Astrid Coast of the south-eastern Lazarev Sea (69°17′S, 10°51′E). Holotype: ZIN 46821.

Diagnosis: D 62; A 56; P 23; C 6; vertebrae 71; P radials 3. Head length about 19% SL. Teeth small, simple, blunt forming bands in both jaws. Mandibular symphyseal pore pair closely set but not opening in a common pit. Gill opening length 3.6% SL, starting above pectoral-fin base and extending ventrally in front of 2 rays. Pectoral-fin notch shallow with relatively long intermediate rays, none rudimentary.

Colour: In life unknown, probably red. In alcohol, lower part of head grey, mouth and gill cavities light grey. Peritoneum black, and stomach light, somewhat reticulated with black. Liver bright yellow.

Distribution: Known only from the holotype, collected at 980–1,080 m. Probably benthic or epibenthic.

Remarks: Holotype, adult male, 140 mm SL.



Distribution of *P. mawsoni*

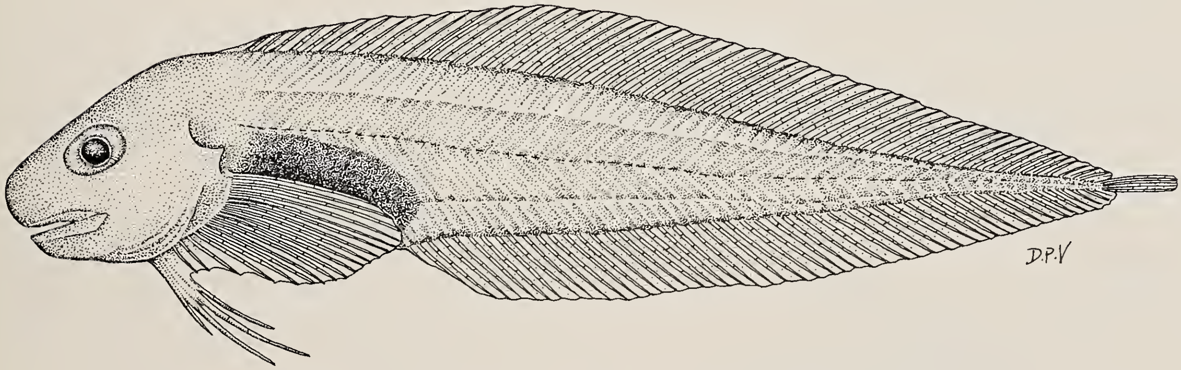


Fig. 24. *Paraliparis mawsoni* ZIN 46821, 140 mm SL, holotype, male (from a photograph by A.P. Andriashev and a line drawing by N. Chernova)

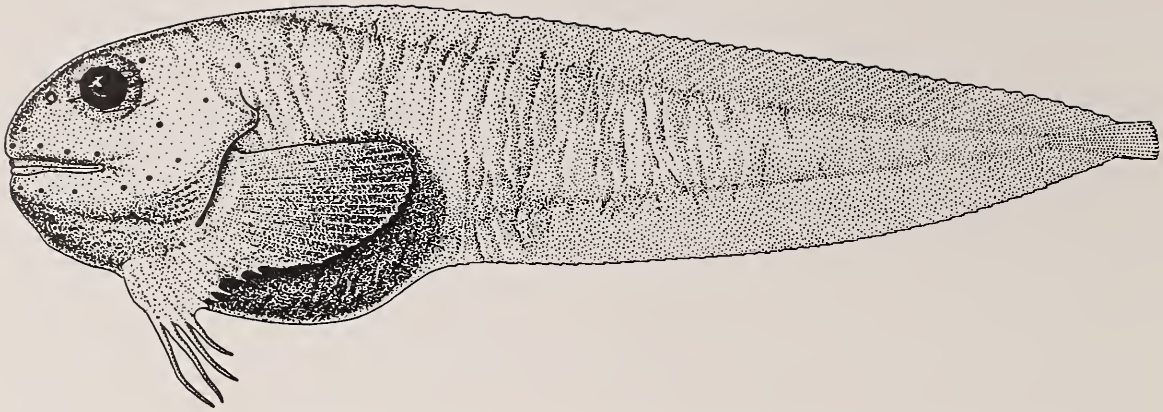


Fig. 25. *Paraliparis meganchus* ZIN 45707, 164 mm SL, holotype, female (from Andriashev, 1986)

Paraliparis meganchus Andriashev, 1982
Fig. 25

Paraliparis meganchus Andriashev, 1982a: 179, figs. 1, 3, South Shetland Islands (61°39′S, 55°39′W). Holotype: ZIN 45707.

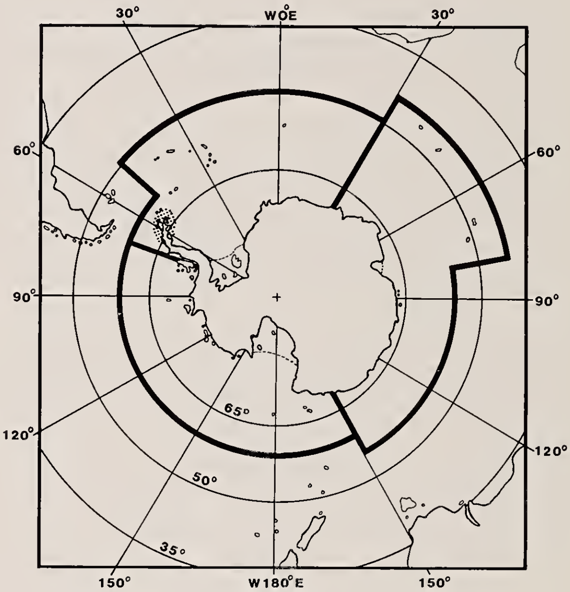
Diagnosis: D 52–58; A 46–52; P 24–27; C 9–12; vertebrae 58–63; P radials 4. Head large, 21.8–26.8% SL. Mouth terminal, snout not extending over upper jaw; small sharp canines forming bands in both jaws. Gill opening long, extending ventrally in front of 16–20 pectoral-fin rays. Pectoral fin deeply notched, upper and lower lobes about equal in length; rudimentary rays absent. Anus closer to snout than to anal-fin origin.

Colour: In life, body pink. In alcohol, body, oral and branchial cavities pale. Peritoneum light or dark brown and stomach pale or blackish-grey, darker dorsally.

Distribution: South Shetland Islands and Bransfield Strait at depths of 220–850 m. Probably benthic or epibenthic.

Remarks: Specimens taken near the South Shetland Islands had eaten benthic and epibenthic invertebrates, primarily mysids, gammarid amphipods, and sipunculids. Females collected in early February had ripe or almost ripe eggs up to 6 mm diameter.

Attains 217 mm SL.



Distribution of *P. meganchus*

Fig. 26. *Paraliparis monoporus* ZIN 44094, 24 cm SL, holotype, female (from Andriashev, 1986)

Paraliparis monoporus Andriashev & Neelov, 1979

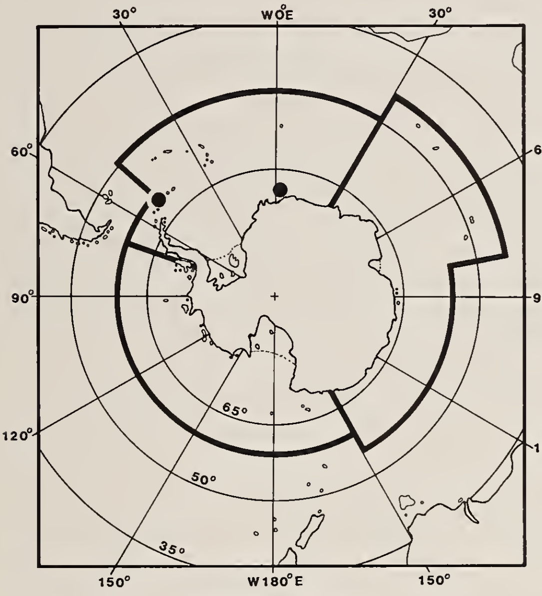
Fig. 26

Paraliparis monoporus Andriashev & Neelov, 1979: 14, figs. 3, 5, Scotia Sea between South Shetland and South Orkney islands (61°10′S, 50°41′W). Holotype: ZIN 44094.

Diagnosis: D 63–68; A 58–62; P 22–25; C 7; vertebrae 72–74; P radials 3. Head length 20.7–20.8% and preanal distance 42–43% SL. Mouth distinctly inferior; small canines forming bands in both jaws. Mandibular symphyseal pore single, unpaired. Gill opening very small, 2.1–2.2% SL, shorter than diameter of eye, completely above pectoral fin. Petoral-fin notch moderately deep, rudimentary rays absent.

Colour: In life, orange-red, more intense caudally. In alcohol, body, oral, and branchial cavities pale; peritoneum black, and stomach pale.

Distribution: Between South Shetland and South Orkney islands and in the Lazarev Sea at 850–1,000 m. Probably benthic or epibenthic.



Distribution of *P. monoporus*

Remarks: A female captured in early February had ripening eggs of 3.2 mm diameter; another captured at the end of the month had 118 almost ripe eggs 3.8–3.9 mm diameter.

Attains 24 cm SL.

Paraliparis neelovi Andriashev, 1982

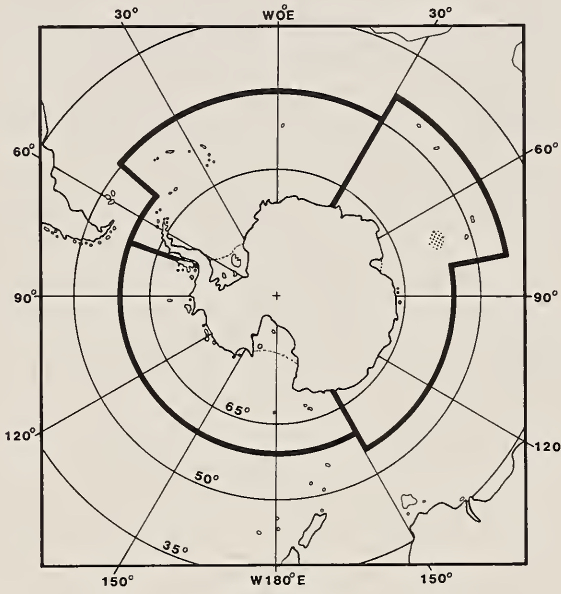
Fig. 27

Paraliparis neelovi Andriashev, 1982b: 721, figs. 1–2, Banzare Banks, south of Heard Island (56°50′S, 71°06′E). Holotype: ZIN 45819.

Diagnosis: D 61–64; A 52–56; P 19–21; C 6; vertebrae 67–70; P radials 3. Head short, 16.1–19.1% and predorsal distance 21–24% SL. Snout blunt, mouth small, terminal. Teeth near symphyses of jaws in several short rows, uniserial posteriorly. Gill opening about equal to pupil diameter of eye, completely above pectoral fin. Opercular flap developed. Pectoral fin deeply notched, rudimentary rays absent. Anus directly below gill opening.

Colour: In alcohol, body pinkish-lilac, paler on trunk; ventral part of pectoral fins and caudal parts of dorsal and anal fins darker. Snout and around mouth blackish-lilac. Oral and branchial cavities blackish-grey; peritoneum black, and stomach pale.

Distribution: Banzare and nearby banks at depths of 1,070–1,575 m. Probably benthic or epibenthic.



Distribution of *P. neelovi*

Remarks: A female, about 25 cm SL, caught in early February had ripening eggs up to 2.8 mm diameter.

Attains 27 cm SL.

Fig. 27. *Paraliparis neelovi* ZIN 45819, 250 mm SL, holotype (from Andriashev, 1986)

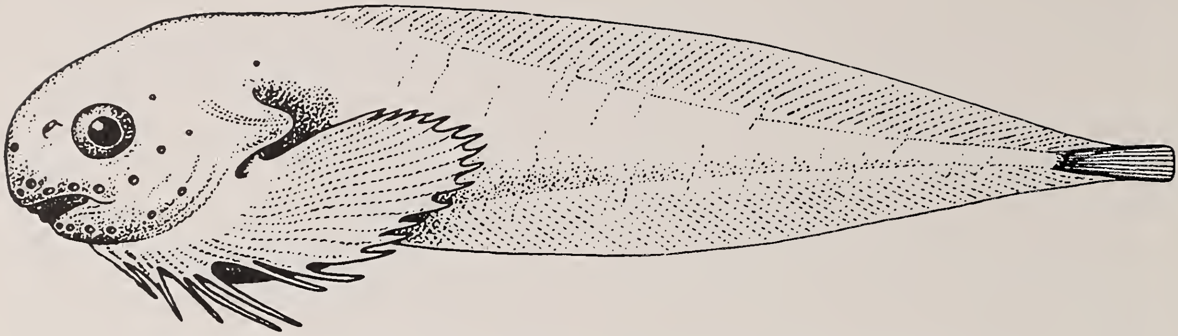


Fig. 28. *Paraliparis operculosus* ZIN 44933, 99 mm SL, holotype (from Andriashev, 1986)

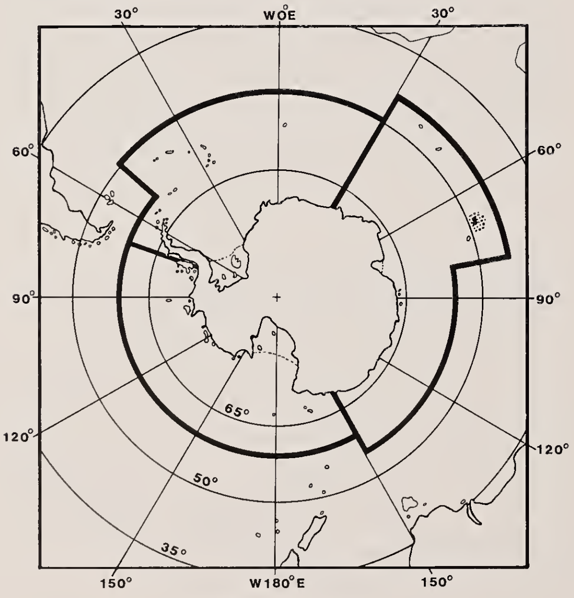
Paraliparis operculosus Andriashev, 1979
Fig. 28

Paraliparis operculosus Andriashev, 1979: 32, fig. 3, near Kerguelen Islands (49°48′S, 71°01′E). Holotype: ZIN 44933.

Diagnosis: D 53–58; A 48–53; P 19–21; C 10 (rarely 9); pyloric caeca 5–7; vertebrae 59–64; P radials 4. Head large, 23.0–24.8% and preanal distance about 33% SL. Mouth slightly inferior, broad; teeth mostly simple, but inner premaxillary teeth with lateral shoulders; teeth forming bands in both jaws. Opercular flap clearly overlapping bases of upper pectoral-fin rays. Pectoral-fin notch very shallow. Lowest pectoral-fin ray below anterior margin of orbit.

Colour: In life unknown. In alcohol, body pale; oral and branchial cavities dark grey to blackish. Peritoneum black; stomach and some pyloric caeca blackish.

Distribution: Kerguelen Islands at 380–937 m, commonly at 600–700 m; Kerguelen Ridge southward to 51°34′S at about 800–1,000 m. Probably benthic or epibenthic.



Distribution of *P. operculosus*

Remarks: Attains about 130 mm SL.

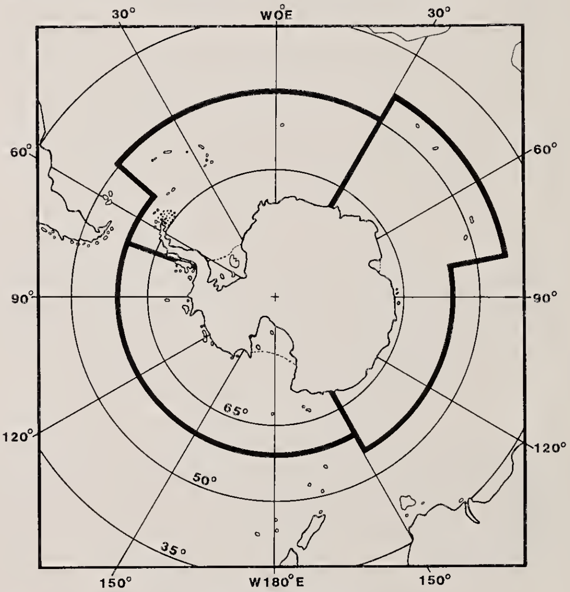
Paraliparis somovi Andriashev & Neelov, 1979
Fig. 29

Paraliparis somovi Andriashev & Neelov, 1979: 12, figs. 2, 5, south-western side of Elephant Island, South Shetland Islands (61°39′S, 55°39′W). Holotype: ZIN 44100.

Diagnosis: D 54–57; A 49–52; P 22–26; C 9; pyloric caeca 6–7; vertebrae 60–63; P radials 4. Preanal distance 36–41% SL. Snout noticeably projecting, the mouth distinctly inferior. Teeth simple, blunt, forming bands in both jaws. Mandibular symphyseal pores well separated. Gill opening length 6.1–7.7% SL, extending ventrally in front of 4–5 pectoral-fin rays. Upper pectoral-fin lobe broadly rounded, notch moderately shallow; lower lobe rays almost completely free.

Colour: In life, probably pinkish. In alcohol, body pale; caudal fin and posterior parts of dorsal and anal fins dusky. Oral cavity dark grey, the branchial cavity almost black. Peritoneum black, visible through gill cover and body wall; stomach blackish, reticulated.

Distribution: South Shetland Islands at depths of 406–850 m. Probably benthic or epibenthic.



Distribution of *P. somovi*

Remarks: Individuals of both sexes collected in February had maturing testes or ovaries.

Attains 207 mm SL.

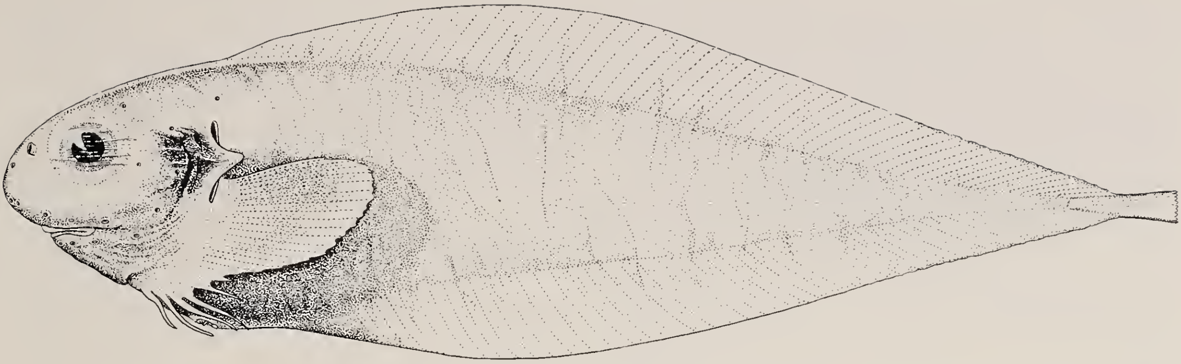


Fig. 29. *Paraliparis somovi* ZIN 44100, 192 mm SL, holotype, female (from Andriashev, 1986)

Paraliparis stehmanni Andriashev, 1986
Fig. 30

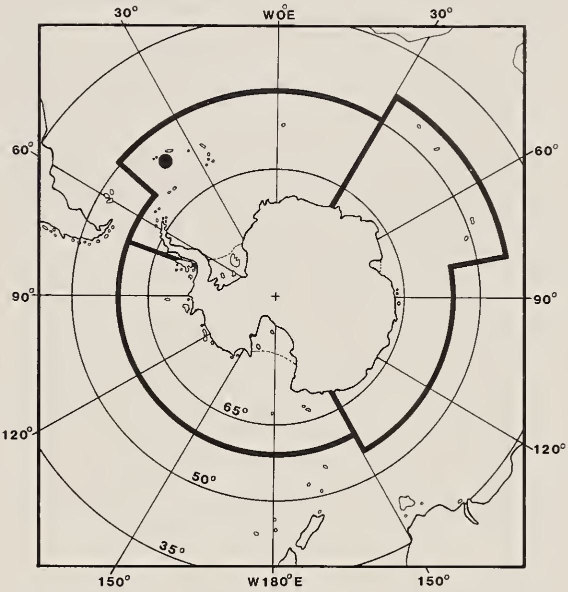
Paraliparis stehmanni Andriashev, 1986: 131, figs. 57–58, northern Scotia Sea (54°12′S, 40°02′W). Holotype: ISH 404/76.

Diagnosis: D 63; A 55–56; P 20–21; C 7; vertebrae 69–71; P radials 4. Head small, 17.8–20.0% and predorsal distance 27–30% SL. Mouth small, subterminal. Dentition uniserial in both jaws except for short extra inner series at premaxillary symphysis. Gill opening length 3.1–3.2% SL, completely above pectoral fin. Pectoral fin deeply notched; 2 rudimentary intermediate rays present, 7–10% of upper pectoral-fin lobe length. Upper 3 pectoral radials notched.

Colour: In alcohol, body violet-pinkish. Oral cavity dark grey, branchial cavity blackish. Stomach and pyloric caeca pale, peritoneum black.

Distribution: Known from 3 specimens collected in the northern Scotia Sea between South Georgia and the Shag Rocks, and near South Shetland Islands at depths of 2,119–2,600 m. Probably benthopelagic.

Remarks: Attains 195 mm SL.



Distribution of *P. stehmanni*

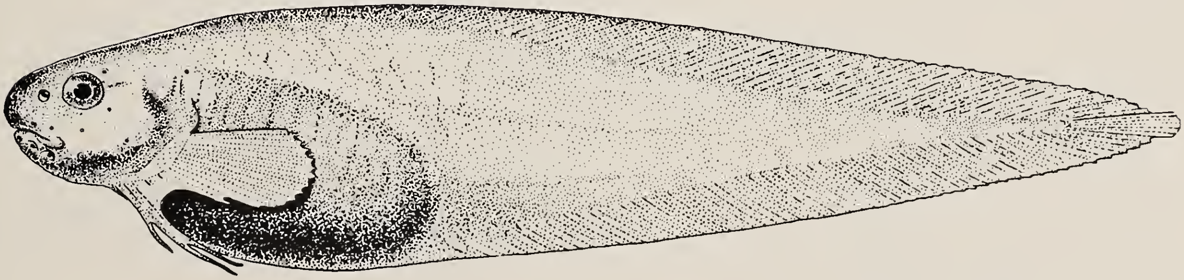


Fig. 30. *Paraliparis stehmanni* ISH 404/76, 195 mm SL, holotype (from Andriashev, 1986)

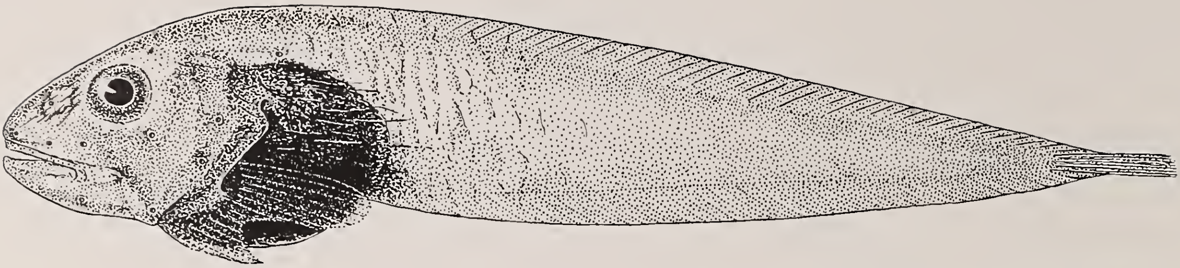


Fig. 31. *Paraliparis terraenovae* ISH 266/81, 68 mm SL, holotype, female (from Andriashev, 1986)

Paraliparis terraenovae Regan, 1916

Fig. 31

Paraliparis terrae-novae Regan, 1916a: 129, pl. 1, fig. 6, Ross Sea, McMurdo Sound (77°15′S, 166°E). Holotype: BMNH 1916.3.20.29.

Paraliparis edentatus Andriashev, 1986: 69, figs. 29–30, Weddell Sea (77°23.8′S, 42°32.2′W).

Diagnosis: D 46–51; A 42–46; P 13–16; C about 10; vertebrae 53–55; P radials 2 (rarely 3). Head length 23.1–27.2% SL. Mouth large, terminal; toothless jaws; pharyngeal teeth also absent. Gill opening starting above pectoral-fin base and extending ventrally in front of up to 7 rays. Pectoral-fin notch moderate, no intermediate rays rudimentary. Anus below posterior part of preopercle, sligthly closer to snout than to anal-fin origin.

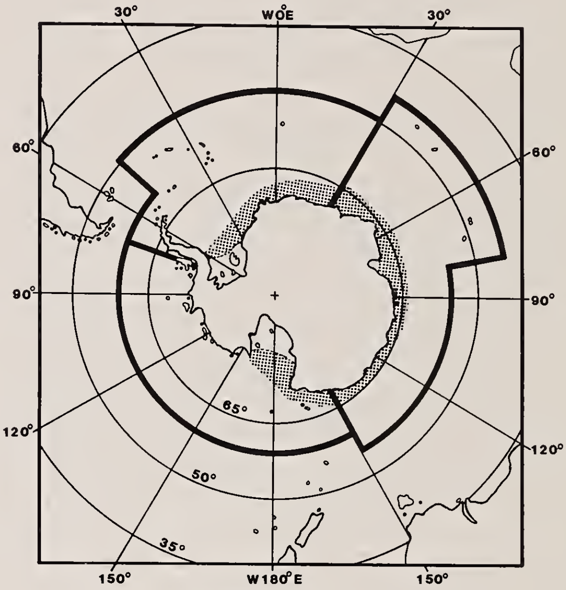
Colour: In life, probably pink. In alcohol, body light grey. Oral and branchial cavities dusky, the latter darker; branchial arches black speckled. Peritoneum, esophagus, and anterior (dorsal) part of stomach black; pyloric caeca and remainder of stomach pale.

Distribution: Southern Weddell Sea at 550 m; Co-operation Sea and Ross Sea at 148–395 m. Probably circum-Antarctic.

Remarks: Allometry is evident in relatively larger eye size, increasingly anterior anus position, and relatively longer pectoral-fin lobes in larger individuals.

Females 55 mm SL or longer are probably sexually mature. A 64 mm SL female (LACM 11386–1) had ripe or ripening eggs of 3.3 mm diameter in mid-January.

Attains 71 mm SL.



Distribution of *P. terraenovae*

Paraliparis tetrapteryx Andriashev & Neelov, 1979

Fig. 32

Paraliparis tetrapteryx Andriashev & Neelov, 1979: 16, figs. 4–5, off South Georgia Island (53°34′S, 36°45′W). Holotype: ZIN 44095.

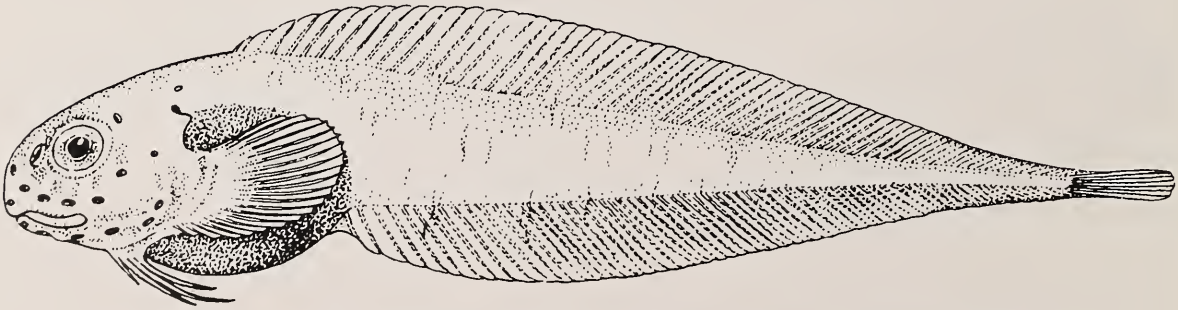
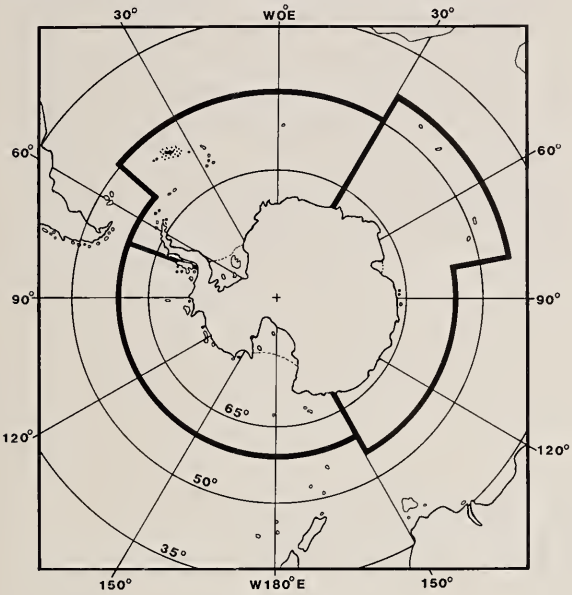


Fig. 32. *Paraliparis tetrapteryx* ZIN 44095, 110 mm SL, holotype, male (from Andriashev, 1986)

Diagnosis: D 68–73; A 63–66; P 26–31; C 7; vertebrae 76–81; P radials 2. Head small, 18.8–20.0% SL. Teeth small, simple, forming bands in jaws; inner posterior teeth, especially in small specimens, may have weakly developed shoulders. Mandibular symphyseal pores open in a common pit, but distinctly separate within it. Pectoral fin deeply notched, 4–5 rudimentary intermediate rays often present; upper and lower fin lobes appearing to be separate.

Colour: In life, body colourless or pinkish. In alcohol, body uniformly pale. Oral and branchial cavities pale; peritoneum black, the stomach pale.

Distribution: South Georgia Island at depths of 330–830 m where bottom temperatures are 1.9–2.0 °C.



Distribution of *P. tetrapteryx*

Remarks: A female collected in mid-May had 36 almost ripe eggs 3.1–3.3 mm diameter.

Attains 142 mm SL.

Paraliparis thalassobathyalis Andriashev, 1982

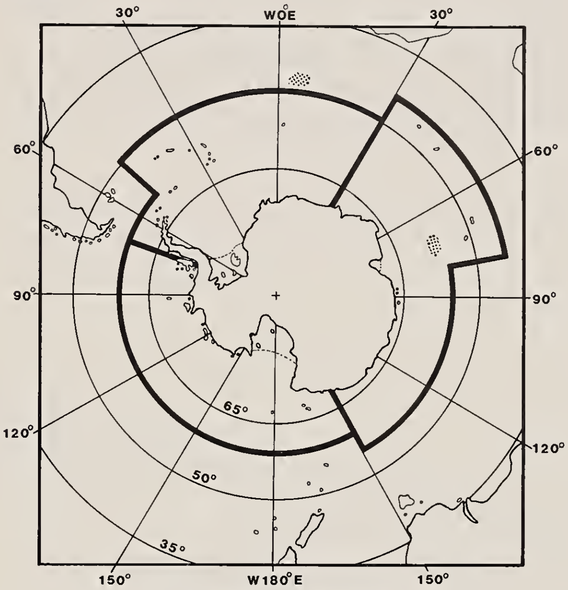
Fig. 33

Paraliparis thalassobathyalis Andriashev, 1982b: 717, figs. 1–2, Banzare Banks south of Heard Island (56°53′S, 70°18′E). Holotype: ZIN 45811.

Diagnosis: D 49–53; A 44–46; P 15–19; C 5; pyloric caeca about 7; vertebrae 56–62; P radials 2. Head length 20.6–22.7%, body depth (measured at occipital region of head) 20.9–23.3%, and preanal distance 38–42% SL. Mouth slightly inferior; jaws teeth in bands, the outer teeth simple, small; inner teeth larger, with distinct shoulders. Gill opening completely above pectoral fin or extending ventrally in front of 1–2 rays. Pectoral-fin notch shallow, rudimentary intermediate rays absent.

Colour: In life, probably pink or red. In alcohol, body pale. Gill cover, abdomen, and ventral surfaces of head darkened by internal pigment of peritoneum, oral and branchial cavities showing through; stomach black, and pyloric caeca pale.

Distribution: Originally described from Banzare and other banks south of Heard Island, also known from Meteor Seamount (south-eastern Atlantic). Depths of occurrence 1,160–1,575 m. Probably benthic or epibenthic.



Distribution of *P. thalassobathyalis*

Remarks: Although there appear to be 2 populations, that from Meteor Seamount exhibits distinctly more pectoral-fin rays (17–19 vs 15–17) and vertebrae (57–62 vs 56–59). The differences were sufficient to cause Andriashev (1986) to list the populations separately. These may be different species.

Attains 135 mm SL.

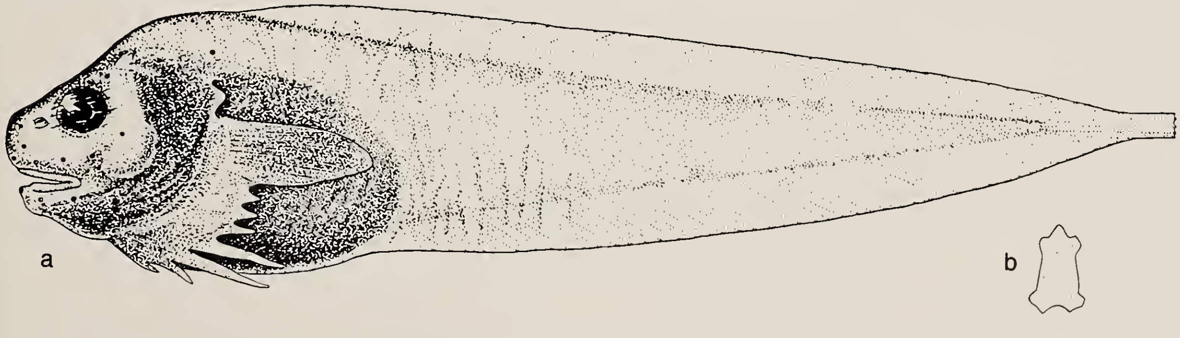


Fig. 33. (a) *Paraliparis thalassobathyalis* ZIN 45811, 103 mm SL, holotype; (b) premaxillary tooth of a paratype (from Andriashev, 1986)

Paraliparis trilobodon Andriashev & Neelov, 1979
Fig. 34

Paraliparis trilobodon Andriashev & Neelov, 1979: 10, figs. 1, 5, South Shetland Islands (61°46′S, 53°59′W). Holotype: ZIN 44098.

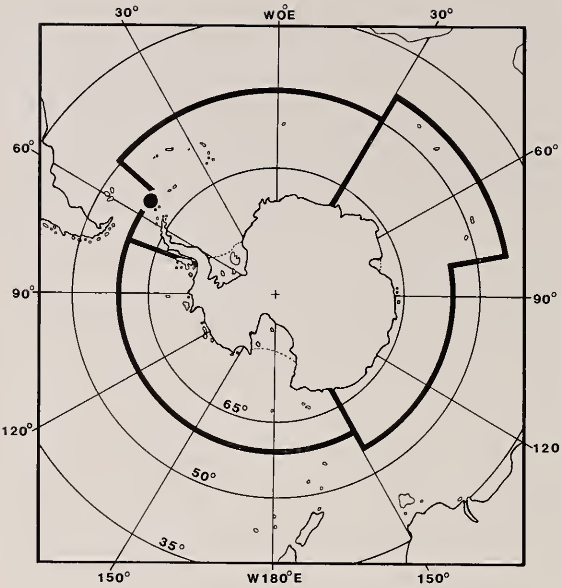
Diagnosis: D 45–49; A 41–43; P 25–27; C 10; vertebrae 51–55; P radials 4. Head large, 24.4–27.4% and preanal distance 36.9–42.0% SL. Snout high and blunt, the mouth subterminal. Larger teeth clearly tricusped, smaller anterior teeth simple; premaxillary teeth in about 17 rows of up to 5 teeth each. Gill opening length 5.4–7.0% SL, starting above pectoral-fin base and extending ventrally in front of 2–4 rays. Hypural plate incompletely fused.

Colour: In life, colour unknown. In alcohol, body, oral and branchial cavities pale. Peritoneum mottled and reticulated brown, pigment denser dorsally; stomach pale.

Distribution: Clarence Island, South Shetland Islands, at 315–335 m depth. Probably benthic or epibenthic.

Remarks: Males and females collected in February were almost ripe. Females had eggs of 4.3–4.6 mm diameter.

Attains 104 mm SL.



Distribution of *P. trilobodon*

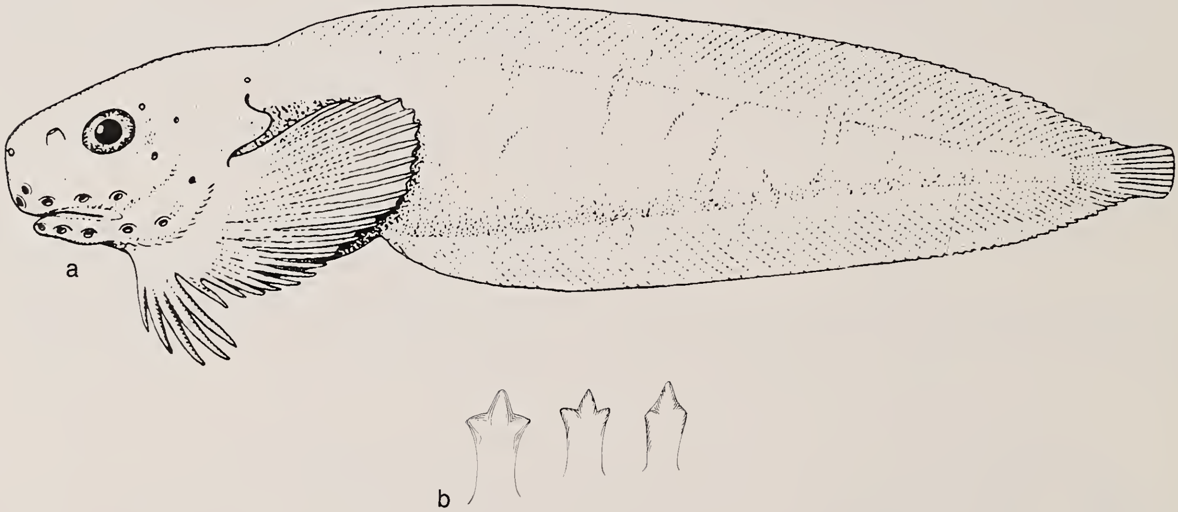


Fig. 34. (a) *Paraliparis trilobodon* ZIN 44098, 104 mm SL, holotype, female; (b) maxillary teeth of a paratype (from Andriashev, 1986)

Paraliparis valentinae Andriashev & Neelov, 1984

Fig. 35

Paraliparis valentinae Andriashev & Neelov, 1984: 1, fig. 1, pl. 1, Gunnerus Ridge, East Antarctica (68°02′S, 34°33′E). Holotype: ZIN 46833.

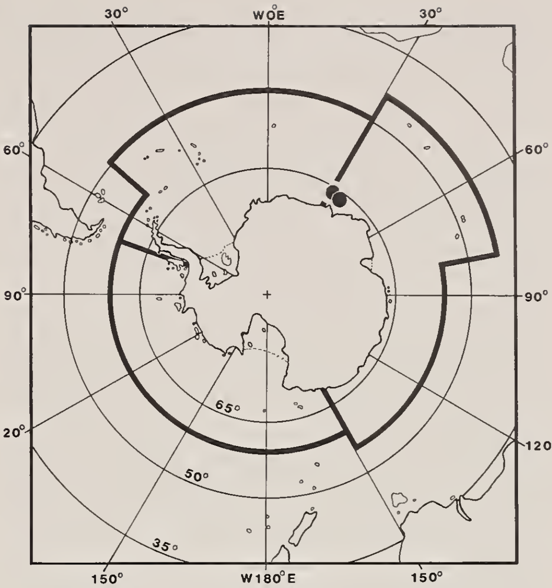
Diagnosis: D 54–57; A 49–53; P 21–25; C 9–10; pyloric caeca 9–10; vertebrae 59–63; P radials 4. Head length 20.0–21.1%, about equal to greatest body depth, and preanal distance 33–35% SL. Mandibular symphyseal pore pair very closely set. Teeth conical, blunt, in rows of up to 5 teeth each, forming narrow bands in jaws. Gill opening starting above pectoral-fin base and extending ventrally in front of 3–5 rays. Pectoral-fin notch shallow. Anus below preopercle.

Colour: In life, head pink, the snout and lower jaw blackish. Opercular flap red. Anterior of body intense pink, becoming red then reddish-lilac caudally. Dorsal and anal fins bright red, the rays black, especially posteriorly; pectoral fins pinkish-red, the upper rays blackish, the lowermost rays red. Black branchial cavity and peritoneum visible externally. In alcohol, body pale violet; snout blackish. Dorsal and anal fins pale, rays black. Oral cavity blackish; branchial cavity and peritoneum black, the stomach pale.

Distribution: Gunnerus Ridge, East Antarctica at depths of 940–1,100 m. Probably benthic or epibenthic.

Remarks: This species is one of the most brilliantly coloured liparidids known. Females captured in late February were almost ripe. A 214 mm SL female had 85 eggs 3.6–3.8 mm diameter.

Attains 24 cm SL.



Distribution of *P. valentinae*

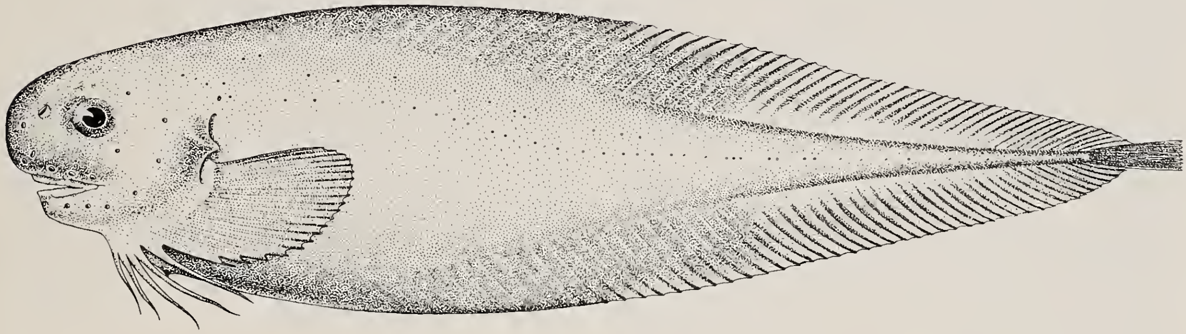


Fig. 35. *Paraliparis valentinae* ZIN 46833, 24 cm SL, holotype (from Andriashev, 1986)

ZOARCIDAE

Eelpouts

by M.E. ANDERSON

As there are a number of aberrant lineages of eelpouts characterised by some unique specialisations, the family and species diagnoses presented here pertains only to those species found in the Southern Ocean.

Body and tail elongate (generally eel-shaped), body rounded or ovoid in cross section, tail laterally compressed, more so posteriorly. Head ovoid or dorsoventrally flattened. Dorsal and anal fins single, confluent with caudal, long and low. Dorsal fin with no spines anteriorly, but first and second elements sometimes unsegmented, unbranched, and bilaterally divided only near base. Anal fin without spines, all rays segmented. Pectoral fin relatively large (e.g. *Pachycara* and *Lycodichthys*), to minute (e.g. *Lycodapus* and *Melanostigma*). Pelvic fins (when present) rudimentary, of 2–3 small rays, inserted below gill slit. Gill slit variable; either a small, porelike opening above pectoral fin, or extending ventrally from midpectoral base to pelvic base, or, in *Lycodapus,* branchiostegal membrane united, forming free fold across isthmus. Branchiostegal rays usually 6 (rarely 5 or 7). Mouth terminal to inferior, horizontal; upper jaw slightly protrusile; teeth present or absent on vomer and palatines. A single, tubular nostril on each side of snout. No head spines. Gills 4, slit behind all; gill rakers generally triangular, blunt, not numerous; pseudobranch present or absent, of few individual filaments.

Scales (when present) cycloid, minute, imbedded. Body lateral line (when present) composed of superficial neuromasts not enclosed in a canal; its ramification generally of little systematic importance. Skin usually firm in scaled species, often gelatinous in unscaled species; skin covers head, including eye, body and unpaired fins in these. Head pore patterns generally species-specific; temporal (postorbital) and preopercular-mandibular canals not connected. Supratemporal (occipital) commissure present or absent (see 'Methods' below).

Septal bones, orbitosphenoid, basisphenoid and supramaxilla absent. Premaxilla with ascending and articular processes, toothed in all species; maxilla without teeth. Usually 3 pairs of upper pharyngeals (2 in *Oidiphorus* and *Melanostigma*). Pectoral radials usually 4 (2–4 in *Melanostigma*; 2–3 in *Lycodapus*). Scapular foramen enclosed by bone. Vertebrae 58–150 (all species), symmetric or asymmetric; constriction shifted anteriorly in shallow dwelling genera or species. Pleural ribs originating on vertebrae 1–3, usually extending to ultimate or penultimate precaudal vertebrae; epipleural ribs originating on vertebrae 1–3, extending posteriorly from mid-region of precaudals to ultimate. Gas-bladder absent. Ovary single-lobed. Pyloric caeca usually 2 small nubs, sometimes both absent or both slightly elongated.

All species are benthic except *Lycodapus* and *Melanostigma,* which are bentho- or mesopelagic and primarily occur in the thalassobathyal, sub-Antarctic regions or over seamounts like *Paraliparis* (see Andriashev 1986). The eelpouts are dominant among the non-notothenioid Antarctic fish fauna, with a few species occurring in the isolated inner shelf basins as shallow as 140 m, but most occur on the outer slope, along the Scotia Ridge, or the encircling abyssal regions to 4000 m.

Benthic zoarcids are carnivorous epi- or infaunal predators and thus feed chiefly on polychaetes, bivalves and gastropods. The pelagic species of *Lycodapus* and *Melanostigma* feed primarily on krill or other small planktonic crustaceans in Southern Ocean waters, as they do elsewhere (Belman & Anderson 1979; Anderson 1981).

Zoarcids are generally slow growing and relatively short lived; most short-lived species investigated mature in their second or third year and live less than 8 years. The generally larger, long-lived species mature near the end of their lives, spawn 1–3 times and die around 9–12 years of age (author's unpubl. data). Fecundity is relatively low, mature eggs range between about 4 and 9 mm in diameter and ripe females have been found to carry between 4 and about 150 maturing ova. One genus, the Northern Hemisphere *Zoarces,* is viviparous. Additional life history information on this family is found in Anderson (1984b).

Wohlschlag (1963) studied metabolic rates of *Lycodichthys dearborni* from McMurdo Sound using oxygen uptake as a function of temperature. He found that the metabolic levels of this zoarcid are about as low as these levels would be at the same lethal freezing temperatures for temperate species that are not cold-adapted. Thus *L. dearborni* appeared not to be highly cold-adapted and survived better in the laboratory in slightly higher temperatures than found in its natural habitat. In addition, *L. dearborni* was found to have metabolic levels lower than any polar poikilotherm known at the time.

Most zoarcids are small (less than 300 mm), some diminuitive (e.g. *Lycodapus, Melanostigma, Oidiphorus*), reaching maturity at less than 120 mm. No Southern Ocean zoarcid species has had economic importance, in fact, most are rare in museum collections.

There are about 220 species of zoarcids and most live in the North Pacific or North Atlantic; only 22 species are known from the area covered by this book. Many species found within this area have sister species in the adjacent South American Magellan Province. Classifications of the family are varied, but most recent authors have followed Andriashev (1939; see also Shmidt 1950; Andriashev 1954; Lindberg & Krasyukova 1975). The generic diagnoses and classification here stem from the author's unpublished Ph.D. dissertation (Anderson 1984a) and descriptions are adapted from a more thorough review (Anderson 1988).

Methods: Vertebral and median fin ray counts are taken from radiographs and the 1–2 epural rays identified and counted as caudal rays. All rays anterior to the epurals are dorsal rays. Supraneural bones, found in *Lycenchelys,* were referred to as "free dorsal-fin pterygiophores" in previous papers (Anderson 1984a, 1988). Often the ventralmost caudal ray either attaches to, or closely associates with, the haemal spine of the second preural vertebra and is counted as an anal ray then. Fin rays are said to be associated with certain vertebrae, meaning that vertebra immediately anterior to the particular fin ray's pterygiophore. Gill raker ratios in *Lycodapus* are calculated by dividing the length of the fourth raker of the first arch by the distance between the ventral edges of the fourth and fifth raker bases. Body height is measured at the anal fin origin. Vertebral counts include the urostyle. Body lateral line terminology follows Andriashev (1954: Fig. 142). Terminology of head sensory canals follows DeWitt *et al.* (this volume, Nototheniidae, Fig), with that of Anderson (1984a) in parentheses.

KEY TO GENERA

1a Branchiostegal membranes united, free of isthmus posteriorly; infraorbital (suborbital) pores, palatine membrane (oral valve), scales and V absent .... *Lycodapus*

1b Branchiostegal membranes attached to isthmus, or skin covering branchiostegal rays greatly restricting gill slit; infraorbital (suborbital) pores and palatine membrane present; scales and V present or absent 2

2a Scales absent; skin pliable, gelatinous.................... 3

2b Scales present; skin relatively firm, usually thickened...... 6

3a Gill slit a small porelike opening entirely dorsal to P; preopercular pores 0–1; postorbital pores 0–1; one pair of (supraorbital) nasal pores set anterior to nostril ..... *Melanostigma*

3b Gill slit extending ventrally to mid-pectoral base or lower; preopercular pores 3; postorbital pores 2–3; two pairs of nasal pores 4

4a V absent; P 11–13.......................... *Seleniolycus*

4b V present; P 14–17 5

5a Low, pyramidal papillae between mandibular lateralis pores; vertebrae 64–68; D 58–63; GR 8; pyloric caeca absent; D origin associated with vertebra 4 .... *Oidiphorus*

5b No mandibular papillae; vertebrae 75–77; D 70–74; GR 12–13; pyloric caeca present; dorsal-fin origin associated with vertebrae 2–3 .... *Dieidolycus*

6a Vomerine and palatine teeth absent; pyloric caeca and pseudobranch absent; infraorbital (suborbital) bones 5...... .... *Lycodichthys*

6b Vomerine and palatine teeth present; pyloric caeca and pseudobranch usually present; infraorbital (suborbital) bones 6–10 7

7a V short, 5.4–12.2% HL, their tips separated from ventral edge of pectoral base by 1–2.5 times V length; lower lip with well developed lateral lobe......................... *Pachycara*

7b V longer, 9.7–22.9% HL, their tips separated from ventral edge of pectoral base by one V length or less, or overlapping pectoral base (*Lycenchelys hureaui* lacks pelvic fins); lower lip without, or with slight, lateral lobe 8

8a D origin associated with vertebrae 2–5; vertebrae 91–111 (if 102–111, then P 12–14) .... *Ophthalmolycus*

8b D origin associated with vertebrae 6–13 (with 3rd vertebra in *L. aratrirostris*); vertebrae ca. 90–130 (if 102–111, then P 15–17; if less than 102, then caudal fin length 30% HL and supratemporal (occipital) pore present) .... *Lycenchelys*

Genus *Dieidolycus* Anderson, 1988

Body robust, height 11.6–12.8% SL; skin gelatinous, transparent, underlying musculature, bone and fin rays easily seen. Scales, lateral line and pseudobranch absent. Head pores enlarged. Gill slit extending ventrally to mid-height of pectoral-fin base. Vertebrae (22–23)+(52–55) = 75–77. Eye small, 12.4–13.1% HL.

Remarks: This genus comprises a single species. It is apparently related to the *Lycodes-Lycenchelys* lineages (Lycodini), but was placed in a separate genus on the basis of its possession of an odd assortment of derived characters found in other genera adapted to deep-sea habitats. These parallelisms include the gelatinous skin (also found in *Lycodapus, Melanostigma, Oidiphorus,* etc.), enlarged head pores (also found in *Lycenchelys*), loss of scales, lateral line and pseudobranch, small eye, and restricted gill slit.

Dieidolycus leptodermatus Anderson, 1988
Fig. 1

Dieidolycus leptodermatus Anderson, 1988: 72, fig. 15, south of South Georgia (55°01′–10′S, 39°55′–46′W). Holotype: LACM 10772-7.

Diagnosis: D 70–74; A 53–58; P 16–17; C 7–9; V 2; GR 3+(9–10); branchiostegal rays 6; vertebrae (22–23)+(52–55) = 75–77. Body height 11.6–12.8% and head length 23.1–24.1% SL. Eye diameter 12.4–13.1, pectoral fin length 53.7–58.0%, and upper jaw length 37.0–38.5%HL. Head robust, ovoid, snout broad. Body moderately elongate, relatively deep. Eye small, ovoid. Pectoral fin large, its origin well below body midline, its base extending on to abdomen; middle pectoral-fin rays longest, ventral rays thickened, exserted. Mouth subterminal; lower lip with small, fleshy lobe. Teeth conical, present on vomer and palatine bones. Head pores enlarged, rounded or ovoid (infraorbitals). Supratemporal (occipital) and coronal (interorbital) pores absent; supraorbital (nasal) pores 2; preopercular-mandibular pores 8; infraorbital (suborbital) pores 5; temporal (postorbital) pores 2–3. Pseudobranch absent. Two nublike pyloric caeca. Dorsal-fin origin associated with vertebra 23.

Colour: In alcohol, uniformly dark brown, head and pectoral fins darker. Probably blue-black or deep purple in life. Lining of orobranchial chamber and peritoneum probably black in life.

Distribution: Probably abyssal, circum-Antarctic. Recorded from the Scotia Sea abyss and off Scott Island in 2,273–3,040 m (Anderson 1988).

Remarks: Attains 166 mm TL.

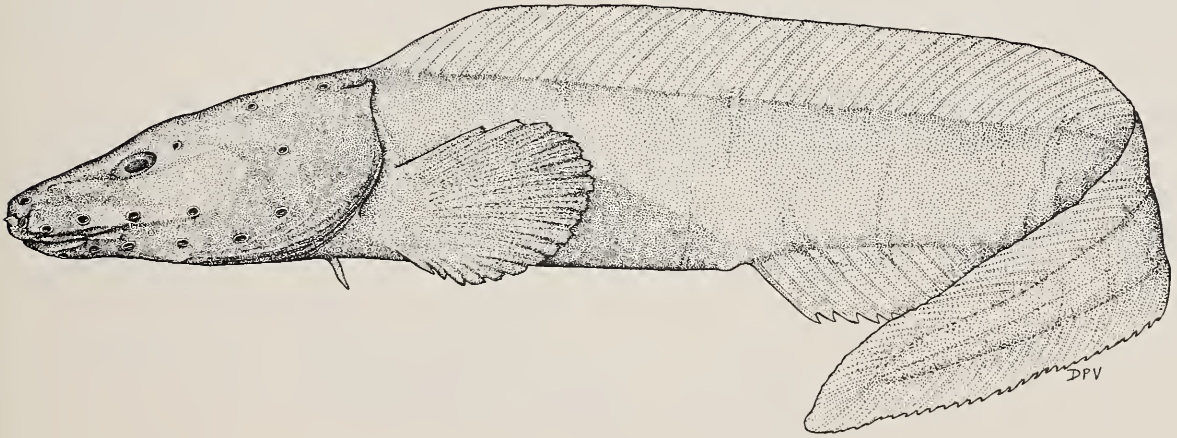
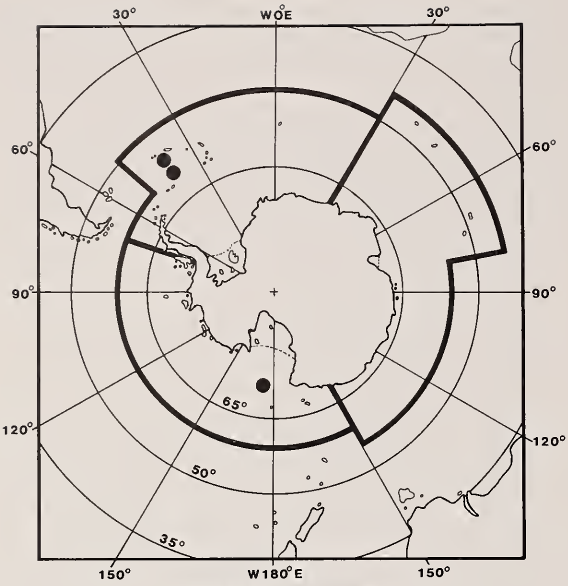


Fig. 1. *Dieidolycus leptodermatus* LACM 11351-6, 142 mm SL, male, off Scott Island



Distribution of *D. leptodermatus*

Genus *Lycenchelys* Gill, 1884

Body and tail low and elongate (body height at anal-fin origin 2.3–9.3% SL; tail length 63–72% SL). Vertebrae 102–144. Dorsal-fin origin associated with vertebrae 3–21. Palatal (pterygoid) arch poorly developed. Infraorbital (suborbital) bones 6–10.

This genus includes 44 species of which 9 occur in our area.

KEY TO SPECIES

1a V absent 2
1b V present 3
2a Head covered with microscopic prickles; branchiostegal rays 5; GR 19 .... *L. nanospinata*
2b Head without prickles; branchiostegal rays 6; GR 10–14 .... *L. hureaui*
3a Vomerine and palatine teeth absent .... *L. wilkesi*
3b Vomerine and palatine teeth present 4
4a Preopercular-mandibular pores 9 (rarely 8); vertebrae 120–130; supraneural bones 6–16 .... *L. antarctica*
4b Preopercular-mandibular pores 8; vertebrae ca. 90–117; supraneurals fewer than 6 5
5a C elongate, 30% HL; median supratemporal (occipital) pore present; GR 18; D 80; A 73 .... *L. argentina*
5b C normal, 5.1–22% HL; median supratemporal (occipital) pore absent; GR 10–15; D 94–109; A 77–91 6
6a Body height 4.2–8.5% SL; preanal length 30.8–33.3% SL; pectoral length 6.1–7.9% SL; temporal (postorbital) pores 2–4 7
6b Body height 8.7–9.3% SL; preanal length 35.5–40.5% SL; pectoral length 8.5–9.9% SL; temporal (postorbital) pores 1–2 8
7a Length of mandibular symphysis (anterior tip of lower jaw to posterior edge of dentary symphysis) 17.9–19.9% HL; 6 pores on ventral branch of suborbital bones and none (rarely one on ascending ramus); 2–3 temporal (postorbital) pores; scales extending onto D and A; D origin associated with vertebrae 3–4 .... *L. aratrirostris*
7b Length of mandibular symphysis 9.4–12.7% HL; 6 pores on ventral branch of suborbital bones and 2 on ascending branch (one on horizontal through premaxillary symphysis, the other behind eye under first temporal pore; 4 temporal (postorbital) pores; no scales on D or A; dorsal origin associated with vertebrae 5–9 .... *L. bellingshauseni*
8a One pair of supraorbital (nasal) pores, located anterior to nasal tube; one pair of temporal (postorbital) pores, located dorsal to upper edge of gill slit; vertebrae 27+77 = 104 .... *L. nigripalatum*
8b Two pairs of supraorbital (nasal) pores, one located anterior to nasal tube, the other just posteromesially; 2 pairs of temporal (postorbital) pores, first located behind eye, the other just anterior to upper edge of gill slit; vertebrae 28+89 = 117 .... *L. tristichodon*

Lycenchelys antarctica Regan, 1913
Fig. 2

Lycenchelys antarcticus Regan, 1913: 242, pl. IX, fig. 3, off South Orkney Islands (62°10′S, 41°20′W). Holotype: NMSZ 1921.143.0487.

Lycenchelys atacamensis Andriashev, 1980b: 1105, figs. 1-4, Peru-Chile Trench (05°52′S, 81°38′W).

Diagnosis: D 102(?)-116; A 98–112; C 6–9; P 15–17; V 2–3; GR (2–3)+(10–13) = 13–16; branchiostegal rays 6 (rarely 5); vertebrae (26–29)+(92–109) = 120–138. Body height 4.6–7.0%, head length 14.2–17.9% SL. Eye diameter 15.8–22.4%, pectoral fin length 52.9–70.4%, and upper jaw length 31.1–44.3% HL. Head small, dorsoventrally depressed in small specimens, more robust and triangular in larger fish. Body elongate, ovoid in cross section. Skin firm, but not thickened. Scales extending anteriorly to vertical through pectoral-fin axil in largest specimens; present on abdomen and unpaired fins. Lateral line ventral, complete. Eye small, ovoid. Pectoral fin moderately long, its origin below body midline; middle pectoral-fin rays longest, ventral rays thickened, exserted. Gill slit extending ventrally to below pectoral base. Mouth inferior; lower lip with slight

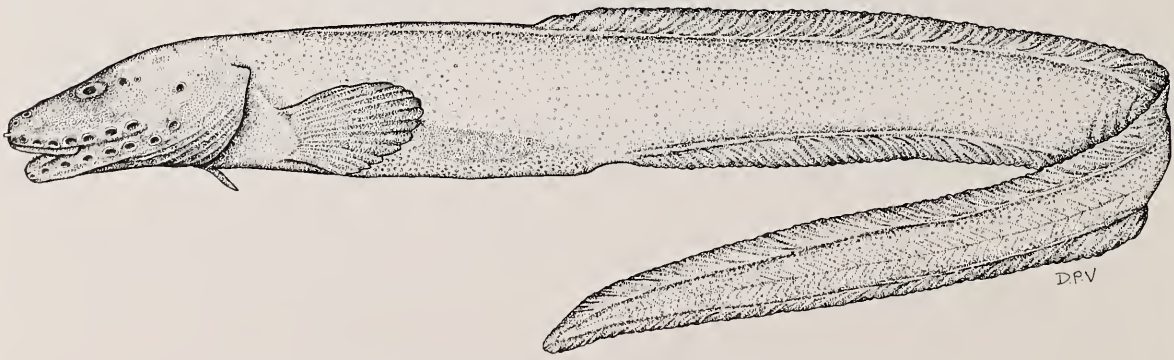
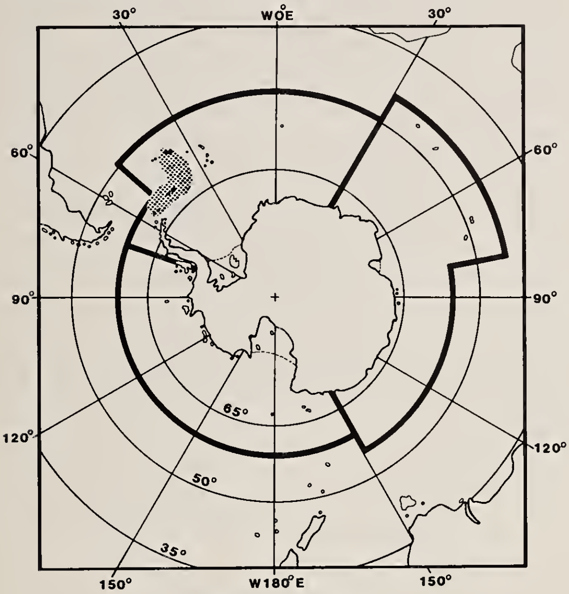


Fig. 2. *Lycenchelys antarctica* LACM 11043–5, 25 cm SL, Scotia Sea

fleshy lobe. Teeth conical, present on vomer and palatine bones. Upper jaw length sexually dimorphic: males with maxillary lengths 41.3–44.3% HL, females with maxillary lengths 33.0–38.5% HL. Head pores enlarged, ovoid anteriorly, more rounded dorsally; supratemporal (occipital) and coronal (interorbital) pores absent; supraorbital (nasal) pores 2; preopercular-mandibular pores 9 (rarely pores 5 and 6 unite producing 8 pores); infraorbital (suborbital) pores 7–9; temporal (postorbital) pores 1 or 2. Pseudobranch of 1–3 filaments. Two nublike pyloric caeca (rarely absent). Dorsal-fin origin associated with vertebrae 12–21, with 6–16 supraneurals.

Colour: In alcohol, uniformly light brown to bluish. Head dark blue, margins of unpaired fins black. Regan (1913) reports "bluish grey; head darker, fins brownish-grey".

Distribution: Scotia Sea abyss (1,976–3,870 m) and Peru-Chile Trench (4,855–5,320 m).



Distribution of *L. antarctica*

Remarks: The 3 known specimens from the Peru-Chile Trench differ from the Scotia Sea forms in having somewhat more supraneural bones (9–16 vs. 6–12) and, consequently, more posterior dorsal-fin origins (origin associated with vertebrae 14–21 vs. 12–18). One specimen with 8 preopercular-mandibular pores has been taken from both areas. Although seemingly isolated populations exist, there is no sill depth between the 2 regions shallower than the recorded depths of this species, thus no formal taxonomic recognition is given to the 2(?) populations.

Attains 26 cm TL.

Lycenchelys aratrirostris
Andriashev & Permitin, 1968
Fig. 3

Lycenchelys aratrirostris Andriashev & Permitin, 1968: 615, figs. 2–4, off South Shetland Islands (62°56′S, 54°49′W). Holotype: ZIN 38342.

Diagnosis: D 97–107; A 79–89; C 9–10; P 15–16; V 3; GR(1–2)+(10–12)=11–14; branchiostegal rays 6; vertebrae (23–24)+(78–86) = 101–110. Body height 5.8–8.5%, head length 16.0–18.2%, mandibular symphysis length 17.9–19.9% HL. Eye diameter 20.1–23.7%, pectoral fin length 41.9–54.6%, upper jaw length 34.6–48.8% HL. Head moderately large, laterally expanded in adult males. Body moderately long, ovoid in cross section. Skin firm, but not thickened. Scales extending anteriorly to vertical through anus in largest specimen, present on unpaired fins. Lateral line ventral, complete. Eye moderate, ovoid. Pectoral fin moderately long, its origin just below body midline; middle pectoral-fin rays longest, ventral rays thickened, exserted. Gill slit extending ventrally to below pectoral-fin base. Mouth subterminal, lower lip with fleshy lobe, more prominent in adults. Lower jaw with characteristic, broad mandibular symphysis marked with deep recess. Teeth conical, sparse, present on vomer and palatine bones. Head pores somewhat enlarged, ovoid anteriorly, smaller and more rounded dorsally. Supratemporal (occipital) and coronal (interorbital) pores absent. Supraorbital (nasal) pores 2; preopercular-mandibular pores 8; infraorbital (suborbital) pores 6 or 7. Pseudobranch of 1–5 filaments or absent. Two nublike pyloric caeca. Dorsal-fin origin associated with vertebrae 3–4.

Colour: In alcohol, uniformly light brown, head darker, becoming bluish-black on ventral surface and throat. Opercular flap, peritoneum, lining of orobranchial chamber, posterior portion of unpaired fins and margin of pectoral fin black. Abdomen dark blue.

Distribution: Off the South Shetland Islands to the Weddell Sea in 562–1,120 m.

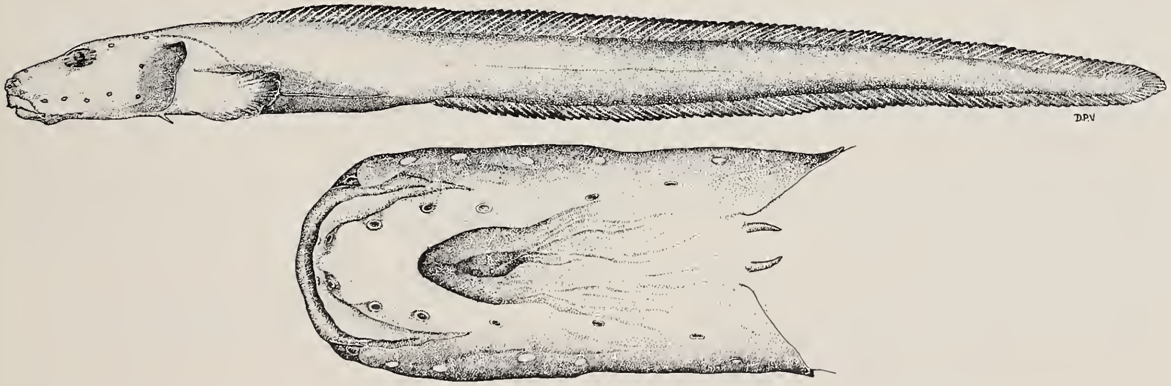
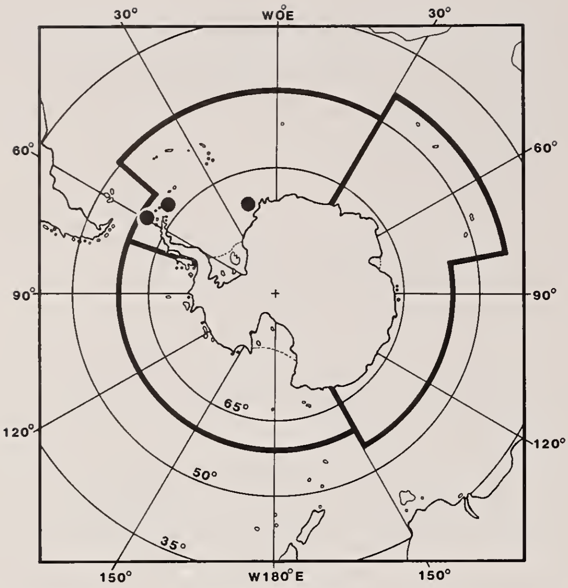


Fig. 3. *Lycenchelys aratrirostris* ISH 61/85, 168 mm SL (72°35.4′S,18°06.8′W), with ventral view of head



Distribution of *L. aratrirostris*

Remarks: Only 4 specimens known, the largest is 23 cm TL.

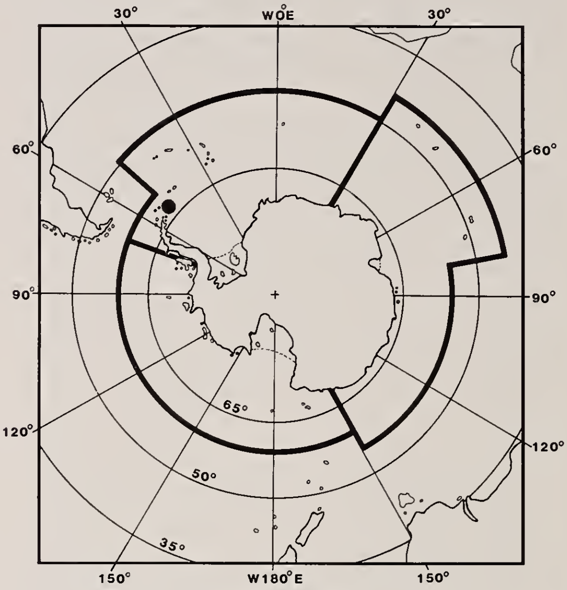
Lycenchelys argentina
Marschoff, Torno & Tomo, 1977
Fig. 4

Lycenchelys argentinus Marschoff, Torno & Tomo, 1977: 3, text figure, west of South Orkney Islands (60°39′S, 50°39′W). Holotype: IAA 3.

Diagnosis: D 80; A 73; C 9; P 18; GR 3+15; branchiostegal rays 6; vertebrae unknown. Body height 8.1% and head length 17.3% SL. Eye diameter 14.0%, pectoral fin length 62.8%, and upper jaw length 37.2% HL. Head large, robust, dorsoventrally depressed. Lips and dorsal region of head covered with minute, wartlike papillae. Body somewhat elongate, ovoid in cross section, but tail relatively short. Skin firm, somewhat thickened on abdomen and head, but pliable. Scales extending anteriorly to just behind posterior margin of pectoral fin. Lateral line with 2 branches: ventral complete; mediolateral complete. Eye small, ovoid. Pectoral fin relatively large, its origin just below body midline; middle pectoral-fin rays longest, ventral rays thickened, exserted. Gill slit extending ventrally to lower end of pectoral-fin base. Mouth subterminal. Teeth conical, relatively sparse, present in vomer and palatine bones. Head pores not enlarged, but rounded; median supratemporal (occipital) pore 1; 1 coronal (interorbital) pore between anterior margin of orbits. Supraorbital (nasal) pores 2; preopercular-mandibular pores 8; infraorbital (suborbital) pores 6; and temporal (postorbital) pores 3 or 4. Two nublike pyloric caeca.

Colour: In alcohol, uniformly dark violet-brown, head and fins violet; areas on tail and body, lateral line and lips whitish. Lining of orobranchial chamber and peritoneum black.

Distribution: Only the holotype known. Capture depth, as reported in original description, was 2,120 m; capture depth reported by Tomo (1981: 79): 300–700 m.



Distribution of *L. argentina*

Remarks: The holotype's catalogue number, IAA 3, was reported by Marschoff *et al.* (1977) also for the holotype of "*Oidiphorus*" *laevifasciatus* (see *Seleniolycus* account below).

Attains 26 cm TL.

Lycenchelys bellingshauseni
Andriashev & Permitin, 1968
Fig. 5

Lycenchelys bellingshauseni Andriashev & Permitin, 1968: 612, figs. 1–2, off South Georgia Island (53°39′S, 36°20′W). Holotype: ZIN 37878.

Diagnosis: D 94–103; A 82–91; C 8–9; P 15–17; V 3; GR (1–3)+(9–11) = 10–14; branchiostegal rays 6; vertebrae (21–23)+(81–87) = 102–110. Body height 4.2–6.6% and head length 12.6–16.4% SL. Eye diameter 21.4–27.1%, pectoral fin length 43.4–55.7%, and upper jaw length 32.7–49.1% HL. Head small, dorsoventrally depressed, snout steeply sloping anteriorly. Head longer and broader in adult males than females. Head length 16.3–16.4% SL in males, 12.6–15.1% SL in females; head width 11% SL in males, 6.0–9.6% SL in females. Body moderately elongate, ovoid in cross section, tail generally more rounded in cross section anteriorly than

Fig. 4. *Lycenchelys argentina,* 26 cm TL, drawn from a photograph of the holotype in Marschoff *et al* (1977)

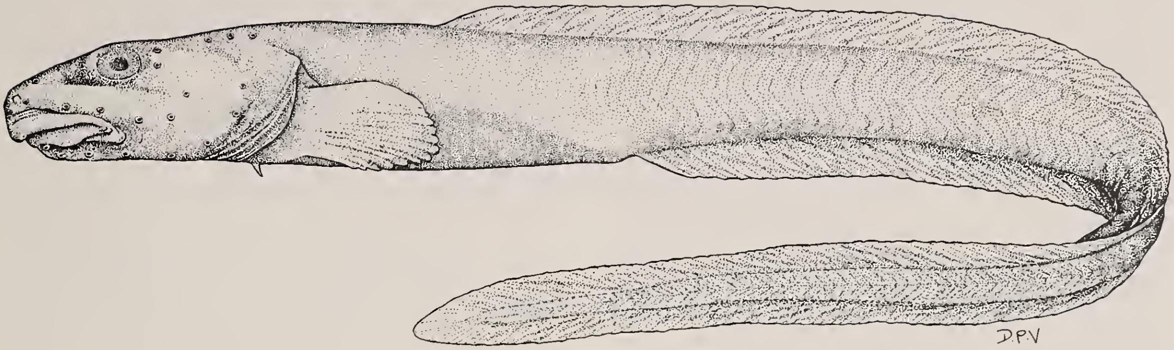


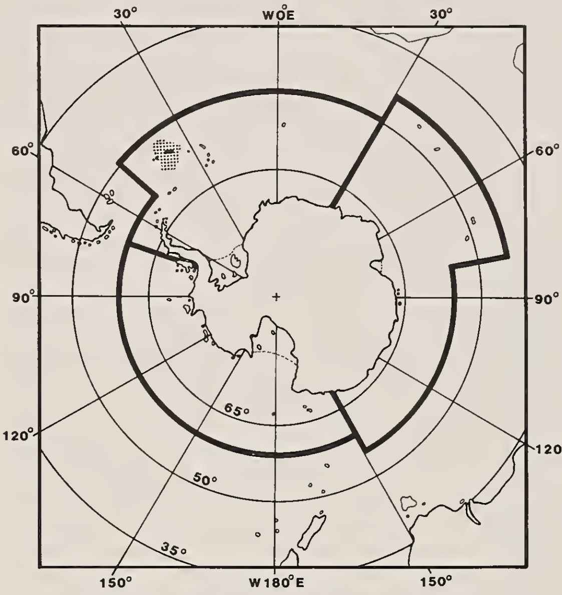
Fig. 5. *Lycenchelys bellingshauseni* LACM 10606–9, 26 cm SL, South Georgia

most other congeners. Skin firm but not thickened, pliable around head. Scales extending anteriorly to vertical just anterior to anus in largest specimens. Lateral line ventral, complete. Eye moderately large, ovoid. Pectoral fin comparatively small, its origin below body midline; middle pectoral-fin rays longest, ventral rays thickened, exserted. Gill slit extending ventrally to below pectoral-fin base, dorsally extending anteriorly a short distance forming weak opercular flap. Mouth inferior, lower lip with well-developed fleshy lobe. Lower jaw with slight mandibular recess, its length 9.4–12.7% HL. Upper jaw length sexually dimorphic: males with maxillary lengths 40.7–49.1% HL, females with maxillary lengths 33.0–38.5% HL. Teeth conical, present on vomer and palatine bones. Head pores not enlarged, rounded; supratemporal (occipital) and coronal (interorbital) pores absent, except 1 specimen with median supraorbital pore between anterior margin of orbits, as in *L. argentina*; postorbital (nasal) pores 2; preopercular-mandibular pores 8; infraorbital (suborbital) pores 8; and temporal (postorbital) pores 4. Pseudobranch of 2–5 moderately long filaments. Two nublike pyloric caeca. Dorsal-fin origin associated with vertebrae 5–9.

Colour: In alcohol, uniformly dark brown, head, pectoral-fin base and abdomen somewhat darker. Dark areas probably black or purple in life. Peritoneum and lining of orobranchial chamber black.

Distribution: Known only from the Scotia Sea off South Georgia Island in depths of 620–2,600 m.

Remarks: Attains 28 cm TL.



Distribution of *L. bellingshauseni*

Lycenchelys hureaui (Andriashev, 1979)
Fig. 6

Apodolycus hureaui Andriashev, 1979: 29, figs. 1–2, Kerguelen Plateau (49°36′S, 71°28′E). Holotype: ZIN 44333.

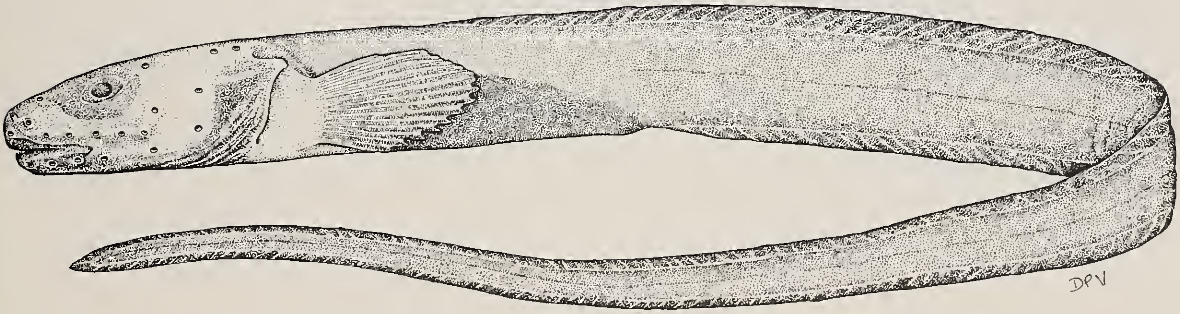


Fig. 6. *Lycenchelys hureaui* MNHN 1984–727, 26 cm SL, Kerguelen Islands

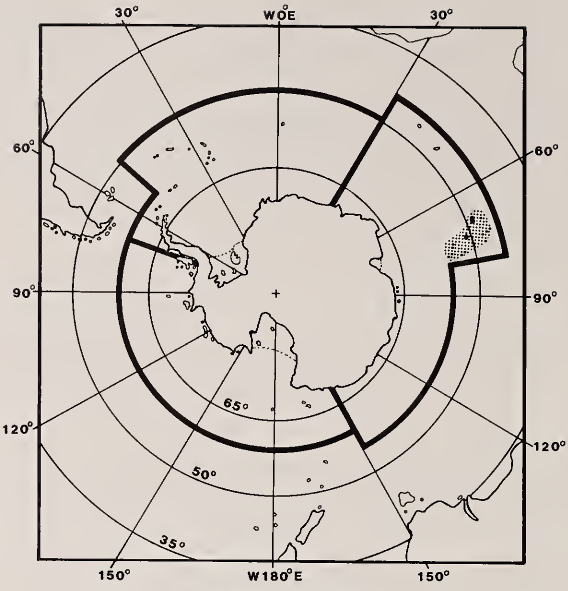
Diagnosis: D 99–108; A 85–93; C 8–10; P 15–17; GR (1–3)+(9–12) = 10–14; branchiostegal rays 6; vertebrae (20–23)+(84–91) = 104–112. Body height 3.9–5.1%, head length 12.7–15.9%, and preanal length 28.1–30.9% SL. Eye diameter 22.7–28.6%, pectoral fin length 52.0–61.5, upper jaw length 29.1–38.9%, and caudal fin length (measured from end of hypural plate to end of middle caudal rays) 21.0–30.4% HL. Head small, dorsoventrally depressed, somewhat ovoid. Body moderately elongate, ovoid or circular in cross section, anterior portion of tail almost circular in cross section. Pelvic fins absent. Skin firm but not thickened. Scales extending anteriorly to just behind vertical through posterior margin of pectoral fin in largest specimens; scales absent on fins and their bases. Lateral line ventral, complete. Eye large, ovoid. Pectoral fins moderately long, inserted below body midline; middle pectoral-fin rays longest, ventral rays thickened, exserted. Gill slit extending ventrally to lower edge of pectoral-fin base. Mouth inferior, lower lip with slight fleshy lobe. Lower jaw with unique, large mandibular lobe; lobe bifurcated ventrally, beneath which is deep mandibular recess similar to that in *L. aratrirostris* (length of mandibular symphysis 14.0–18.8% HL). Teeth conical, present on vomer and palatine bones. Upper jaw length sexually dimorphic: males with maxillary lengths 37.6–38.9% HL, females with maxillary lengths 29.1–35.6% HL. Head pores not enlarged, rounded; supratemporal (occipital) and coronal (interorbital) pores absent; supraorbital (nasal) pores 2; preopercular-mandibular pores 8; infraorbital (suborbital) pores 6–8, usually 7 emanating from ventral ramus of bone chain and none from ascending ramus; temporal (postorbital) pores 3 (rarely 2). Pseudobranch of 2–6 small filaments. Two nublike pyloric caeca. Dorsal-fin origin associated with vertebrae 4–5.

Colour: In alcohol, dark reddish-brown ventral surfaces of head and lips darker brown. Opercular region, branchiostegal membranes, fins, peritoneum, and lining of orobranchial chamber black. Eye and abdomen bluish-black.

Distribution: Known only from the Kerguelen Plateau in depths of 560–937 m.

Remarks: When described, this species differed significantly from others in the genus only by its lack of pelvic fins, prompting the erection of a new genus (Andriashev 1979). Anderson (1982, 1984a) showed this character to be homoplasiously distributed in the family and did not use it alone to define genera.

Attains 274 mm TL.



Distribution of *L. hureaui*

Lycenchelys nanospinata Anderson, 1988
Fig. 7

Lycenchelys nanospinata Anderson, 1988: 96, fig. 35, Scotia Sea (59°08′S, 36°57′W). Holotype: LACM 10816–2.

Diagnosis: D 97; A 83; C 10; P 15; GR 3+16; branchiostegal rays 5; vertebrae 23+82 = 105. Body height 8.9% and head length 15.9% SL. Eye diameter 23.5%, pectoral fin length 59.9%, and upper jaw length 34.0% HL. Head moderately large, ovoid, somewhat dorsoventrally depressed, snout steeply sloping anteriorly. Body elongate, somewhat laterally compressed. Skin firm but not thickened; pliable around mouth. Head, including nape, occiput, snout, lips, chin and cheeks

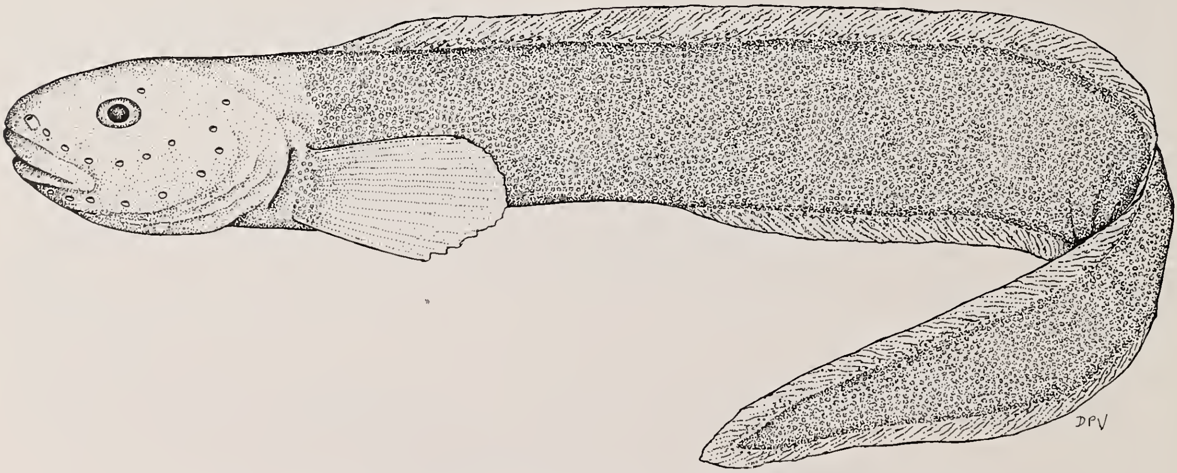
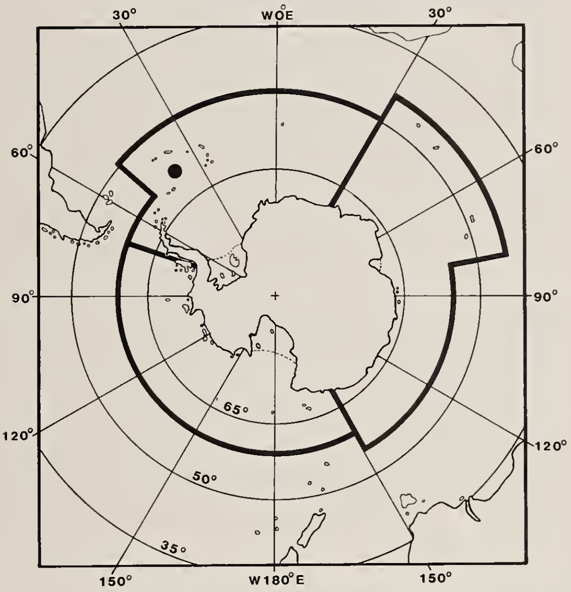


Fig. 7. *Lycenchelys nanospinata* LACM 10816–2, 185 mm SL, female, holotype

covered with simple, microscopic, epidermal prickles. Scales present on body, vertical fins, pectoral axil and base, and abdomen, extending anteriorly to isthmus. Lateral line ventral. Eye small, ovoid. Pelvic fins absent. Pectoral fins moderately long, inserted below body midline; middle pectoral-fin rays longest, all but dorsal-most 2 rays exserted. Gill slit extending ventrally to opposite pectoral rays 10–11 (not extending to lower margin of pectoral-fin base). Mouth subterminal, lower lip with slight fleshy lobe. Teeth conical, relatively small, present on vomer and palatine bones. Head pores moderately enlarged, ovoid and larger anteriorly; supratemporal (occipital) and coronal (interorbital) pores absent; supraorbital (nasal) pores 2; preopercular-mandibular pores 8; infraorbital (suborbital) pores 6; temporal (postorbital) pores 2. Pseudobranch of 3 filaments. Two nublike pyloric caeca. Dorsal-fin origin associated with vertebra 6.

Colour: In alcohol, faded to pinkish-white, with scattered patches of brown over body and tail. Peritoneum and lining of orobranchial chamber dark brown, probably black in life.

Distribution: Known only from the holotype which was collected at 2,815–2,818 m along the Scotia Ridge.



Distribution of *L. nanospinata*

Remarks: The holotype is an immature female.

Lycenchelys nigripalatum DeWitt & Hureau, 1979
Fig. 8

Lycenchelys nigripalatum DeWitt & Hureau, 1979: 812, figs. 8–9, off Adelaide Island (67°40.2′S, 70°16.2′W). Holotype: MNHN 1974–86.

Diagnosis: D 96; A 77; C 10; P 15; V 3; GR 3+12; branchiostegal rays 6; vertebrae 27+77 = 104. Body height 9.3%, head length 15.6%, and preanal length 40.5% SL. Eye diameter 16.1%, pectoral fin length 63.5%, and upper jaw length 42.7% HL. Head short and deep, somewhat triangular in lateral and dorsal views. Body robust, elongate, with greater height at anal origin and preanal length than congeners in Southern Ocean. Skin firm but not thickened, pliable around mouth. Scales extending anteriorly to nape, present on unpaired fins (posteriorly), pectoral-fin base, axil, and abdomen; absent on abdominal midline and head. Lateral line ventral, probably complete. Eye moderately large, ovoid. Pectoral fins long, inserted slightly below body midline; middle pectoral-fin rays longest, lowermost thickened, exserted. Gill slit extending ventrally to below pectoral-fin base. Mouth inferior, lower lip with slight fleshy lobe. Teeth conical, relatively numerous and large, present on vomer and palatine bones. Head pores not enlarged, rounded; coronal (interorbital) and supratemporal (occipital) pores absent; 1 supraorbital (nasal) pore; preopercular-mandibular pores 8; infraorbital (suborbital) pores 6; 1 temporal (postorbital) pore. Pseudobranch of 4 filaments. Two nublike pyloric caeca. Dosal-fin origin associated with vertebra 4.

Colour: In alcohol, uniformly dark brown, head black. Peritoneum and lining of orobranchial chamber black. Pectoral fin dark, also probably black in life.

Distribution: Known only from the holotype which was captured off Adelaide Island at 580–650 m.

Remarks: DeWitt & Hureau (1979: 816) mistook the posterior temporal (postorbital) head pores for supratemporal (occipital) pores and partially diagnosed the species on the presence of these pores. Redetermined assignment of pores to their canals is given above. DeWitt & Hureau described as "noteworthy" the great head depth (58.7% HL) of this species, however, Anderson (1988) re-evaluated this figure and showed it to be a preservation artifact with a value comparable to 3 other species in the area.

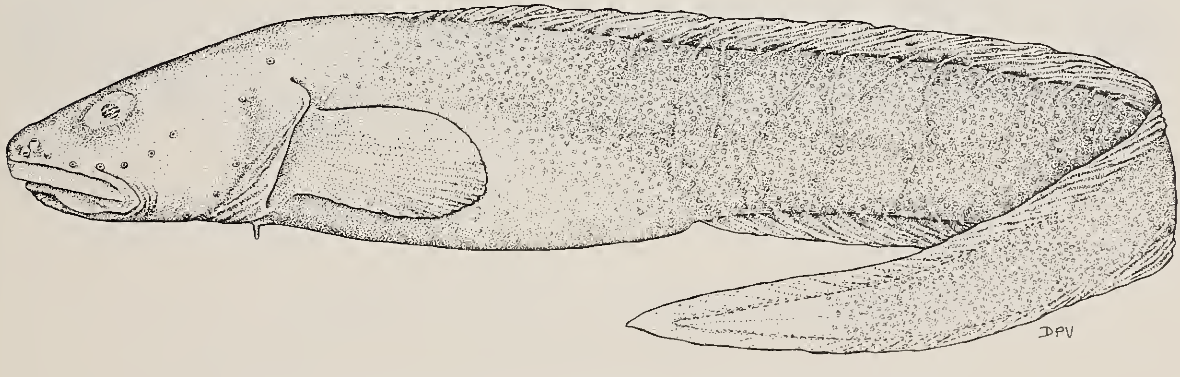
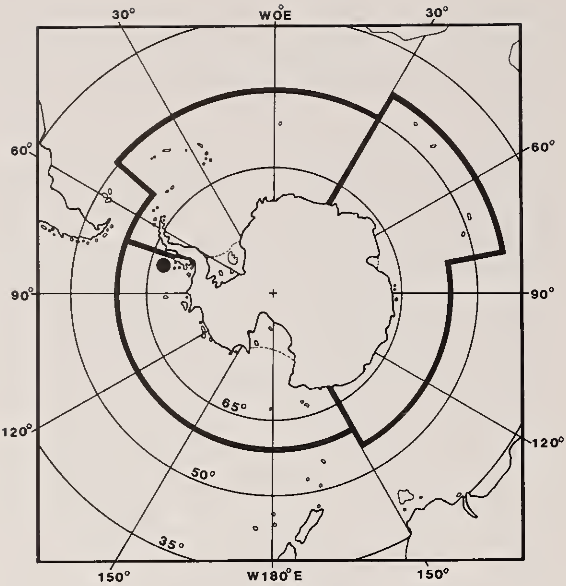


Fig. 8. *Lycenchelys nigripalatum* MNHN 1974–86, 28 cm TL, holotype



Distribution of *L. nigripalatum*

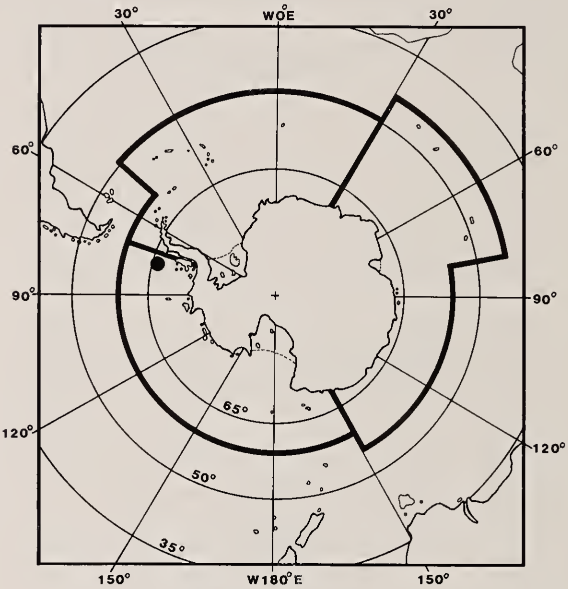
Lycenchelys tristichodon DeWitt & Hureau, 1979
Fig. 9

Lycenchelys tristichodon DeWitt & Hureau, 1979: 816, fig. 10, off Adelaide Island (67°15.6′S, 70°12.0′W). Holotype: MNHN 1974–87.

Diagnosis: D 109; A 91; C 10; P 17; V 3; GR 3+12; branchiostegal rays 6; vertebrae 28+89 = 117. Body height 8.7% and head length 12.3% SL. Eye diameter 21.2%, pectoral fin length 69.2%, and upper jaw length 38.9% HL. Head short, ovoid. Body elongate, ovoid in cross section. Skin firm but not thickened, pliable around mouth. Scales extending anteriorly to nape, present on pectoral-fin axil and base, abdomen, and unpaired fins. Lateral line mediolateral, incomplete (?). Eye moderate, ovoid. Pectoral fins large, inserted just below body midline; dorsalmost pectoral-fin rays longest, ventral rays thickened, exserted. Gill slit extending ventrally just to lower margin of pectoral-fin base; dorsal margin of gill slit not extending anteriorly. Mouth inferior, lower lip without fleshy lobe. Teeth conical, relatively numerous, present on vomer and palatine bones; in single row on palatines. Head pores not enlarged, rounded; coronal (interorbital) and supratemporal (occipital) pores absent; supraorbital (nasal) pores 2; preopercular-mandibular pores 8; 6 infraorbital (suborbital) pores on right side, 5 on left; temporal (postorbital) pores 2. Pseudobranch of 4 filaments. Two nublike pyloric caeca. Dorsal-fin origin associated with vertebra 4.

Colour: In alcohol, uniformly dark brown; fins and head darker than body, probably black in life. Lining of mouth pale yellowish-brown, speckled with minute melanophores. Peritoneum black. Abdomen and eye blue.

Distribution: Known only from the holotype which was captured off Adelaide Island at 630–650 m.



Distribution of *L. tristichodon*

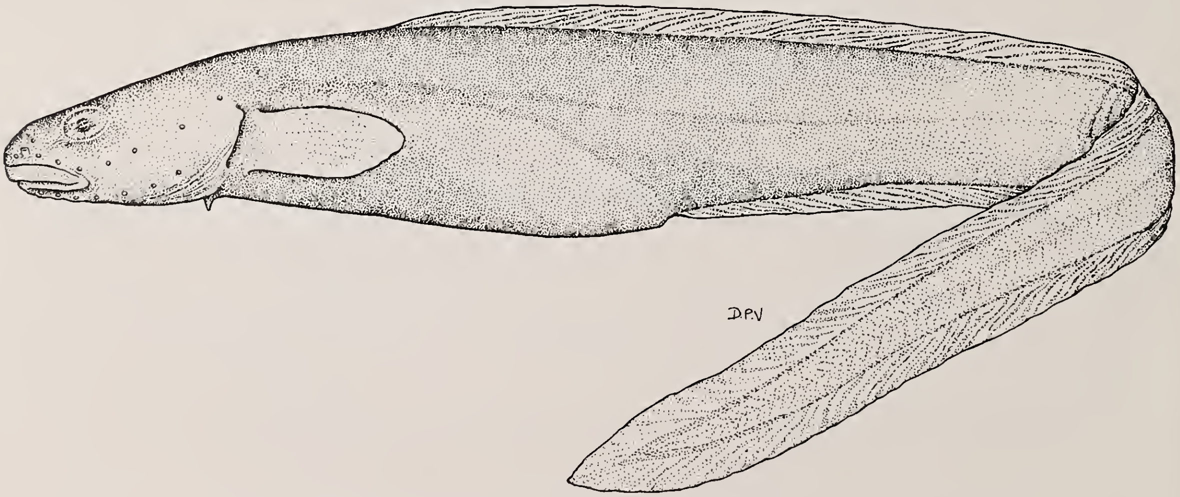


Fig. 9. *Lycenchelys tristichodon* MNHN 1974–87, 30 cm TL, female, holotype

Remarks: Head length proportionately shorter and pectoral-fin length proportionately longer than any congener in the Southern Ocean.

As with *L. nigripalatum* (above) DeWitt & Hureau (1979) assigned some head pores to the wrong canals, thus miscounting them. Corrected assignments are given above. DeWitt & Hureau also reported this species to have 3 rows of palatine teeth and based their trivial name on this, stating it to be unique. Anderson (1988) showed that these authors mistook gustatory papillae on the palate for teeth.

The holotype is 308 mm TL.

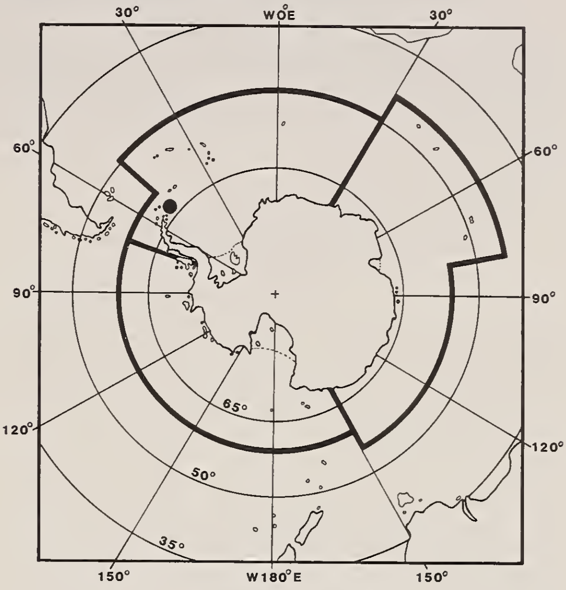
Lycenchelys wilkesi Anderson, 1988
Fig. 10

Lycenchelys wilkesi Anderson, 1988: 100, fig. 37, Bransfield Strait (62°07′S, 55°58′W). Holotype: LACM 10476–2.

Diagnosis: D 93; A 76; C 9; P 15; V 3; GR 2+12; branchiostegal rays 6; vertebrae 22+73 = 95. Body height 6.2% and head length 16.4% SL. Eye diameter 18.4%, pectoral fin length 36.8%, and upper jaw length 32.1% HL. Head moderately large, dorsoventrally depressed, snout steeply sloping anteriorly. Body moderately long, almost circular in cross section. Skin firm but not thickened, pliable around mouth. Scales present on tail only, extending anteriorly to vertical through first third segment of tail. Lateral line ventral. Eye moderate, ovoid. Pectoral fins relatively small, inserted below body midline; dorsalmost pectoral-fin rays longest, ventralmost thickened, exserted. Gill slit extending ventrally to just above lower margin of pectoral-fin base. Mouth inferior, lower lip with moderate fleshy lobe. Lower jaw with very slight mandibular recess at dentary symphysis; mandibular symphysis length 8.6% HL. Teeth conical, absent on vomer and palatine bones. Anterior margin of palate with branching, villiform papillae. Head pores not enlarged, rounded; supratemporal (occipital) and coronal (interorbital) pores absent; supraorbital (nasal) pores 2; preopercular-mandibular pores 8; infraorbital (suborbital) pores 6; temporal (postorbital) pores 3. Pseudobranch of 2 filaments. Two nublike pyloric caeca. Dorsal-fin origin associated with vertebra 2.

Colour: In alcohol, faded to pale pinkish-brown, head and pectoral fin dark brown. Lining of mouth pale. Peritoneum dark brown.

Distribution: Known only from the holotype which was collected in Bransfield Strait at 1,113–1,153 m.



Distribution of *L. wilkesi*

Genus *Lycodapus* Gilbert, 1890

Body robust to thin, height 3.2–10.0% SL. Skin gelatinous, transparent or opaque. Scales, pelvic fins and suborbital pores absent. Frontal and parasphenoid separated by pterosphenoid. Sphenotic and parietal articulating. Only first suborbital bone (lacrimal) present. Pectoral radials 2–3, cartilaginous. Palatal (pterygoid) arch weak; palatal membrane (oral valve) absent. Mandibular and preopercular canals separated by septum. branchiostegal membranes united, forming free fold posteriorly. Thirteen species, 2 in the Southern Ocean.

KEY TO SPECIES

1a Vertebrae 98–105; D 92–99; A 80–86; head length 15–18% SL; predorsal length 17–21% SL............ *L. antarcticus*

1b Vertebrae 75–82; D 67–75; A 58–65; head length 19–25% SL; predorsal length 22–28% SL........... *L. pachysoma*

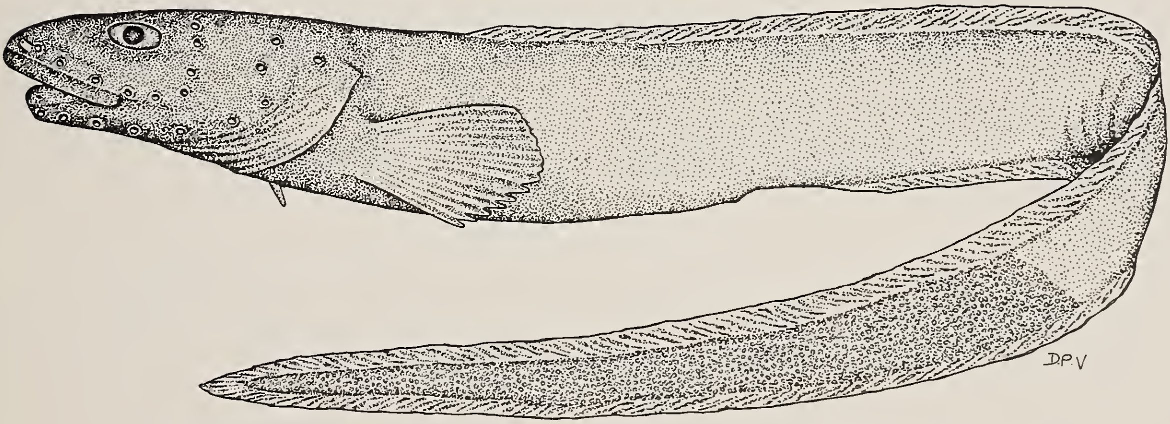


Fig. 10. *Lycenchelys wilkesi* LACM 10476–2, 249 mm SL, adult female, holotype

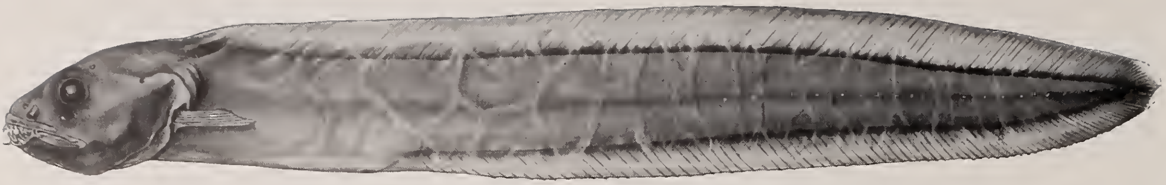


Fig. 11. *Lycodapus antarcticus* MNHN 1984–761, 184 mm SL, Kerguelen Plateau

Lycodapus antarcticus Tomo, 1981
Fig. 11

Lycodapus sp. Peden & Anderson, 1978: 1936, South Georgia Island.

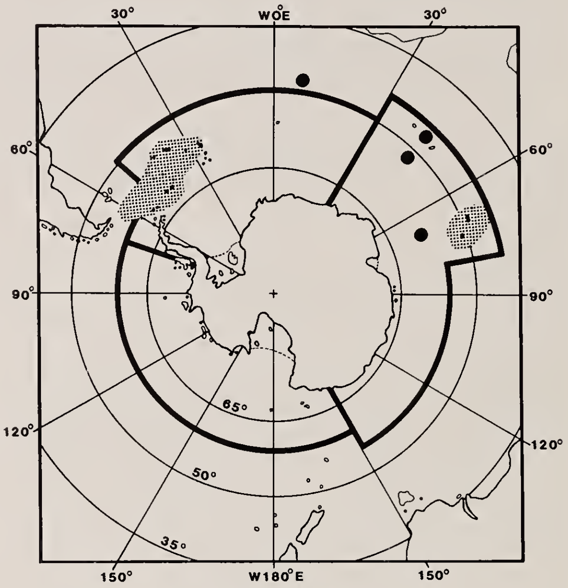
Lycodapus antarcticus Tomo, 1981: 84, figs. 63–64, off South Orkney Islands.
Holotype: IAA 5.

Diagnosis: D 92–99; A 80–86; C 8–10; P 6–9; GR (1–3)+(10–13) = 11–16; GR ratio 43–89%; branchiostegal rays 6; vertebrae (17–20)+(79–86) = 98–105. Body height 6.1–10.0%, head length 15.2–18.3%, and predorsal length 16.9–20.9% SL. Eye diameter 23.6–28.3%, pectoral fin length 27.6–49.7%, and upper jaw length 44.4–53.2% HL. Head small, triangular in lateral view. Body moderately long, ovoid in cross section, juveniles with proportionately longer bodies than largest adults. Lateral line mediolateral, complete. Eye moderate, rounded. Pectoral fins small, inserted well below body midline; lowermost pectoral-fin rays longest, rays only slightly exserted in some. Gill slit extending dorsally to just above pectoral fin, ventrally free of isthmus. Mouth terminal, lips not fleshy, without lobes. Lower jaw slightly projecting beyond upper. Dentition sexually dimorphic. Spawning males with enlarged, fang-like jaw teeth in 2–3 anterior rows; females with small, conical jaw teeth, only few, small caniniform teeth in 3–5 anterior rows. Teeth present on vomer and palatine bones. Head pores small, rounded, sparse; supratemporal (occipital) and infraorbital (suborbital) pores absent; supraorbital (nasal) pores 2; 1 coronal (interorbital) pore; preopercular-mandibular pores 7–8; 1 temporal (postorbital) pore. Pseudobranch of 2–3 filaments, rarely absent. Two nublike pyloric caeca. Dorsal-fin origin associated with vertebrae 3–5.

Colour: In life, uniformly pearl-white with silver-blue abdomen, fading in alcohol to uniform light brown. Ventral surface of head and throat blue-black. Opercular flap, peritoneum, lining of orobranchial chamber, posterior portion of unpaired fins and margin of pectoral fin black.

Distribution: Around the Scotia Arc from Burdwood Bank to the South Shetland Islands and east to Kerguelen Plateau and southerly seamounts. All specimens known are from bottom trawls fished in 323–1,200 m, but the species is either meso- or bathypelagic, as are its 12 congeners (Peden & Anderson 1978; Anderson 1981).

Remarks: Spawning appears to commence in the early austral summer (gravid females with ova averaging 2.6 mm in diameter were found in November samples) and end about February; however, the species' winter condition is unknown. The diet consists mainly of copepods and krill, *Euphausia superba*, midwater crustaceans typical of the diet of congeners (Anderson 1981, 1988).
Attains 206 mm TL.



Distribution of *L. antarcticus*

Lycodapus pachysoma Peden & Anderson, 1978
Fig. 12

Lycodapus pachysoma Peden & Anderson, 1978: 1944 (corrected), figs. 5, 9, 16, north-eastern Pacific (43°23.0'N, 125°18.5'W). Holotype: USNM 216468.

Diagnosis: D 67–75; A 58–65; C 9–10; P 6–8; GR (1–3)+(11–12) = 12–14; GR ratio 50–88%; branchiostegal rays 6; vertebrae (16–18)+(59–65) = 75–82. Body height 3.2–8.8%, head length 18.7–24.9%, and preanal length 37.4–44.6% SL. Eye diameter 12.5–22.4%, pectoral fin length 23.5–43.4%, and upper jaw length 46.2–53.7% HL. Head large and deep in adults, triangular in lateral view in all stages. Body short, deep, ovoid in cross section, convex at nape. Lateral line mediolateral, complete. Eye small, rounded. Pectoral fins small, inserted well below body midline; middle pectoral-fin rays longest, none exserted. Gill slit extending dorsally to well above pectoral fin, ventrally free of isthmus. Mouth terminal, lips not fleshy, without lobes. Lower jaw slightly projecting beyond upper. Dentition sexually dimorphic. Largest male without fanglike jaw teeth; teeth in 3 anterior rows in premaxilla and 4 anterior rows in dentary. Adult females with teeth in both jaws in 5–6 anterior rows. Teeth present on vomer and palatine bones. Head pores small, rounded, sparse; supratemporal (occipital) and infraorbital (suborbital) pores absent; supraorbital (nasal) pores 2; 1 coronal (interorbital) pore; preopercular-mandibular pores 8; 1 temporal (postorbital) pore. Pseudobranch of usually 2

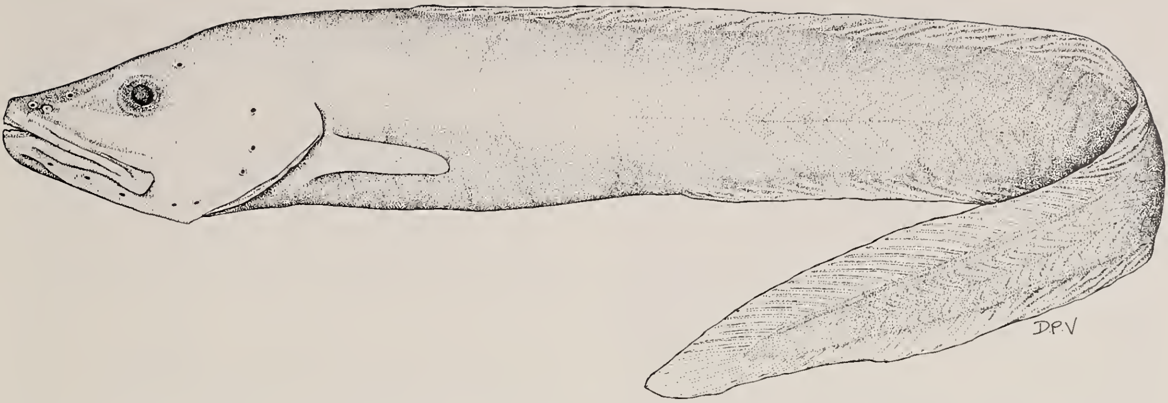
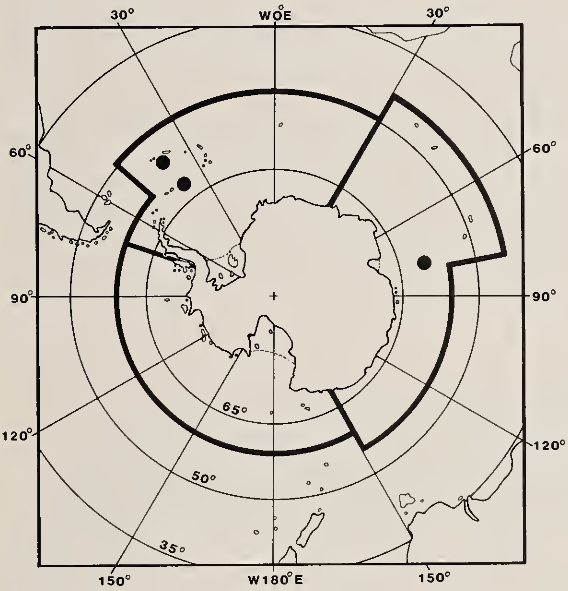


Fig. 12. *Lycodapus pachysoma* ISH 403/76, 185 mm SL, South Georgia

filaments when present. Two nublike pyloric caeca. Dorsal-fin origin associated with vertebrae 3–6.

Colour: In alcohol, pale brown or yellowish, probably pearl-white with silver-blue abdomen in life, as congeners. No black swath along tail tip. Lining of orobranchial chamber, stomach wall, peritoneum, lips, branchiostegal membrane and orbital lining black.

Distribution: In Southern Ocean: Scotia Sea and Banzare Bank, Kerguelen Plateau at depths to 2,600 m. In north-eastern Pacific Ocean: Oregon to British Columbia at depths to 2,195 m. Probably bathypelagic and/or benthopelagic along continental slopes and thalassobathyal regions.



Distribution of *L. pachysoma*

Remarks: Attains 200 mm TL.

Genus *Lycodichthys* Pappenheim, 1911

Body robust, height 8.4–12.7% SL. Skin firm, thickened. Scales and lateral line present. Pelvic fins present or absent. Five infraorbital (suborbital) bones and pores. Gill slit usually not reaching lower edge of pectoral base. Vomerine and palatine teeth absent. Pyloric caeca and pseudobranch absent. Palatal (pterygoid) arch well developed. Two species endemic to the coast of Antarctica.

KEY TO SPECIES

1a V present .... *L. antarcticus*
1b V absent .... *L. dearborni*

Lycodichthys antarcticus Pappenheim, 1911

Fig. 13; Pl. 4, Fig. 1

Lycodichthys antarcticus Pappenheim, 1911: 382, Wilhelm Land, Antarctica, *Gauss* winter station. Syntypes: ZMH 12993, BMNH 1913.4.15:60–61.

Diagnosis: D 83–90; A 67–74; C 9–12; P 16–17; V 2; GR (1–2)+(8–13) = 9–14; branchiostegal rays 6; vertebrae (22–25)+(65–72) = 87–95. Body height 8.9–11.3% and head length 17.0–21.6% SL. Eye diameter 19.0–29.6%, pectoral fin length 58.9–70.5%, and upper jaw length 38.6–61.7% HL. Head moderately large, robust, ovoid, dorsal profile strongly flattened. Male head length 19.1–21.6%, female head length 17.0–19.7% SL. Body moderately long, ovoid in cross section. Scales extend anteriorly to dorsal-fin origin, absent on head, nape, abdomen, anal fin, pectoral fin base and axil (present on dorsal fin). Lateral line mediolateral, complete. Eye moderate, ovoid. Middle pectoral fin rays longest, ventral rays thickened, slightly exserted. Gill slit extending ventrally to lower edge of pectoral fin base in larger

Fig. 13. *Lycodichthys antarcticus* AMS IA.440, 186 mm SL, Queen Mary Coast (66°18′S, 94°58′E)

specimens; slightly above it in small specimens. Mouth subterminal, lips with moderate, fleshy lobes. Males with longer jaws than females; maxillary lengths 51.4–61.7% HL in adult males, 38.6–48.7% HL in adult females. Teeth in jaws conical, retrorse. Head pores small, rounded; supratemporal (occipital) and coronal (interorbital) pores absent; supraorbital (nasal) pores 2; preopercular-mandibular pores 8; infraorbital (suborbital) pores 5; temporal (postorbital) pores 2. Dorsal-fin origin associated with vertebrae 2–5.

Colour: In life, yellowish, with brown mottling (denser on head and anterior portion of body); large, solid dark brown areas on head and dorsum in largest specimens. Abdomen and pectoral fins yellowish with small brown blotches. Lips yellowish.

Otoliths

Diagnostic features: The obovate shape, the ostial and homosulcoid sulcus acusticus, which is not differentiated into ostium and cauda.

Ontogeny: Otoliths of fish smaller than 200 mm TL more triangular than obovate, whereafter the shape becomes obovate. In fish larger than 24 cm TL the margin becomes slightly irregular.

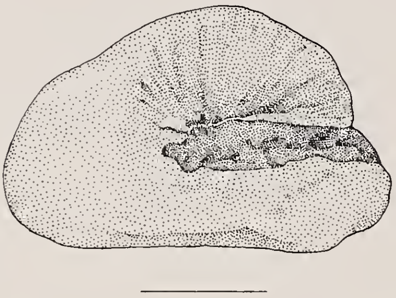
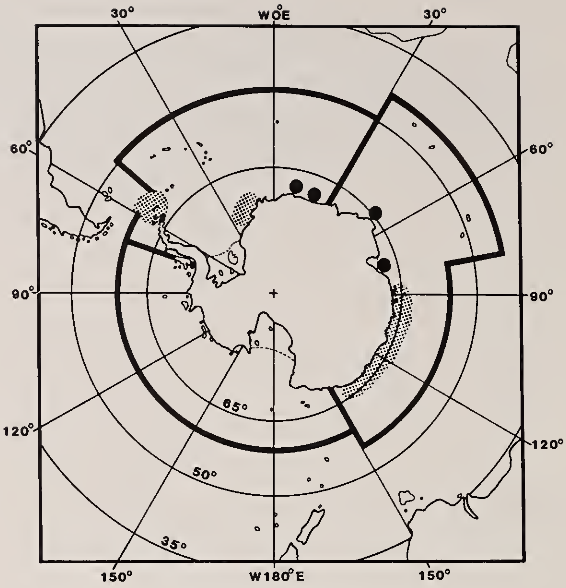


Fig. 14. Representative otolith of *L. antarcticus*; fish length 223 mm TL; scale bar 1 mm

Distribution: Queen Maud Land to Wilkes Land and off South Shetland Islands in 195–540 m.

Remarks: Attains at least 24 cm TL.



Distribution of *L. antarcticus*

Lycodichthys dearborni (DeWitt, 1962)

Fig. 15

Rhigophila dearborni DeWitt, 1962a: 819, figs. 1–4, McMurdo Sound, Ross Sea (77°53′S, 166°44′E). Holotype: SU 54154.

Diagnosis: D 85–91; A 69–75; C 10–12; P 15–17; GR (1–2)+(7–10) = 8–12; branchiostegal rays 6; vertebrae (23–26)+(67–75) = 90–98. Body height 8.4- 12.7% and head length 16.5–24.0% SL. Eye diameter 16.9–24.5%, pectoral fin length 51.5–68.3%, and upper jaw length 46.2–61.2% HL. Head moderately large, robust, ovoid, dorsal profile strongly flattened. Male head length 17.8–24.0%, female head length 16.4–21.2% SL. Body moderately long, ovoid in cross section. Scales extend anteriorly to dorsal-fin origin, absent on head, nape, abdomen, anal fin, pectoral fin base and axil (present on dorsal fin). Lateral line mediolateral, complete. Eye ovoid. Pectoral fins large, inserted slightly below body

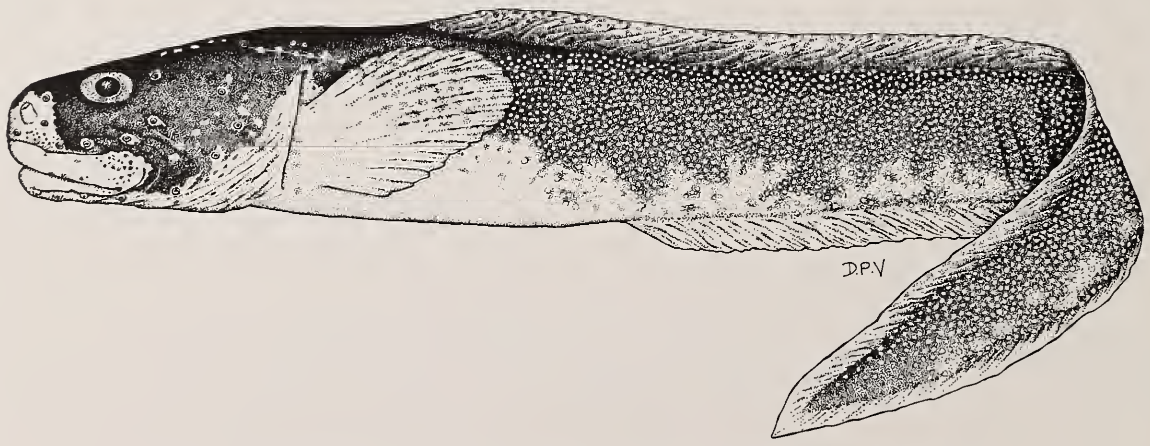
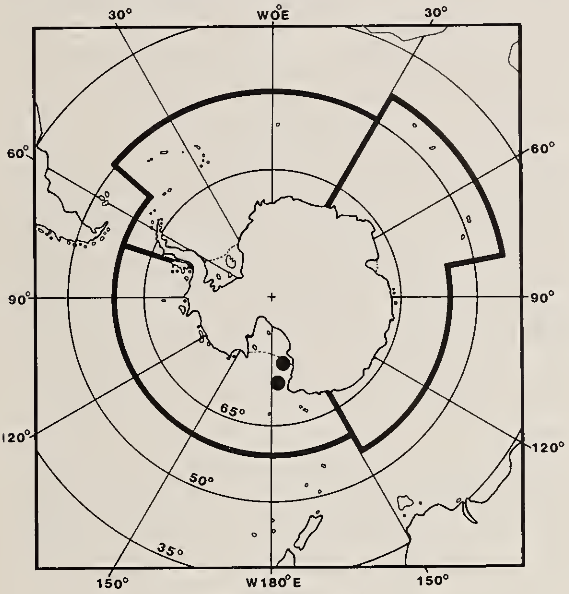


Fig. 15. *Lycodichthys dearborni* SU 59569, 169 mm TL, paratype, McMurdo Sound

midline; dorsalmost pectoral fin rays longest, ventral rays thickened, slightly exserted. Gill slit extending ventrally to lower edge of pectoral fin base in larger specimens; slightly above it in small specimens. Mouth subterminal, lower lip with moderate, fleshy lobe; upper lip without lobe. Males with longer jaws than females; maxillary lengths 45.8–61.2% HL in adult males, 41.9–46.2% HL in adult females. Teeth in jaws conical, retrorse. Head pores small, rounded; supratemporal (occipital) and coronal (interorbital) pores absent; supraorbital (nasal) pores 2; preopercular-mandibular pores 8; infraorbital (suborbital) pores 5; temporal (postorbital) pores 2. Dorsal-fin origin associated with vertebrae 3–4.

Colour: In life, yellowish with brown mottling similar to that in *L. antarcticus*. Largest specimens more or less uniformly dark brown, head and nape darker. Pectoral fins yellowish with light brown mottling in young; this fading in larger specimens. Lining of mouth dark in larger specimens, often with dark brown mottling on a lighter background in young (DeWitt 1962a: fig. 2).

Distribution: Known only from the Ross Sea in 550–588 m. All collections are from McMurdo Sound, except one (Iwami & Abe 1981a).



Distribution of *L. dearborni*

Remarks: Attains 23 cm TL.

Genus *Melanostigma* Günther, 1881

Infraorbital (i.e. suborbital) bones 4–5, from which emanate 3–6 pores close to the eye. Gill slit a small, porelike opening above pectoral fin. Frontal bone excluded from parasphenoid wing by pterosphenoid. Palatal arch weak. Preopercular canal and pores absent except in *M. vitiazi*. Sphenotic and parietal articulating. Single pair of supraorbital (nasal) pores. Lower pharyngeal teeth absent; 2 pairs of dentate upper pharyngeals. Skin loose, gelatinous. Scales, pelvic fins and (usually) lateral line absent.

The following key is to all 7 known species; most occur in the Northern Hemisphere; non-Antarctic species' localities are given in parentheses (see also Anderson 1988).

KEY TO SPECIES

1a Temporal (postorbital) pore present 2

1b Temporal (postorbital) pore absent 3

2a Preopercular-mandibular pores 7; P 10.9–12.7% SL; P 9–10; LL present; GR 14–19 .... *M. vitiazi*

2b Preopercular-mandibular pores 5; P 7.3–10.6% SL; P 7–8 (rarely 9); LL absent; GR 10–16, usually less than 14 .... *M. gelatinosum*

3a Total vertebrae 93–100, usually 95 or more (but 86 in 1 *M. inexpectatum)* 4

3b Total vertebrae 78–94, usually 92 or less 6

4a Total GR 14–16; D origin associated with vertebrae 5–6 ... . *M. inexpectatum* (Indo-West Pacific)

4b Total GR 10–13; D origin associated with vertebrae 3–4 5

5a P length 26–40% HL; tip of tail without black pigmentation .... *M. orientale* (Japan)

5b P length 45–47% HL; tip of tail with black pigmentation (often fades in alcohol) .... *M. atlanticum* (North Atlantic)

6a Flesh whitish to light brown, head never black; supratemporal (occipital) canal complete, but without pores..... *M. bathium*

6b Flesh dark brown or black, especially head; supratemporal (occipital) canal absent .... *M. pammelas* (Northeastern Pacific)

Melanostigma bathium Bussing, 1965

Fig. 16

Melanostigma bathium Bussing, 1965: 219, figs. 15–16, off Chile (40°16'S, 78°18'W). Holotype: LACM 10063.

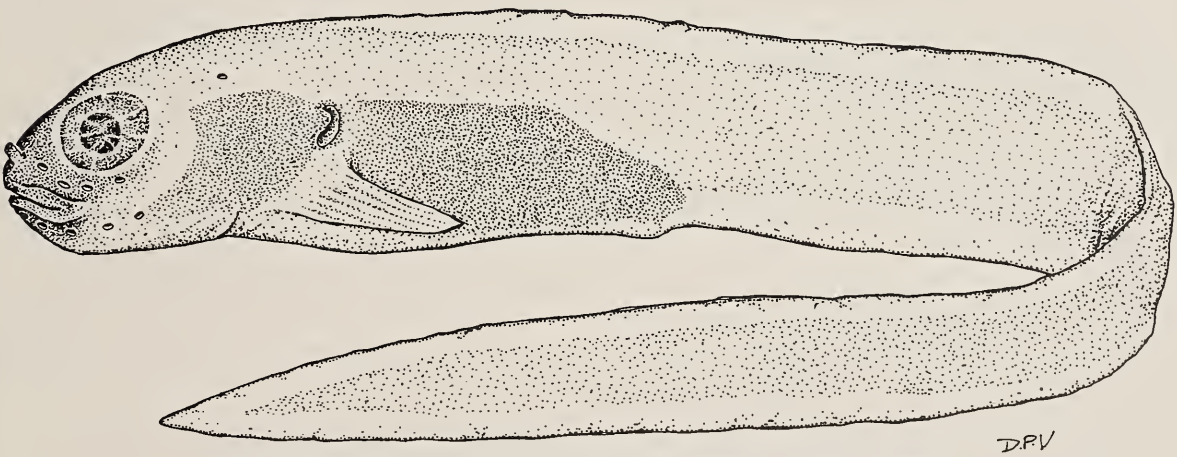
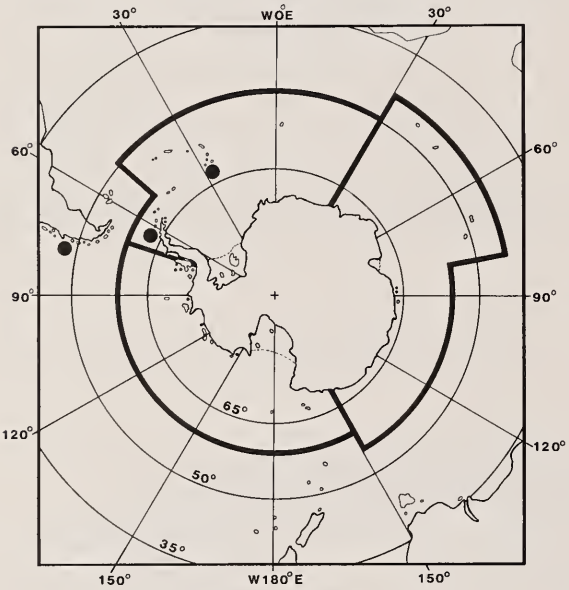


Fig. 16. *Melanostigma bathium* SIO 72-49, 79 mm SL, Galapagos Islands

Diagnosis: D 74–86; A 62–72; C 6–10; P 5–8; GR 0+(10–15); branchiostegal rays 5–7 (usually 6); vertebrae (16–20)+(62–71) = 78–90. Body height 5.5–10.0%, head length 10.8–15.8%, and preanal length 32.1–36.8% SL. Eye diameter 31.0–42.4%, pectoral fin length 42.2–61.2%, and upper jaw length 30.2–42.3% HL. Head small, rounded. Body short, irregularly rounded in cross section. Eye large, rounded. Pectoral fins small, inserted just below body midline, usually of 6 rays; middle pectoral fin rays longest, tips slightly exserted. Gill slit above pectoral fin, generally smaller than in similarly sized *M. gelatinosum*. Mouth small, terminal, no fleshy lobes. Males with longer jaws than females; maxillary lengths 39.0–42.3% HL in adult males, 30.2–37.6 % HL in adult females. Teeth in jaws and palate very small, conical, retrorse. Head pores small, rounded; supratemporal (occipital), coronal (interorbital), and temporal (postorbital) pores absent; 1 supraorbital (nasal) pore anterior to nostril; preopercular-mandibular pores 5 (rarely 4); infraorbital (suborbital) pores 3–5. Pseudobranch of 2–4 filaments. Two nublike pyloric caeca. Dorsal-fin origin associated with vertebrae 3–4.

Colour: In life, juveniles transparent or whitish, adults brown, apparently becoming darker with age; largest specimens with black swath at tail tip. Abdomen black or bluish. Peritoneum, orobranchial chamber and chin regions black.

Distribution: Humboldt Current area from the Galapagos Islands to southern Chile; two records from Antarctic waters. The species is probably mesopelagic, but all captures have been from midwater trawls fished without closing gear between 370 and 2,635 m.



Distribution of *M. bathium*

Remarks: Attains 114 mm TL.

Melanostigma gelatinosum Günther, 1881
Fig. 17; Pl. 4, Fig. 2

Melanostigma gelatinosum Günther, 1881: 20, Straits of Magellan, Chile. Holotype: BMNH 1880.7.28.7.

Melanostigma flaccidum Waite, 1914: 129, pl. VI, New Zealand.

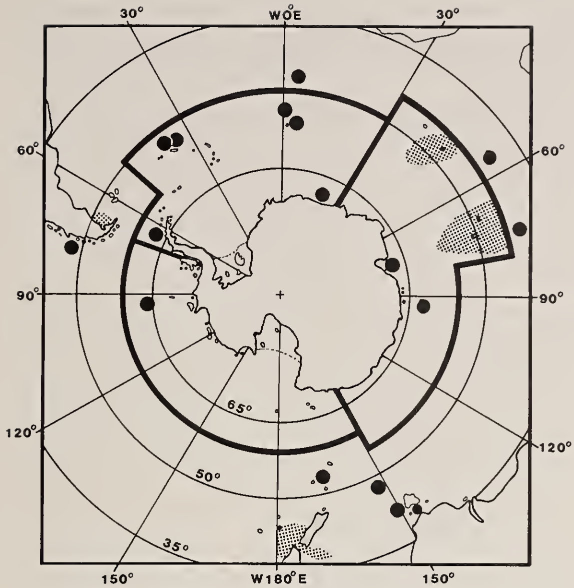
Diagnosis: D 77–90; A 63–75; C 8–10; P 7–9; GR 0+(10–16); branchiostegal rays 6; vertebrae (19–23)+(62–74) = 82–94. Body height 6.2–12.7%, head length 13.4–19.7%, and preanal length 36.0–40.5% SL. Eye diameter 25.0–40.0%, pectoral fin length 45.2–56.5%, and upper jaw length 40.8–52.7% HL. Head small, rounded, longer and deeper than similarly sized congeners. Body relatively long, ovoid in cross section. Eye large, rounded. Pectoral fins small, inserted just below body midline, usually of 7–8 rays; length always longer than similarly sized *M. bathium* and smaller than similarly sized *M. vitiazi*; middle pectoral fin rays longest, tips slightly exserted in some; skin covering rays thicker in larger specimens. Mouth small, terminal, no fleshy lobes. Males with longer jaws than females; maxillary lengths 45.0–52.7% HL in adult males, 40.8–48.7% HL in adult females. Teeth in jaws and palate small, conical, retrorse, females generally have more premaxillary teeth at a given size than males. Head pores small, rounded; supratemporal (occipital) and coronal (interorbital) pores absent; 1 supraorbital (nasal) pore mesial to nostril; preopercular-mandibular pores 5; infraorbital (suborbital) pores 4–5; 1 temporal (postorbital) pore. Pseudobranch of 3–5 filaments. Two nublike pyloric caeca. Dorsal-fin origin associated with vertebrae 2–4.

Colour: In life, adults pale yellowish to pearl white. Tip of tail with black swath through fins and onto body. Dorsal surface of head black in juveniles, more dusky in largest adults. Abdomen bluish or black; orobranchial chamber and peritoneum black.

Distribution: Circumglobal and apparently mesopelagic in temperate and polar regions of the Southern Ocean. All captures have been with open nets fished between 44 and 2,561 m.

Remarks: Attains 29 cm TL.

Fig. 17. *Melanostigma gelatinosum* NMNZ P15466, 27 cm SL, Hikurangi Trough (41°17.2′S, 176°21.3′E)



Distribution of *M. gelatinosum*

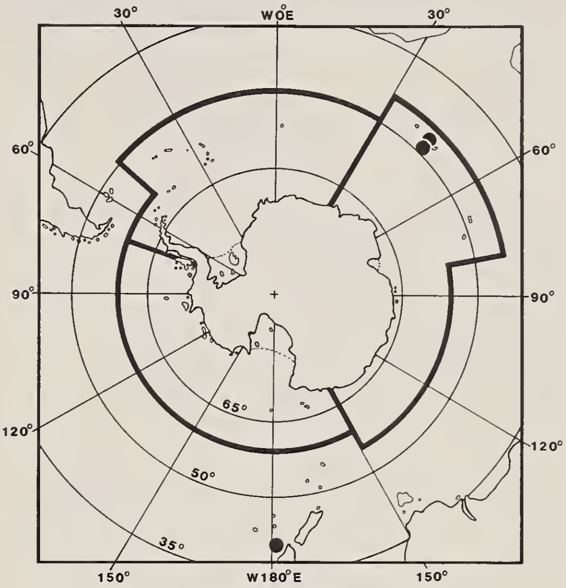
Melanostigma vitiazi Parin, 1979
Fig. 18

Melanostigma (Bandichthys) vitiazi Parin, 1979: 167, figs. 1–2, Banda Sea (06°39′S, 126°37′E). Holotype: ZIN 44000.

Diagnosis: D 79–86; A 67–74; C 9–11; P 9–10; GR 0+(14–19); branchiostegal rays 6; vertebrae (18–23)+(66–73) = 84–94. Body height 6.0–12.2%, head length 15.5–19.4%, and preanal length 37.0–38.9% SL. Eye diameter 38.0–47.0%, pectoral fin length 62.7–70.5%, and upper jaw length 30.8–41.8% HL. Head small, rounded, not as long or deep as similarly sized *M. gelatinosum*. Body relatively long, ovoid in cross section. Two body lateral lines present, of free neuromasts not imbedded in canal: mediolateral complete; dorsal incomplete. Eye large, rounded. Pectoral fins small, but longest in relation to head in genus, inserted well below body midline; middle pectoral fin rays longest, tips not exserted. Mouth small, terminal, no fleshy lobes. Males (all subadults) with longer jaws than females; maxillary lengths 41.1–41.8% HL in males, 30.8–35.5% HL in females. Teeth in jaws and palate small, conical, retrorse. Head pores small, rounded; supratemporal (occipital) and coronal (interorbital) pores absent; 1 supraorbital (nasal) pore mesial to nostril; preopercular-mandibular pores 7; infraorbital (suborbital) pores 5; 1 temporal (postorbital) pore. Pseudobranch of 3–4 filaments. Two nublike pyloric caeca. Dorsal-fin origin associated with vertebrae 3–4.

Colour: In alcohol, juveniles whitish or pale yellowish with transparent skin. Adults chocolate brown in life, with black snouts, lips and chin. No distinct black swath through tail tip. Abdomen and opercular areas bluish. Orobranchial chamber and peritoneum black.

Distribution: Indo-Pacific from tropics to subpolar regions. All captures have been with open nets fished between 890 and 1,600 m.



Distribution of *M. vitiazi*

Remarks: Attains 170 mm TL.

Genus *Oidiphorus* McAllister & Rees, 1964

Body robust, height 9.5–11.1% SL. Vertebrae (15–18)+(43–50) = 58–68. Skin gelatinous. Lateral line, scales,

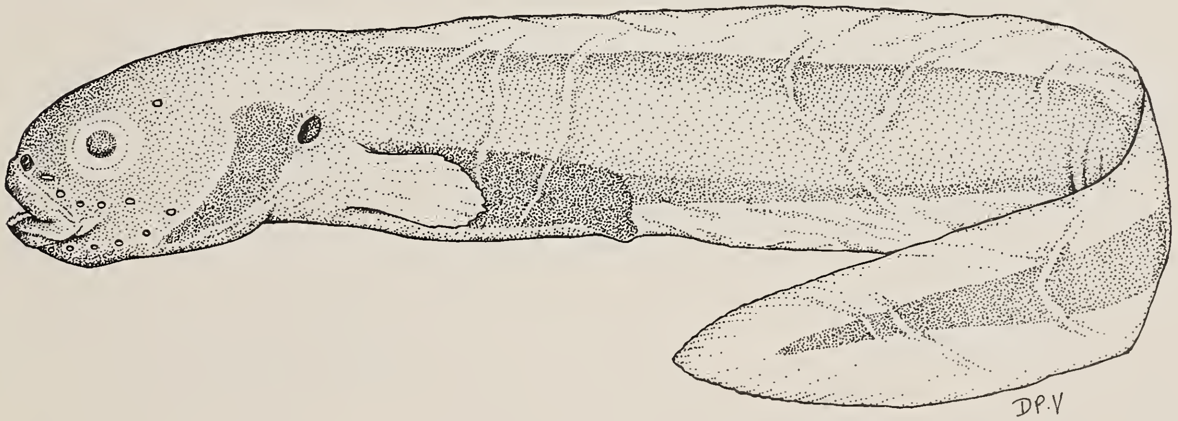


Fig. 18. *Melanostigma vitiazi* MNHN 1984–793, 125 mm SL, Crozet Islands

pyloric caeca and pseudobranch absent. Dermal papillae usually present on jaws, cheeks, nape and above eye, occasionally absent from 1 or more areas, rarely completely absent. Gill slit extending ventrally to middle of pectoral fin base or slightly below, never to ventral edge of pectoral fin base. Frontal bones wide, their width 77–84% of their length; lower pharyngeals edentate; 2 pairs of dentate upper pharyngeals. Palatal (pterygoid) arch weak. Sphenotic and parietals excluded by frontals. Parietals meeting in midline. Frontal articulating with parasphenoid wing. Infraorbital (suborbital) pores 5–6.

Two species; *O. brevis* (Norman, 1937a) is known only from the upper slope of the Magellan Province of South America.

KEY TO SPECIES

1a V present; preopercular-mandibular pores 7; infraorbital (suborbital) pores 5; P 14–17 .... *O. mcallisteri*
1b V absent; preopercular-mandibular pores 8; infraorbital (suborbital) pores 6; P 17–19 .... *O. brevis*

Oidiphorus mcallisteri Anderson, 1988

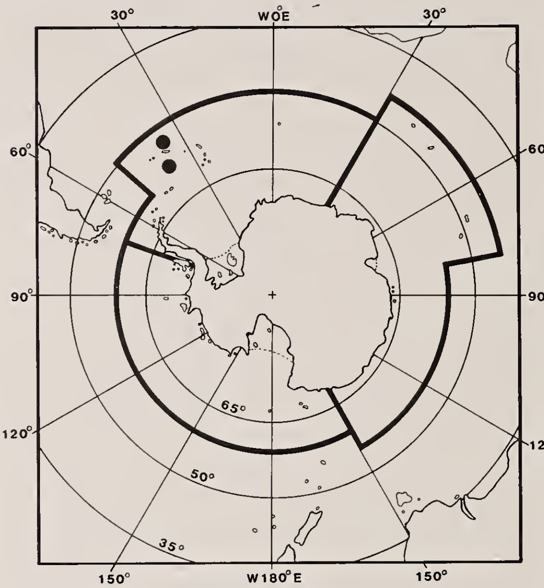
Fig. 19

Oidiphorus mcallisteri Anderson, 1988: 102, figs. 8B, 38, off South Georgia Island (53°23′S, 37°11–21′W). Holotype: LACM 10608–2.

Diagnosis: D 58–63; A 47–52; C 7; P 14–17; V 2; GR 0+8; branchiostegal rays 6; vertebrae 18+(46–50) = 64–68. Body height 10.1–10.7% and head length 20.0–20.1% SL. Eye diameter 23.9–25.0%, pectoral fin length 57.4–63.0%, and upper jaw length 49.3–50.0% HL. Head relatively long owing to very short tail, ovoid, dorsoventrally depressed, snout steeply sloping. Body short, rounded or ovoid in cross section, tail laterally compressed. Eye moderate, ovoid; skin covering eye somewhat thickened. Pectoral fins long, inserted slightly below body midline; middle pectoral fin rays longest, lower-most thickened and sightly exserted. Gill slit extending ventrally to just below midheight of pectoral-fin base. Mouth subterminal; lower lips with well-developed fleshy lobe. Low pyramidal papillae present on lower jaw between pores and on cheek. Teeth in jaws small, conical, retrorse, female with more and smaller teeth than male. Head pores small, rounded; supratemporal (occipital) and coronal (interorbital) pores absent; supraorbital (nasal) pores 2; preopercular-mandibular pores 7; infraorbital (suborbital) pores 5; temporal (postorbital) pores 2. Dorsal-fin origin associated with vertebra 4.

Colour: In alcohol, uniformly brownish-grey, eye and abdomen bluish. Pectoral fin light brown. No dark markings evident, unlike *O. brevis*, which is brightly marked with swaths of brown and yellow over a whitish background.

Distribution: Known only from the Scotia Sea off South Georgia Island in 1,299–3,038 m.



Distribution of *O. mcallisteri*

Remarks: The largest of the 2 known specimens, an adult male, is 111 mm TL.

Genus ***Ophthalmolycus*** Regan, 1913

Body slender, height 4.9–10.3% SL. Palatal (pterygoid) arch well developed. Infraorbital (i.e suborbital) bones 7–8, with 6 pores. Vertebrae 91–111. Scales, pyloric caeca, pelvic fins, vomerine and palatine teeth present. Five species, 2 in the Southern Ocean.

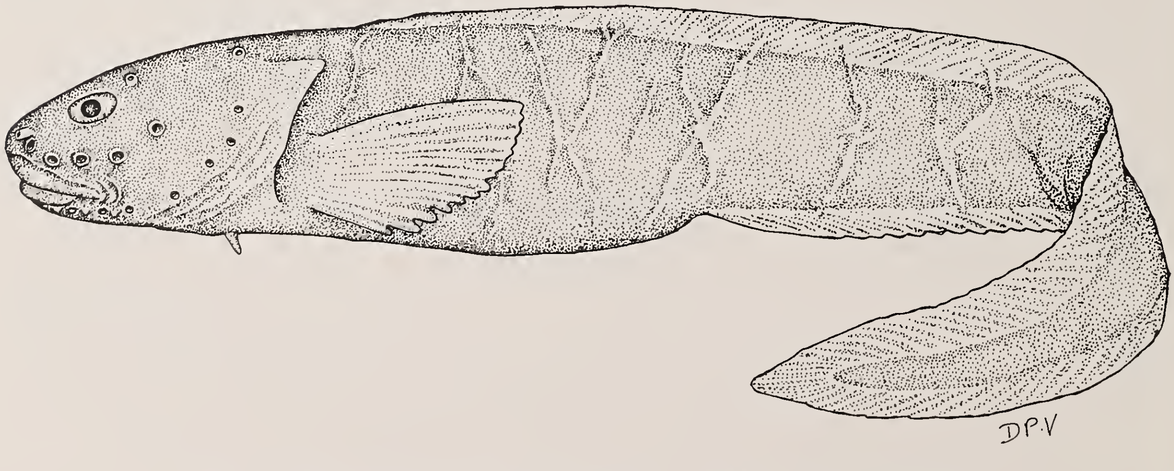


Fig. 19. *Oidiphorus mcallisteri* LACM 10608–2, 100 mm SL, female, holotype

KEY TO SPECIES

1a Vertebrae 91–100; P 16–18; LL of mediolateral and ventral branches; predorsal length 21–25% SL; preanal length 38–42% SL .... *O. amberensis*
1b Vertebrae 104–111; P 12–14; LL of mediolateral branch only; predorsal length 17–18% SL; preanal length 32–35% SL .... *O. bothriocephalus*

Ophthalmolycus amberensis
(Tomo, Marschoff & Torno, 1977)
Fig. 20

Lycodes concolor Roule & Despax, 1911: 279, South Shetland Islands. Holotype: MNHN 1911-99. (Preoccupied by *Lycodes concolor* Gill & Townsend, 1897.)

Austrolycichthys concolor: Norman, 1938: 84, fig. 54, Admiralty Bay, King George Island.

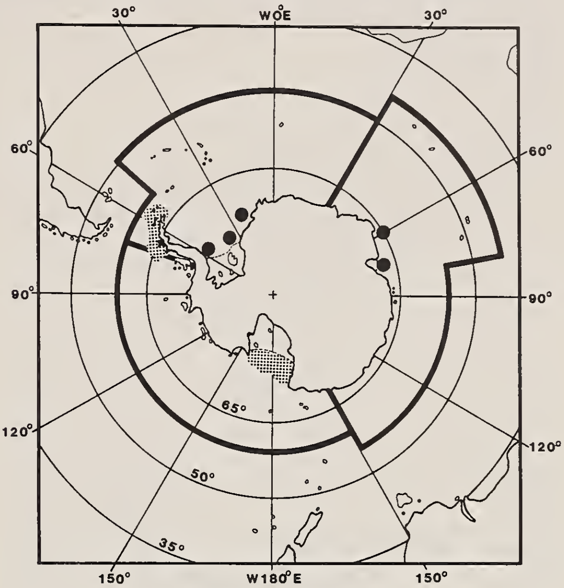
Lycenchelys amberensis Tomo, Marschoff & Torno, 1977: 1, text figure, off Anvers Island, Antarctic Peninsula (64°40'S, 63°20'W). Holotype: IAA 2.

Austrolycichthys dolloi Andriashev & Fedorov, 1986: 31 (replacement name).

Diagnosis: D 88–98; A 72–81; P 16–18; C 9–11; V 3; GR (1–3)+(8–12) = 10–14; branchiostegal rays 6; vertebrae (20–23)+(71–79) = 91–100. Body height 8.0–10.3%, head length 17.7–23.3%, predorsal length 20.6–25.2%, and preanal length 37.6–42.3% SL. Eye diameter 16.1–25.8% and pectoral fin length 47.4–67.8% HL. Head length 20.0–23.3% SL in adult males and 17.7–21.8% SL in adult females; head width 11.4–14.7% SL in males, 8.1–11.3% SL in adult females. Body moderately elongate, somewhat rounded in cross section. Skin firm, but pliable around head, thickened over eye. Scales extending anteriorly to no more than a vertical through midpectoral fin, absent on head, nape, abdomen and pectoral fin base and axil. Lateral line with 2 branches: mediolateral complete; ventral complete. Eye moderate, ovoid. Pectoral fins large, inserted on body midline; dorsal-most pectoral fin rays longest, ventral rays thickened, exserted. Gill slit extending ventrally to lower edge of pectoral fin base or just above it. Mouth inferior, lower lip with moderate fleshy lobe. Upper jaw length sexually dimorphic: males with maxillary lengths 42.3–53.8% HL, females with maxillary lengths 35.0–42.4% HL. Teeth conical, retrorse, present on vomer and palatine bones. Head pores enlarged, ovoid or rounded; supratemporal (occipital) and coronal (interobital) pores absent; supraorbital (nasal) pores 2; preopercular-mandibular pores 8; infraorbital (suborbital) pores 6–7; temporal (postorbital) pores 1–2. Pseudobranch of 1–5 filaments. Two nublike pyloric caeca. Dorsal-fin origin associated with vertebrae 3–5.

COLOUR: In alcohol, uniformly dark brown, fins sometimes with dark blotches. Pectoral fin dark, almost black. Orobranchial chamber, branchiostegal membranes and peritoneum black. Eye blue. Edges and lining of head pores white.

Distribution: Circum-Antarctic on upper slope in nearshore areas and basins in depths of 140–826 m.



Distribution of *O. amberensis*

Remarks: Attains 35 cm TL.

Ophthalmolycus bothriocephalus
(Pappenheim, 1912)
Fig. 21

Lycodes bothriocephalus Pappenheim, 1912: 178, pl. X, fig. 2, Antarctica, Wilhelm II Coast, *Gauss* winter station. Holotype: ZMB 18927.

Diagnosis: D 99–107; A 84–90; C 8–10; P 12–14; V 2; GR (2–3)+(8–9) = 10–11; branchiostegal rays 6;

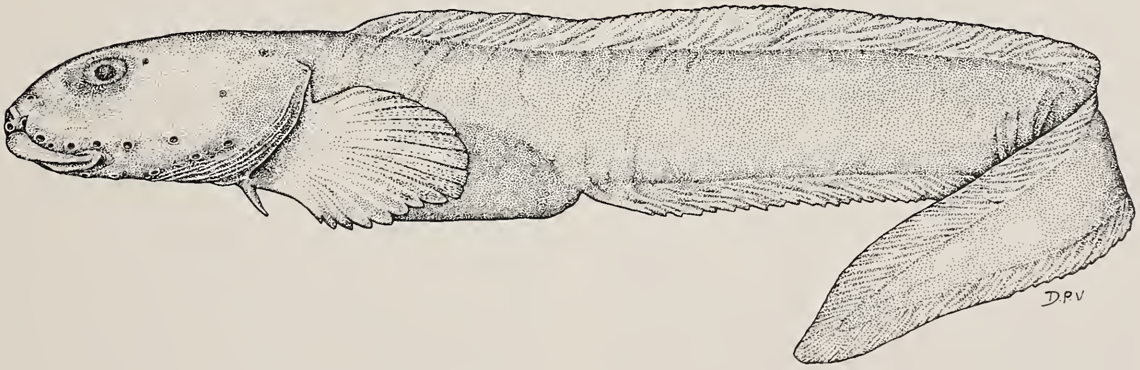


Fig. 20. *Ophthalmolycus amberensis* LACM 11376-2, 22 cm SL, Ross Sea

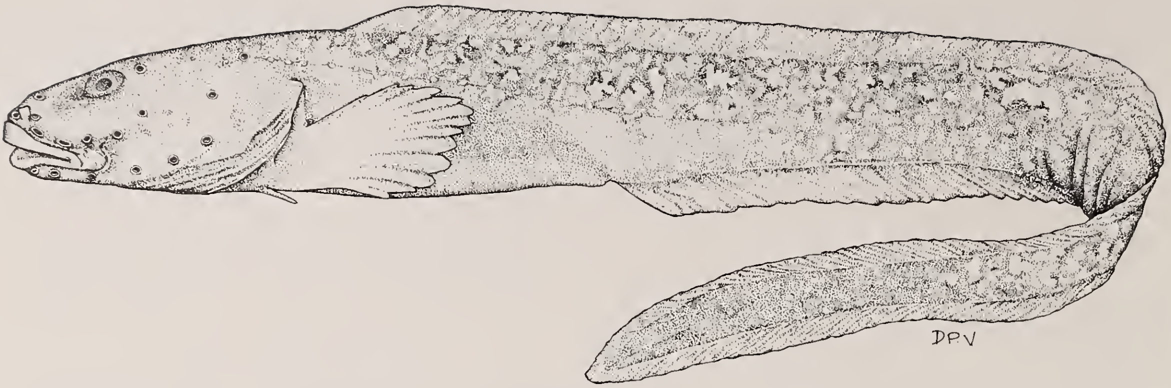
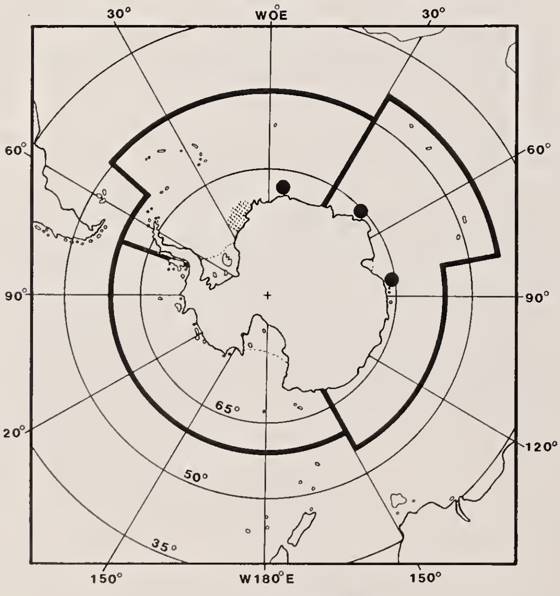


Fig. 21. *Ophthalmolycus bothriocephalus* ISH 102/85, 161 mm TL, Weddell Sea

vertebrae (21–24)+(81–88) = 104–111. Body height 4.9–7.8%, head length 13.8–16.3%, predorsal length 17.4–18.1%, and preanal length 31.8–34.8% SL. Eye diameter 17.1–24.4%, pectoral fin length 59.4–72.4%, and upper jaw length 29.3–43.3% HL. Head moderately long, ovoid, somewhat dorsoventrally flattened. Body short, ovoid in cross section. Skin firm but not thickened except on lower jaw and around anterior head pores. Scales extending anteriorly to vertical about one head length posterior to anal-fin origin; absent on fins, abdomen, and head. Eye moderately large, ovoid. Pectoral fins moderately long, narrow, origin below body midline; middle pectoral fin rays longest, ventral rays thickened, exserted. Gill slit extending ventrally to midpectoral base or slightly below. Mouth terminal, lower lip with small lateral lobe. Upper jaw length sexually dimorphic: males with maxillary lengths 36.5–43.3% HL, females with maxillary lengths 29.3–35.2% HL. Teeth in jaws relatively long, conical, retrorse posteriorly, present on vomer and palatine bones. Head pores enlarged, ovoid or rounded; supratemporal (occipital) and coronal (interorbital) pores absent; supraorbital (nasal) pores 2; preopercular-mandibular pores 8; infraorbital (suborbital) pores 6; temporal (postorbital) pores 2. Pseudobranch absent. Two long pyloric caeca, equal to or longer than one eye diameter. Dorsal-fin origin associated with vertebrae 2–3.



Distribution of *O. bothriocephalus*

Colour: In alcohol, background pale brown with dense, darker brown variegations over body, tail and dorsal surface of head. Opercular area, eye, throat, and abdomen blue. Orobranchial chamber and peritoneum black.

Distribution: East Antarctica, from the Weddell Sea to Wilhelm II Coast, on the inner slope and in deep basins at depths of 293–600 m.

Remarks: Attains 183 mm TL.

Genus *Pachycara* Zugmayer, 1911

Body robust, height about 9–13% SL in adults. Skin firm, thickened. Scales, vomerine and palatine teeth, pyloric caeca, pseudobranch and lateral line(s) present. Pelvic fins present or absent. Infraorbital (suborbital) bones 6–8. Chin ridges (submental crests) absent. Palatal (pterygoid) arch well developed. Precaudal vertebrae 21–32.

Remarks: This genus was recently revised by Anderson (1989) and is presently composed of 13 species. *Austrolycichthys* Regan, 1913, was synonymised with *Pachycara* by Anderson (1988).

Pachycara brachycephalum (Pappenheim, 1912)
Fig. 22

Lycodes brachycephalus Pappenheim, 1912: 179, pl. X, fig. 3, Antarctica, Wilhelm II Coast, *Gauss* winter station. Lectotype: ZMB 18929.

Austrolycichthys brachycephalus: Regan, 1913: 244, fig. 2.

Pachycara brachycephalus: Anderson, 1988: 74, fig. 16.

Diagnosis: D 88–107; A 72–90; C 10–12; P 16–18; V 3; GR (0–3)+(9–13) = 9–16; branchiostegal rays 6; vertebrae (23–27)+(71–86) = 95–113. Body height 8.0–11.6% and head length 14.0–19.9% SL. Eye diameter 15.9–38.6%, pectoral fin length 61.2–77.2%, and upper jaw length 35.0–56.7% HL. Head moderately large, ovoid, somewhat dorsoventrally flattened in largest specimens, usually longer in males at a given size than females. Head length 16.1–19.9% SL in adult males, 14.0–16.7% SL in adult females. Body moderately long, ovoid in cross section. Scales extend anteriorly to nape, covering abdomen and vertical fins, absent on head,

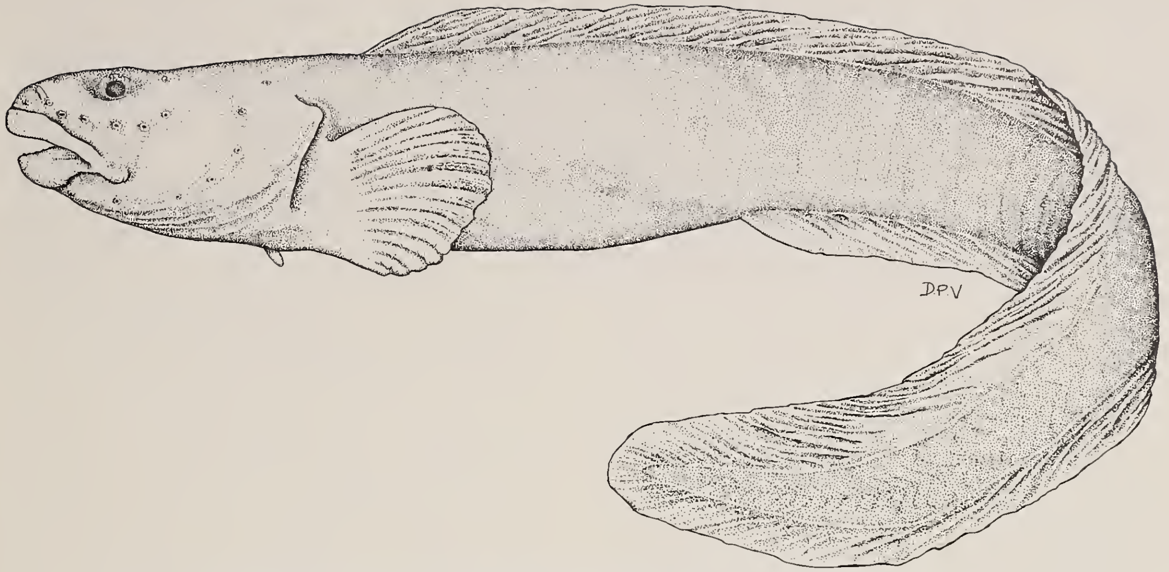
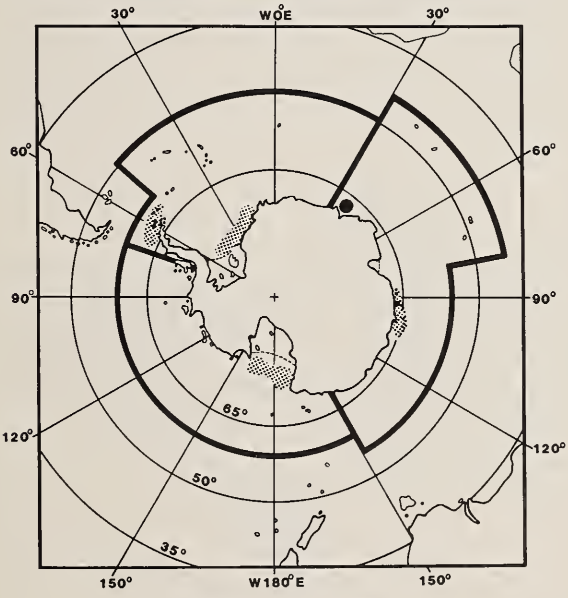


Fig. 22. *Pachycara brachycephalum* LACM 11469–2, 34 cm SL, Ross Sea

pectoral fins and their base. Lateral line with 2 branches: mediolateral complete; ventral complete. Eye moderate, rounded in largest specimens. Pectoral fins large, inserted at body midline; dorsal-most pectoral fin rays longest, ventral rays thickened, but not exserted. Gill slit extending ventrally to just below ventral margin of pectoral fin base. Mouth inferior, lower lip with strong, fleshy lobe. Males with longer jaws than females; maxillary lengths 50.1–56.7% HL in adult males, 35.0–49.8% HL in adult females. Teeth in jaws conical, retrorse, present on vomer and palatine bones. Head pores very small in adults, rounded; supratemporal (occipital) and coronal (interorbital) pores absent; supraorbital (nasal) pores 2; preopercular-mandibular pores 8; infraorbital (suborbital) pores 5–6; temporal (postorbital) pores 1–2. Pseudobranch of 2–5 filaments. Two nublike pyloric caeca. Dorsal-fin origin associated with vertebrae 3–7.



Distribution of *P. brachycephalum*

Colour: In alcohol, uniformly dark brown. Ventral surface of lower jaws, chin and inner surfaces of lips whitish or light brown. Ventral margin of pectoral fin with light band.

Distribution: Circum-Antarctic on coastal upper slope and in nearshore basins from 200–1,810 m.

Remarks: Attains 35 cm TL.

Genus ***Seleniolycus*** Anderson, 1988

Body robust, height 9.4–13.6% SL. Suborbital bones six. Skin gelatinous. Scales and pelvic fin absent. Lateral line mediolateral, complete. Frontals excluded from parasphenoid by pterosphenoid. Sphenotic and parietal articulating. Lower pharyngeals dentate; two pairs of upper pharyngeals. Palatal (pterygoid) arch weak.

Remarks: This monotypic genus was erected as the primitive sister group of *Melanostigma* by Anderson (1988) who postulated a Southern Ocean origin for both.

Seleniolycus laevifasciatus
(Torno, Tomo & Marschoff, 1977)
Fig. 23

Oidiphorus laevifasciatus Torno, Tomo & Marschoff, 1977: 3, text figures, South Sandwich Islands (59°25′S, 26°54′W). Holotype: IAA 3.

Seleniolycus laevifasciatus: Anderson, 1988: 68, figs. 7, 8C, 9–13.

Diagnosis: D 71–75; A 53–58; C 7–9; P 11–13; GR 0+(11–13); branchiostegal rays 6; vertebrae (22–24)+(54–57) = 76–80. Body height 9.4–13.6% and head length 17.6–20.1% SL. Eye diameter 21.4–29.2%, pectoral fin length 55.0–67.0%, and upper jaw length 40.5–49.6% HL. Head moderately large, somewhat

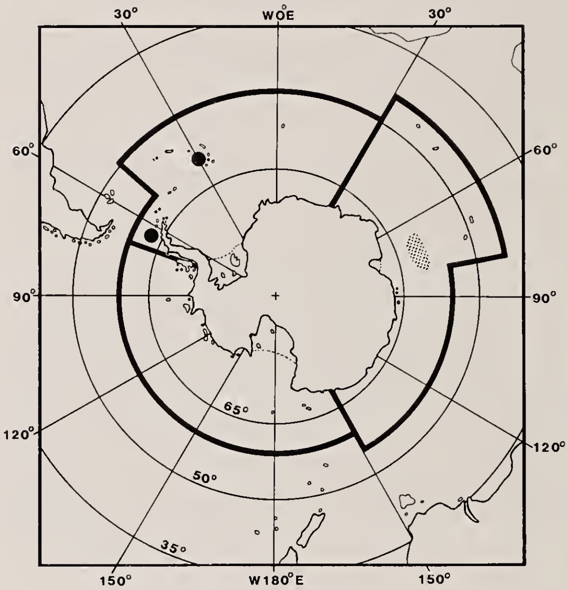
Fig. 23. *Seleniolycus laevifasciatus* CAS 57393, 186 mm TL, Bransfield Strait

spherical in juveniles more ovoid in adults. Body moderately long, ovoid in cross section. Eye large, rounded. Pectoral fins small, covered in thickened skin, inserted below body midline; middle pectoral fin rays longest tips slightly exserted. Gill slit slightly inclined forward extending ventrally to middle of pectoral fin base or almost to its ventral margin. Mouth small, terminal, no fleshy lobes. Teeth in jaws and palate small, conical, present on vomer and palatine bones. Head pores small, rounded; supratemporal (occipital) and coronal (interorbital) pores absent; supraorbital (nasal) pores 2; preopercular-mandibular pores 7; infraorbital (suborbital) pores 5; temporal (postorbital) pores 2. Pseudobranch of 2–4 filaments. Two nublike pyloric caeca. Dorsal-fin origin associated with vertebrae 3–5.

Colour: In alcohol, uniformly yellowish-white, tail tip and snout swathed in black. Lining of orobranchial chamber and peritoneum black, abdomen appearing bluish externally.

Distribution: South Shetland and South Sandwich islands at depths of 807–1,080 m. Probably benthopelagic.

Remarks: Attains 21 cm TL.



Distribution of *S. laevifasciatus*

BOVICHTIDAE

Thornfishes

by O. GON

Body long and compressed. Head small to large and compressed to depressed. Two dorsal fins, the first spinous. No spines in anal fin. Pelvic fins inserted in front of pectoral-fin base. Gill membranes separate and free from isthmus. Opercular spine varies from a weak, flat spine to a large, strong and pointed spine. Scales ctenoid (when present) or absent. Lateral line continuous and complete, consisting of scales or a series of tubular pores. A single nostril. Mouth protractile. Jaws, vomer and palatines with small, conical teeth. Ectopterygoid teeth present or absent. Epibranchial teeth present. Supra-orbital tentacle may be present. One radial bone of the pectoral girdle on scapula and other 2 on coracoid. Swim-bladder absent.

Three genera and 11 species restricted to the Southern Hemisphere. Small, mostly benthic and littoral fishes. One euryhaline species, *Pseudaphritis urvillii,* found in marine, estuarine as well as riverine habitats.

Remarks: Subsequent to Regan (1913) no revisions of Bovichtidae have been made. Recent authors disagree on the number of species in this family. Nelson (1984) recognised 4 genera and 6 species; Stevens *et al.* (1984) found 3 genera and 12–13 species; Norman (1966) listed 4 genera, of which 3 are monotypic and the fourth, *Bovichtus,* with "several species". Hardy (1988:1640) synonymised *Aurion* Waite, 1916, with *Bovichtus* in which he listed 9 species, thus bringing the total number of species in the family to 11. The commonly used family name Bovichthyidae is here replaced by Bovichtidae (see Remarks for the genus *Bovichtus* below).

Genus ***Bovichtus*** Valenciennes, 1832

Head somewhat depressed. Scales absent. Lateral line consists of a row of vertically oriented pores. Opercle with a strong, sharp spine and a superior process that articulates with post-temporal bone. Posterior anal-fin rays thickened and partially free from membrane. Lowermost pectoral-fin rays simple, thickened and partially free from membrane. Found in all oceans of the Southern Hemisphere. Hardy (1988) revised Australasian species. Nine species, 1 in our area.

Remarks: The spelling of the genus name *Bovichtus* adopted here is the original spelling by Valenciennes (1832). Swainson (1838) changed it to *Bovichthus,* and Agassiz (1845) and Richardson (1846) to *Bovichthys.* The latter has been the most commonly used spelling since then. Hardy (1988:1640) recognised *Bovichtus* as the correct spelling of the genus name, but in forming the family name he regarded the *-ichtus* part of the name as an "emendation (or lapsus)" of the latinized form *-ichthus* and recommended the family name Bovichthidae. I find the emendations made by these authors unjustified. Valenciennes' (1832) spelling appears more than once in his original description and is, in fact, a latinized version of his vernacular name Le Bovichte which uses the correct French spelling as, for example, in '*ichtyologie*'. Consequently, in forming the family name, the stem 'Bovicht' should be used in creating Bovichtidae. It should be noted though that an inadvertent, or printer's, error apparently had been made in Richardson (1846). The species name in the heading of the description was spelt *Bovicthys,* but in the text it appears as *Bovichthys.*

Bovichtus elongatus (Hureau & Tomo, 1977)
Fig. 1

Bovichthys elongatus Hureau & Tomo 1977: 68, figs. 1–2, Antarctic Peninsula, near Admiral Brown Station (64°53′S, 62°53′W). Holotype: MNHN 1976–375.

Diagnosis: Based on holotype (81.4 mm SL). D VIII+21; A 16; P 15; LL 82; GR 3+8; vertebrae 16+25; branchiostegal rays 7. Body depth at pectoral fin base 5.3 and head length 3.0 in SL. Body width at pectoral fin base 0.9 in body depth. Snout length 4.5, eye diameter 3.7, interorbital space 10.1 and upper jaw length 2.6 in HL. Pectoral-fin length 3.8 in SL, reaching anal-fin origin. Pelvic-fin length 4.0 in SL, not reaching anus. Caudal peduncle depth 2.1 in its length and the length 8.7 in SL. Distances from snout to first dorsal-fin origin 3.7, to second dorsal-fin origin 2.2, to upper pectoral fin base 3.1, to pelvic-fin insertion 4.3, and to anal-fin origin 1.7 in SL. Four lowermost pectoral fin rays unbranched and interconnected by incised membrane. All anal-fin rays unbranched and rays 13–15 elongate, thickened and interconnected by deeply incised membrane. Last dorsal- and anal-fin ray split to base. Lateral line extends onto caudal-fin base (3–4 pores). Head with a well-developed sensory canal system. Maxilla reaching to

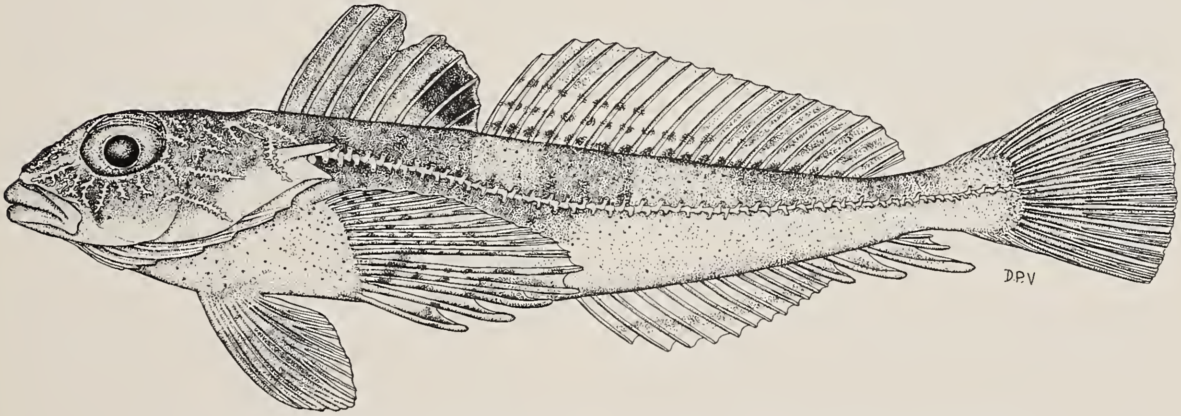


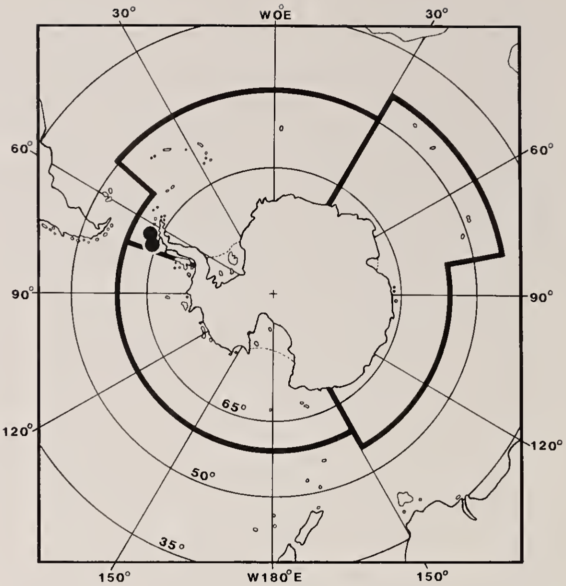
Fig. 1. *Bovichtus elongatus* MNHN 1976-375, 81.4 mm SL, holotype, Antarctic Peninsula

below anterior edge of eye. Jaws, vomer and palatines with a polyserial band of small conical teeth. Anus a short distance in front of anal-fin origin.

Colour: In alcohol, head dark brown. Body brown, paler on its rear part and abdomen, and with 4 dark brown saddles between lateral line and dorsal fins' base. First dorsal fin dark brown, with a black spot on posteriormost rays. Second dorsal, anal and pectoral fins with lines of dark spots. Caudal fin dusky and pelvic fins dark brown with a pale posterior margin.

Distribution: Known only from the type locality and Wiencke Island in the Antarctic Peninsula, in shallow inshore water.

Remarks: *Bovichtus elongatus* is the only bovichtid species found south of the Antarctic Convergence. It inhabits the intertidal zone in the Antarctic Peninsula (Tomo 1981). In its general morphology, mouth size and type of teeth, *B. elongatus* resembles species of *Harpagifer* and may be expected to occupy a similar, if not the same, habitat in the Peninsula area. *Harpagifer* species differ from *B. elongatus* in having a lower as well as upper opercular spine. In addition, *Harpagifer* lacks the thickened pectoral- and anal-fin rays, vomer and palatine teeth, and the complex, visible head sensory canal system (see illustrations).



Distribution of *B. elongatus*

NOTOTHENIIDAE

Notothens

by H.H. DEWITT, P.C. HEEMSTRA & O. GON

Body oblong to elongate and fusiform. Usually 2 separate dorsal fins, the first of 3–11 flexible (rarely pungent) spines, the second of 25–42 segmented (soft) rays. (In *Lepidonotothen nudifrons* the spinous dorsal fin is joined by a membrane from the last spine to the proximal third of the first soft-ray.) Anal fin similar to soft dorsal fin, with 22–40 segmented rays. Most soft dorsal- and anal-fin rays branched, but the last rays not divided to the base. Pectoral fins large, with 16–33 rays, the dorsalmost ray unbranched, the rest branched. Pelvic fins jugular, with 1 weak spine and 5 branched rays. Caudal fin rounded to forked, with 10–17 branched rays. Branchiostegal membranes usually joined to isthmus and forming a short free fold over the isthmus (some species with the membranes narrowly connected to isthmus or free); branchiostegal rays usually 6 (rarely 5 or 7). Mouth terminal, horizontal to oblique; upper jaw slightly protrusile; no teeth on vomer or palatines. A single nostril on each side of snout; no internal nares. Opercle and preopercle without spines (except *Trematomus scotti,* which has a distinct blunt spine on the opercle). Gills 4, gill rakers well developed; pseudobranch present.

Scales usually ctenoid, the ctenii reduced or absent on certain parts of the body, and in a few species all of the scales are smooth. One to 3 lateral lines (comprising tubed or perforated scales): the upper lateral line (ULL) runs along dorsal part of body from upper end of gill opening to below second dorsal-fin base (slightly past last ray in a few species); the middle lateral line (MLL) runs forward from caudal-fin base along midlateral part of peduncle to under second dorsal fin or as far forward as pectoral fin; lower lateral line (LLL) runs along ventral part of body just above anal-fin base.

Vertebrae 45–59; epipleural ribs well developed, attached to parapophyses; anterior pleural ribs well developed, attached to epipleurals some distance from vertebrae; posterior pleurals floating. Pectoral fin skeleton with 3 radials, the upper connected to scapula and coracoid; the dorsalmost fin rays attached to scapula; scapular foramen enclosed entirely by scapula or partly bordered by coracoid. Swim-bladder absent. Basisphenoid usually present. Baudelot's ligament attached to basioccipital.

Methods: Interorbital width is the least fleshy width of the interorbital space. Lateral scale series (LSS) is the number of subvertical scale series counted from the upper end of the pectoral-fin base to the base of the caudal fin. Unless specified to the contrary, the term "gill rakers" (or GR) refers to the lateral (outer) rakers on the first arch.

The terminology of the head sensory canals is shown in Fig. 1. The coronal commissure is a short canal running across the interorbital space and connecting the supraorbital canals. In some species the head canals are broken into segments; certain segments and pores may be absent. In the diagnoses, pore numbers in segmented canals are given for individual segments (e.g. infraorbital pores 5+3 represents an anterior segment with 5 pores and a posterior segment with 3 pores). In cases in which the preopercular-mandibular canal is discontinuous, the segment on the lower jaw is termed "mandibular canal" and the segment on the cheek "preopercular canal".

Classification: With about 49 valid species, of which 32 occur in the Southern Ocean, the Nototheniidae is one of the 2 most speciose Southern Ocean fish families (the Liparididae, with 31 described species and at least 20 undescribed species, may be the most speciose family of Antarctic fishes). In his paper on the osteology and relationships of the Channichthyidae, Iwami (1985) discussed the interrelationships of the 5 notothenioid families and presented evidence for recognition of the Nototheniidae as the sister taxon of a group comprising the 3 other Antarctic notothenioid families (Harpagiferidae, Bathydraconidae and Channichthyidae). The recent revision of the generic classification of this family by Andersen (1984) differs in some ways from that employed here. Although a detailed critique of Andersen's work is beyond the scope of the present work, we offer some comments on our differences with his classification.

Using primarily the configuration of the caudal fin skeleton and cephalic sensory canals, Andersen (1984) recognises 11 genera. Unfortunately, Balushkin's (1984) revision of the subfamily Nototheniinae, providing anatomical support for his earlier generic classification (Balushkin 1976a, 1982), was published too late to be considered by Andersen. Andersen was also not aware of Balushkin's (1982) description of the genus *Pseudotrematomus*. The recent work on the osteology of the visceral skeleton by Voskoboynikova (1980, 1986) also supports the classification of Balushkin.

Both Andersen (1984) and Balushkin (1984) stress the configuration of the caudal fin skeleton (fusions of hypurals, fusion of epurals and fusion of various hypurals with the stegural complex) as an important character indicating generic relationships. But the value of similarities in the fusion of hypurals as an indication of nototheniid relationships is called into question when Andersen (1984: fig. 30) shows parallel evolution of fused H_3 and H_4 in *Notothenia* and in the Pleuragramminae; and the caudal skeleton illustrated by Balushkin (1984: fig. 26) for *N. coriiceps* (the type of *Notothenia)* is not of the pattern said by Andersen (1984: 6) to be a derived specialization ("autapomorphy") that characterizes the genus *Notothenia*! The independent evolution of hypural fusion in numerous unrelated fish families (Gosline 1961) indicates that this tendency (mere fusion) is unlikely to be a useful taxonomic character. Andersen's statement that "better swimming abilities" have been developed "by fusion of caudal skeleton elements" is presumably inferred from the caudal skeleton of *Pleuragramma antarcticum,* a pelagic species with considerable fusion of caudal bones. But this supposition is contradicted by the lack of fusion in the pelagic species of *Dissostichus* (Andersen 1984: figs. 6–7), by the considerable fusion in benthic species such as *Artedidraco mirus* (Andersen 1984: fig. 18) and also by Gosline's (1961) conclusion "the author can at present suggest no sound functional explanation for the fusions that occur between any of the elements in the basal percoid caudal skeleton".

Further details regarding differences between the generic classification used here and those of Andersen (1984) and Balushkin (1984) will be given in the individual generic accounts below.

Biology: Species range in size from about 10 cm to over 2 m. Most species are benthic, dominating the bottom fish fauna of the shelf region of the Southern Ocean and forming an important benthic component of the Patagonian Region. Although not deep-sea fishes in the usual sense of the word, nototheniids occur from the shore to depths of 700–800 m (1,500 m for some pelagic species). The deeper living species occur in the deep inner shelf basins that are isolated from the original continental slope by a shallow sill, and on the continental slope itself. The formation of these isolated basins (and their largely endemic species) was a result of the submergence of the Antarctic Continent due to the build-up of the polar ice cap. It seems as if the nototheniid fishes were pushed into deeper water along with the bottom of the continental shelf on which they were living. Some species have adapted to pelagic life, and a few are "cryopelagic" (associated with the underside of sea ice).

Nototheniids are carnivorous, the benthic species feeding mainly on macroinvertebrates and fishes, the pelagic species feeding mainly on zooplankton and fishes. A few species also ingest significant amounts of macroalgae. Necrophagy (feeding on the carcasses of penguins, seals and other dead animals) has been reported in some species (Arnaud 1970).

Nototheniids are slow growing and relatively long-lived; most species investigated were not mature before their fifth year. Fecundity is relatively low, the eggs being large (1.5–5.0 mm in diameter) and usually demersal; hence the species are especially vulnerable to over-exploitation. Nototheniids (and other Antarctic fishes of the suborder Notothenioidei) exhibit certain unusual physiological features that represent adaptations to the extreme cold of the Antarctic environment (see Eastman, this volume, for a more detailed discussion). The freezing points of the blood serum of most notothenioids are significantly lower than those of other fishes (−1.8 to −2.2 °C versus −0.7 °C for a temperate species; Eastman & DeVries 1986a). This increased freezing-point depression of the blood is due to the presence in notothenioids of glycopeptide molecules that act as antifreezes to inhibit the formation of ice crystals in the body fluids (Eastman & DeVries 1986a). The lack of the relatively small glycopeptide molecules in the urine indicates that the aglomerular structure of the kidneys in the notothenioid species examined may be an adaptation to conserve their antifreezes and thereby save energy (Eastman & DeVries 1986a). Another energy-saving adaptation in nototheniids is the development of neutral buoyancy in the pelagic species. Lacking a swimbladder, these species have accomplished their neutral buoyancy by production of lipids (low density triglycerides) and reduced calcification of their skeleton.

Recognition of allopatric species and subspecies: Some species of benthic nototheniids exhibit differences in various biological and morphological parameters at different localities in the Southern Ocean. For example, Duhamel & Ozouf-Costaz (1985) found considerable differences in the growth rates of *Lepidonotothen squamifrons* at the Crozet and Kerguelen islands. Slight differences in various morphological and meristic characters have been used to justify recognition of certain allopatric species or subspecies (e.g. the 3 recently described species of the *Lepidonotothen* subgenus *Nototheniops* (Balushkin 1976b), or the various subspecies of *Lepidonotothen squamifrons, Notothenia coriiceps,* and *N. rossii*). In these latter 3 species, the subspecific distinctions were based on samples from only one or two localities of each subspecies and, in the case of the *Notothenia* species, the samples of the nominate subspecies were much too small to be representative of the populations in question. Recognition of subspecies in these 3 species in the current literature is due more to taxonomic inertia than to cogent evidence in favour of such recognition. Additional discussion of the validity of these allopatric taxa is given under the relevant species accounts.

Common names: The misnomer "rockcod" has recently been applied as a so-called "common name" to many nototheniid species. This name is an unfortunate choice for nototheniids, as it will lead to confusion with the true cods (Family Gadidae) and other fishes that are commonly known as rockcods (e.g. *Sebastes* in the North Pacific and groupers of the family Serranidae). In place of the name "rockcod" for many of the nototheniid species in this account, we suggest the use of the name "notothen" as a common name that is distinctive and more appropriate for this family.

KEY TO GENERA

1a Infraorbital canal interrupted and absent below eye (Figs. 1a, b), with an anterior section in the preorbital below front of eye and a posterior section behind eye (no pores below eye) 2

1b Infraorbital canal usually continuous below eye or rarely narrowly divided into 2 (more rarely 3) segments, but always with at least a segment and pores below middle of eye (Figs. 1c–g) 3

2a C distinctly notched; tubular LL scales absent; supraorbital canal interrupted above eye (Fig. 1a) .... *Pleuragramma*

2b C rounded or truncate, not distinctly notched; tubular LL scales normally present in ULL (may be absent in small specimens); supraorbital canal not interrupted (Fig. 1b) .... *Pagothenia*

3a ULL curves steeply upward below anterior D_2 rays and runs close to D base; lower GR 31–37; specimens larger than 30 cm with first 2 D_1 spines and second V ray greatly elongated .... *Aethotaxis*

3b ULL not running close to D; lower GR fewer than 30; D spines and V rays not elongate 4

4a Distinct canine teeth in upper jaw near symphysis and in lower jaw posteriorly or along most of jaw; snout distinctly longer than eye diameter; branchiostegal rays 7 5

4b No distinct canines in jaws; snout subequal to eye diameter; branchiostegal rays 6 (rarely 5 or 7 and then usually on one side only) 6

5a Occipital and interorbital regions scaly; coronal commissure complete, with a median pore (Fig. 1e); infraorbital canal complete; ULL with 83–99 tubed scales; MLL with 35–77 tubed scales .... *Dissostichus*

5b Top of head naked; coronal commissure interrupted, with a pair of pores, each at the end of a short branch from the supraorbital canals (Fig. 1b); infraorbital canal interrupted; ULL with 9–11 tubed scales; MLL absent or without tubed scales .... *Gvozdarus*

6a No tubular LL scales; coronal commissure of supraorbital canals opens from each side into a large median depression (Fig. 1c); supratemporal canal incomplete, represented by a short branch on each side from temporal canals (Fig. 1c) .... *Cryothenia*

6b Tubular LL scales present, at least in ULL; coronal commissure with a small median pore (Figs. 1d, e) or (rarely) a median pair of closely spaced pores (Fig. 1f); supratemporal canal usually complete (Figs. 1d, e), or if not, a median section present (Fig. 1f) 7

7a First pore of infraorbital canal behind a vertical through anterior edge of nostril (Figs. 1d–f); top of head usually scaly (naked in a few species); ventral edge of preorbital bone with only 2 pores 9

7b First infraorbital pore usually in front of vertical through anterior edge of nostril (Fig. 1g); top of head naked (temporal scales present in some species); usually 3–4 pores on ventral edge of preorbital bone (2 pores in subgenus *Indonotothenia*) 8

8a Maxilla not reaching vertical at middle of eye; upper jaw length less than or subequal to interorbital width; D_2 28–31 .... *Paranotothenia*

8b Maxilla reaching to or beyond middle of eye; upper jaw distinctly longer than interorbital width; D_2 32–40 .... *Notothenia* (in part)

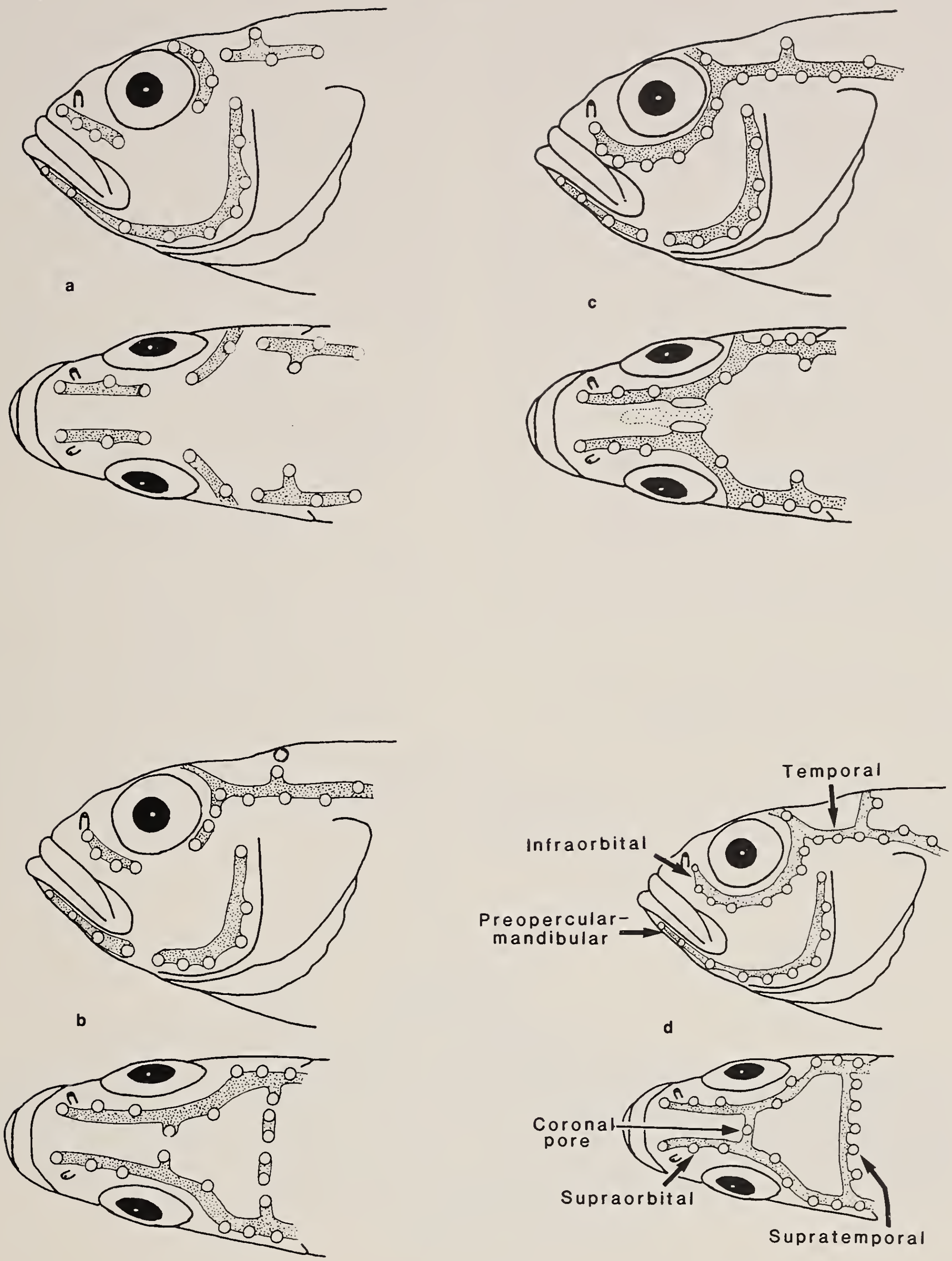


Fig. 1. Arrangement of head sensory canals in selected species of Nototheniidae: (a) *Pleuragramma antarcticum*; (b) *Pagothenia borchgrevinki*; (c) *Cryothenia peninsulae*; (d) *Patagonotothen guntheri*;

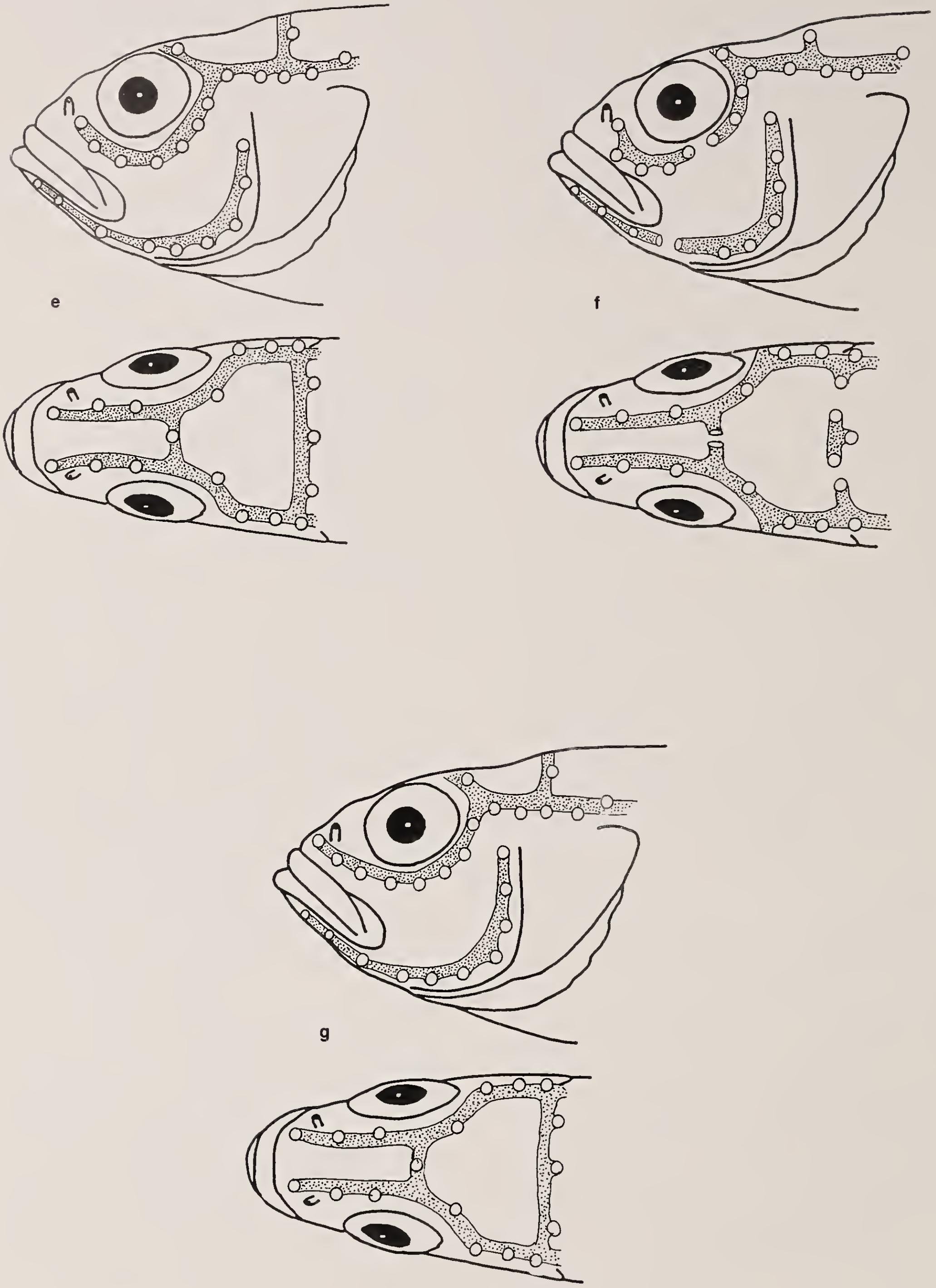


Fig. 1 (cont.) Arrangement of head sensory canals in selected species of Nototheniidae: (e) *Lepidonotothen squamifrons*; (f) *Trematomus bernacchii*; (g) *Paranotothenia magellanica*

9a Supraorbital canal with 2 pores posterior to coronal commissure (Fig. 1d); supratemporal canal complete across head, with 4–8 (usually 5–6) pores (Fig. 1d) ...... *Patagonotothen*
9b Supraorbital canal with 1 pore posterior to coronal commissure (Figs. 1e, f); supratemporal canal with 3 (rarely 4–5) pores (Fig. 1e), or the canal is in 3 segments and has 5 pores (Fig. 1f) 10
10a Scales present on preorbitals 11
10b Preorbitals naked (*Trematomus loennbergii* with a few scales on rear end of preorbitals) 12
11a Branched C rays 14–17 .... *Lepidonotothen* (in part)
11b Branched C rays 12–13 .... *Trematomus* (in part)
12a P 18–23 13
12b P 22–33 (if less than 24, as in a few *T. bernacchii* and *T. vicarius,* then there are 14 branched C rays and P are longer than V .... *Trematomus* (in part)
13a Body scales non-ctenoid (smooth), except for scales covered by P; interorbital width subequal to or greater than eye diameter .... *Notothenia* (in part)
13b Body scales mostly ctenoid, except for scales on belly and at bases of fins; interorbital width half or less of eye diameter 14
14a MLL with tubular scales; branched C rays 10–12 .... *Gobionotothen*
14b MLL scales may be perforated, but never tubed; branched C rays 12–14 .... *Lepidonotothen* (in part)

Genus *Aethotaxis* DeWitt, 1962

Body elongate, moderately compressed. Head depressed, snout elongate. Mouth large, oblique, the lower jaw projecting, the upper jaw reaching to or beyond a vertical through middle of eye. Cephalic sensory canals enlarged, the pores on head appearing as large holes or pits. Preopercular and mandibular canals separated by a gap (Fig. 1b); supratemporal canal divided into 4 segments (Fig. 1b); supraorbital canal with 4 large pores, the coronal commissure represented by a large transverse pit shaped like a pair of wings; infraorbital canal not interrupted below eye. Upper lateral line (of tubed scales) curves steeply upward below anterior rays of second dorsal fin, then turns sharply posteriorly to run close to base of dorsal fin and ends below last rays of fin; middle lateral line (also of tubed scales) runs forward along midside from caudal-fin base to pectoral fin; no lower lateral line (see Remarks below). Snout, preorbital, and top of head naked. First 2 spines of dorsal fin and second ray of pelvic fins of adults greatly elongated (Fig. 2). Caudal fin rounded, with 12 branched rays. Gill rakers numerous, long and slender, non-dentigerous. Branchiostegal rays 7, the membranes narrowly joined to one another and to isthmus. Hypural bones appear to be sutured (fused?) to the stegural complex; H_1 and H_2 not fused; H_3, H_4 and H_5 more or less fused with one another. Vertebrae 16+36. Pectoral foramen entirely within scapula.

Remarks: This genus comprises a single species. It appears to be related to *Pleuragramma* and *Cryothenia,* which together with *Gvozdarus* make up the Tribe Pleuragrammiini of the subfamily Pleuragramminae, but the features shared by these 4 monotypic genera (hypural fusions, splitting of supraorbital commissure, loss of segments in the supratemporal canal, and development of neutral buoyancy), the supposed "autapomorphies" of Andersen (1984: 25, fig. 30) may be examples of parallel evolution and/or convergent adaptations for a pelagic life-style. For example, the storage of lipids (low-density triglycerides) that provide buoyancy is in large connective tissue sacs in *Pleuragramma,* but in *Aethotaxis* it is in cells of the adipose tissue (Eastman & DeVries 1982).

Kotlyar (1978b: fig. 1) illustrates a specimen of 193 mm TL from the South Shetland Islands. His figure shows a third (lower) lateral line running just above the anal-fin base, but he makes no mention of it in his brief description.

Aethotaxis mitopteryx DeWitt, 1962
Threadfin pithead
Fig. 2

Aethotaxis mitopteryx DeWitt, 1962b: 829, figs. 1–4, McMurdo Sound, off Pram Point, Ross Island (77°53′S, 166°44′E). Holotype: SU 59634.

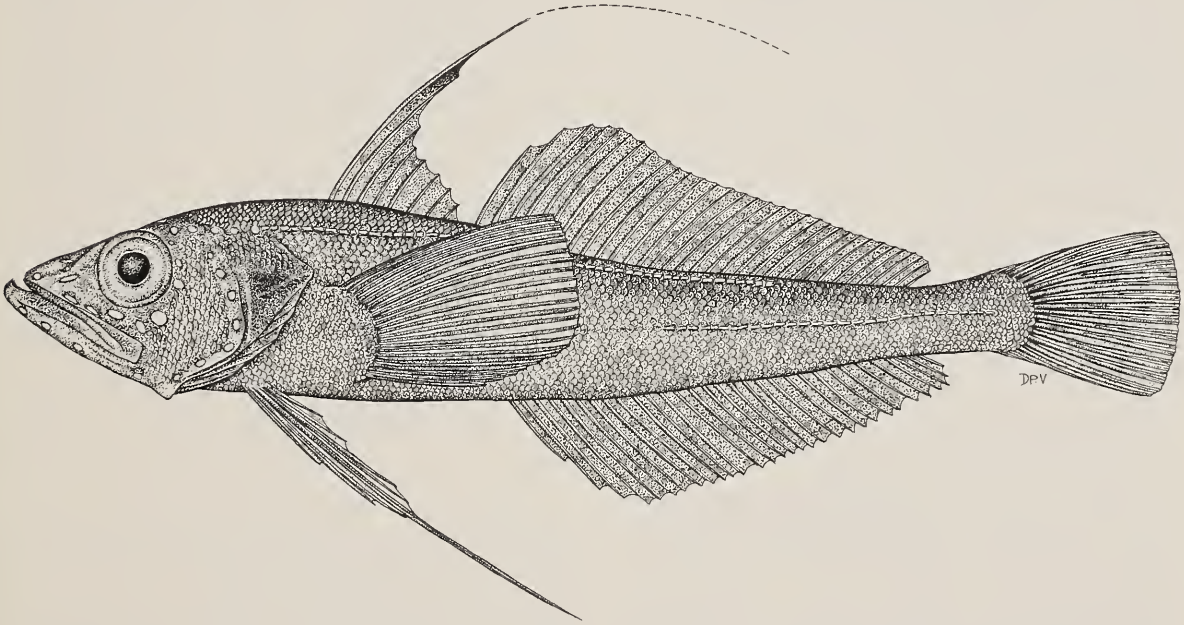


Fig. 2. *Aethotaxis mitopteryx* ADH S870387, 182 mm SL, Prydz Bay (67°13.7′S, 70°14.3′E)

Diagnosis: D VII–VIII+32–34; A 30–31; P 24–28; GR (11–15)+(31–37)=42–51; ULL 49–54; MLL 30. Body depth 4.9–5.7 and head length 3.3–3.5 in SL. Eye diameter subequal to interorbital width, about 4–5 times in HL. Jaws with a narrow band or single series of villiform teeth. Infraorbital canal with 9 large pores, the anteriormost directly ventral to the nostril tube, the 5th greatly enlarged (as if the 2 halves of a large hole had been pulled apart); mandibular canals with 4 pores, the 3rd pore greatly elongated (its length equals half eye diameter); preopercular canal with 7 pores, the 1st, 2nd and 7th much smaller than the others; supraorbital canal usually with 4 large pores (not counting the large transverse coronal opening), the 1st on the anterior edge of the snout the last above the rear edge of the eye; temporal canal with 5 pores; supratemporal pores 1+2+2+1, represented by 4 short segments (Fig. 1b) consisting of a short branch from each temporal canal ending in a pore, and a short segment on each side of the midline with a pore at each end (DeWitt, 1962b, overlooked the 2 lateral branches from the temporal canals in the original description). Pectoral fins large, reaching to a vertical at about 8th anal-fin ray. Elongated pelvic-fin ray reaches well past anal-fin origin. Body covered with deciduous scales, those on head and anterior part of body smooth, those on posterior part of body weakly ctenoid.

Colour: "Grey with violet hue; lighter below with metallic lustre; fins dark grey; caudal fin apparently unpigmented but with whitish margin." (Hureau 1985f).

Otoliths

Diagnostic features: The ovate anterior shape, the notched posterior margin, the squared-off rostrum and the shallow ostio-caudal and heterosulcoid sulcus acusticus.

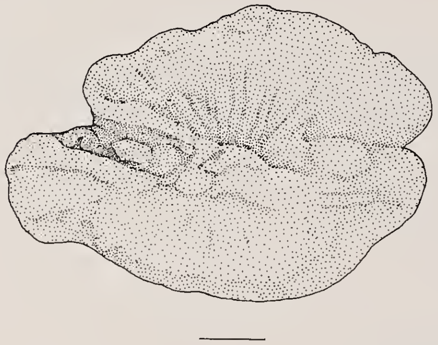
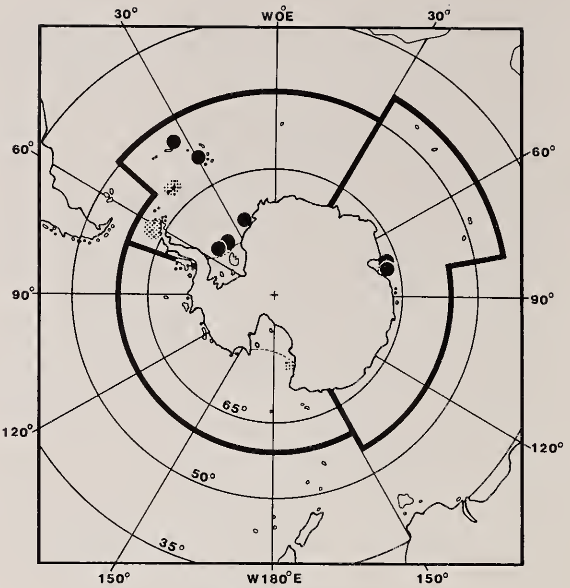


Fig. 3. Representative otolith of *A. mitopteryx*; fish length 37 cm TL; scale bar 1 mm

Distribution: Apparently circum-Antarctic. Recorded from islands of the Scotia Sea, Weddell Sea, Prydz Bay and the Ross Sea (Hureau 1985f). A pelagic species known to a depth of 850 m; postlarvae were collected in the upper 100 m (Efremenko 1984).

Remarks: According to Hureau (1985f), the Ross Sea population may represent a separate subspecies, but no evidence in support of this statement has been given. Efremenko (1983: fig. 22) illustrated a 38.5 mm SL postlarva.

Aethotaxis mitopteryx is a pelagic species that feeds on zooplankton. Buoyancy is provided by the storage of lipids in cells of adipose tissue and by reduced calcification of the skeleton (DeVries & Eastman 1981). The vertebrae enclose a large notochordal canal. Not yet commercially exploited.



Distribution of *A. mitopteryx*

Attains 42 cm TL.

Genus *Cryothenia* Daniels, 1981

Body elongate, fusiform. Head depressed. Mouth large, the lower jaw projecting, the upper jaw reaching past front edge of eye. Cephalic sensory canals with large, conspicuous pores. Preopercular, mandibular and temporal canals separate; supraorbital canals open into a large median interorbital pit through a pair of wide coronal pores; infraorbital canal complete or incomplete; supratemporal canal interrupted by a broad median gap (Fig. 1c). No tubular lateral-line scales; upper lateral line of pored scales, following dorsal body profile along upper part of body from gill opening to below posterior dorsal-fin rays; middle lateral line also of pored scales, along midlateral part of body from pectoral fin to base of caudal fin; no lower lateral line. Anterior part of head (including interorbital region and area below eye) naked. No elongate fin spines or rays. Caudal fin rounded, with 12 branched rays. Gill rakers short, non-dentigerous. Branchiostegal rays 6. Vertebrae 50–53. Pectoral foramen entirely within scapula, but separated from coracoid by only a narrow strip of bone.

Remarks: A single species, apparently related to *Aethotaxis* and *Pleuragramma* (see account of *Aethotaxis* above). The osteology of *Cryothenia* has yet to be studied.

Cryothenia peninsulae Daniels, 1981
Pithead
Fig. 4

Cryothenia peninsulae Daniels, 1981: 559, figs. 1–2, Penola Strait, west of Antarctic Peninsula (65°10′S, 64°07′W). Holotype: USNM 219833.

Diagnosis: D IV–VI+34–36; A 33–35; P 24–26; GR (7–8)+(17–18)=25; ULL 30–37; MLL 34–38. Body depth 4.9–5.8 and head length 3.2–3.5 in SL. Eye

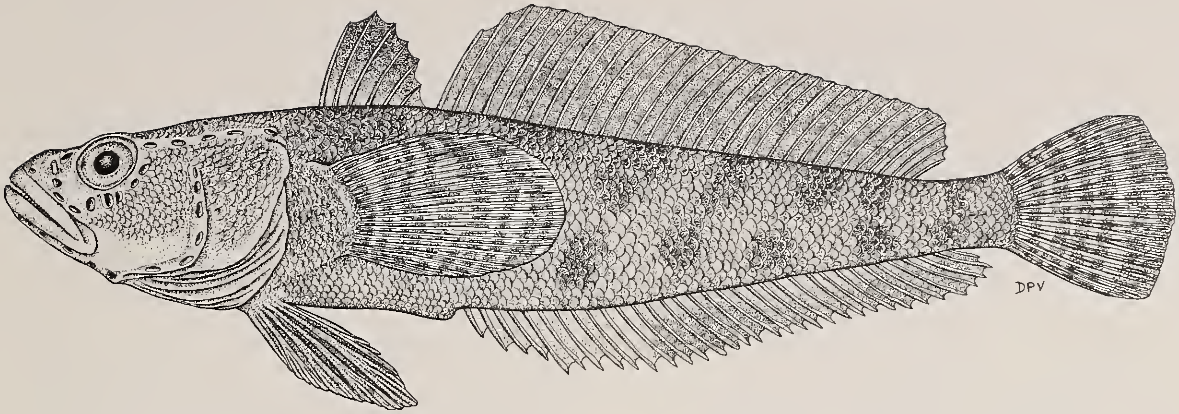
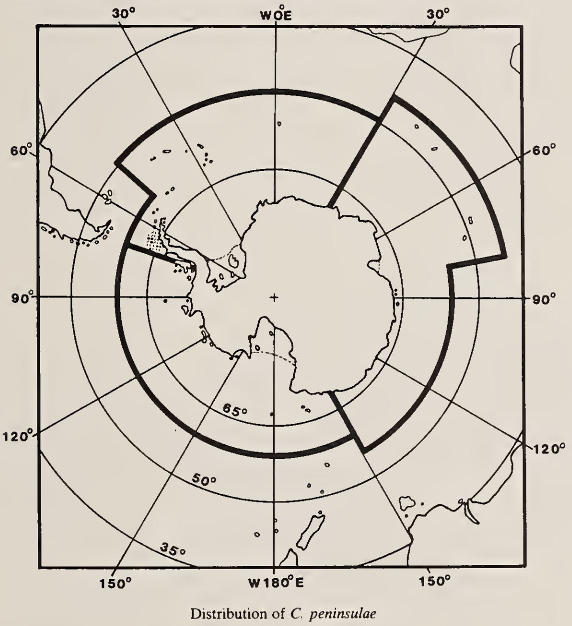


Fig. 4. *Cryothenia peninsulae* CAS 43499, 144 mm SL, Antarctic Peninsula, off Janus Island, Arthur Harbour (64°46′S, 64°04′W)

diameter slightly greater than interorbital width, about 4.0 in HL. Jaws with villiform teeth in a narrow band anteriorly, becoming a single row posteriorly. Infraorbital canal with 7–9 large (often confluent) pores, the first immediately ventral to the nostril; mandibular canal with 4 pores; preopercular canal with 7 narrow slit-like pores; supraorbital canal with 5 pores, the 1st in front of nostril, the 4th opens into the median interorbital pit; temporal canal with 5 pores; supratemporal canal short, branching off from the temporal canal at the 3rd pore and ending in a small pore (Fig. 1c). Pectoral fins large, reaching past anal-fin origin. Pelvic fins not reaching anus. Body covered with adherent, ctenoid scales; cycloid scales on head.

Colour: Body with dark blotches or irregular bars. Dorsal fins, posterior anal-fin rays, and blotches on body dark purple; pectoral and caudal fins barred.

Distribution: Known only from off the west coast of the Antarctic Peninsula in depths of 50–400 m.



Distribution of *C. peninsulae*

Remarks: It is surprising that this species was only recently discovered in an area that was supposed to have been well sampled. The type-series (20 specimens) was collected with an otter trawl at 3 sites off Graham Land in February 1975. Judging from the stomach contents (mainly krill, *Euphausia superba*), *Cryothenia peninsulae* is pelagic or engibenthic (Daniels 1981). The species name was incorrectly spelt as "*peninsula*" in the original description, but this is an inadvertent error, and the name is correctly spelled as *C. peninsulae*.

This appears to be a small species; the holotype, a ripe female, is only about 170 mm TL.

Genus **Dissostichus** Smitt, 1898

Body elongate, fusiform. Head depressed, the interorbital region broad and flat; snout length greater than eye diameter. Mouth large, the maxilla reaching past a vertical at middle of eye; lower jaw projecting, its length equal to about half head length; a patch of large canine teeth on each side of symphysis of upper jaw and a single row of canines on lower jaw. Pores of cephalic sensory canals not enlarged, but most are situated at the end of a short branch (canaliculus) from the main canal; coronal commissure and supratemporal canals complete; preopercular-mandibular canal complete and connected to temporal canal at the junction of the supratemporal canal; infraorbital canal complete, connected to temporal canal. Upper lateral line (of tubed scales) runs straight along dorsolateral part of body from upper end of gill opening to below the last few dorsal-fin rays; middle lateral line also with tubed scales. No fin spines or rays elongated; caudal fin emarginate, with 14 branched rays. Gill rakers short to rudimentary, dentigerous. Branchiostegal rays 7. All hypurals separate from one another and from stegural. Vertebrae (19–21)+(30–35) = 51–54. Pectoral foramen entirely within scapula or (occasionally) bordered ventrally by upper edge of coracoid.

Remarks: The genus *Dissostichus*, with only 2 species, is supposed to be related to the monotypic *Eleginops*. *E. maclovinus* (Cuvier in Cuvier & Valenciennes, 1830) is known only from the Patagonian Region and Tristan da Cunha (the latter locality is here reported based on a 231 mm SL specimen examined by the senior author at the South African Museum, SAM 22892). It differs from *Dissostichus* in having a smaller mouth (maxilla not reaching past front of eye, lower jaw length much less than half of HL), 6 branchiostegal rays and 25 abdominal vertebrae. Contrary to the literature, *Eleginops* does

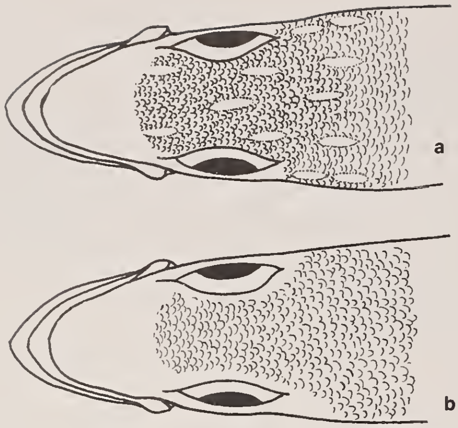


Fig. 5. Scales on the head of *Dissostichus* species: (a) *eleginoides*; (b) *mawsoni*

have 2 lateral lines, the upper composed of tubed scales extending posteriorly to the caudal-fin base, the middle of pored scales extending from the caudal-fin base a variable distance anteriorly, but not reaching the tip of the pectoral fin. These 2 genera comprise the subfamily Eleginopinae, which Andersen (1984) characterized by the canaliculi of the cephalic sensory canals, the high number of abdominal vertebrae (21 & 25) and the autogenous hypurals. But some species of *Pagothenia* (sensu Andersen) have 21–22 abdominal vertebrae, and we have seen radiographs of *D. eleginoides* that show only 19–20 abdominal vertebrae. Since the number of abdominal vertebrae does not distinguish *Dissostichus* from *Pagothenia* (sensu Andersen), and since the autogenous condition of the hypurals is considered a plesiomorphic character by Andersen (1984: 23), we are left only with the presence of canaliculi as the diagnostic feature of the Eleginopinae. This feature needs to be verified in *D. mawsoni*.

KEY TO THE SPECIES

1a Dorsal surface of head with several, narrow, elongate scaleless areas (Fig. 5a); MLL extends forward to tip of P .... *D. eleginoides*

1b No elongate scaleless areas on top of head (Fig. 5b); MLL begins well posterior to tip of P................ *D. mawsoni*

Dissostichus eleginoides Smitt, 1898
Patagonian toothfish
Fig. 6

Dissostichus eleginoides Smitt, 1898: 4, pl. 1, figs. 1–3, southern Patagonia (55°24′S, 68°17′W). Syntypes: NRM SYD/1896067.3235 and SYD/1896071.3236.

Macrias amissus Gill & Townsend, 1901: 937, off Chonos Archipelago, Chile (45°35′S, 75°55′W).

Diagnosis: D VIII–XI+26–31; A 26–31; P 25–26 (28); GR (2–6)+(11–16); ULL 83–99; MLL 64–77. Body depth 5.0–6.4 and head length about 3 in SL. Eye diameter subequal to interorbital width, considerably less than snout length. Teeth in upper jaw biserial, those in the outer series enlarged, canine-like, with 1–3 extra-large canines on each side of symphysis; lower jaw teeth uniserial, spaced canines. About half of the gill rakers on the lower limb are rudimentary (mere tooth patches); most or all of the upper-limb gill rakers are also rudimentary. Infraorbital canal with 7–9 pores, all at the ends of canaliculi, the first pore anteroventral to nostril; preopercular-mandibular canal joined to temporal canal, with 11–13 pores of which 4–5 are on the mandible; supraorbital canal with 4 pores, the 4th situated behind the coronal commissure at the end of a canaliculus running posteromedially (not laterally, as shown by Andersen 1984: fig. 27) from the main canal; coronal commissure complete, with a single small pore at the end of a short canaliculus; temporal canal with 4 pores; supratemporal canal with 3 pores. Pectoral fins large, the upper rays longest, reaching slightly past anal-fin origin. Pelvic fins reaching slightly past pectoral-fin base. Caudal fin emarginate. Body covered with ctenoid scales; head scaly except for snout, preorbital, preopercular flange, and lower jaw.

COLOUR: Brownish-grey, with more or less distinct darker blotches.

Otoliths

DIAGNOSTIC FEATURES: The generally ovate to fusiform shape, the distinct collum, the well-developed cristae and the prominent crenate margin.

Intraspecific variation: Quite marked, but the various types illustrated should eliminate any misidentification. Rostrum length varies as does the otolith length/depth ratio; also, the position, length and robustness of the cristae are variable.

Ontogeny: The crista superior becomes crenate and more robust in fish greater than 80 cm TL.

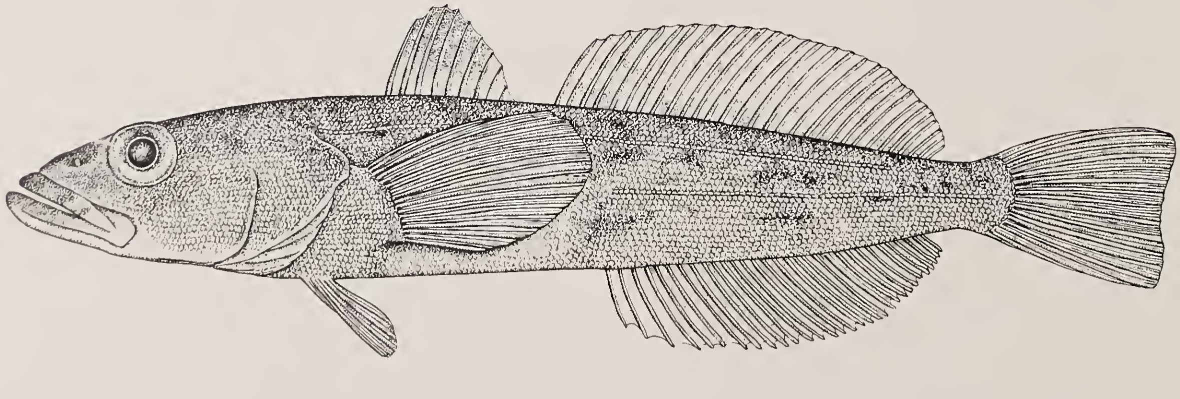


Fig. 6. *Dissostichus eleginoides*, about 58 cm SL (after Fischer & Hureau 1985)

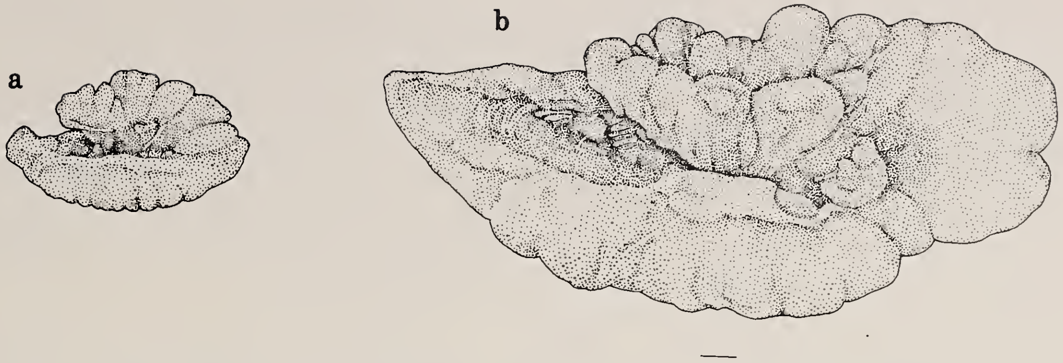
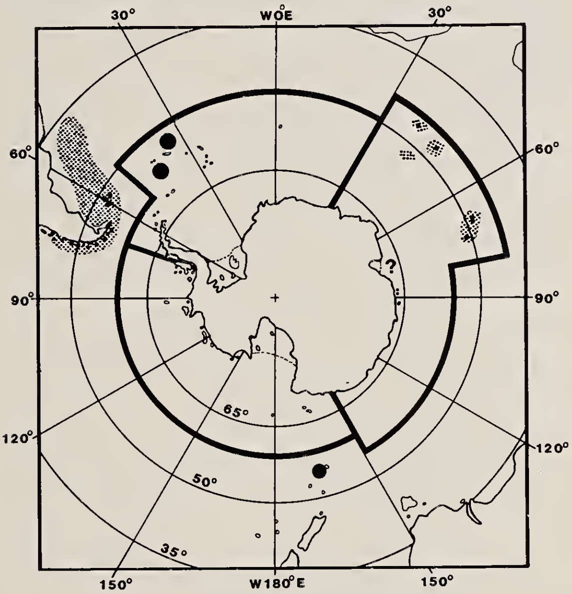


Fig. 7. Representative otoliths of *D. eleginoides*; fish lengths: (a) 39 cm and (b) 183 cm TL; scale bar 1 mm

Distribution: Southern Chile, Patagonia, Falkland Islands, Shag Rocks, South Georgia, sub-Antarctic islands and seamounts of the Indian Ocean sector, and Macquarie Island. *D. eleginoides* appears to be confined to waters north of 55°S (Yukhov 1972), but Hureau (1985f) reports a juvenile from Prydz Bay, Antarctica. *D. eleginoides* is an engibenthic or midwater species that is reported to be pelagic during some periods of its life; it has been taken in bottom trawls at depths of 70–1,500 m. Two specimens reported from Elephant Island (Kock 1982), were reidentified as *D. mawsoni* (Tiedtke & Kock 1989).



Distribution of *D. eleginoides*

Remarks: The original description of *Macrias amissus* by Gill & Townsend (1901) was based on a photograph of a specimen "nearly five feet long" trawled by the *Albatross* off southern Chile. The photograph of the specimen (which was, unfortunately, thrown overboard soon after being photographed) was published some years after the original description (Townsend 1936). Oyarzun & Campos (1987) have demonstrated that there is only 1 species of tooth fish (*D. eleginoides)* in Chilean waters.

The question of how many populations of *D. eleginoides* exist is still unresolved. Initially, Zacharov (1976), using statistical analysis of meristic and morphometric characters, concluded that fishes from the Patagonian Region comprise a different population from those around South Georgia, but did not provide any biological data to support this conclusion. Hureau & Ozouf-Costaz (1980) recognised 2 biologically distinct populations, one in the south-west Atlantic (Patagonia to South Georgia) with larger maximum size and faster growth rate, and another at the sub-Antarctic region of the Indian Ocean with smaller maximum size and slower growth rate. Data obtained from more recent captures, however, indicate that the maximum size is similar in both ocean sectors (206 versus 215 cm TL respectively). In the Atlantic Ocean sector sexual maturity is reached at about 90–100 cm TL (9–10 year) in most fishes, but a few mature males were less than 80 cm TL (Kock pers. comm.) Similar values were found in fishes from the Kerguelen Islands, but in the Crozet Islands maturity is reached slightly earlier (Duhamel 1987b).

Spawning in the Kerguelen Islands takes place on the bottom in April and May (Duhamel 1981). Eggs and larvae are large; post-larvae (49–62 mm SL) were caught in December-January off South Georgia (Efremenko 1983) and from middle October onward on the southern Patagonian Shelf (Ciechomski & Weiss 1976). In the Kerguelen Islands, larvae and juveniles feed on krill (*Euphausia similis)* and as they grow, they feed increasingly on fishes (primarily *Champsocephalus gunnari, Lepidonotothen squamifrons* and myctophids) which dominate the stomach contents of immature and adult specimens (Duhamel 1981). In the South Georgia area, juvenile *D. eleginoides* feed on fishes (principally nototheniids) and, to a lesser degree, on the decapod *Crangon antarcticus* (Tarverdiyeva 1972). The Patagonian toothfish is commonly eaten by sperm whales (Yukhov 1972).

According to Eastman (this volume), *D. eleginoides* is not found in waters colder than 2 °C, lacks antifreeze and has at least a few glomeruli in its kidneys.

Dissostichus mawsoni Norman, 1937
Antarctic toothfish
Fig. 8

Dissostichus mawsoni Norman, 1937b: 71, fig. 6, off MacRobertson Land (66°45'S, 62°03'E). Holotype: BMNH 1937.9.21.123.

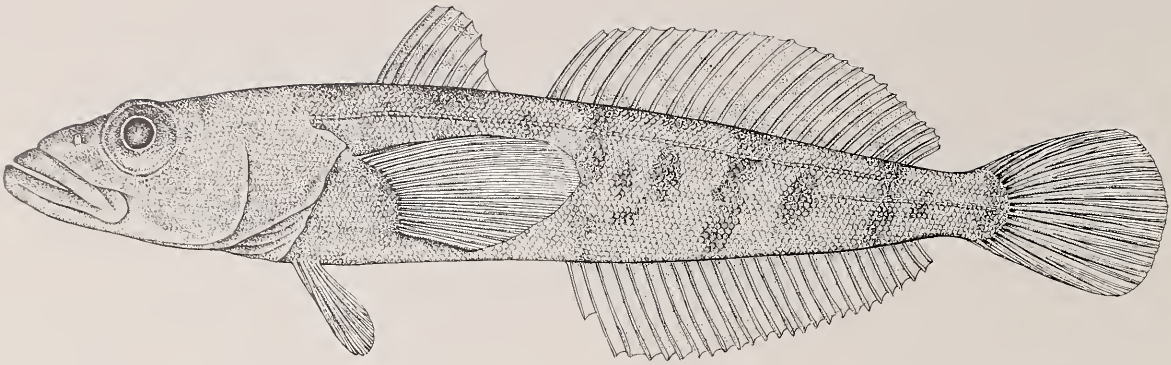


Fig. 8. *Dissostichus mawsoni*, about 66 cm SL, (after Fischer & Hureau 1985)

Diagnosis: D VII–IX+24–27; A 25–28; P 26–29; GR (3–5)+(10–15) = 15–18; ULL 92–97; MLL 35–48. Body depth 5–6 and head length 3.2–3.4 in SL. Eye diameter distinctly less than interorbital width or snout length. Upper jaw teeth in 2 rows, the outer teeth enlarged; lower jaw teeth essentially uniserial canines. Gill rakers short, dentigerous. Infraorbital canal with 7 pores; preopercular-mandibular canal joined to temporal canal, with 10 pores; supraorbital canal usually with 4 pores, the coronal commissure usually with a single pore; temporal canal with 4–5 pores; supratemporal canal usually with 3 pores. Pectoral fins large, the upper rays longest, reaching anal-fin origin in small specimens. Pelvic fins reaching slightly past pectoral-fin base. Caudal fin truncate to emarginate. Body scales smooth, except for area covered by pectoral fins where they are ctenoid; head scaly except for snout, preorbitals, lower jaw, margin of orbits, and margin of preopercles; scales on top of head not extending in front of eyes.

Colour: Body greyish, sometimes with large darker saddles dorsally and scattered, irregular darker markings. Gon (1988) has illustrated the distinctively barred colour pattern of the juvenile.

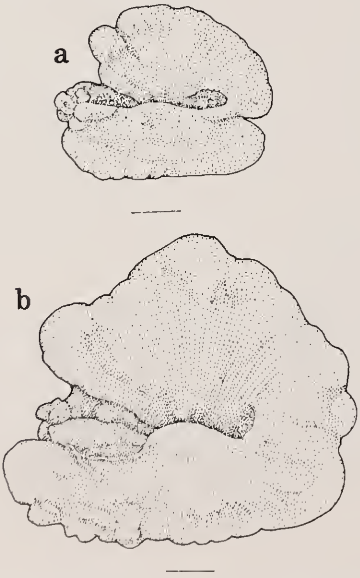


Fig. 9. Representative otoliths of *D. mawsoni*; fish lengths: (a) 28 cm and (b) 70 cm TL; scale bar 1 mm

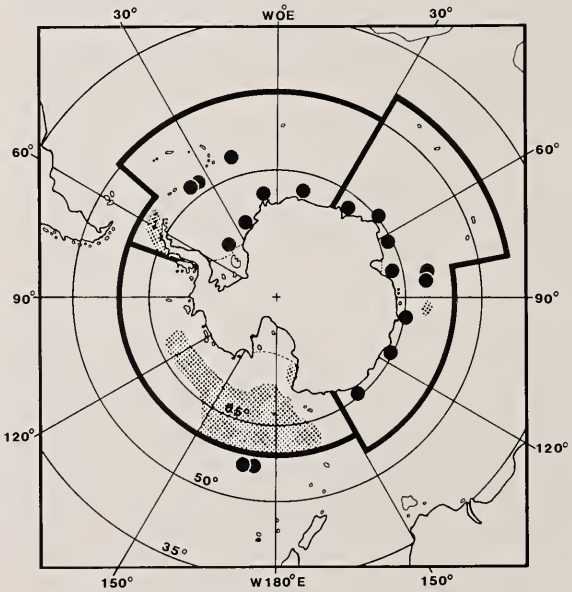
Otoliths

Diagnostic features: The discoid to subquadrate shape, the irregular margin, the deep ostium and the notch in the dorsal margin above the antirostrum.

Intraspecific variation: The sculpture of the margin varies from irregular to lobed in specimens of all lengths.

Ontogeny: The most distinctive ontogenetic feature is the change in the shape of the rostrum from being a separate projection on the anterior margin in specimens less than 80 cm TL to being prominent in specimens greater than 100 cm TL. In specimens less than 80 cm TL the sulcus acusticus is ostial but becomes ostio-caudal in larger specimens. The general shape of the otolith also changes from square to discoid/subquadrate with an increase in fish size.

Distribution: The Antarctic toothfish is endemic to the seas around Antarctica (circumpolar at latitudes higher than 55 °S); records from South Georgia and the South Sandwich Islands are dubious. It is an engibenthic species that is usually caught near the bottom in depths of 88–1,600 m.



Distribution of *D. mawsoni*

Remarks: Sexual maturity is reached at 8 years and 100 cm TL (Burchett *et al.* 1984). Spawning occurs during spring or early summer. The eggs are about

4.0 mm in diameter, which suggests that large larvae are produced (Yukhov 1971a). In the open ocean, *D. mawsoni* feed mainly on squid; near shore and under the ice, fishes are the main food item. Yukhov (1982) provides a comprehensive review of the morphology, biology and distribution of this species.

Bouyancy is provided by reduced calcification of the skeleton and production of lipids (triglycerides) in the cells of adipose tissue (Eastman & DeVries 1986a).

Attains 175 cm TL and 80 kg at 31 years, but remains from the stomachs of sperm whales indicate that larger specimens may exist (Yukhov 1971b).

Genus *Gobionotothen* Balushkin, 1976

Body elongate, compressed posteriorly. Dorsal profile of head convex. Interorbital region very narrow, the width half or less of eye diameter and 5–10% head length. Mouth small, the maxilla not reaching a vertical at middle of eye; lower jaw not projecting; no large canine teeth. Cephalic sensory canals with small pores. Preopercular-mandibular canal separate from temporal canal; supraorbital canal with 1 pore posterior to coronal commissure; infraorbital canal complete; supratemporal with 3 pores (Fig. 1e). Body with 2 lateral lines of tubed scales. Snout, preorbital, margin of preopercle and lower jaw naked, the rest of head scaly; scales on top of head ctenoid, extending forward to front of interorbital region. Caudal fin rounded, with 10–12 branched rays. Pectoral-fin rays 18–23. Gill rakers on first arch short, non-dentigerous, 16–22. Branchiostegal rays 6, the membranes broadly united to one another and to isthmus, but also forming a narrow free fold over the isthmus. Vertebrae (15–18)+(28–35) = 44–52. Pectoral foramen bordered by scapula and coracoid, the dorsal edge of coracoid deeply indented by the foramen.

Remarks: The original description of *Gobionotothen* (Balushkin, 1976b: 128) includes 4 species: *Notothenia gibberifrons* Lönnberg, 1905 (the type species); *N. acuta* Günther, 1880; *N. marionensis* Günther, 1880; and *N. angustifrons* Fischer, 1885. We agree with this definition of the genus (except that we regard *angustifrons* as a synonym of *marionensis)* which equals the Acuta-Group of DeWitt (1966) but differs from that of Andersen (1984) who also includes *N. cyanobrancha*. The 3 species of *Gobionotothen* that we recognise share a similar (goby-like) appearance: convex head profile, very narrow interorbital region (5–10% HL), small horizontal mouth placed low in the head, and anal-fin origin under the 1st to 4th rays of the second dorsal fin. They also have a low number of branched caudal-fin rays (10–12), fewer than any other species of nototheniids, and a high number of tubed scales in the middle lateral line (14–52).

N. cyanobrancha is here assigned to the subgenus *Indonotothenia* of the genus *Notothenia*. Andersen (1984: 24) uses 2 character "autapomorphies" to relate *N. cyanobrancha* with the species of *Gobionotothen* (which he recognises as a subgenus). The first character ("infraorbital bones more or less flattened") was apparently taken from Balushkin (1976b), as Andersen does not illustrate or discuss the nature of the infraorbitals in his paper. Balushkin (1984: 18) mentions this feature in his key to genera, but there (couplet 12) it is said to apply to both *Gobionotothen* and *Lindbergichthys* (this latter genus is considered by Andersen to be a synonym of the genus *Nototheniops*). But if this infraorbital character also occurs in a different genus, it cannot be an autapomorphy of *Gobionotothen*. Furthermore, it is not at all clear from Balushkin's illustration of the infraorbitals of several species of notothenines that those of *Gobionotothen gibberifrons* (Balushkin's fig. 4, K & K') are less tubular than in the species of other genera he illustrates. The second "autapomorphy" listed by Andersen for *Gobionotothen* ("Upper and lower hypural plates fused to the ural vertebral centrum") is shown by Balushkin (1984: fig. 26, K) not to be the case for *G. acuta,* in which the lower hypural plate is depicted as autogenous.

We thus see no "autapomorphies" that relate *N. cyanobrancha* to the species of *Gobionotothen,* and the "other diagnostic characters" that Andersen uses (1984: 24) for a generic-level taxon that includes these 4 species plus *N. cyanobrancha* ("Upper part of head scaly, at least posteriorly. Naked in front of eye. Infraorbital *(sic)* width narrow. Medial lateral line with 15–42 tubular scales.") also do not fit *N. cyanobrancha.* According to Regan (1913: 275) and Hureau (1985f: 348), in *N. cyanobrancha* the upper surface of the head is naked except for a few temporal and post-temporal scales, the interorbital width is much wider (subequal to eye diameter, and 17–20% HL, versus much less than eye and 5–10% HL in species of *Gobionotothen*), and the middle lateral line has only 4–15 tubed scales. We believe that *N. cyanobrancha* is more closely related to the species of the genus *Notothenia* than to those of *Gobionotothen,* and it is thus here assigned.

The species of *Gobionotothen* are known only from the sub-Antarctic islands and the northern end of the Antarctic Peninsula (north of 65 °S).

KEY TO SPECIES

1a A small median lobe on upper lip in groove between lip and snout; interorbital width about 10% HL (Prince Edward, Crozet, South Georgia and South Sandwich islands) .... *G. marionensis*
1b No small median lobe on upper lip in groove between upper lip and snout; interorbital width 6–8% HL 2
2a MLL with 25–42 tubed scales; D_2 31–34; A 31–34 (northern end of Antarctic Peninsula, islands of the Scotia Arc and Heard Island)............................ *G. gibberifrons*
2b MLL with 14–25 tubed scales; D_2 28–30; A 28–31 (sub-Antarctic islands of Indian Ocean sector).......... *G. acuta*

Gobionotothen acuta (Günther, 1880)
Triangular notothen
Fig. 10

Notothenia acuta Günther, 1880: 17, Kerguelen Islands. Holotype: BMNH 1879.5.14.360.

Diagnosis: D V–VII+28–30; A 28–31; P 19–20; GR (5–6)+(13–15) = 19–20; ULL 34–39; MLL 14–25. Body depth 5.9–6.5 and head length 3.2–3.4 in SL. Eye diameter 3.6–3.7 in HL, about equal to or slightly greater than snout length. Interorbital width narrow, 3.7–4.0 in eye diameter. Upper jaw teeth in 2 narrow bands, the inner band (smaller teeth) confined to anterior half of jaw, the outer band extending three-fourths length of jaw; lower jaw teeth in a narrow band, uniserial in part, similar in size to outer teeth of upper jaw. Gill rakers rather short and mostly blunt, those of medial series knob-like. Infraorbital canal with 7 pores; preopercular-mandibular canal with 10 pores; supraorbital canal with 4 pores; coronal commissure with a single median pore; temporal canal with 5 pores; and supratemporal canal with 3 pores. First spine of dorsal fin distinctly longer than others. Pectoral fins extend to above 7th to 9th anal-fin rays. Pelvic fins not reaching anal-fin origin. Caudal fin slightly rounded, with 10 branched rays. Body scales ctenoid except along anterior

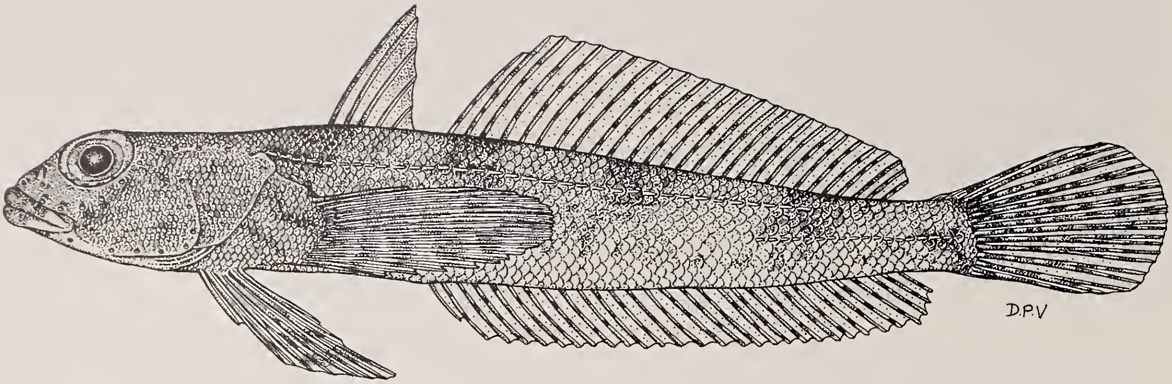


Fig. 10. *Gobionotothen acuta* BMNH 1937.9.21.51, 78.9 mm SL, Kerguelen Islands, Bras Bossiere

half of anal-fin base, on belly, and anterior to pectoral fins; head covered with scales, except for snout and preorbitals; the scales ctenoid except on lower and anterior parts of cheeks.

Colour: In alcohol (from 1 specimen), 4 more or less distinct dark bars cross back, ending at about midside of body or a little lower. Upper and lateral parts of head dark; many pores of head canals visible as dark spots. A median dark area and a lateral horizontal line present on upper lip, the line extending onto lower lip and part of lower jaw. Regan's (1913: pl. 8, fig. 3) excellent figure of the holotype shows the side marked with 3 somewhat irregular rows of dark blotches as well as the line across the upper and lower lips. Also shown are some irregular bars on the upper part of the pectoral fin and dark spots on the spines and rays of the dorsal fins.

Otoliths

Diagnostic features: The fusiform shape, the distinctly separated ostium and cauda, the narrow crista inferior in association with the split crista superior.

Ontogeny: Otolith of small fish slightly rectangular with crenate margin; otolith of larger fish fusiform, the margin entire to lobed, and the ostium separated from the cauda.

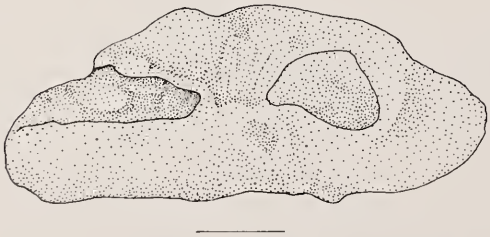
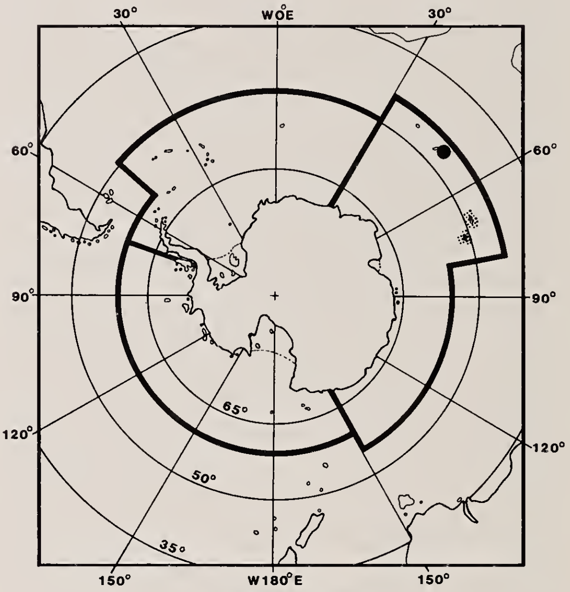


Fig. 11. Representative otolith of *G. acuta*; fish length unknown; scale bar 1 mm

Distribution: *G. acuta* is known only from sub-Antarctic islands of the Indian sector of the Southern Ocean, but it has not yet been found at the Prince Edward Islands. It occurs from the shore to depths of 300 m.

Remarks: This is a small benthic species that feeds on benthic invertebrates, mainly amphipods and isopods (Hureau 1985f).



Distribution of *G. acuta*

The common name of this species, "triangular notothen", refers to the triangular shape of the first dorsal fin, which is due to the first spine being distinctly longer than the others and the remaining spines decreasing regularly in length to the last. This acute triangular shape of the first dorsal fin is rare in species of nototheniids.

Attains 35 cm SL.

Gobionotothen gibberifrons (Lönnberg, 1905)
Humphead notothen

Fig. 12

Notothenia gibberifrons Lönnberg, 1905b: 33, pl. 3, fig. 10, South Georgia. Syntypes: NRM SYD/1902192.2992; SYD/1902192.9279; SYD/1902200.2291; SYD/1902203.2990; SYD/1902205.9280; SYD/1902212.2297; SYD/1902234.1161; SYD/1902902.9281.

Notothenia vaillanti Regan, 1913: 272, Booth Island, off Graham Land, Antarctic Peninsula (65°05′S, 64°00′W).

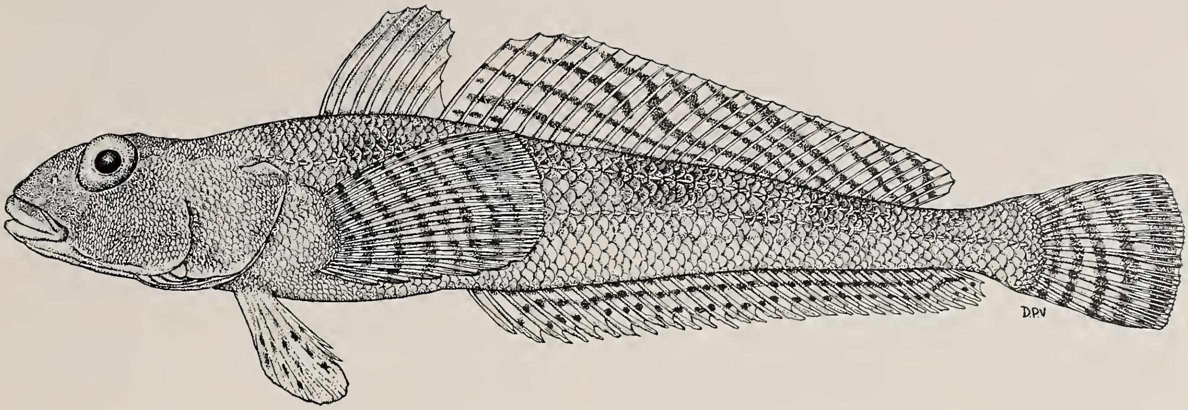


Fig. 12. *Gobionotothen gibberifrons* UMO 511, 28 cm SL, off South Georgia (53°38′S, 38°01.8′W)

Diagnosis: D VI–VIII+31–34; A 31–34; P 20–22; GR (4–6)+(11–13) = 16–19; ULL 34–51; MLL 30–42. Body depth 5.0–6.5 and head length 3.3–3.7 in SL. Eye 2.9–4.7 in HL. Interorbital width narrow, about 8% HL and 3.0–4.2 in eye diameter. Snout profile steep, the eyes bulging into the dorsal head profile; head depressed behind the eyes; the steep snout, dorsal eyes with a narrow interorbital space and the depressed head give this species a distinctive, callionymid-like aspect. No median lobe on upper lip. Teeth small, conical, in 1–2 irregular series on both jaws. Gill rakers short, those on lateral side of first arch non-dentigerous, the rest with teeth. Infraorbital canal with 7–8 pores; preopercular-mandibular canal with 9–11 pores; supraorbital canal with 4 pores; coronal commissure with a median pore; temporal canal with 5–6 pores; and supratemporal canal with 4–5 pores. First 3 dorsal-fin spines subequal. Anal-fin origin under 2nd-5th dorsal-fin rays. Pectoral fins reach above 5th-7th anal-fin rays. Pelvic fins not reaching anus. Caudal fin truncate, with 10–12 branched rays. Middle lateral line reaches anteriorly to the area covered by the pectoral fin. Body scales ctenoid, except for those on belly, chest, and anterior to pectoral fins; head scaly, except for preorbitals, anterior part of snout and area around nostrils, lower jaw, gular area and branchiostegal membranes, narrow margin of preopercles, and interopercles; head scales mostly ctenoid.

Colour: Yellowish, upper part of head and body with irregular dark spots and blotches. Fins greenish, the dorsal, caudal and pectoral fins with a series of brown spots forming transverse bands; anal fin pale, with 2–3 horizontal bands.

Otoliths

Diagnostic features: The fusiform to ovate shape, the constricted and raised collum, the triangular shaped ostium and cauda, the prominent mid-section of the crista inferior and domed dorsal margin and ridge-like crista superior in larger fish.

Ontogeny: The shape changes from fusiform to ovate with an increase in fish size. The dorsal margin becomes more dome shaped in specimens greater than 28 cm SL, the antirostrum is absent in specimens greater than 40 cm TL and the crista superior becomes ridge-like in larger fishes.

Distribution: Known from all the islands of the Scotia Arc, the northern part of the Antarctic Peninsula and Heard Island. Depth range 5–750 m. Around Elephant

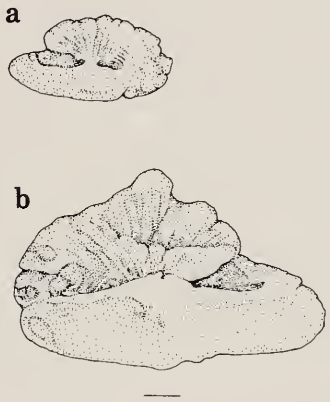
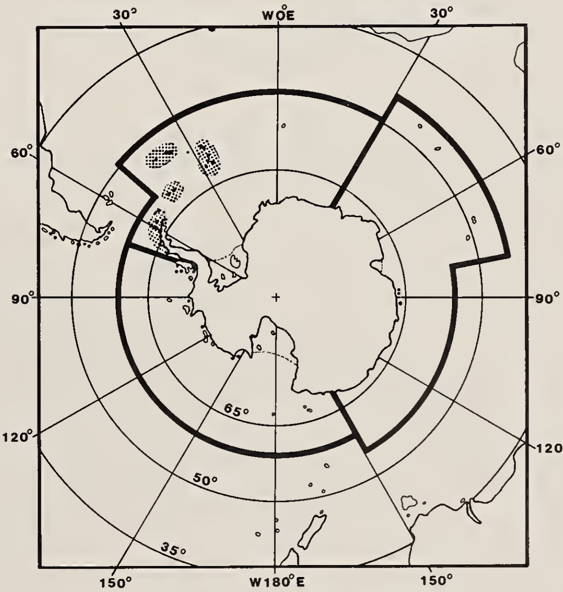


Fig. 13. Representative otoliths of *G. gibberifrons*; fish lengths: (a) 150 mm and (b) 394 mm TL; scale bar 1 mm



Distribution of *G. gibberifrons*

Island maximum abundance was at 100–400 m (Tiedtke & Kock 1989).

Remarks: In Elephant Island sexual maturity is reached at about 36 cm TL and first spawning occurs at 36 (males) and 38.6 (females) cm TL (Kock 1989) and probably at somewhat shorter length in South Georgia. Spawning occurs at the end of winter and beginning of spring, but with latitudinal differences between places, i.e. August-September in Elephant Island (Kock 1989) and July-August in South Georgia (Kozlov 1982). Hatching takes place in spring and early summer; length at hatching is about 7 mm SL (Kellermann 1989). Larvae appear in the water column in Elephant Island in November (Kock 1989) and in September in South Georgia (Efremenko 1983). Postlarval development continues to the end of the austral summer when juveniles change from pelagic to benthic life. Absolute fecundity was 21,699–143,620 eggs (fish length 34–47 cm TL) in Elephant Island (Kock 1989); 23,570–84,660 eggs (fish length 35–42 cm TL) in the South Orkneys (Permitin & Sil'yanova 1971); and 30,000–135,000 eggs (fish length 35–52 cm TL) in South Georgia (Lisovenko & Sil-'yanova 1979). Egg diameter in South Georgia was 1.5–2.5 mm (Sil'yanova 1980).

G. gibberifrons is a benthic species feeding on infaunal and engibenthic animals such as sedentary polychaetes, echiurans, sipunculids and priapulids, bivalves, and crustaceans; when krill is abundant it will also feed heavily on this resource (Richardson 1975; Tarverdiyeva & Pinskaya 1980; Targett 1981; Kozlov 1982; Takahashi 1983). Lönnberg (1905b: 56) reported that adults feed heavily on fish eggs, but this is likely to be a patchy, seasonally available resource.

This species is of some commercial importance in the vicinity of South Georgia, South Orkneys and the South Shetland islands. In Elephant Island, as a result of heavy fishing of *Notothenia rossii* and *Champsocephalus gunnari* during the 1978–79 and 1979–80 seasons, *G. gibberifrons* is now the most abundant species comprising 65–80% of the biomass between 50–550 m (Nast *et al.* 1988).

Attains 55 cm TL.

Gobionotothen marionensis (Günther, 1880)
Lobe-lip notothen
Fig. 14

Notothenia marionensis Günther, 1880: 17, Marion Island. Holotype: BMNH 1879.5.14.364.

Notothenia angustifrons Fischer, 1885: 55, South Georgia.

Notothenia angustifrons sandwichensis Nybelin, 1947: 16, pl.1, figs. 1, 3, 5, 7, Candlemas Island, South Sandwich Islands.

Diagnosis: D V–VIII+27–32; A 27–32; P 18–21; GR (4–7)+(10–13) = 16–19; ULL 26–35; MLL 15–26; LSS 47–50. Body depth 4.3–6.2 and head length 3.1–3.6 in SL. Eye 3.5–4.5 and snout 3.2–4.0 in HL. Interorbital width narrow, 3.1–3.3 in eye diameter. Upper lip with a small lobe on posterior edge at dorsal midline. Upper jaw with narrow band of small conical teeth tapering to a single row posteriorly; lower jaw teeth similar, more or less uniserial. Gill rakers short, those on first arch non-dentigerous, the rest with teeth. Infraorbital canal with 7 pores; preopercular-mandibular with 10 pores; supraorbital canal with 4 pores ; coronal commissure with 1 median pore; temporal canal with 6 pores; and supratemporal with 3 pores. First and second spines of first dorsal fin subequal. Pectoral fins extend to vertical at about 7th anal-fin ray. Pelvic fins not reaching anus. Caudal fin rounded, with 10 branched rays. Body scales ctenoid, except for those on belly, chest and anterior to pectoral fins; head covered with scales, except for snout, preorbitals, lower jaw and gular region, branchiostegal membranes, and lower part of cheeks and opercula; head scales mostly ctenoid.

Colour: In alcohol, body greyish-brown, darker dorsally with 4 indistinct dark saddles, the first joining upper ends of pectoral-fin bases, the last at bases of 23rd to 28th dorsal-fin rays. Dark bar at base of caudal fin. Head, fins, and lateral parts of body with dark spots and blotches.

Otoliths

Diagnostic features: The distinctly fusiform shape, the separated ostium and cauda in association with the prominent crista inferior.

Intraspecific variation: Negligible, except that the anterior colliculum and the excisura ostii can either be present or absent.

Ontogeny: The margins change from being entire to dorsally lobed in fish greater than 12 cm TL and the otolith becomes more fusiform with increasing size.

Distribution: *G. marionensis* is known from South Georgia and the South Sandwich islands in the Atlantic Ocean sector, and Crozet and the Prince Edward islands in the Indian Ocean sector. Depth range 0–150 m.

Remarks: Lönnberg (1905b) thought that *Notothenia angustifrons* and *N. marionensis* were conspecific, but was unsure whether they should be considered sub-

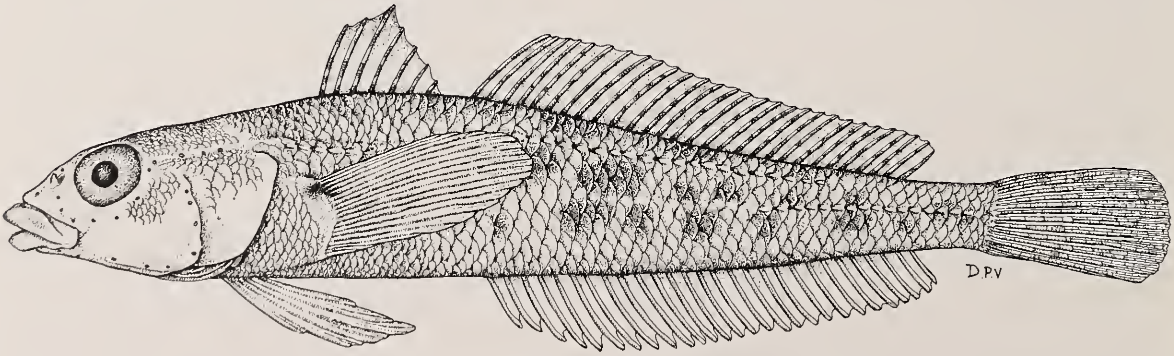


Fig. 14. *Gobionotothen marionensis*, holotype, 70.3 mm SL

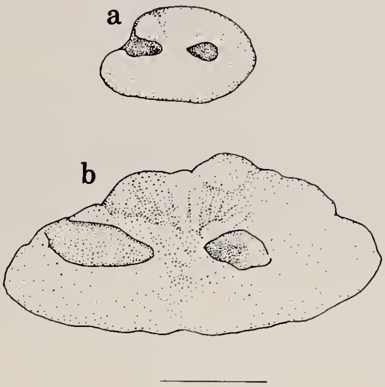
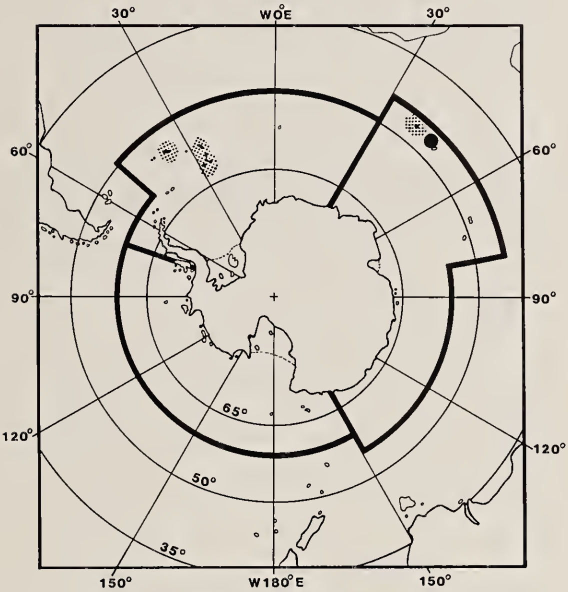


Fig. 15. Representative otoliths of *G. marionensis*; fish lengths: (a) 55 mm and (b) 127 mm TL; scale bar 1 mm



Distribution of *G. marionensis*

specifically distinct. Other authors (Regan 1914b; Norman 1938; Nybelin 1947; DeWitt 1971; Hureau 1985f; Duhamel *et al.* 1983; Andersen 1984; and Balushkin 1984) regarded *G. marionensis* as a valid species endemic to the Prince Edward Islands, although it was known only from the holotype. Gon & Klages (1988) compared 21 specimens of *G. angustifrons* from the Scotia Sea with 6 specimens (including the holotype of *G. marionensis)* collected in the Prince Edward Islands and concluded that the wide range of variation in meristic and morphometric characters of these populations does not justify the recognition of *G. angustifrons* as a separate species. Although the Scotia Sea specimens generally had more dorsal- and anal-fin rays (28–31 and 29–31, respectively) than the Prince Edward Islands' specimens (27–30 and 27–29, respectively), the small size of the "*marionensis*" sample weakens the value of these apparent meristic differences.

Nybelin (1947: 16) recognised the South Sandwich Islands population as a distinct subspecies of *Notothenia angustifrons* on the basis of fin ray counts and squamation. The principal difference was the number of second dorsal-fin rays: 29–30, $\bar{x}$ = 29.46, n = 13 in the South Georgia population and 29–32, $\bar{x}$ = 30.65, n = 23 in the South Sandwich Islands' fishes.

In the Atlantic Ocean sector, *G. marionensis* feeds on benthic invertebrates, mostly crustaceans. In South Georgia, stomachs contained krill, mysids, amphipods, isopods and polychaetes whereas at the South Orkneys, the fish fed almost exclusively on amphipods (Targett 1981).

Attains 20 cm TL.

Genus *Gvozdarus* Balushkin, 1989

Body elongate, fusiform, broadest anteriorly. Head broad posteriorly. Interorbital space broad and flat. Snout distinctly longer than eye. Mouth large, the maxilla extending to below front part of pupil; lower jaw projecting; premaxilla non-protrusile, tightly joined to tip of snout. Caniniform teeth present in both jaws, an inner patch near symphysis of upper jaw, an outer series in posterior part of lower jaw. Mandibular and preopercular sensory canals separate, not connected to temporal canals (Fig. 1f); infraorbital canal narrowly interrupted, with an anterior section in the preorbital and second suborbital bone and a posterior section running through the remaining suborbitals to connect with the temporal canal (Fig. 1f); coronal commissure interrupted, with a pair of coronal pores at the ends of short medial branches from the supraorbital canals (Fig. 1f); temporal canal not passing through upper end of supracleithrum; supratemporal canal incomplete across head, formed of a short branch and pore from the temporal canal of each side (Fig. 1c). Branchiostegal rays 7.

Remarks: The genus comprises a single recently described species. Balushkin (1989) places it with *Pleuragramma, Cryothenia* and *Aethotaxis* in his subfamily Pleuragramminae (see Balushkin 1984) on the basis of the scapular foramen and characteristics of the cephalic lateral line canals. The non-protrusile upper jaw and the disposition of the canine teeth are unique within the family.

Gvozdarus svetovidovi Balushkin, 1989
Naked-head toothfish
Fig. 16

Gvozdarus svetovidovi Balushkin, 1989: 85, Ross Sea (73°36′S, 171°00′E). Holotype: ZIN 41058.

Diagnosis. D VI–VII+30–34; A 31; P 27–28; GR 6+16 = 22; ULL 9–11 tubed scales; LSS 101–102; vertebrae 18+33 = 51. Body depth 5.9, head length 3.3, snout to anal-fin origin 2.0, anal-fin origin to caudal-fin base 1.9 in SL. Eye diameter 5.3 and interorbital width 3.0 in HL. Anal fin usually with fewer rays than second dorsal fin. Cephalic lateral line canals as described for generic diagnosis. Mandibular canal with 4 pores; preopercular canal with 7 pores; infraorbital canals with 5+3 pores; supraorbital canal with 5 pores, the branches to the fourth pore representing the incomplete coronal commissure; temporal canal with 5 pores; supratemporal canal with 1+1 pores. About 4 series of teeth near symphysis of upper jaw, the inner series with 4 larger canines; 3–4 series of teeth anteriorly in lower jaw, with about 8 canine-like teeth in posterior part of outer series. Tubed scales of upper lateral line followed by a number of pored scales; middle lateral line apparently absent. Most scales on body ctenoid; non-ctenoid scales present

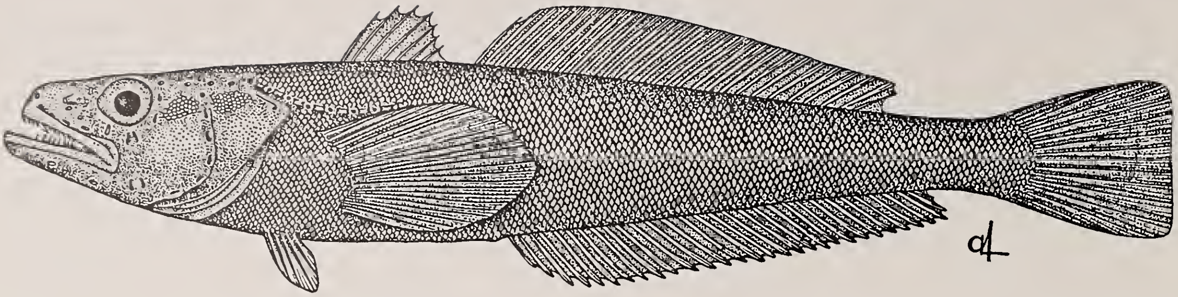
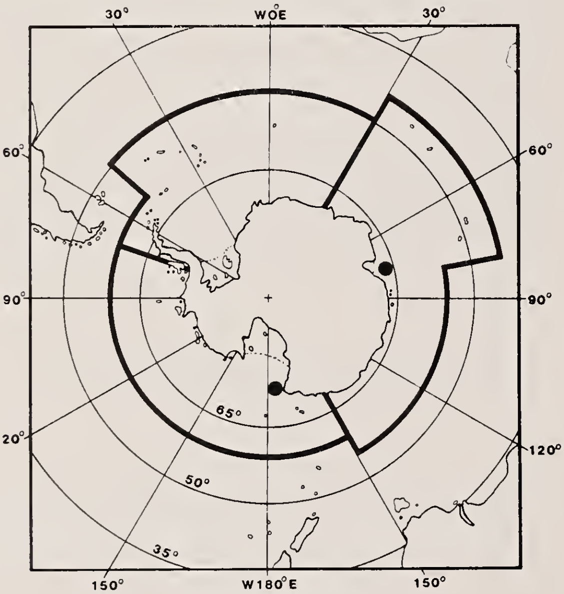


Fig. 16. *Gvozdarus svetovidovi*, holotype, 53 cm TL (after Balushkin 1989)

on belly, bases of pectoral fins, and on back anterior to dorsal fins; head naked except for a few non-ctenoid scales behind eye and on upper part of opercles.

Colour: In alcohol, body more or less uniformly brownish or greyish, the head darker. Fins pale, with transparent or semi-transparent membranes, except for first dorsal and caudal fins, which are blackish distally. Peritoneum black.

Distribution: Probably circum-Antarctic south of the Antarctic Polar Front. At present the species is known only from the holotype, taken in the Ross Sea at 550 m, and 1 other specimen captured in the Co-operation Sea.



Distribution of *G. svetovidovi*

Remarks: Balushkin (1989) states clearly that the holotype shows no trace of a middle lateral line on the body, but that one may be represented by a series of naked neuromasts along the midline. We believe the latter is highly probable and that the neuromasts are situated on pored scales, although they may be very difficult to see.

The holotype, 53.3 cm TL, is an immature female indicating that *G. svetovidovi* grows to a large size, perhaps to more than 100 cm. The second specimen is 65 cm TL. The stomach of the holotype contained remains (including a lower jaw) of *Pleuragramma antarcticum,* the most abundant pelagic fish known from over the Antarctic continental shelves. This indicates that *G. svetovidovi* is a large pelagic piscivore.

In addition to the original description (Balushkin, 1989), the above information is from a manuscript, illustration and 2 letters kindly sent to us by Dr. A. V. Balushkin of the Zoological Institute in Leningrad. We thank Dr. Balushkin for allowing us to use his data in order to make our review of the Nototheniidae as complete as possible.

Genus ***Lepidonotothen*** Balushkin, 1976

Body oblong, compressed posteriorly. Eyes dorsal, the dorsal edge of the orbits in contact with or bulging above dorsal head profile; interorbital width distinctly less than eye diameter and less than 12% HL. Mouth small, the maxilla not reaching vertical at middle of eye; no large canine teeth. Cephalic sensory canals with small pores. Preopercular-mandibular canal not joined to temporal canal; supraorbital canal with 1 pore posterior to coronal commissure; supratemporal canal with 3 pores (Fig. 1e). Caudal fin truncate or rounded, with 12–17 branched rays. Pectoral-fin rays 21–27. Gill rakers short. Branchiostegal rays 6, the membranes broadly united to one another and to isthmus, and also forming a narrow free fold over the isthmus. Vertebrae (14–19)+(32–41) = 48–57. Pectoral foramen bordered by scapula and coracoid.

Remarks: The genus *Lepidonotothen* as here recognised comprises 9 species and includes the nominal genera *Nototheniops* Balushkin, 1976a, and *Lindbergichthys* Balushkin, 1979. Our decision to combine these 3 taxa is based on our conviction that they are more closely related to one another than to any of the other genera of the family. Andersen (1984) included *Lepidonotothen* and *Gobionotothen* as subgenera of *Notothenia* based on a single "autapomorphy", the fusion of hypural bones $H_1 + H_2$ and $H_3 + H_4$. We have already discussed the use of this character as an indicator of phyletic relationships (see family account and remarks under *Gobionotothen*). We agree with Balushkin (1984) that *Gobionotothen* is more closely related to *Lepidonotothen* than to *Notothenia*. The species of *Gobionotothen* and *Lepidonotothen* have narrow interorbital regions, the top of the head is scaly (except in *L. nudifrons)* and their juveniles do not have forked caudal fins or silvery sides. Whether *Gobionotothen* should also be included in the genus *Lepidonotothen* is a moot question, but it seems to us that the species of *Gobionotothen* (with their reduced number of pectoral- and caudal-fin rays) are less closely related to the species of *Lepidonotothen (sensu lato)* than they are to one another.

In his cladogram of the Nototheniidae, Andersen (1984: fig. 30) links *Nototheniops* with *Paranotothenia,* but he provides no evidence for this relationship; and we see no reason to suppose that these 2 genera are closely related.

KEY TO SUBGENERA

1a Scales present on preorbitals; branched C rays 14–17; P subequal to or longer than V 2
1b Preorbitals naked; branched C rays 12–14; P subequal to or shorter than V .... *Lindbergichthys*
2a Dorsal part of eyes with scales; ULL and MLL with tubed scales .... *Lepidonotothen*
2b No scales on eyes; no tubed scales in MLL .... *Nototheniops*

Subgenus ***Lepidonotothen*** Balushkin, 1976

Head nearly to completely scaly, including snout, preorbitals, lower jaw and dorsal part of eyes. Two lateral lines (upper and middle) with tubed scales. Pectoral fins subequal to pelvics. Branched caudal-fin rays 15–17.

Remarks: This subgenus comprises 3 species and is equivalent to the "Squamifrons Group" of DeWitt (1966). The species assigned to this subgenus are similar in colour pattern, morphometric and meristic characters. Permitin & Sazonov (1974) treated the systematics of this group, and our account is based mainly on their work.

Lepidonotothen macrophthalma (Norman, 1937a) is an allopatric species that is not represented in our area, but we have included it in the following key. It is known only from the Falkands area and the Burdwood Bank off the tip of Patagonia.

KEY TO SPECIES

1a Eye diameter 32–36% HL (specimens 14–18 cm SL); A 28–32; front of snout naked; (Burwood Bank and Falkland Islands) .... *L. macrophthalma*
1b Eye diameter 23–33% HL; A 30–35; front of snout scaly in specimens more than 15 cm SL 2
2a Interorbital width 5–9% HL in juveniles (<20 cm SL), 8–12% HL in adults (> 20 cm SL); vertebrae 52–55; (Scotia Arc, northern end of Antarctic Peninsula, Bouvet, Prydz Bay, Scott and Balleny islands) .... *L. kempi*
2b Interorbital width 9–19% HL; vertebrae 49–52; (South Georgia and sub-Antarctic islands) .... *L. squamifrons*

Lepidonotothen (Lepidonotothen) kempi
(Norman, 1937)
Striped-eye notothen
Fig. 17

Notothenia kempi Norman, 1937c: 475, Schollaert Channel, Palmer Archipelago, Antarctic Peninsula. Holotype: BMNH 1937.7.12.38.

Diagnosis: D V–VI+34–38; A 30–35; P 23–26; GR (5–9)+(13–18) = 19–26; ULL 40–47; MLL 3–17; vertebrae (17–19)+(34–36) = 52–55. Body depth 3.8–4.7 and head length 3.2–4.0 in SL. Eye diameter greater than snout length, 3.1–3.9 in HL. Interorbital width 3.0–6.6 times in eye diameter. A band of small, conical teeth in jaws, the outer teeth slightly enlarged. Lateral gill rakers on first arch short, non-dentigerous, the rest dentigerous. Infraorbital canal with 7 pores; preopercular-mandibular canal with 10 pores; supraorbital canal with 4 pores; coronal commissure with 1 median pore; temporal canal with 6 pores; and supratemporal canal with 3 pores. Caudal fin subtruncate, with 16–17 branched rays. Body covered with ctenoid scales, except for those on belly and chest; lips and ventral surface of head naked, the rest of head (including dorsal surface of eyes and proximal part of lower jaw) covered with ctenoid scales.

COLOUR: Body greyish dorsally, with about 9 irregular, broad, dark bars that merge ventrally. A dark streak along front edge of snout continuing back to lower edge of preopercle and another from lower edge of eye to corner of preopercle. Upper part of eye with 2 dark transverse stripes. Distal part of first dorsal fin blackish.

Otoliths

DIAGNOSTIC FEATURES: The oval to ovate shape, the distinct notch in the posterodorsal margin, the split crista superior and the large, fusiform and bold crista inferior.

Intraspecific variation: Negligible, except for presence or absence of antirostrum and excisura ostii.

Distribution: Probably circum-Antarctic. Reported from the Scotia Arc: South Georgia, South Sandwich, South Orkney, South Shetland islands; northern part of Antarctic Peninsula; coast of east Antarctica; Scott and Balleny islands; and Bouvet Island (Balushkin 1986). Depth range 100–900 m. In Elephant Island, maximum abundance was at 250–550 m (Tiedtke & Kock 1989).

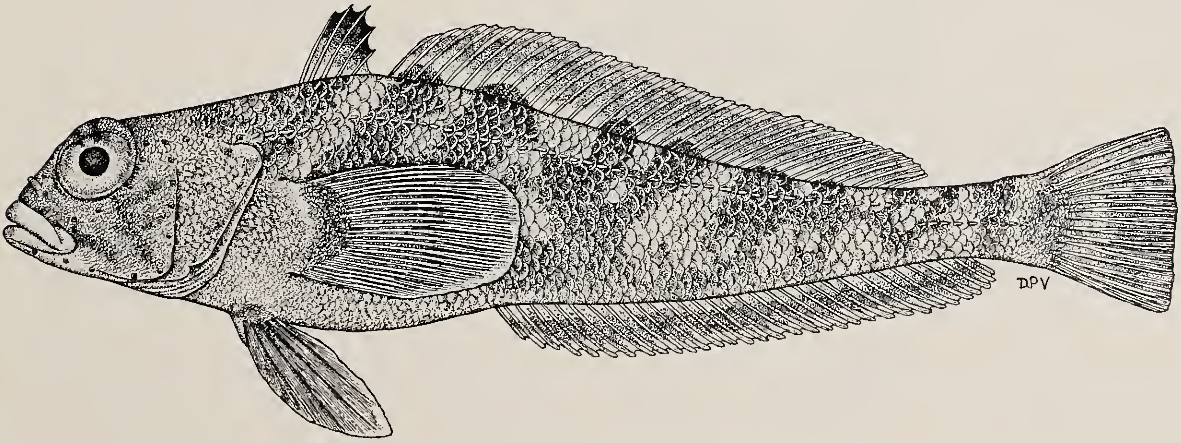


Fig. 17. *Lepidonotothen kempi* BMNH 1937.12.39. 39–44, 180 mm SL, Palmer Archipelago, Scholaert Channel

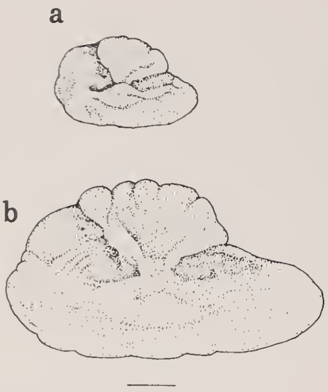
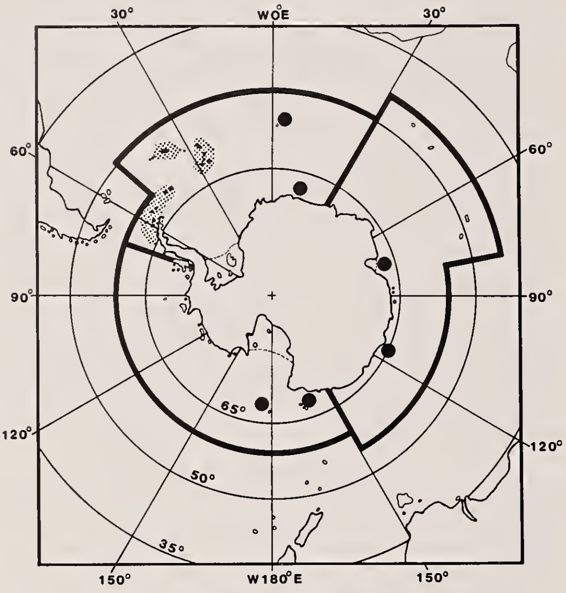


Fig. 18. Representative otoliths of *L. kempi*; fish lengths: (a) 97 mm and (b) 30 cm TL; scale bar 1 mm



Distribution of *L. kempi*

Remarks: Age and growth of *L. kempi* were studied by Shust & Pinskaya (1978). At the northern end of the Antarctic Peninsula and its associated islands hatching occurs in early January; length at hatching is about 7 mm SL. Pelagic development is long, stretching through winter and spring to the second summer (Kellermann 1989).

Tarverdiyeva & Pinskaya (1980) reported that, in addition to benthic invertebrates, this species also feeds heavily on krill and macrozooplankton. Takahashi (1983) examined the stomach contents of 10 specimens from the South Shetland Islands; all of the 9 fish with food in their stomachs had eaten krill (*Euphausia superba)* and 3 fish had also eaten myctophids.

L. kempi is taken as a bycatch in bottom trawls but is of no commercial importance.

Attains 50 cm TL.

Lepidonotothen (Lepidonotothen) squamifrons
(Günther, 1880)
Grey notothen
Fig. 19

Notothenia squamifrons Günther, 1880: 16, pl. 8, fig. C, Kerguelen Islands. Lectotype: BMNH 1879.5.14.357.

Notothenia squamifrons atlantica Permitin & Sazonov, 1974: 596, South Georgia.

Notothenia brevipectoralis Hureau, 1966d: 387, fig. 1, Kerguelen Islands.

Diagnosis: D IV–VI+32–38; A 29–33; P 23–26; GR (7–9)+(12–16) = 22–25; ULL 37–48; MLL 9–29; vertebrae (17–18)+(32–35) = 49–52. Body depth 3.4–4.7 and head length 3.0–3.6 in SL. Eye diameter greater than snout length, 3.0–4.0 in HL. Interorbital width 2.8–3.1 in eye diameter. A band of small conical teeth in jaws, the outer teeth slightly enlarged. Lateral gill rakers on first arch short, non-dentigerous, the rest dentigerous. Infraorbital canal with 7 pores; preopercular-mandibular canal with 9 or 10 pores; supraorbital canal with 4 pores; coronal commissure with 1 median pore; temporal canal with 6 pores; and supratemporal canal with 3 pores. Caudal-fin branched rays 15–16. Body covered with ctenoid scales, except for those on belly and chest; lips and ventral surface of head naked, the

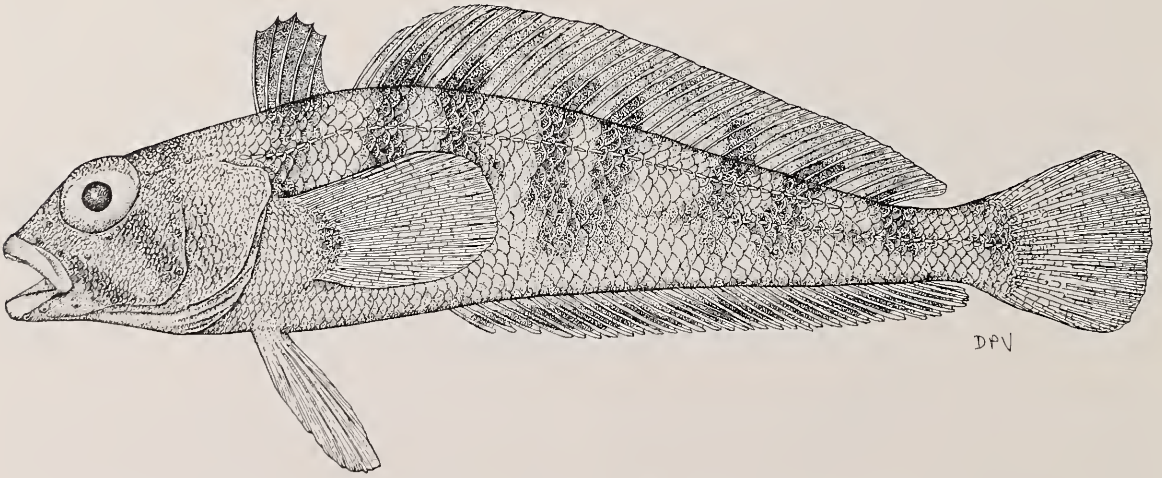


Fig. 19. *Lepidonotothen squamifrons* BMNH 1979. 8.4.11, 190 mm SL, Kerguelen Islands (48°21′S, 70°02′E)

rest of head (including dorsal surface of eyes and proximal part of lower jaw) covered with ctenoid scales.

Colour: As described for *L. kempi* (above).

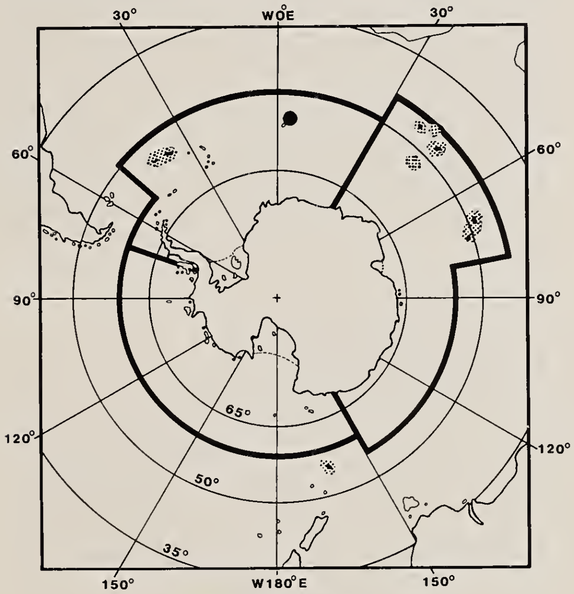
Otoliths

Diagnostic features: The ovate to pyriform shape, the prominent and distally rounded rostrum, the bold crista inferior with a crenate dorsal surface and the generally sinuate ventral margin.

Intraspecific variation: Negligible, except for the sculpture of the margin which, although generally sinuate, can sometimes be entire.

Fig. 20. Representative otolith of *L. squamifrons*; fish length 39 cm TL; scale bar 1 mm

Distribution: Sub-Antarctic islands and intervening seamounts of the Indian Ocean sector; South Georgia Island and Bouvet Island in the Atlantic Ocean sector. The reports of *L. squamifrons* from Elephant Island (Rembiszewski & Zielinski 1980; Kock 1982) may be misidentifications of *L. kempi.* Depth range 5–570 m.



Distribution of *L. squamifrons*

Remarks: Permitin & Sazonov (1974) described *Notothenia squamifrons atlantica* as a new subspecies based on 52 specimens from the South Georgia region. They found slight (modal) differences in the number of transverse scale rows on the body and the second dorsal-fin rays in their South Georgia specimens compared with 24 specimens from the Crozet and Kerguelen islands. The South Georgia subspecies was also said to have no or very few short processes on the bases of the inner (medial) gill rakers, whereas the nominate subspecies was said to have the bases of the inner gill rakers covered with "frequent short processes". The ranges of the meristic characters used by Permitin & Sazonov (1974) to separate these 2 subspecies overlap greatly: scale rows 51–64 versus 56–67, and dorsal-fin rays 33–37 versus 33–38. The supposed difference in the processes on the inner gill rakers is difficult to evaluate. Furthermore, the variation in these characters exhibited by specimens from other intervening localities (e.g. Bouvet and the Prince Edward islands) would likely further diminish the distinction of these 2 nominal subspecies. We believe, therefore, that the validity of these nominal subspecies is dubious.

In the Kerguelen Islands, where the greatest plankton productivity occurs, *L. squamifrons* was the dominant fish species; and their rate of growth was faster (sexual maturity was attained at a length of 34–36 cm in 8 or 9 years) than any of the other populations studied. Kerguelen fish also attained a larger maximum size (54 cm TL) than fish at the Crozet Islands or Lena Seamount (Duhamel & Ozouf-Costaz 1985). In South Georgia the maximum size was 55 cm TL at 14–15 years (Shust & Pinskaya 1978). Growth rate at South Georgia is apparently higher than in Kerguelen Islands at which fishes of the same age were less than 50 cm TL.

Spawning in the Kerguelen and Crozet islands takes place at the end of October (Duhamel & Ozouf-Costaz 1985), but in South Georgia it occurs in February (Sil'yanova 1981). Hatching time has not yet been established accurately, but Duhamel & Ozouf-Costaz (1985) estimated that embryonic development takes about 2–3 months. In South Georgia, postlarvae of about 30 mm SL were captured in December (Efremenko 1983). Absolute fecundity was 48,650–196,150 eggs (fish length 28–44 cm TL) in Kerguelen Islands (Duhamel & Ozouf-Costaz 1985), and about 69,000–185,000 (fish length 35–50 cm TL) in South Georgia (Lisovenko & Sil'yanova 1979). Egg diameter, 1.4–1.7 mm, was similar in both ocean sectors (North & White 1987).

Although *L. squamifrons* is a benthic species common in bottom trawls from depths of 220–330 m in Kerguelen Islands and 250–350 m in South Georgia, it feeds primarily on macrozooplankton (mainly crustaceans, cnidarians and salps) and midwater fishes (Shust & Pinskaya 1978; Duhamel 1981).

L. squamifrons populations are commercially exploited in both ocean sectors. In Kerguelen Islands it is the third important species after *N. rossii* and *C. gunnari* (Duhamel & Ozouf-Costaz 1985), but of lesser importance in South Georgia.

Subgenus *Lindbergichthys* Balushkin, 1979

Head scalation variable, the preorbitals, snout, lower jaw, nasal region and eyes always naked; dorsal surface of head and interopercles scaled or not. Upper lateral line with tubed scales; middle lateral line without tubed scales. Pelvic fins longer than pectoral fins (small specimens), becoming equal to pectoral fins in large specimens. All gill rakers of first arch non-dentigerous. Caudal fin with 12–14 branched rays.

Remarks: This subgenus comprises 2 closely related species that differ primarily in head scalation, number of dorsal-fin rays and lateral scales. Andersen (1984: 24) synonymized *Lindbergichthys* with *Nototheniops* on the basis of the "Autapomorphy: upper *(sic)* lateral line with perforated scales." We presume that he is referring to

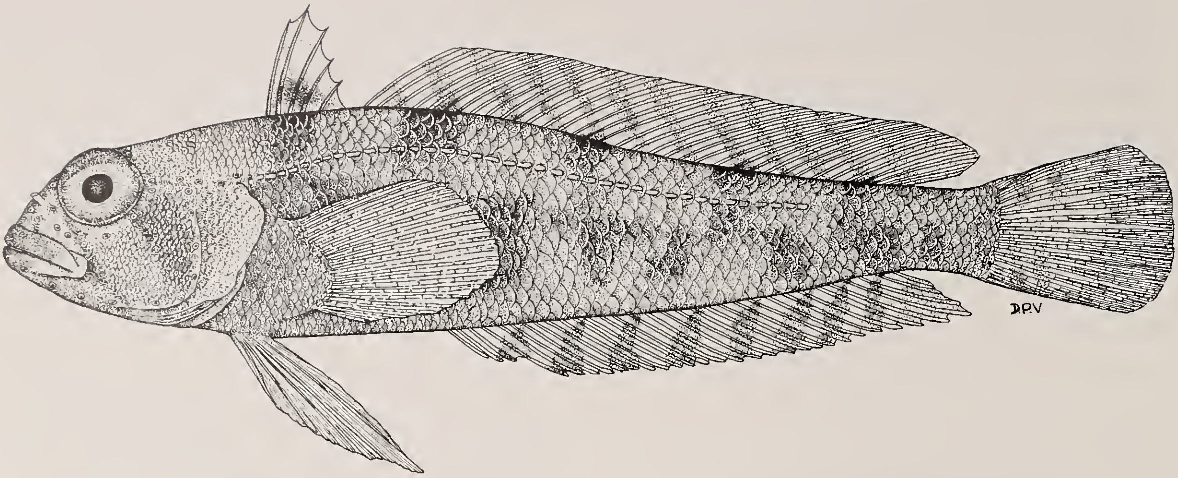


Fig. 21. *Lepidonotothen mizops* BMNH 1937.9.21.48, 64.2 mm SL, Kerguelen Islands, Bras Bolinder

the *middle* lateral line of these species, which is represented by perforated rather than tubed scales. This condition is equivalent to a "loss character" (i.e. loss of the lateral line tubes on the midlateral scales) and is, therefore, less certain as truly apomorphic for these taxa Although we believe that *Lindbergichthys* and *Nototheniops* are closely related (hence their assignment here to the same genus), it is not clear to us that they are more closely related to one another than to the subgenus *Lepidonotothen*.

KEY TO SPECIES

1a Scales present on occipital region of head; D_2 34–37; LSS 48–55; D_1 distinctly separate from D_2 (sub-Antarctic islands of Indian Ocean sector) .... *L. mizops*

1b Scales usually absent on occipital region (rarely a few present); D_2 36–40; LSS 50–64; D_1 connected by membrane to proximal third of first D_2 ray (South Georgia, islands of Scotia Arc and Antarctic Peninsula)............ *L. nudifrons*

Lepidonotothen (Lindbergichthys) mizops
(Günther, 1880)
Toad notothen
Fig. 21

Notothenia mizops Günther, 1880: 16, pl. 8, fig. D, Kerguelen Islands. Syntypes: BMNH 1879.14.351–355.

Diagnosis: D IV–V+34–37; A 33–35; P 20–22; GR (5–7)+(11–12) = 16–19; ULL 35–41; vertebrae (14–16)+(33–36) = 48–50. Body depth 4.3–5.3 and head length 3.4–3.8 in SL. Eye diameter 2.7–3.4 and snout length 3.5–4.1 in HL. Interorbital width 3.3–6.2 in eye diameter. Pelvic fin length 1.0–1.4 and pectoral fin length 1.1–1.9 in HL; pelvic fins longer than pectorals in small specimens, about equal to pectorals in large specimens. Teeth in jaws conical, outermost enlarged, but not forming true canines. Lateral gill rakers of first arch slender and elongate, slightly flattened dorsoventrally, and occasionally bifid; medial gill rakers also elongate; all non-dentigerous. Preopercular-mandibular canal with 10 pores; infraorbital canal usually with 7 (occasionally 6) pores; supraorbital canal with 4 pores; coronal commissure with 1 pore; temporal canal with 5–6 pores; supratemporal canal with 3 (occasionally 4) pores. Second spine of first dorsal fin longest. Most body scales ctenoid; non-ctenoid scales present on cheeks, opercles and on top of head behind eyes (extending anteriorly to coronal pore); Norman (1938: 17) states that the interorbital region is scaly, but we have been unable to find such scales in our material; remainder of head naked.

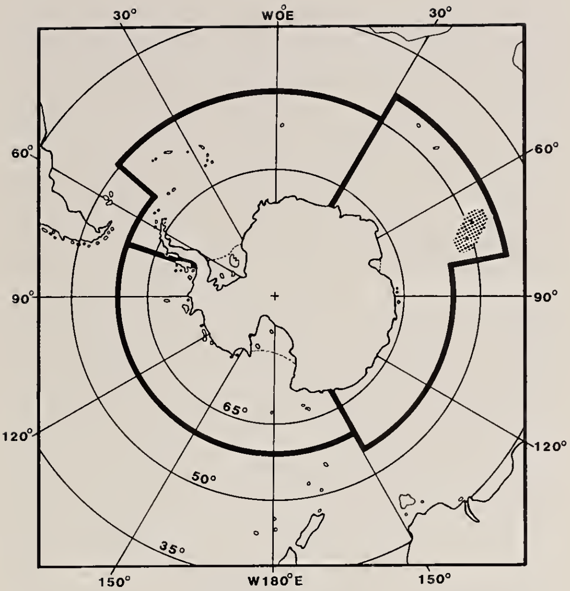
COLOUR: In alcohol, 5 dark bars across back, from beneath first dorsal fin to posterior end of second dorsal fin, the dark colour continued up onto fins; 5 dark blotches below midline, not aligned with upper bars, together creating a slight checkerboard effect; a median dark blotch at base of caudal fin and a similar blotch anterior to base of pectoral fin. Upper parts of head dark, including snout and upper lip; opercles dark with lighter mottling. Two dark stripes on cheek, first a continuation of dark pigment of preorbital extending along ventral edge of preopercle, second extending from posteroventral margin of eye to angle of preopercle. Lower parts of body pale. Second dorsal fin with short dark lines extending posteroventrally from margin; similar lines on anal fin extend nearly vertically from edge of fin; uppermost and lowermost rays of caudal fin with series of spots. The colour pattern is shown well in Günther's (1880) figure except that it shows no anal fin lines and the caudal fin has faint bars.

Distribution: Known from Kerguelen and Heard islands (Balushkin (1976b) includes the Prince Edward and Crozet islands). Depth range 20–220 m.

Remarks: The low count of 26 upper lateral line scales given by Hureau (1985f) is probably taken from DeWitt (1966) who recorded it (without explanation) from one side of a small (58.5 mm) specimen (BMNH 1937.9.21.67). We feel that this unusually low count is probably due to incomplete development of tubes in the scales of this specimen.

The figure published by Günther (1880: pl. 8, fig. D) is excellent, except that it shows the middle lateral line with tubed scales. It would appear that Günther's figure is the source for those in Hureau (1985f: 362- 363), for they also show the middle lateral line with tubed scales. All of the specimens of this species that we have examined, including Günther's syntypes, lack tubed scales in the middle lateral line.

Attains about 150 mm.



Distribution of *L. mitops*

Lepidonotothen (Lindbergichthys) nudifrons
(Lönnberg, 1905)
Gaudy notothen
Fig. 22

Notothenia mizops var. *nudifrons* Lönnberg, 1905b: 30, pl. 1, fig. 2, South Georgia Island. Lectotype: NRM SYD/1902203.9274.

Diagnosis: D IV–VI+36–40; A 33–36; P 21–23 (one side of one fish with 24); GR (5–6)+(11–14) = 16–22; ULL 33–42; vertebrae (15–16)+(34–38) = 50–53. Body depth 4.4–5.6 and head length 3.0–3.6 in SL. Eye diameter 2.9–3.6 in HL, greater than snout length which is 3.5–3.9 in HL. Interorbital width 1.9–7.2 in eye diameter, becoming relatively narrower in larger specimens. Last spine of first dorsal fin joined by membrane to proximal third of first dorsal soft ray; second spine of dorsal fin longest. Pectoral fin length 1.0–1.3 and pelvic fin length 1.2–1.4 in HL. Pectoral fins longer than pelvic fins in smaller specimens, but becoming subequal in specimens of about 12 cm or more. Teeth conical, in 2 distinct bands in each jaw, the outer essentially a uniserial row of larger teeth, but not truly canine-like. Largest gill rakers of outer (lateral) series of first arch moderately elongate, flattened, and non-dentigerous; inner (medial) gill rakers conical in cross section and also non-dentigerous. Preopercular-mandibular canal with 10 pores; infraorbital canal with 7 pores; supraorbital canal with 4 pores; coronal commissure with 1 medial pore; temporal canal with 5–6 (rarely 4)pores; and the supratemporal canal with 3 (rarely 2) pores. Most body scales ctenoid; upper surface of head (including interorbital space), snout, preorbitals, and ventral parts of head naked; non-ctenoid scales on cheek extending to preorbital, on operculum, in angle made by temporal and supratemporal lateral-line canals, and in triangular area formed by head and posttemporal bone.

Colour: In alcohol, 5 dark bars cross back, first at origin of first dorsal fin, others under second dorsal, and may be continued below midline almost to anal fin; some lower extensions are offset anteriorly or posteriorly; additional fainter bars may be present between the 5 dark bars. Dark blotch at base of caudal fin. Dark pigment may be present along midside tending to obscure bars. First dorsal fin with an intense black spot; second dorsal fin with dark bands extending posteroventrally. Anal fin with about 9–10 short, subvertical, dark lines. Uppermost and lowermost caudal-fin rays with 4 narrow cross bars; other rays with 1–2 spots near tips forming cross bars. Upper parts of head, including preorbitals, dark; 2 dark stripes on cheek, lower continues dark of preorbital to middle of lower edge of preopercle, upper extends from posteroventral margin of eye toward angle of preopercle. Upper lip usually dark.

In life, mature males of *L. nudifrons* are one of the most brightly coloured fishes of the Antarctic. The following notes were taken from a Kodachrome transparency of a freshly caught specimen. Upper and lateral parts of body with a warm orange-brown ground colour; bars on side of body (as described for preserved specimens) brown. Ventral parts paler, with belly and isthmus white; a silvery area present anterior to bases of pectoral and pelvic fins. First dorsal fin orange, with a large black spot; second dorsal fin orange, with short yellow bars running posteroventrally from distal edge and a few

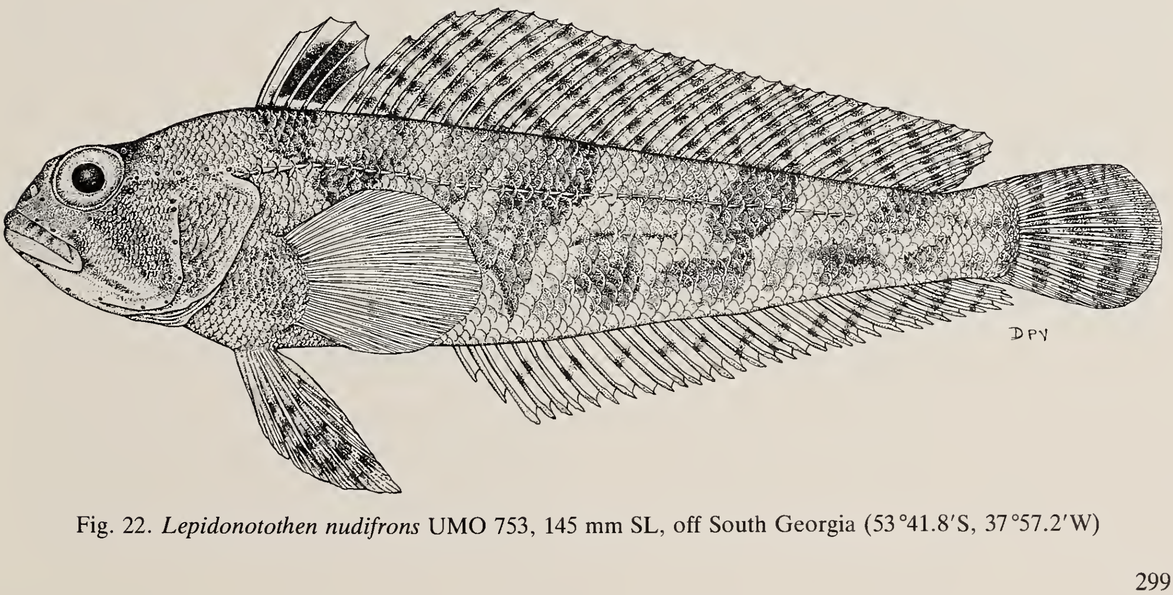


Fig. 22. *Lepidonotothen nudifrons* UMO 753, 145 mm SL, off South Georgia (53°41.8′S, 37°57.2′W)

scattered brownish markings present on some rays. Anal fin with alternating orange-brown and yellow bars running posterodorsally from distal margin. Pectoral fins orange, darker distally. Pelvics pale yellow, with faint orange-brown cross-bars. Caudal fin with alternating orange-brown and pale yellow bars, the yellow bars broadest near base of fin and becoming progressively narrower posteriorly, the orange-brown bars varying inversely in width; the fin thus appears yellowish basally and orange-brown distally. Immature males and adult females are nearly uniformly yellow or a pale yellowish-brown; the fins have brownish bars (Hourigan & Radtke 1989; Kock 1989).

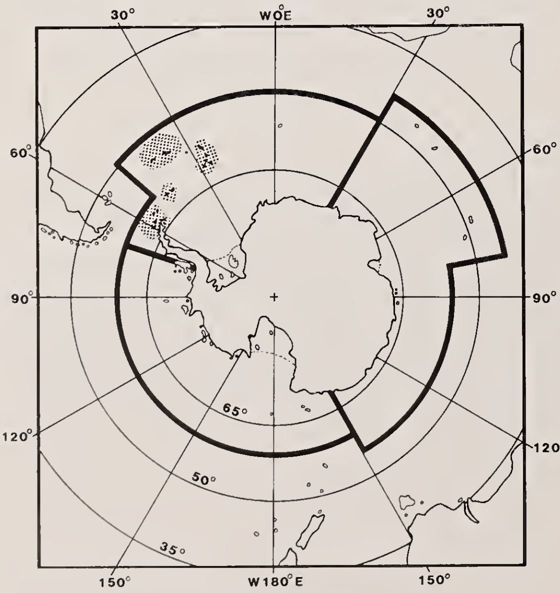
Otoliths

Diagnostic features: The ovate to pyriform shape, the separated ostium and cauda, the characteristic mid-ventral bulge of the crista inferior, and the crista superior which is only present over the ostium.

Intraspecific variation: Negligible, except for minor variation in the shape of the cauda and the sculpture of the margin.

Fig. 23. Representative otolith of *L. nudifrons*; fish length 170 mm TL; scale bar 1 mm

Distribution: Scotia Arc, from the Antarctic Peninsula and associated islands northward to South Georgia at depths of 5–350 m.



Distribution of *L. nudifrons*

Remarks: The head scalation of *L. nudifrons* may rarely vary from the above description and is one of the reasons why it is considered a close relative of *L. mizops*. In 1 specimen of the type series (NRM SYD/1902192.9273) there is a roughly oval-shaped patch of scales in the middorsal line posterior to the coronal pore, the patch not extending posteriorly to the hind edge of the head. In addition, there is on each side above the temporal canals a rather large triangular patch of scales which extends toward, but does not reach, the middorsal line along the anterior edge of the supratemporal canal.

Length at sexual maturity in Low Island, Antarctic Peninsula, was 9.0–9.5 cm SL in both sexes (Hourigan & Radtke 1989). Length at first spawning was 12.4 in females and about 13 cm TL in males in Elephant Island (Kock 1989) and 12–14 cm TL in females in the Antarctic Peninsula (Hourigan & Radtke 1989). According to Kellermann (1989) and Hourigan & Radtke (1989), spawning is intermittent, from April–May to October. The eggs are relatively small, about 2.5 mm in diameter (Kock 1989), demersal, and are laid in nests near or under the cover of rocks. The nest is guarded by the male for about 4 months (Hourigan & Radtke 1989). Larvae, about 7.0 mm TL at hatching, were found in the shelf water of the Antarctic Peninsula and Scotia Sea islands from September to April (Efremenko 1983; Hourigan & Radtke 1989; Kellermann 1989). Absolute fecundity gradually decreased latitudinally, from 1,646–6,886 eggs (fish length 12–18 cm TL) in South Georgia (Permitin & Sil'yanova 1971) to 110–3,460 eggs (fish length 11–17 cm TL) in the South Shetland Islands (Hourigan & Radtke 1989). In Kock (1989: table 5), data on the absolute fecundity of *N. neglecta* from Adélie Land (Hureau 1970) were inadvertently referred to *L. nudifrons*.

L. nudifrons is a benthic species that feeds mainly on epifauna (polychaetes, gammaridian amphipods and isopods); with increasing size, *L. nudifrons* also feeds on fish eggs and shrimp (Targett 1981). Small specimens may also feed extensively on copepods (Richardson 1975).

Attains 190 mm TL.

Subgenus *Nototheniops* Balushkin, 1976

Preorbitals and snout scaly; no scales on eyes. Body with only 1 lateral line (upper) with tubed scales. Pectoral fins subequal to or longer than pelvics. First and 2nd spines of first dorsal fin subequal, longer than 3rd spine; membrane from last spine connected to base of 1st soft ray. Branched caudal-fin rays 14–15. A band of small, sharp, conical teeth at front of jaws, becoming uniserial posteriorly, the uniserial and outer teeth slightly enlarged. Outer gill rakers of 1st arch rather long, slender and non-dentigerous, the rest dentigerous. Vertebrae (15–17)+(34–41) = 51–57.

Remarks: Balushkin (1976b) described a "*larseni*" group of species in the genus *Notothenia* comprising *Notothenia larseni* Lönnberg and 3 allopatric new species (*N. nybelini, N. loesha* and *N. tchizh*). The sample sizes of Balushkin's new species (9 specimens of *nybelini* and 5 of each of the other 2 species) were too small to give an accurate picture of the meristic and morphometric variation of these allopatric populations. This led Gon & Klages (1988) to question the validity of Balushkin's 3 new species. Moreover, the data published by Shandikov (1985) for a large sample of *N. tchizh* (n = 91) from the Lena Bank show that the intra-populational variation in the morphometric and meristic characters of this single "species" is sufficient to encompass or greatly overlap the ranges for the 3 other "species". Our examination of specimens from the localities of *larseni, nybelini* and *tchizh* has convinced us that the supposed differences in scalation of the lower jaw and coloration for these species (Balushkin, 1976b) are obscured by the ontogenetic and individual variation of these characters. Consequently we regard Balushkin's 3 new species as synonyms of *Lepidonotothen larseni*.

Although we have decided to synonymize the 4 species of the "*larseni*" group, this does not imply that we believe there are no statistically significant differences in the various isolated populations of these nominal species. Indeed, Shandikov & Parukhin (1987) have demonstrated that there are differences in some morphometric and meristic characters of the populations of "*Nototheniops tchizh*" at the Ob' and Lena banks southeast of the Prince Edward Islands. The Ob' Bank is 360 miles from Marion Island, and the Lena Bank is only 100 miles from the Ob'. If one were to accord taxonomic status to every isolated population of nototheniid that shows "statistically significant" differences in some characters, the plethora of new species and subspecies would debase the species-level taxonomy of nototheniids to the extent that the species category in this group would have little biological or phylogenetic meaning.

The relationships of *Nototheniops* were discussed under the *Remarks* section of the subgenus *Lindbergichthys* above.

Lepidonothen (Nototheniops) larseni
(Lönnberg, 1905)
Painted notothen
Fig. 24

Notothenia larseni Lönnberg, 1905b: 31, pl. 1, fig. 3; pl. 2, fig. 6, Shag Rocks and South Georgia. Syntypes: NRM SYD/1902166.3009; SYD/1902234.3010 & 9361.

Notothenia nybelini Balushkin, 1976b: 8, figs. 1a, b & 3, Mordvinov Island, South Shetland Islands.

Notothenia loesha Balushkin, 1976b: 11, fig. 4, Sturge Island, Balleny Islands.

Notothenia tchizh Balushkin, 1976b: 12, figs. 1c, 5, Lena Bank (53°S, 45°E).

Diagnosis: D V–VII+35–40; A 34–39; P 23–27; GR (7–10)+(13–19)=22–29; ULL 52–56; vertebrae (15–17)+(34–41)=51–57. Body depth 4.5–7.7 and head length 3.0–4.0 in SL. Eye diameter distinctly greater than snout length, 2.5–3.2 in HL. Interorbital width 3.1–5.1 in eye diameter. Body and head mostly covered with ctenoid scales; lower jaw with or without scales. Preopercular-mandibular canal with 10 pores; infraorbital canal with 7 pores; supraorbital canal with 4 pores; coronal commissure with 1 median pore; temporal canal with 5–6 pores; and supratemporal canal with 2–3 pores.

Colour: Body dorsally and laterally with 3 or 4 irregular, dark, oblique bands, extending onto proximal part of dorsal fin as blackish-brown blotches. Tip of first dorsal fin black. Second dorsal fin with oblique dark bands. Area between pectoral and pelvic fins pale. Shandikov (1985) noted sexual dichromatism in mating fishes.

Otoliths

Diagnostic features: The ovate to fusiform shape, the constricted collum and the separate ostium and cauda, the prominent ventral area in larger fish in association with the crista superior which is only well developed over the ostium.

Intraspecific variation: Negligible, except for slightly variable shape.

Ontogeny: In fish greater than 15 cm TL the crista inferior changes from being only bulbous below the collum to broad and prominent below the entire sulcus acusticus, and in fish greater than 18 cm TL the ventral area becomes prominent.

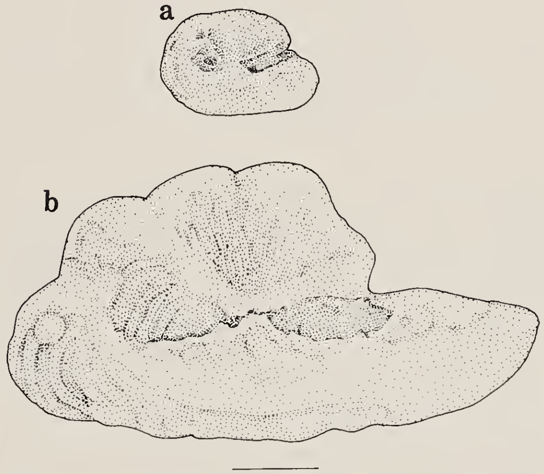


Fig. 25. Representative otoliths of *L. larseni*; fish lengths: (a) 64 mm and (b) 206 mm TL; scale bar 1 mm

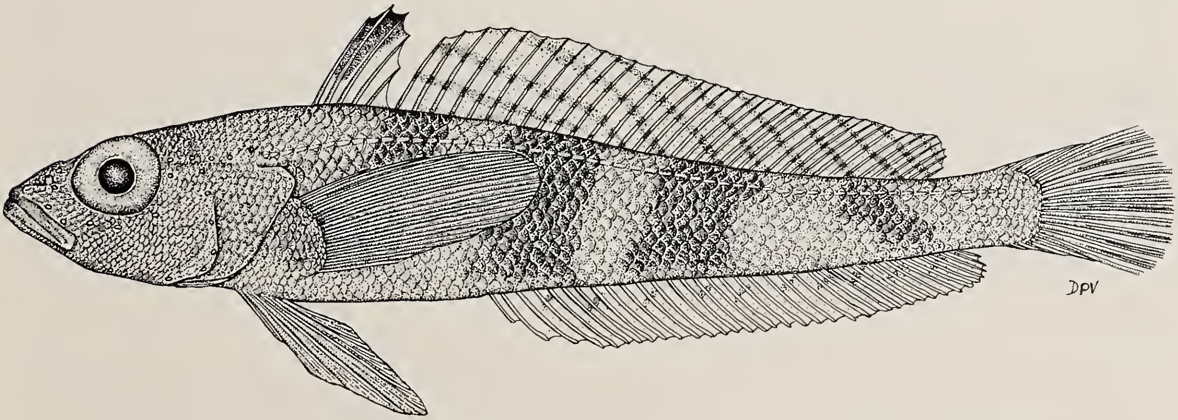
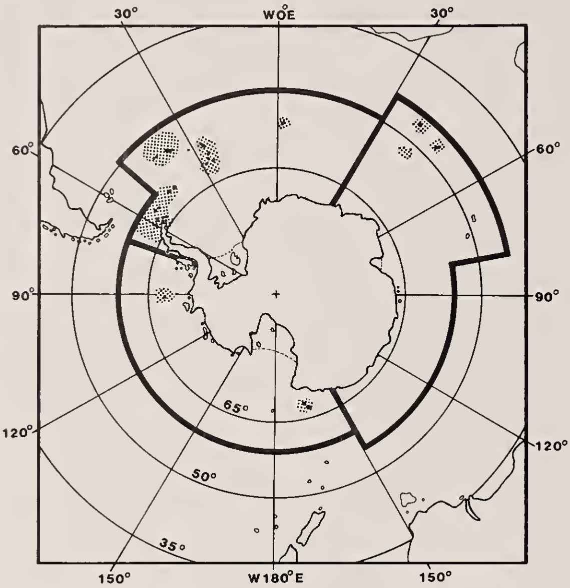


Fig. 24. *Lepidonotothen larseni* BMNH 1937.7. 12.116–123, 73.1 mm SL, South Georgia Island

Distribution: Balleny Islands, Peter I Island, Palmer Archipelago, Graham Land, South Shetlands, South Orkneys, South Sandwich, South Georgia, Shag Rocks, Bouvet, and sub-Antarctic islands and seamounts of the Indian Ocean Sector (except Kerguelen, Heard, McDonald and Macquarie islands and Kara Dag seamount). Depth range 30–550 m.



Distribution of *L. larseni*

Remarks: Length at sexual maturity, 11–12 cm TL, is known only for fishes from the Crozet Islands (Duhamel & Pletikosic 1983). Length at first spawning is slightly larger, 12–13 cm TL in Crozet Islands (Duhamel & Pletikosic 1983), Ob' and Lena banks (Shandikov 1985), and Elephant Island (Kock 1989). Spawning takes place in June–July in South Georgia (Sil'yanova 1981), July–August in Elephant Island (Kock 1989) and Ob' and Lena banks (Shandikov 1985), but from March to June in Crozet Islands (Duhamel & Pletikosic 1983). Hatching occurs in September in South Georgia (Efremenko 1983) and in October in the Antarctic Peninsula (Kellermann 1989). In the Indian Ocean sector, hatching in Ob' and Lena banks is probably concurrent with South Georgia, but earlier in Crozet Islands. Length at hatching is about 8.0 mm TL (Kellermann 1989). Absolute fecundity varied from 2,000–12,000 eggs (fish length 14–21 cm TL) in South Georgia (Permitin & Sil'yanova 1971; Lisovenko & Sil'yanova 1979), to 1,851–7,127 eggs (fish length 14–21 cm TL) in the South Orkney and Elephant islands (Permitin & Sil'yanova 1971; Kock 1989), to 1,041–4,575 eggs (fish length 13.0–17.5 cm TL) in Ob' and Lena banks (Shandikov 1985), and to 1,600–3,060 eggs (fish length 11.5–13.7 cm TL) in Crozet Islands (Duhamel & Pletikosic 1983). Egg size, 2.0–2.2 mm diameter, in the Indian Ocean sector (Duhamel & Pletikosic 1983) was somewhat higher than the 1.6–2.0 mm measured in fishes of the Atlantic Ocean sector (Permitin & Sil'yanova 1971; Kock 1989).

The presence of pelagic larvae and juveniles in the Antarctic Peninsula throughout spring and summer led Kellermann (1989: fig. 9) to propose a long pelagic phase of well over a year for this species, leaving the time of transition to benthic life an open question. In Marion Island, the largest pelagic larvae (32 mm TL; RMT 2) and benthic juveniles (45.5–57.6; dredge) were collected in April. It appears therefore, that the pelagic phase at Marion Island lasts throughout spring and summer and the shift to benthic life occurs during autumn or winter. Assuming a similar pattern in the Antarctic Peninsula, another interpretation of Kellermann's (1989) observations may be that small juveniles return to the pelagic zone in the second spring and summer to feed on abundant zooplankton.

In South Georgia, *L. larseni* feeds mainly on krill, hyperiid amphipods and mysids (Permitin & Tarverdiyeva 1972; Targett 1981). Takahashi (1983) reports that this species feeds mainly on krill in the South Shetland Islands. Targett (1981) found that juveniles feed on calanoid copepods as well as krill, but that adults feed mostly on krill.

Attains 24 cm.

Genus *Notothenia* Richardson, 1844

Body oblong, robust, compressed posteriorly. Head large, 2.9–3.5 in SL. Mouth large, the lower jaw not projecting, the maxilla reaching well past front of eye (upper jaw length distinctly greater than interorbital width); teeth moderate, no large canines. Interorbital width greater than 15% HL. Eye small, its diameter less than or equal to interorbital width and usually distinctly less than snout length. Pores of cephalic sensory canals not enlarged; coronal commissure and supratemporal canal complete (Fig. 1g). Two lateral lines with tubed scales; upper lateral line running straight along dorsolateral part of body from upper end of gill opening to below rear third of dorsal fin; middle lateral line not extending forward beyond middle of dorsal fin. Body scales mostly smooth (non-ctenoid); snout, preorbital and upper part of head naked (temporal scales present behind eyes). No fin spines or rays elongated. Pectoral fins distinctly longer than pelvics. Caudal fin rounded, truncate, or emarginate, with 14 branched rays. Gill rakers short and flattened, 10–15 on lower limb of first arch, those near the angle often bifid; most of the lateral gill rakers on the first arch are non-dentigerous, but most of the others bear minute teeth. Branchiostegal rays 6, the membranes broadly united to one another and to isthmus. Pectoral foramen bordered by scapula and coracoid. Vertebrae (16–21)+(30–35) = 46–55.

Remarks: Our concept of this genus comprises 5 species, including *N. cyanobrancha,* which Balushkin (1984) assigned to a new monotypic genus, *Indonotothenia*. We have already discussed our disagreement with Andersen's (1984) inclusion of *Gobionotothen* and *Lepidonotothen* in the genus *Notothenia* (see accounts of these 2 genera above). *N. cyanobrancha* seems less closely related to the other species of *Notothenia* than they are to one another (see key and species account for *cyanobrancha* below), and it would be justified to recognise *Indonotothenia* as a separate genus if this would serve some useful purpose. But it also seems to us that *cyanobrancha* is more closely related to the other species of *Notothenia* than to any other nototheniids. The large, mostly naked head, with its large mouth and wide interorbital space, and the loss of ctenii from most of the scales appear to be derived homologous features that indicate (to us) a congeneric relationship for *Indonotothenia* and *Notothenia.*

Of the 5 species here assigned to this genus, 2 (*N. angustata* and *N. microlepidota),* both described by Hutton (1875) are extralimital to the Southern Ocean and are not treated in this work.

KEY TO SUBGENERA AND SPECIES

1a Interorbital width 15–20% HL (specimens > 10 cm SL), not more than eye diameter; preorbital section of infraorbital canal with 4 pores (only 2 on ventral edge of preorbital next to upper lip), the 1st pore close to nostril and below or slightly behind it ....(subgenus *Indonotothenia*)
....*N. cyanobrancha*

1b Interorbital width 22–25% HL (specimens > 10 cm SL), greater than eye diameter; preorbital section of infraorbital canal with 5–6 pores (3 or 4 at or near ventral edge of preorbital), the 1st pore usually anterior to a vertical through nostril..........................(subgenus *Notothenia)* 2

2a P 20–24; preopercular-mandibular canal with 10 pores .....
....*N. rossii*

2b P 16–19; preopercular-mandibular pores 8–9 ....
....*N. coriiceps*

Subgenus *Indonotothenia* Balushkin, 1984

Otic capsules expanded, protruding laterally from skull. Orbital process of lateral ethmoid not articulated with lower ridge of frontal bone. Parasphenoid narrow, its width about 20 times in skull length. No sutured articulation between ceratohyal and epihyal. Four separate "postlacrimals". No uncinate process on hyomandibula. Preorbital section of infraorbital canal with 4 pores, the 1st pore close below and slightly posterior to nostril; preopercular-mandibular canal not connected to temporal canal. Upper jaw with 2 rows of small, conical teeth; lower jaw with a single row of larger, spaced teeth. Vertebrae (16–17)+(30–32) = 47–49.

Remarks: This subgenus comprises a single species. The diagnosis above was compiled mainly from Balushkin (1984).

Notothenia (Indonotothenia) cyanobrancha
Richardson, 1844
Bluegill notothen
Fig. 26

Notothenia cyanobrancha Richardson, 1844b: 7, pl. 4, Kerguelen Islands. Holotype: BMNH 1965.7.3.2.

Notothenia purpuriceps Richardson, 1844b: 7, pl. 2, figs. 3–4, Kerguelen Islands.

Diagnosis: D IV–VI+33–36; A 30–34; P 20–21; GR 5+(10–13) = 15–18; ULL 31–39; MLL 4–15. Body depth 4.0–5.0 and head length 3.0–4.0 in SL. Eye diameter less than or subequal to snout length, 4.0–6.5 in HL. Interorbital width subequal to eye diameter, 5.0–6.5 in HL. Body scales non-ctenoid except for scales covered by pectoral fins; dorsal part of cheek and operculum with non-ctenoid scales, the rest of head, except for angle of temporal and supratemporal canals, naked. Infraorbital canal with 6–7 pores; preopercular-mandibular canal with 10 pores; supraorbital canal with 4 pores; coronal commissure with 1 median pore; temporal canal with 6 pores; and supratemporal canal with 3–4 pores.

Colour: In life, uniformly dark brown, paler ventrally. Margin of opercular membrane dark-blue.

Otoliths

Diagnostic features: The oval shape, the separate ostium and cauda in specimens 10 cm TL and the generally occurring middorsal and midventral marginal indentations.

Intraspecific variation: Negligible, except the middorsal and ventral marginal indentation sometimes absent.

Fig. 27. Representative otoliths of *N. cyanobrancha*; fish lengths: (a) 100 mm and (b) 180 mm TL; scale bar 1 mm

Distribution: Known only from shallow water (0–20 m) at Kerguelen and Heard islands.

Remarks: Data on the reproduction of this species are from Hureau (1970). Sexual maturity is reached at the age of about 3–4 years and a length of about 100 mm TL. Spawning takes place in April, but first time spawners apparently spawn in January. Egg diameter was

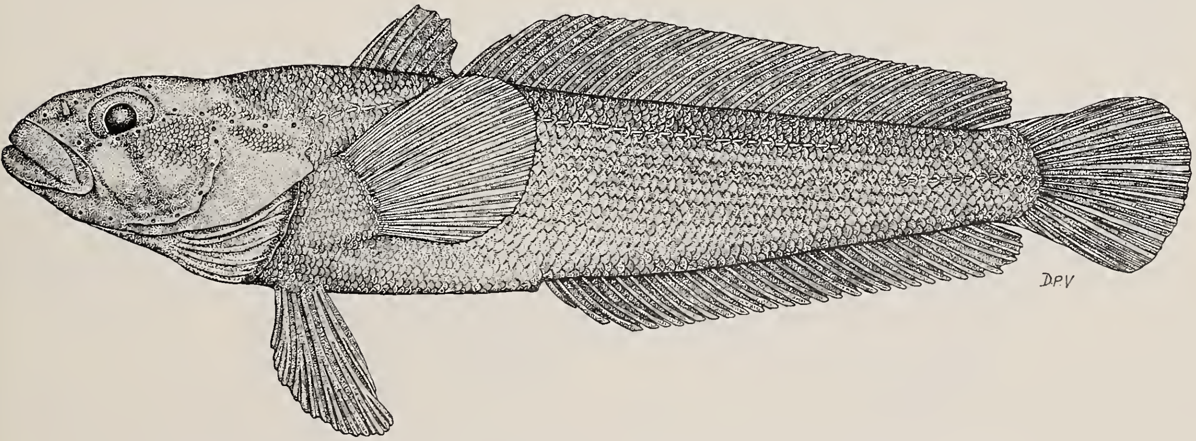
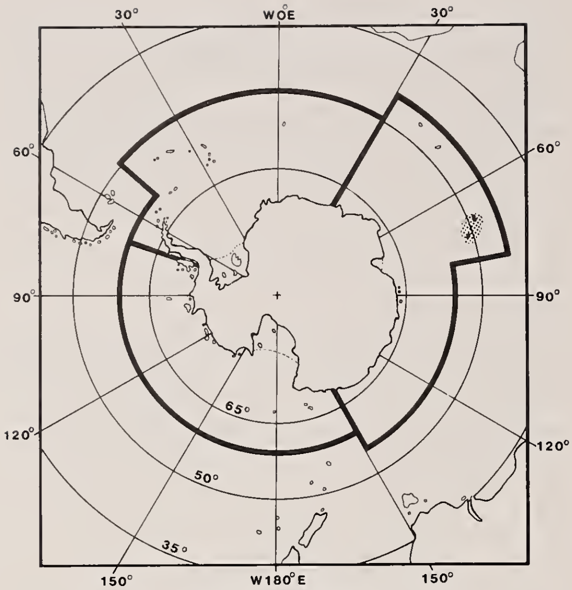


Fig. 26. *Notothenia cyanobrancha* MNHN 1987–675, 70.5 mm SL, Kerguelen Islands



Distribution of *N. cyanobrancha*

1.3–1.6 mm and absolute fecundity 20,000- 30,000 eggs (fish length not stated).

N. cyanobrancha is a benthic species; it feeds mainly on amphipods, isopods (*Exsosphaeroma gigas*; *Serolis* sp.), the decapod *Halicarcinus planatus*, and molluscs of the *Patinigera* group (Hureau 1970, 1985f).

Attains 30 cm.

Subgenus *Notothenia* Richardson, 1844

Otic capsules not expanded laterally. Orbital process of lateral ethmoid articulated with ventral surface of frontal bone. Parasphenoid width contained 9–12 times in skull length. Ceratohyal and epihyal joined by a sutured articulation. Only 3 "postlacrimals" (the 3rd and 4th have fused). Uncinate process present on hyomandibula just anterior to opercular condyle (Balushkin 1984). Infraorbital canal with 8–10 (rarely 7) pores, the preorbital section with 5–6 pores (3–4 at or near ventral edge of preorbital), the anterodorsal most pore anterior to a vertical at anterior edge of nostril. Interorbital width 22–25% HL. Top of head and parts of cheeks and operculum covered with small dermal papillae. Upper jaw with 4–10 rows of minute teeth and an outer series of teeth 2–3 times larger than inner teeth; lower jaw with band of small teeth anteriorly (the outer teeth enlarged), narrowing to a single series of larger teeth posteriorly. Vertebrae (19–21)+(31–35) = 51–55.

Remarks: Fingerlings more or less pelagic, with deeply emarginate or forked caudal fins and silvery sides, those of most species sometimes found in open water over great depths.

Notothenia (Notothenia) coriiceps
Richardson, 1844
Bullhead notothen

Fig. 28; Pl. 5, Fig. 2

Notothenia coriiceps Richardson, 1844b: 5, pl. 3, figs. 1–2, Kerguelen Islands. Holotype: BMNH 1965.7.3.1.

Notothenia neglecta Nybelin, 1951: 17, Leith Harbour, Stromnes Bay, South Georgia.

Diagnosis: D III–VII+35–40; A 26–32; P 16–19; GR (4–7)+(12–14) = 16–21; ULL 34–49; MLL 6–17. Body depth 4.0–5.0 and head length 3.0–3.6 in SL. Eye diameter distinctly less than snout length, 5–6 in HL, and 1.2–2.2 in interorbital width. Interorbital 3.0–4.5 in HL. Body scales mostly non-ctenoid (anterior half of body with ctenoid scales in some specimen); head mostly covered with small dermal papillae; a few embedded, non-ctenoid scales behind eyes and in temporal region. Infraorbital canal with 7–11 pores; preopercular-mandibular canal joined to temporal canal and with 8–9 pores; supraorbital canal with 4–5 pores; coronal commissure with 1 median pore; temporal canal with 6–7 pores; and supratemporal canal with 3–4 pores.

Colour: In life, variable; in South Georgia, benthic juveniles usually brightly coloured with crimson, orange and yellow, but may also be nearly as dark as adults. Adults more or less dark brown with pale brown, black or greenish spots, the belly and underside of head yellow, becoming yellow-green or greenish with age; adults in South Orkney Islands and Antarctic Peninsula area are whitish grey on belly and underside of head. Pelagic and recently demersal juveniles silvery steel blue dorsally and whitish grey ventrally, the fins colourless except distal third of pectorals conspicuously black.

Otoliths

Diagnostic features: The ovate shape, the crenate dorsal surface of the crista inferior, the crenate to sinuate margin and the partially divided ostium and cauda.

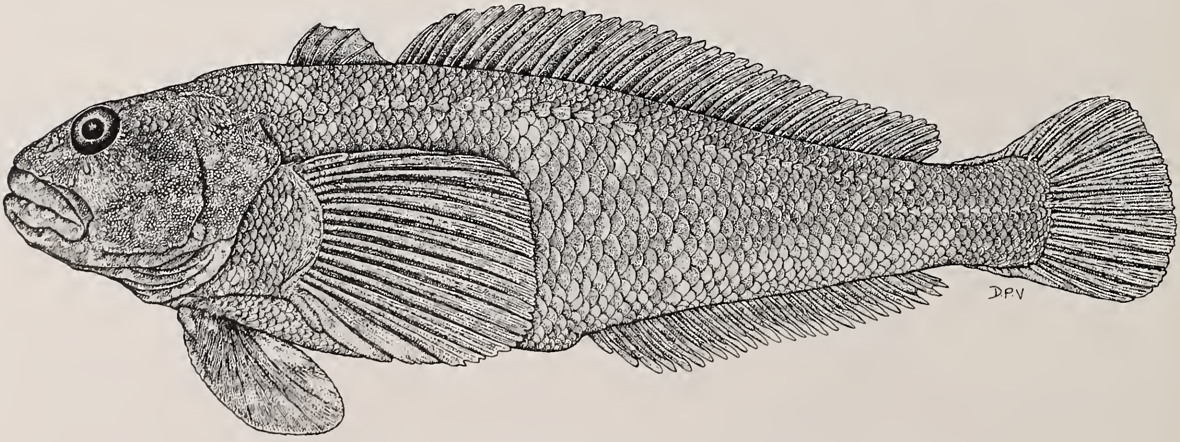


Fig. 28. *Notothenia coriiceps* RUSI 18233, 37 cm SL, Marion Island

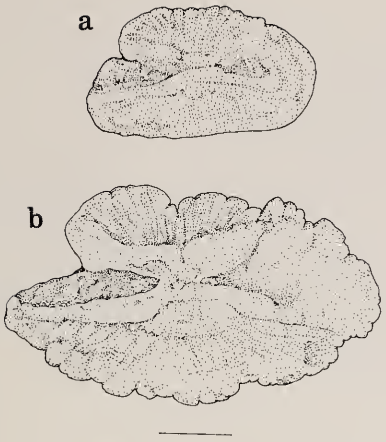
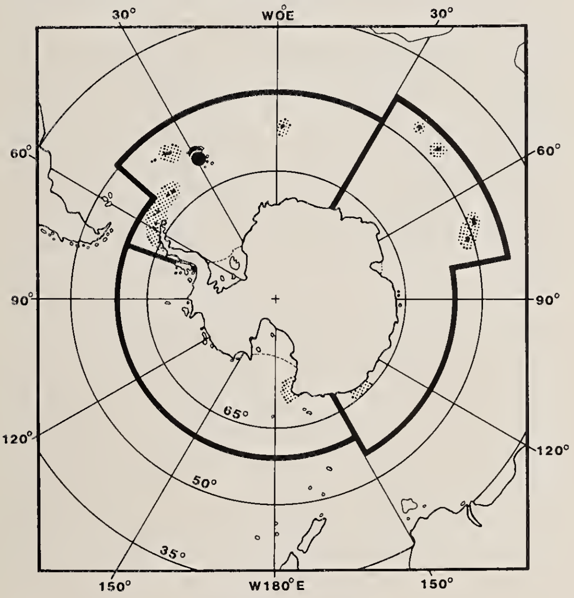


Fig. 29. Representative otoliths of *N. coriiceps*; fish lengths: (a) 21 cm and (b) 46 cm TL; scale bar 1 mm

Intraspecific variation: Rounded posterior margin sometimes entire, rostrum either pointed or rounded distally.

Ontogeny: In fish less than 120 mm SL, the margin is entire, whereafter it becomes sinuate to dentate. The raised collum becomes more constricted in fish greater than 120 mm SL.

Distribution: Probably circum-Antarctic on the continental shelf, but still unknown from most of the Antarctic coastline. Known from the western Ross Sea, Balleny islands, Adélie Land, Antarctic Peninsula and associated islands, islands of the Scotia Arc to South Georgia, Weddell Sea, Bouvet,and the sub-Antarctic islands of the Indian Ocean sector. Depth range: 0–550 m, but most common in less then 200 m.



Distribution of *N. coriiceps*

Remarks: *N. coriiceps* is a widely distributed shallow-water species and, as expected, it exhibits considerable variation in meristic and morphometric features throughout its range. Nybelin (1951) described *N. neglecta* as a new species from islands of the Scotia Arc and Palmer Archipelago. Because of Nybelin's small sample size for *N. coriiceps* (only 2 specimens from the type-locality) and the intermediacy of the 2 specimens examined by Nybelin from Crozet and Heard islands, DeWitt (1966) demoted *N. neglecta* to a subspecies of *N. coriiceps*. In view of the intermediacy of specimens that we have examined from Marion Island, and the probable diminution of the supposed differences between these 2 taxa when additional specimens from the Kerguelen Islands are examined, we do not believe that recognition of *N. neglecta* as a distinct species or subspecies is justified. Gon & Klages (1988) compared data from 14 Marion Island specimens with published data from other localities and arrived at the same conclusion regarding the synonymy of *N. coriiceps* and *N. neglecta*.

The widespread distribution of this shallow-water benthic species is undoubtedly due to the pelagic habit of the fingerlings, which have been collected in mid-ocean.

Length at sexual maturity was 34–35 cm TL in the South Orkneys and Elephant Island (Everson 1970a; Kock 1989). In Adélie Land, the smallest mature female and male were 22.5 cm (8 years) and 18.0 cm (7 years) respectively (Hureau 1970). Spawning takes place in April–May in South Georgia (Burchett *et al.* 1983), May in the South Orkney Islands (Everson 1970a), May–June in Elephant Island (Kock 1989), and January in Adélie Land (Hureau 1970). Larvae appear in the water column in October–November in South Georgia (White *et al.* 1982; Burchett *et al.* 1983) and in December in the Antarctic Peninsula (Kellermann 1989), South Orkneys (Everson 1970a), and Elephant Island (Kock 1989). Size at hatching is about 12 mm SL (White *et al.* 1982; Kellermann 1989). The pelagic phase lasts over a year in the South Orkney Islands and the Antarctic Peninsula (Everson 1970b; Kellermann 1989). Egg diameter varied from 1.2 mm in Adélie Land (Hureau 1970) and 3.0–3.2 mm in the South Orkneys (Everson 1970a) to 4.1 mm in South Georgia (Burchett *et al.* 1983) and 4.6 mm in Elephant Island (Kock 1989). Absolute fecundity was 36,397–48,383 eggs (fish length unknown) in South Georgia (Burchett *et al.* 1983), 15,800–32,700 eggs (fish length 36.3–47.3 cm) in the South Orkneys (Bellisio 1964), 6,897–41,024 eggs (fish length 34–55 cm TL) in Elephant Island (Kock 1989), and 20,000–30,000 eggs (fish length unknown) in Adélie Land (Hureau 1970). No information is available on the reproduction of *N. coriiceps* in the Indian Ocean sector.

N. coriiceps is primarily a benthic predator, its main prey in Adélie Land and South Georgia being amphipods, with isopods and molluscs also important (Hureau 1970; Richardson 1975; Burchett *et al.* 1983). At Marion Island, the limpet *Nacella delesserti* was the major prey item (Blankley 1982). Significant amounts of macroalgae were also ingested by fishes at all these localities. The food of the pelagic fingerlings has not been studied, but probably consists of small crustaceans similar to that of *N. rossii* fingerlings.

Attains 62 cm TL (Burchett *et al.* 1983).

Notothenia (Notothenia) rossii Richardson, 1844

Marbled notothen

Fig. 30; Pl. 6, Fig. 1

Notothenia rossii Richardson, 1844b: 9, pl. 5, figs. 1–2, type-locality probably Kerguelen Islands (Regan 1916b). Holotype: lost.

Notothenia marmorata Fischer, 1885: 53, South Georgia.

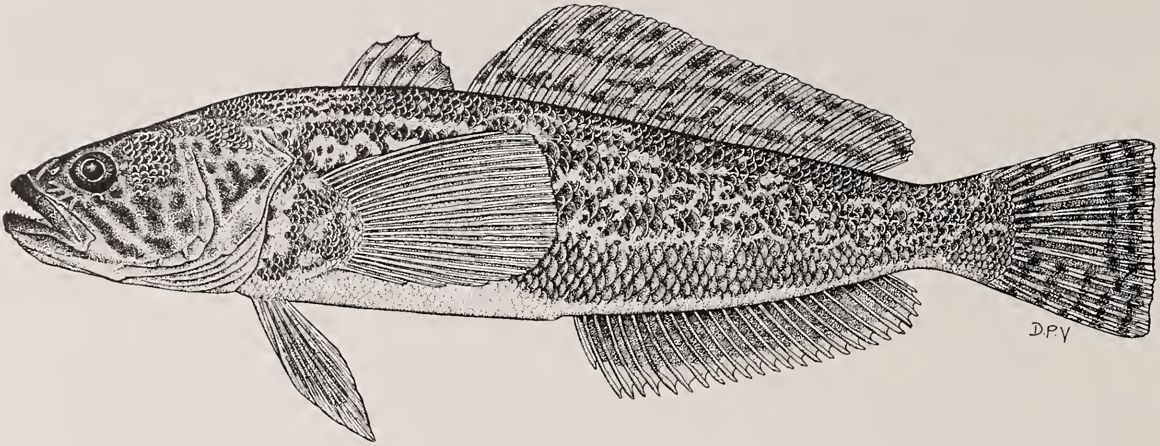


Fig. 30. *Notothenia rossii* RUSI 17826, 28 cm SL, Marion Island

Notothenia coriiceps var. *macquariensis* Waite, 1916: 64, pl. 5, fig. 3, Macquarie Island.

Diagnosis: D IV–VII+32–36; A 26–30; P 20–24; GR (5–6)+(12–15) = 18–21; ULL 40–57; MLL 13–23. Body depth 4.0–5.0 and head length 3.1–3.7 in SL. Eye diameter less than snout length, 3.6–6.6 in HL and 1.3–2.2 in interorbital width. Inteorbital 2.7–3.7 in HL. Body scales mostly non-ctenoid except in area covered by pectoral fins; head mostly covered with fine dermal papillae; a few non-ctenoid scales behind and below eye and on temporal region. Infraorbital canal with 7–9 pores; 10 pores in preopercular-mandibular canal, which is not joined to temporal canal; supraorbital canal with 4 pores; coronal commissure with 1 median pore; temporal canal with 6–7 pores; and supratemporal canal with 3 pores.

Colour: In life, variable; generally dark brown with blackish marbling dorsally, paler below. First dorsal fin with a large black spot at middle of each interspinous membrane. Benthic juveniles yellowish-brown or golden. The pelagic young are silvery with colourless fins (no black pectoral blotch as in *N. coriiceps*).

Otoliths

Diagnostic features: Generally the otoliths of the genus *Notothenia* are extremely difficult to characterise. Recognition is best achieved by referring to the illustrations. However, the most characteristic feature of these otoliths is the notch in the posterior margin of the crista inferior and the indented dorsal margin.

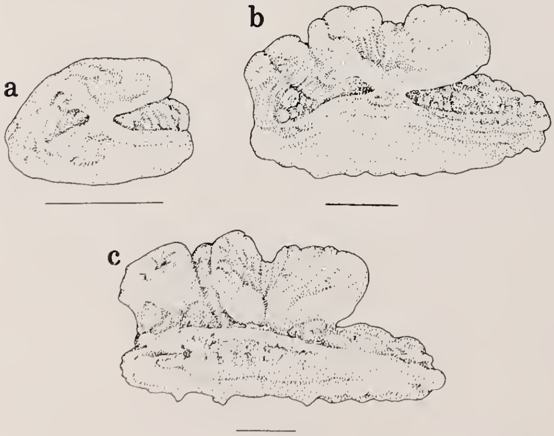
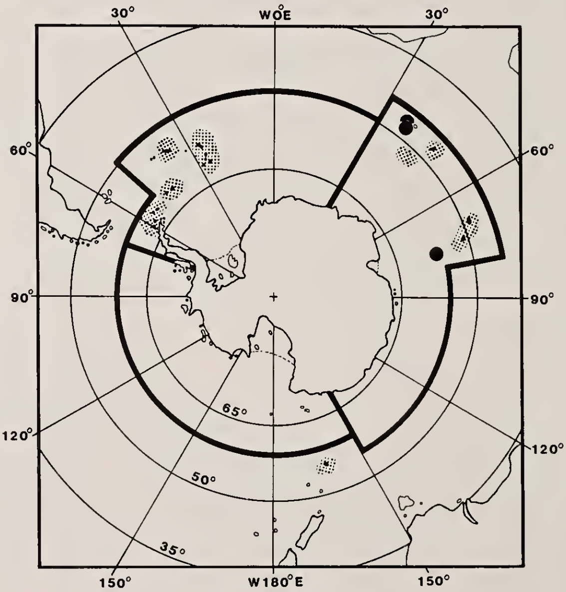


Fig. 31. Representative otoliths of *N. rossii*; fish lengths: (a) 10 cm, (b) 46 cm, and (c) 65 cm TL; scale bars 1 mm

Intraspecific variation: Sculpture of margin variable. Crista superior occasionally split into anterior and posterior sections. Sulcus acusticus sometimes ostio-pseudocaudal.

Distribution: *N. rossii* is a widely distributed (possibly circum-Antarctic) species known from the northern end of the Antarctic Peninsula, Scotia Arc (not yet reported from Bouvet), Prince Edward, Crozet, Kerguelen, Heard and Macquarie islands, and Ob' and Lena banks. Depth range 0–550 m.



Distribution of *N. rossii*

Remarks: Hureau (1985f: 327) says of the 2 supposed subspecies of *N. rossii* (*N. rossii rossii* and *N. rossii marmorata*): "These subspecies are probably geographical populations; they differ only by their coloration and in some ecological aspects." Nybelin (1947, 1951) was the first to recognise *marmorata* as a subspecies of *rossii*.

He compared 36 specimens from South Georgia and the South Shetland islands with data and the illustration of a specimen from Macquarie Island published by Waite (1916). DeWitt (1966) found that "this paper cannot be relied upon even for very obvious characters such as ctenoid or non-ctenoid scales, branchiostegal rays, or the correct determination and recognition of species in the material examined. Therefore I suspect immediately conclusions based upon the descriptions and illustrations contained in it, especially when they pertain to small details. Thus the pectoral fin of the Macquarie Island specimen is truncate posteriorly, and not rounded as illustrated by Waite. The scales on the upper part of the cheek are directed backwards and slightly upwards, much as described by Waite, but the South Georgia specimens examined by me may have these scales directed slightly upwards or downwards. However, there may be real colour differences between specimens from the 2 areas, for the Macquarie Island specimen lacks the marbling characteristic of the specimens from the Scotia Arc." The supposed difference in number of lower gill rakers for the Macquarie fish (given as 10 by Waite) is also erroneous; DeWitt examined Waite's specimen and found 13 or 14 lower gill rakers on the first arch. Furthermore, the low count of 33 soft rays in the second dorsal fin is within the range given by Nybelin (1951) for *N. marmorata*. Consequently, the only real difference between the Macquarie specimen and specimens of "*marmorata*" seems to be in colour. Since the Macquarie specimen is larger than the specimens of "*marmorata*" that have been described, this supposed colour difference may be related to size, or it may have to do with the habitat of the fish (specimens from dark environments are usually much darker than specimens taken in light coloured areas). In view of the great variation in colour pattern for this species (and for nototheniids in general) and the probability that examination of specimens from throughout the ranges of both "subspecies" would reveal additional variation in colour pattern of both forms, it seems there is insufficient evidence for recognition of subspecies in *N. rossii*. This was also the conclusion of Gon & Klages (1988) and Tankevich (1986).

Since *N. rossii* is an important commercial species, several studies of its life history, biology and population structure have been made. In the Indian Ocean sector, embryonic development was studied by Camus & Duhamel (1985); biological aspects of juvenile life were investigated by Hureau (1970) and of adult life by Duhamel (1982). In the Atlantic sector, Burchett (1983 a-e) and Burchett *et al.* (1983) studied the biology of juveniles, while adults were studied by Scherbich (1975, 1976) and Freytag (1980).

Spawning takes place on certain areas of shelf regions in depths of 120–350 m to which the ripe adults migrate. These migrations occur in the fall and spawning occurs in April–June in South Georgia and June–July in the Kerguelen Islands. There is some evidence that the eggs may be pelagic, but this has not been demonstrated conclusively. Egg diameter is 4.5–5.0 mm in fishes from both ocean sectors. Fecundity is also similar, about 19,000–130,000 eggs (fish length 50–84 cm TL) in the Scotia Sea and about 12,000–110,000 (fish length 47–77 cm TL) in the Kerguelen Islands. The eggs hatch in the spring (September and October) in South Georgia, the South Orkneys and Kerguelen Islands, the newly hatched larvae being from 10 to perhaps 15 mm in length. The larvae and young offshore fingerlings (about 18 to 38 mm) are pelagic; the latter migrate to nearshore regions of macroalgae some 6 to 8 months after hatching in the Scotian region and after about a year in the Kerguelen Islands (some individuals may remain pelagic for longer periods). The fingerlings change colour from blue to brown and at the same time become demersal, living in the algae beds. At a length of about 10–11 cm, and slightly more than a year after hatching, the fingerlings acquire a mottled colouring and are termed juveniles. The juveniles remain in the algae beds for several years before reaching maturity, at about 4 years and a size of about 38–40 cm in South Georgia and about 5–6 years and 43 cm for males, 6–7 years and 48.5 cm for females in the Kerguelen Islands. At the onset of maturity the young adults become semipelagic and migrate to the offshore shelf feeding areas and join the spawning migrations with older fishes, moving annually to and from the spawning areas. Individuals may reach an age of about 15 years. Almost certainly, the widespread distribution of this species is related to its relatively long pelagic growth period.

The food habits of *N. rossii* are related to the growth stages of its life history (Hureau 1970; Tarverdiyeva 1972; Hoshiai 1979; reviewed by Duhamel 1981, for the Kerguelen Islands area and by Burchett 1983d, for South Georgia). The youngest stages (postlarvae and young fingerlings) feed mainly on larvae of larger crustacea and other small zooplankton. Nearshore fingerlings feed on small planktonic copepods, amphipods, fish larvae and decapod larvae. Juveniles inhabiting macroalgae beds feed primarily on fishes, euphausiids, isopods, amphipods and algae, together with lesser amounts of other demersal groups such as polychaetes, gastropods and decapods. Algae is a regular food item and is not taken accidentally. When they are present, young fish are the preferred prey. Adult *N. rossii* feed mainly on ctenophores, hydrozoans, amphipods, euphausiids and fishes, depending upon the abundances of the prey organisms. Fishes and hydrozoans seem to be more important in the Kerguelen Islands, whereas ctenophores may at times be the dominant food in South Georgia.

Attains 92 cm TL and a weight of about 10 kg.

Genus *Pagothenia* Nichols & Lamonte, 1936

Body oblong, compressed posteriorly. Snout subequal to eye diameter. Maxilla reaches to or slightly past vertical at front of eye. Coronal commissure incomplete, opening via a pair of pores (Fig. 1b); supratemporal canal incomplete, divided into 2 short segments and a short branch from each temporal canal (pores 1+2+2+1); 2nd and 3rd suborbital bones absent (Andriashev & Jakubowski 1971), the infraorbital canal with a wide gap below eye, represented by 2–4 free neuromasts (pit organs, but no pores) below middle part of eye, with an anterior section of 4 pores below front of eye, a posterior section of 2 pores along rear edge of eye, and usually a short branch with 1 pore from temporal canal (Fig. 1b); supraorbital canal with 4 pores, not counting the pore at end of short branch of coronal commissure or the one at junction of temporal and infraorbital canals; temporal canal with 5 pores, including pore at junction with supraorbital and infraorbital canals; mandibular canal with 4 pores, separate from preopercular canal which has 6 pores and is separate from temporal canal (Fig. 1b). Jaws with a band of short, slender, curved, sharp teeth, the band narrowing posteriorly to a single series; outer teeth slightly enlarged. Body with weakly ctenoid and non-ctenoid scales; head naked except for a few non-ctenoid scales behind eye and on upper part of opercle. Lateral lines more or less indistinct, with or without tubed scales. Caudal fin rounded, with 12–14 branched rays. Pectoral fins longer than pelvics. Branchiostegal rays 6, the membranes joined to each other and to isthmus for only a short distance anteriorly, the free fold over isthmus very short. Gill rakers slender, 16–19 on lower limb of first arch. Pectoral foramen entirely within scapula.

Remarks: This genus comprises 2 species. We agree with Andriashev & Jakubowski (1971) that the type species, *P. antarctica* Nichols & LaMonte, is a synonym of *Notothenia brachysoma* Pappenheim, and that *Trematomus borchgrevinki* Boulenger should also be assigned to this genus. DeWitt (1964a: 686), in discussing the relationships of the, at that time monotypic, genus *Pagothenia*, commented: ". . . I examined most of the species of *Trematomus* and found that not only is the genus extremely variable, but some species approach *Pagothenia* and *Pleuragramma* in several striking ways. Probably *T. borchgrevinki* (as well as *T. brachysoma*, although I have not been able to examine this species) should be removed from the genus. In this species the preopercular-mandibular canals are divided, the infraorbital canals are divided leaving a broad hiatus beneath the eyes, the supraorbital canals are not joined to each other, and the supratemporal canals are divided into 4 segments. Further, none of the gill rakers of the first arch are dentigerous, and the posterior rakers only occasionally bear a few teeth. In addition, the number of tubular lateral line scales is small or there may be none."

In discussing the relationships of *Pagothenia* with other species of *Trematomus*, DeWitt (1964a) continues: "*Trematomus bernacchii* and *T. hansoni* also show some characteristics similar to *Pagothenia*, but they are less well marked and variations occur which connect them with the usual pattern of *Notothenia* and the remaining species of *Trematomus*. For instance, in *T. bernacchii* the infraorbital canals are narrowly divided and the supraorbital canals may sometimes be separated from each other. In *T. hansoni*, the infraorbital canals may be divided or in a single unit. *T. bernacchii* also has the preopercular-mandibular canal divided and both species have the supratemporal canal divided, although this varies in *T. hansoni*." Andersen (1984) assigned *T. bernacchii* and *T. hansoni* to *Pagothenia* on the basis of the numerous pit-lines (lines of free neuromasts or pit organs) on the head of these species. According to Andersen (1984) these pit-lines are supposed to be absent on most other species of nototheniids, but we have found a complete series of pit-lines on *Trematomus newnesi* and all but one (the mentomandibular) on *Paranotothenia magellanica* (they are, however, difficult to see because of the numerous dermal papillae on the head of the latter species). This would seem to negate the pit-lines as apomorphies for *Pagothenia*. Although we would agree that *T. bernacchii* and *T. hansoni* are probably more similar to *Pagothenia* than are any of the other species of *Trematomus*, we do not believe that these 2 species belong in *Pagothenia*. Rather, they represent intermediate states in an evolutionary tendency that culminates in *Pagothenia*, with a large gap separating *Pagothenia* from the other species in the group.

KEY TO SPECIES

1a D_2 34–37; interorbital width 3.0–4.0 in HL .... *P. borchgrevinki*
1b D_2 29–32; interorbital width 4.0–5.5 in HL .... *P. brachysoma*

Pagothenia borchgrevinki (Boulenger, 1902)
Bald notothen
Fig. 32

Trematomus borchgrevinki Boulenger, 1902: 179, pl. 12, Duke of York Island and Cape Adare, Robertson Bay, Victoria Land. Syntypes: BMNH 1901.11.8.24–26.

Notothenia hodgsoni Boulenger, 1907: 2, pl. 2, fig. 2, *Discovery* "winter quarters", Ross Island (in part).

Diagnosis: D IV–VI+34–37; A 30–33; P 23–24; GR 8+(16–19) = 24–27; LSS 78–97; ULL 43–52 pored scales (usually 2 tubed scales at anterior end); MLL 8–10 pored scales; vertebrae (18–20)+(31–34) = 49–54. Body depth 4.0–5.0 and head length 3.5–4.2 in SL. Eye diameter 3.4–4.3 in HL and interorbital width 25–33% HL. Infraorbital canal with 4+2+1 pores.

Colour: Head and body dark dorsally, with dark spots or irregular cross-bars, the ventral parts yellowish. Dorsal and caudal fins with a series of spots but caudal fin without transverse bands.

Otoliths

Diagnostic features: The ovate shape, the oblique posterior margin, the anteriorly continuous cristae around the ostium, the well developed anterior colliculum and the horizontal groove in the central, broader portion of the crista inferior.

Distribution: Shores of Antarctica (Ross Sea, Davis Sea, Weddell Sea, Antarctic Peninsula), also South Orkney and South Shetland islands. Depth range 0–30 m; small juveniles were found within krill concentrations between 10–72 m (Kock 1982).

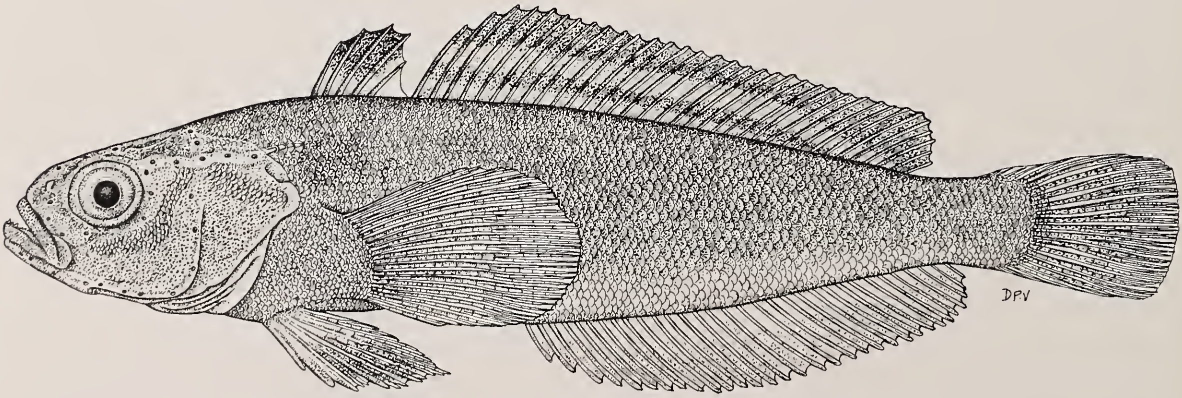
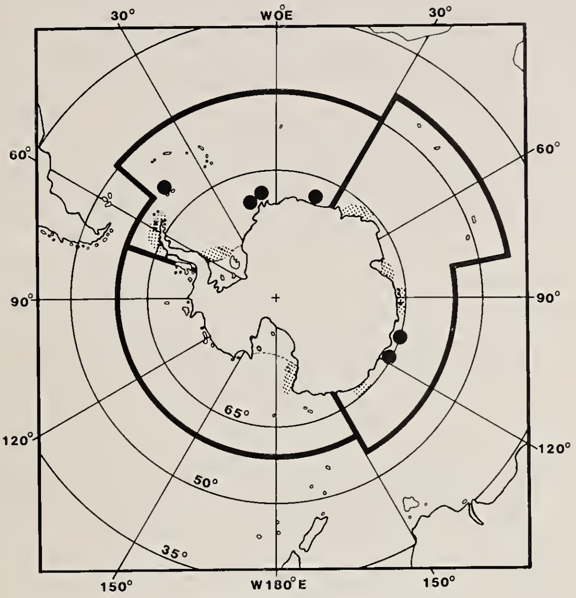


Fig. 32. *Pagothenia borchgrevinki* RUSI 27676, 124.9 mm SL, Prydz Bay, Rauer Island

Fig. 33. Representative otolith of *P. borchgrevinki*; fish length unknown; scale bar 1 mm



Distribution of *P. borchgrevinki*

Remarks: *Notothenia hodgsoni* Boulenger has been placed in the synonymy of *Trematomus newnesi* (see Norman 1938: 28), but the type series actually includes specimens of 3 species: *T. newnesi, T. bernacchii,* and *P. borchgrevinki*. The specimen illustrated (Boulenger 1907: pl. 2, figs. 2, 2A) is clearly *P. borchgrevinki* (the dorsal view shows the supraorbital canal divided and the median coronal pore replaced by a pair of pores), and this specimen is therefore designated as the lectotype of *Notothenia hodgsoni*.

P. borchgrevinki is a cryopelagic species associated with the underside of ice (Andriashev 1970). Small juveniles (39–63 mm SL) were found within krill swarms east of Joinville Island (Kock 1982) and Bransfield Strait (Slosarczyk & Rembiszewski 1982). In a study of the benthic fishes of the Vestfold Hills region, Prydz Bay, Williams (1988a) observed that 80% of *P. borchgrevinki* were collected under sea ice and were uniformly pale while the other 20% were collected near the bottom up to 5 m depth and had dark olive brown spots or vermiculated pattern. *P. borchgrevinki* feeds on copepods and krill.

Attains 28 cm.

Pagothenia brachysoma (Pappenheim, 1912)
Bandtail notothen
Fig. 34

Trematomus brachysoma Pappenheim, 1912: 172, winter station of the *Gauss*, Kaiser Wilhelm II Land. Lectotype: ZMB 18904.

Pagothenia antarctica Nichols & LaMonte, 1936: 3, fig. 1, Ross Sea (78°45′S, 165°00′W).

Diagnosis: D IV–V+29–32; A 29–30; P 23–24; GR (8–10)+(15–18) = 23–27; LSS 55–63; ULL 25–37 pored scales (first 2–4 scales with tubes); MLL with 24–30 pored scales; vertebrae (15–16)+(30–31) = 45–47. Body depth 4.1–5.0 and head length 3.0–3.4 in SL. Eye diameter 3.4–4.0 in HL and interorbital width 18–25% HL. Infraorbital canal with 4+2+1 or 4+2 pores (section from temporal canal sometimes absent).

Colour: In life, yellowish brown, iridescent blue dorsally; some specimens with patches of coral pink near the head. Fins with dusky tips or edges. Spinous dorsal fin blackish. Second dorsal fin and anal fin with spots on membrane. Dark transverse bands on caudal fin.

Distribution: Shores of Antarctica: Ross Sea, Davis Sea, Wilhelm II coast and west coast of Antarctic Peninsula.

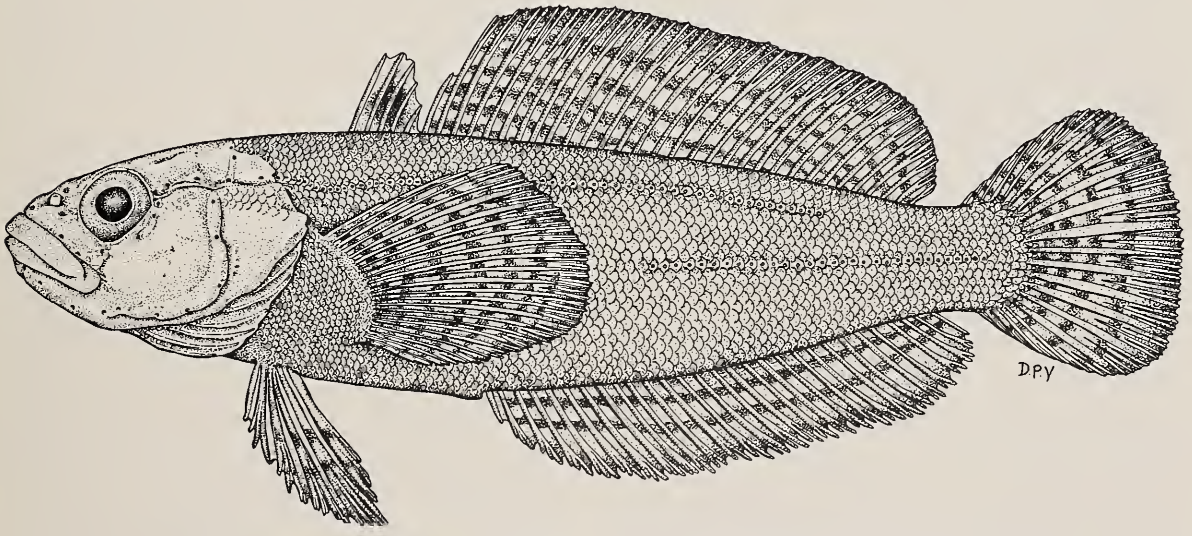
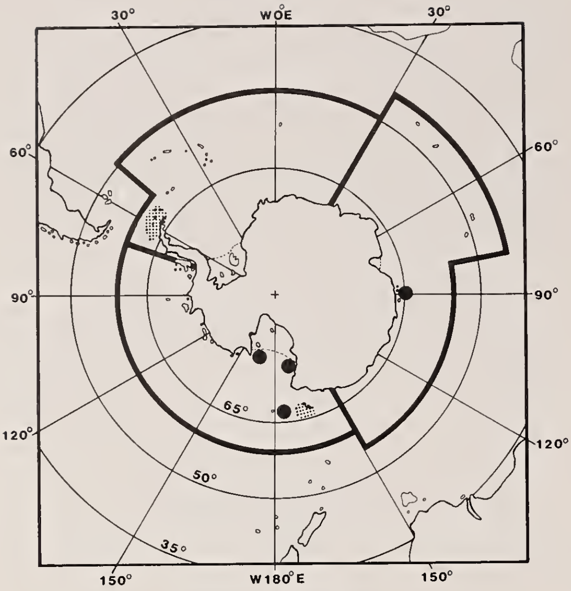


Fig. 34. *Pagothenia brachysoma* BMNH 1913. 12.4.128, 137 mm SL (67°24′S, 177°34′W)



Distribution of *P. brachysoma*

Depth range 0–30 m, but near Elephant Island small juveniles were found in krill concentrations between 40–90 m.

Remarks: Like its congener, *P. borchgrevinki,* this is a cryopelagic species associated with the underside of ice (Andriashev 1970). Small juveniles were found within krill concentrations at Elephant Island (Kock 1982), South Shetland Islands, Bransfield Strait, off Palmer Archipelago (Andriashev & Permitin 1981; Slosarczyk & Rembiszewski 1982), and Balleny Islands (Slosarczyk 1983). *P. brachysoma* feeds on copepods and euphausiids (Hureau 1985f).

Attains 170 mm.

Genus *Paranotothenia* Balushkin, 1976

Head broad, snout short; length of upper jaw equal to or less than interorbital width, not extending past vertical at middle of eye. Anterior part of snout steep, with a prominent preorbital bulge. Interorbital width greater than 30% HL, noticeably wider than in *Notothenia.* Cranium very broad, about 85% of its basal length; upper surface rugose, with numerous crests, depressions and pits. Supraoccipital crest extending posteriorly beyond basioccipital condyle. Hyomandibular without a lateral hook-like apophysis. Head mostly naked as in *Notothenia*; small patches of scales present behind eyes, on uppermost parts of opercula, and at junctions of temporal and supratemporal canals. Pores of cephalic sensory canals small; supraorbital canal with 4 pores, 1 behind eye (Fig. 1g); infraorbital canal with 7–8 pores, 4 in preorbital; supratemporal canal usually with 3 pores; preopercular-mandibular canal not joined to temporal canal. Two lateral lines with tubed scales; upper extending posteriorly along dorsolateral part of body to below last few rays of second dorsal fin; tubed portion of middle lateral line not extending anteriorly to end of adpressed pectoral fin. Most body scales non-ctenoid (except in large high Antarctic specimens). Caudal fin forked in juveniles, becoming emarginate or sometimes slightly rounded in large individuals (except large high Antarctic specimens where the fin is emarginate with pointed lobes); 12–14 branched caudal-fin rays. Branchiostegal rays 6. Scapular foramen extends into coracoid, but does not open onto cleithrum. Vertebrae (16–18)+(28–30) = 45–47.

Remarks: *Paranotothenia magellanica,* the only species in the genus, is in many respects similar to species of *Notothenia.* We recognise *Paranotothenia* on the basis of the cranial characteristics described by Balushkin (1976b; 1984), especially the shape and rugosity of the dorsal bones and the development of the supraoccipital crest, the short jaws, the position and number of infraorbital canal pores, and the shape of the scapular foramen. Similarities include the pelagic habit of the fingerlings of *Notothenia* species together with the concomitant changes in fin and body coloration and caudal fin shape.

Balushkin (1976b; 1984) states that the first and second suborbitals (post-preorbital elements) form a subocular shelf sensu Smith & Bailey (1962). Although Balushkin's illustration (his fig. 4m) shows somewhat more robust suborbitals, this does not resemble the shelves illustrated by Smith & Bailey. More conclusively, however, we notice that Smith & Bailey in their table 1 list *Notothenia macrocephala* (= *Paranotothenia magellanica)* as not having a subocular shelf.

Paranotothenia magellanica (Forster, 1801)
Orange throat notothen
Fig. 35; Pl 6, Fig. 2

Gadus magellanicus Forster in Bloch and Schneider, 1801: 10, seas about Tierra del Fuego. (No types preserved; original description based on notes and an unpublished sketch of fresh specimens.)

Notothenia macrocephalus Günther, 1860: 263, Falkland Islands (corrected to *N. macrocephala* in later publications).

Diagnosis: D III–VI+28–31; A 22–26; P 16–18; GR (3–6)+(10–14) = 14–19; ULL 36–46 tubed scales; MLL 5–14 tubed scales; LSS 46–64. Body depth 3.5–4.8 and head length 3.1–3.6 in SL. Eye diameter 3.4–5.4 and interorbital width 2.0–3.6 in HL. First (anteriormost) pore of infraorbital canal anterior to a vertical at anterior edge of nostril. Head, especially in larger specimens, with many small papillae, those on upper surface thicker and more blunt, those on jaws more slender and densely spaced. Maxilla short, 8.7–10.6 in HL, not reaching vertical at middle of eye, subequal to or shorter than interorbital width. Relative width of interorbital space increasing with size.

Colour: In alcohol, usually bluish-grey to dark brown, paler on lower part of body; sometimes small spots and mottling present on upper part of body and head, including snout and upper lip. Fins usually dusky to dark, but may also be striped and spotted.

In life, colour varies markedly with age and mode of life. Pelagic fingerlings are iridescent greenish-blue above and silvery below. Juveniles transforming to benthic life and already in the kelp zone are brown above and pale below, gradually changing to bright red or golden brown. These colours change gradually to greyish-green and dark brown in subadults. Mature adults are metallic blue to nearly black above and silvery-grey below. Fins are pale in fingerlings and small juveniles, but become increasingly darker with the darkening of body colour. At all stages from small benthic juveniles to adults, the branchiostegal membrane is bright orange-red or orange-yellow.

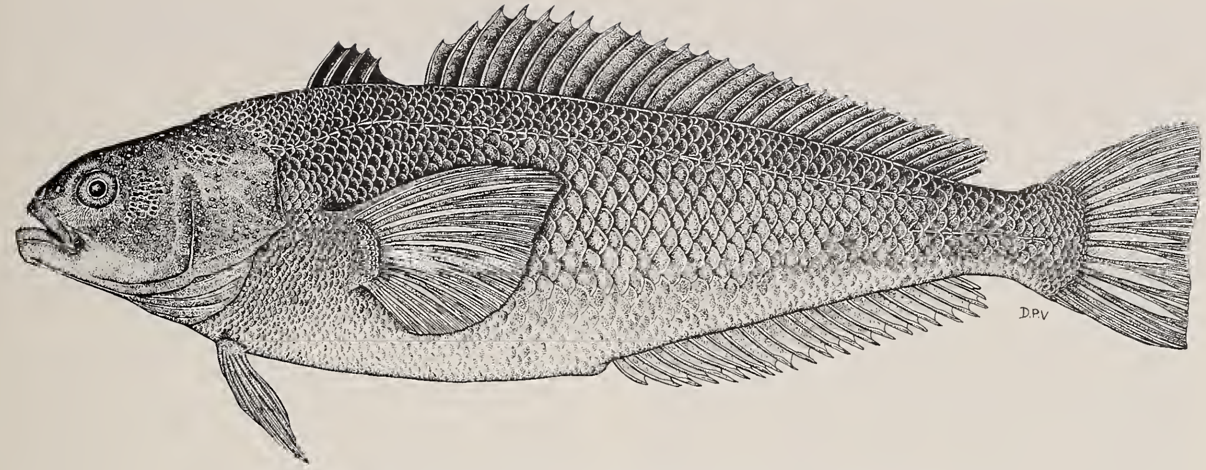


Fig. 35. *Paranotothenia magellanica* RUSI 20420, 36.5 cm SL, Marion Island

Otoliths

Diagnostic features: The ovate to rectangular shape, the notch in the posterodorsal margin, the ostio-caudal sulcus acusticus, the prominent crista superior and the anterodorsally directed antirostrum.

Intraspecific variation: light variation in sculpture of margins.

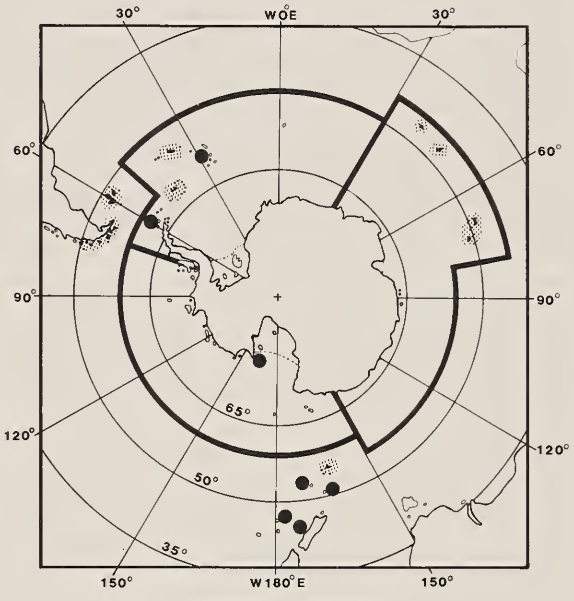
Ontogeny: Dorsal margin generally entire in fish less than 9 cm SL, whereafter the margin becomes more lobed to crenate. Dorsal area only becomes well defined in specimens larger than 125 mm SL and the surface of the crista inferior becomes noduliferous.

Fig. 36. Representative otolith of *P. magellanica*; fish length 24 cm SL; scale bar 1 mm

Distribution: Magellanic region of South America; Falkland, South Georgia, South Orkney, South Shetland, Prince Edward, Crozet, Kerguelen, Heard and Macquarie islands; southern New Zealand and associated islands, and (rarely) in the Ross Sea. Depth range 0–255 m.

Remarks: Balushkin (1976b) implied that DeWitt (1970a) chose a specimen from the type series of *Notothenia hassleriana* as the lectotype for the name *N. magellanica*. This is incorrect as DeWitt was selecting a lectotype for the name *N. hassleriana*. Since there were no types of *Gadus magellanicus,* it is impossible to select a lectotype (although a neotype could be chosen if it were considered necessary). We also noticed that DeWitt (1970a: 303) is in error in listing "*Notothenia magellanicus* Günther, 1860 . . ." ; the reference should have been placed under *Notothenia magellanica*.

The pelagic fingerlings of *P. magellanica* have been captured far from land over deep water. Large Antarctic specimens may become very dark above with almost black dorsal fins and pale bellies; they appear to be pelagic. Adults elsewhere appear to stay close to shore although they may also be somewhat pelagic in habit (they are rarely caught in large bottom trawls).



Distribution of *P. magellanica*

In Kerguelen Islands spawning apparently takes place in April-May; size at hatching is not known as the capture of larvae has never been reported. Absolute fecundity was 60,000–70,000 eggs; the eggs are pelagic and about 0.8 mm in diameter (Hureau 1970).

In Tierra del Fuego, *P. magellanica* fed mainly on amphipods and algae; decapods (*Munida gregaria*), copepods, and isopods (*E. gigas)* were secondary items; hydrozoans, molluscs and larval crustaceans were also present in stomachs (Moreno & Jara 1984). In the Kerguelen Islands, isopods (*E. gigas* and *Serolis* sp.) and bivalves (*Gaimardia trapesina)* were the most important food items whereas amphipods, decapods (*Halicarcinus planatus)* and small fishes were of secondary importance (Hureau 1970). In Marion Island, the isopod

Dynamenella huttoni, the amphipod *Jassa falcata,* the polychaete *Platynereis australis* and red algae formed the bulk of the diet (Blankely 1982). In Marion Island as well as Tierra del Fuego, *P. magellanica* had the widest variety of food amongst the species studied in these places (3 and 8 respectively); this observation was attributed to its relatively higher mobility (Moreno & Jara 1984). *P. magellanica* is the most abundant inshore fish at Marion Island (Gon & Klages 1988) and at Macquarie Island (Williams 1988b).

Attains about 38 cm SL.

Genus ***Patagonotothen*** Balushkin, 1976

Fishes of moderate to small size. Head small to moderate, 2.9–3.8 in SL. Scalation of head variable, from nearly naked as in *Notothenia* to moderate, with top of head, cheeks and opercles scaled. Skin of head smooth, without dense papillae. Cephalic lateral line canals of normal pattern (Fig. 1d): supraorbital canal with 5 (rarely 4 or 6) pores, 2 (rarely 1) pores posterior to coronal commissure (*P. canina* may normally have 4 pores with 1 posterior to coronal commissure); coronal commissure complete and with a median pore; infraorbital canal complete below eye, with 7–9 pores, 4 in preorbital, first pore behind vertical from anterior edge of nostril; supratemporal canal complete, with 3–8 pores; preopercular-mandibular canal uninterrupted, not connected to temporal canal. Skull narrower than in *Notothenia,* cranial width about 1.5–1.7 in length. Interorbital width moderate to narrow. Usually 3–4 (rarely 5) post-preorbital suborbitals. Supraoccipital crest not projecting behind basioccipital condyle. Hyomandibular without a hook-shaped apophysis. Two lateral lines on body (a third, lower, lateral line rarely may be present in individuals of 2 species), with tubed scales (rarely absent in middle lateral line of one species). Upper lateral line ends below posterior rays of second dorsal fin or may extend almost to end of body. Caudal fin with 12–17 branched rays. Branchiostegals 6. Enlarged canine teeth absent.

Remarks: This genus includes species known almost exclusively from the Patagonian Region of South America. The type-locality of *Notothenia normani* Nybelin (1947), a synonym of *Patagonotothen cornucola* (Richardson), is South Georgia, but this locality is probably erroneous as this species has otherwise never been reported from South Georgia. A population of *P. guntheri* has recently been discovered at the Shag Rocks west of South Georgia, hence this species is included in the present account.

Patagonotothen guntheri (Norman, 1937)
Yellowfin notothen
Fig. 37

Notothenia guntheri Norman, 1937a: 75, continental shelf north of the Falkland Islands (49°54′15″S, 60°35′30″W). Holotype: BMNH 1936.8.26.582.

Patagonotothen guentheri shagensis Balushkin & Permitin, 1982: 544, Shag Rocks.

Diagnosis: D V–VII+35–37; A 33–35; P 24–28; branched C rays 16–17; GR (8–14)+(17–26) = 26–40; ULL 45–50 tubed scales; MLL 3–10 tubed scales; LSS (Patagonian material) 67–78; vertebrae (16–17)+(35–36) = 51–53. Body depth 5.1–6.2 and head length 3.4–3.7 in SL. Eye diameter 3.4–3.7 and interorbital width 5.0–6.2 in HL. Supraorbital sensory canal with 5–6 pores, 2 behind coronal commissure; infraorbital canal with 7–8 pores; preopercular-mandibular canal with 10 pores; temporal canal with 6 pores; supratemporal canal with 5 pores. Upper lateral line ends behind base of second dorsal fin. Scale rows between supratemporal commissure and origin of first dorsal fin 21–27; scale rows between eyes 7–9.

Colour: In life, caudal, pectoral and pelvic fins lemon yellow; dorsal and anal fins yellow; tips of all fins lighter. In preserved specimens 7–8 dark transverse bars descend from bases of dorsal fins, those on posterior half of body separate into upper and lower spots giving a checkered pattern. Snout and top of head dark. Two or 3 dark stripes extend posteroventrally across cheek, and an upper horizontal stripe may be present behind eye.

Distribution: *Patagonotothen guntheri* is known primarily from the southern portion of the shelf and uppermost slope of the Argentine Patagonian Region, the Falkland islands and the Burdwood Bank, all outside our area. In 1974 a single specimen was captured near the Shag Rocks west of South Georgia, but a more detailed survey in 1975 found it in abundance (Kock pers. comm.) Although it has not yet been reported from South Georgia, we would not be surprised if it is found there as well. It inhabits depths of about 120–250 m in our

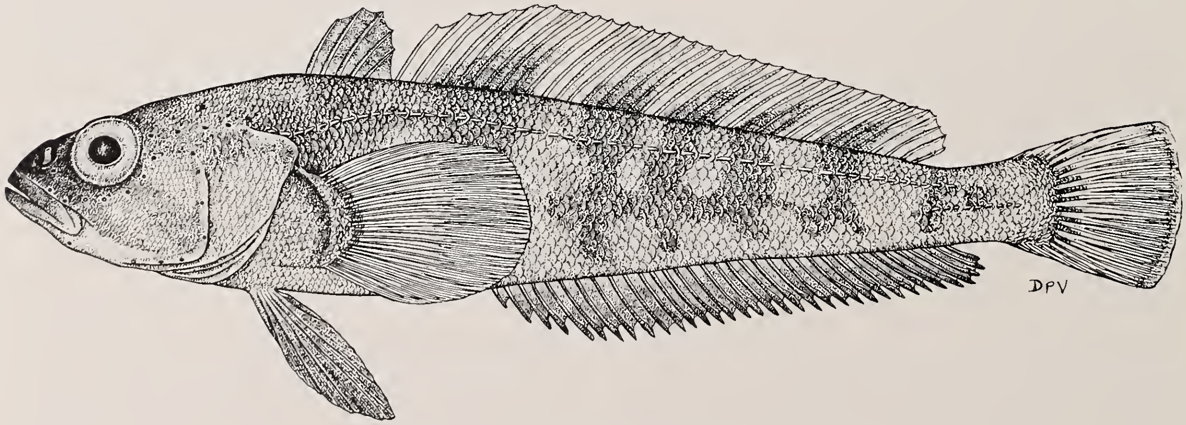
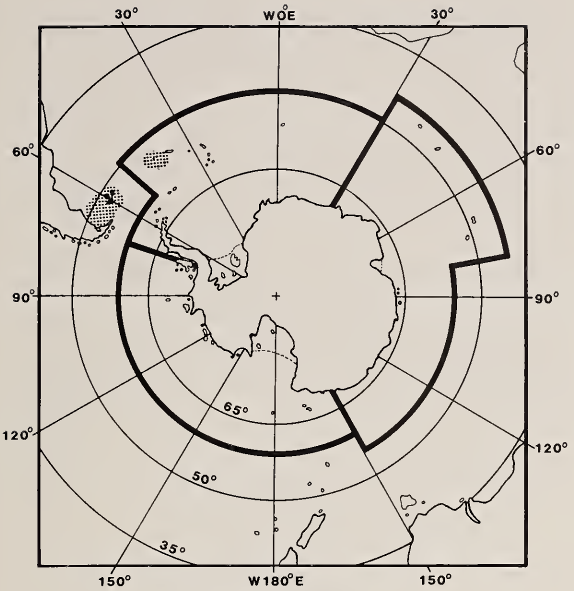


Fig. 37. *Patagonotothen guntheri* USNM 308623, 146 mm SL, Shag Rocks



Distribution of *P. guntheri*

region, but somewhat greater depths in the Patagonian Region.

Remarks: *Patagonotothen guntheri* is very similar to *P. brevicauda* (Lönnberg, 1905b) which occurs in the same Patagonian-Falklands area. Norman (1937c) differentiated the 2 on the basis of eye diameter (23.1–26.7% vs 22.2–23.1% of HL), lower limb gill rakers (19–23 vs 16–19), and caudal peduncle depth (less than 33.3% vs about 33.3% of HL). DeWitt (1966) recognised *P. guntheri* as a subspecies of *P. brevicauda,* basing his conclusions on aspects of distribution and on some new material which indicated greater overlap in the 3 characters used by Norman to differentiate the species. Unfortunately his sample sizes, especially of *P. brevicauda,* were small. These 2 forms have a distributional relationship to each other similar to that between *P. ramsayi* and *P. wiltoni*: the first of each pair inhabit the open continental shelf; the others are found near shore, especially in bays and fjords. Hureau (1985f) followed DeWitt, but other workers have not.

We compared data from 41 specimens of *P. guntheri* (50.5–166 mm SL, including the holotype and the type of *Notothenia longicauda* Thompson, 1916) with those from 25 specimens of *P. brevicauda* (37.5–139 mm SL, including the holotype). Our results are (data for *P. guntheri* listed first): eye 25–33% vs 22–33%; caudal peduncle depth 26–31% vs 27–35%, all of HL; lower limb gill rakers 17–26 (mean 20.5) vs 15–21 (mean 17.0). The increased overlap indicated by our data is somewhat misleading, however, since our samples include fairly small specimens. Plots of the raw data for the eye and caudal peduncle show that the relationships with the head length are somewhat curvilinear. We fitted log transformed data to the allometric equation using Bartlett's "Three-group" method (Simpson *et al.* 1960). The eye diameter in both species becomes relatively smaller (exponents equal 0.7803 and 0.8288, respectively) whereas the caudal peduncle depth increases slightly in *P. guntheri* (exponent equals 1.0310) and decreases slightly in *P. brevicauda* (exponent equals 0.9425). Thus, for the eye diameter, which shows the most curvilinearity, the ranges of percents of head length, using values calculated from the fitted equations, are: 24.7–32.2% for *P. guntheri* over a head length range of 15–50 mm and 23.9–30.9% for *P. brevicauda* over a head length range of 10–45 mm. At any one size, however, the separation seems fairly good: 27.6% vs 25.6% at a head length of 30 mm. For the caudal peduncle depth, on the other hand, percents of head length calculated from values derived from the equations never overlap, ranging from 26.9–28.0% and 30.0%–32.7%, respectively, over the same size ranges. The measured overlap in the caudal peduncle depth is due to some mid-sized specimens of *P. brevicauda* which have slender caudal peduncles and the holotype of *P. guntheri* which has a rather deep caudal peduncle. We cannot determine whether the small measurements for *P. brevicauda* are real or due to error or shrinkage in preservative since the material is not now available to us, but the data do not seem consistent with the other measurements. The large measurement for the holotype of *P. guntheri* is probably real since it is the largest specimen we measured and therefore least susceptible to error and the effect of preservative, if any, would be to make the measurement smaller. In addition, although in *P. brevicauda* the eye diameter is always smaller than the caudal peduncle depth (over the range of our material), in *P. guntheri* the eye diameter is larger than the caudal peduncle depth in smaller specimens, but smaller than the caudal peduncle depth in larger specimens, the mean cross-over point (from the fitted equations) being at a head length of 30 mm (equals about 100 mm SL).

Other characters that show differences between the 2 forms are (data for *P. guntheri* given first): total number of gill rakers 26–39 vs 22–27 (one count of 32); pectoral fin rays 23–26 (mean 24.8) vs 22–25 (mean 23.0). We conclude that recognition of the 2 species is probably justified.

Balushkin & Permitin (1982) described *P. guntheri shagensis* as a new subspecies from the Shag Rocks area. This population differs from the nominate subspecies in its wider interorbital width (16–20% vs 11–15% HL), more pectoral-fin rays (26–28, usually 27, vs 24–27, usually 25), and more vertebrae (51–53 vs 49–51). Our data from 29 *P. guntheri guntheri* and 18 *P. guntheri shagensis* support this subspecific distinction.

Perhaps believing that Dr. Albert Günther of the British Museum (Natural History) was the person honoured by the specific name *guntheri,* some recent authors (e.g. Balushkin & Permitin 1982) have changed the spelling to *guentheri.* This is incorrect since the person being honoured was Mr. E.R. Gunther, a fisheries biologist of the British *Discovery* Investigation (see Norman 1937a: 76).

P. guntheri shagensis is apparently benthopelagic, leaving the bottom at night to feed at depths as little as 30–50 m. Its food is predominantly krill (*Euphausia superba*), about 89% by weight, with most of the remainder composed of the hyperiid amphipod *Themisto gaudichaudi* (Naumov *et al.* 1983), a diet similar to the pelagic feeding *Lepidonotothen larseni* (Targett 1981). No food study has been made of the Patagonian population.

P. guntheri shagensis has been commercially exploited since 1978–79. The catches, about 12,000 tonnes per year, indicate that it breeds in the Shag Rocks area.

Postlarvae were described by Efremenko (1984).

Attains 23 cm TL.

Genus *Pleuragramma* Boulenger, 1902

Pelagic fishes with relatively compressed body and head. Mouth upturned, protractile, with the lower jaw projecting and the caudal fin deeply emarginate. Scales thin, cycloid, and deciduous. Three lateral lines on body, the lateral-line scales with a median notch in posterior border, without tubes, but with a central pore. Cephalic lateral line canals reduced in extent, leaving areas where the sensory neuromasts lie exposed on the skin (Fig. 1a): preopercular-mandibular canal complete, separate from temporal canal; infraorbital canal reduced to an anterior preorbital section and a posterior section behind eye connected to temporal canal (rarely an intermediate section may be present, enclosed in an abnormal and incomplete suborbital element); supraorbital canal reduced to an anterior nasal-frontal section and a posterior frontal section connected to temporal canal; temporal canal reduced to a short anterior section narrowly divided from a longer posterior section; supratemporal canal reduced to a short tube on each side connected to each temporal canal above the second pore of the posterior segment. Teeth in a single band, in part uniserial, in each jaw; 1–3 enlarged teeth near symphysis of upper jaw; 3–4 enlarged teeth about midway in length of lower jaw. Symphysis of lower jaw produced into upper and lower pointed knobs. Branchiostegal rays 6, the membranes united for about half the length of the isthmus and forming a free fold across the isthmus. Anterior gill rakers of first arch slender, elongate, and pointed, without teeth; all other gill rakers short, knob-like, and bearing a distal tuft of teeth. Pectoral foramen enclosed entirely within the scapula. Caudal skeleton with hypurals fused into a single, broad wedge-shaped element and fused to the ural centrum (Totten 1914; Andersen 1984).

Remarks: *Pleuragramma* comprises a single, common, widespread species that has recently become the subject of much research because of its possible commercial use and its importance in the food web of the coastal Southern Ocean.

Modifications for a pelagic life, besides the thin scales and reduced (exposed) cephalic canals, are the reduced skeletal ossification, with the vertebrae thin cylinders enclosing a persistent and unconstricted notochord; and the retention of lipids in small subcutaneous sacs and large (0.5–3.0 mm diameter) intermuscular sacs (Totten 1914; DeVries & Eastman 1978; Eastman & DeVries 1982).

Pleuragramma antarcticum Boulenger, 1902
Antarctic silverfish
Fig. 38

Pleuragramma antarcticum Boulenger, 1902: 187, pl. 18, Ross Sea, Ross Ice Shelf (78.35° S). Syntypes: BMNH 1901.11.8.86–87 (in bad condition).

Diagnosis: D VI–VIII + 35–38; A 36–39; P 19–21; C branched rays 12; GR (8–12) + (20–26) = 29–35; LSS 50–56; vertebrae 52–56 (authors agree on the total number of vertebrae, but vary rather widely in their identification of abdominal and caudal centra, made difficult by the lightly ossified skeleton). Body depth 5.2–7.8 and head length 3.4–3.9 in SL. Eye diameter 3.0–3.7 and interorbital width 5.2–6.4 in HL. Preopercular-mandibular canal pores 9 (rarely 10), with 3 (rarely 4) on the mandible. Infraorbital canal with 4+2 pores; lateral line organs (neuromasts) present in exposed region between the canal segments, the normal number probably being 4 (rarely 5), but some or all are often missing. Supraorbital canal with 3+1 pores (a second, more posterior pore rarely present in postero-dorsal section); between these 2 supraorbital canal segments is a trough divided by 3 low transverse ridges into 4 shallow depressions; on each ridge is a neuromast organ. Temporal canal with 1+4 pores; between the 2 segments lies a single exposed neuromast. Supratemporal canal with 1+1 pores; no traces of neuromasts were found in the intervening regions.

Mouth directed upward, with the lower jaw protruding. Most teeth in jaws small, villiform; in upper jaw, a single band with 1–3 enlarged teeth near symphysis; in lower jaw a narrow band anteriorly, becoming uniserial about third of length of jaw from symphysis; near middle of side of jaw 3–4 teeth increase in size, with largest tooth abruptly followed by a uniserial row of small teeth.

Body, opercles and cheeks (except area of infraorbital canal) covered by large, thin, deciduous, cycloid scales; scales apparently absent on dorsal parts of head. Three lateral lines on body, all without a canal or tubed scales. Lateral-line scales distinct in having a median notch in the posterior edge and a median pore through which passes a branch from the lateral line nerve; each branch divides into 3 branchlets that extend to a vertical row of 3 neuromasts on the surface of the scale. The numbers of scales in the lateral lines are not known with certainty; Norman (1938) counted "about 45" in the upper lateral line and "about 35" in the middle and lower lateral lines, but these values are almost certainly low for the upper and lower lines. The upper lateral line extends (presumably) from the upper end of the gill opening posteriorly near the base of the dorsal fins to 1 or 2 scales from the base of the caudal fin, which would probably give a count of 55–60 scales. The middle lateral line extends from the base of the caudal fin anteriorly an unknown distance; naked neuromasts extend out onto the caudal fin between the middle rays. The lower lateral line extends from 1 or 2 scales posterior to base of pelvic fin, in advance of pectoral-fin base, along lower side of belly

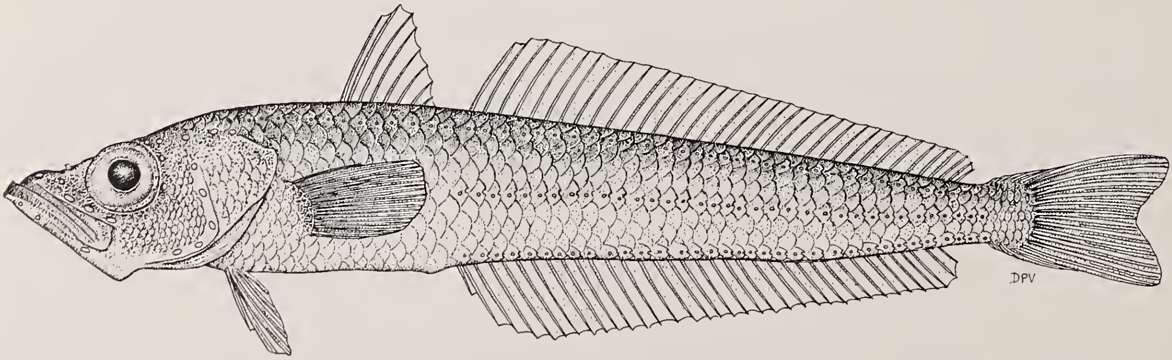


Fig. 38. *Pleuragramma antarcticum* RUSI 28267, 146 mm SL, Prydz Bay (68°57.5′S, 74°26.8′E)

and anal-fin base to end at an undetermined point near or on the caudal peduncle; we estimate the scale count to be about the same as for the upper lateral line. Dorsal and anal fins with unbranched rays. Caudal fin deeply emarginate.

Colour: In life, pink with a silvery hue, the dorsal surface slightly darker. All fins pale, with clear hyaline membranes. The body becomes silvery with a darker dorsum only after death (Gerasimchuk 1986).

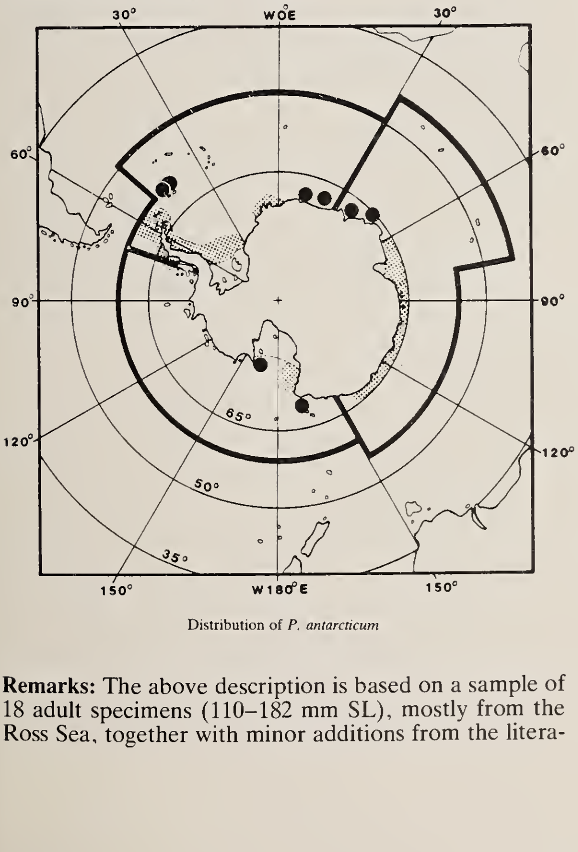
Otoliths

Diagnostic features: The discoid to oval shape, the lunate ventral half, the domed dorsal half, the entire margin, the horizontal groove in crista inferior and the presence of the ventral area.

Intraspecific variation: Negligible, except for the opening of the sulcus acusticus which can be either ostial or ostio-caudal.

Fig. 39. Representative otolith of *P. antarcticum*; fish length 190 mm TL; scale bar 1 mm

Distribution: Circum-Antarctic in pelagic waters over and near the bottom of the Antarctic continental shelf and the Antantic Peninsula, South Shetland, Elephant, and South Orkney islands; rarely in water over greater depths. Depth range 0–700 m.



Distribution of *P. antarcticum*

Remarks: The above description is based on a sample of 18 adult specimens (110–182 mm SL), mostly from the Ross Sea, together with minor additions from the literature. Gerasimchuk (1986) presents morphological data for extensive material from Prydz Bay. Unfortunately his data are given as percentages of SL and HL defined to include the lower jaw, thus making his data inconsistent with ours. We also find some inconsistencies between his meristic data and ours (gill rakers, fin-ray counts), so we have decided not to include his counts. Gerasimchuk does present data, however, that show sexual dimorphism in the development of the pelvic fins. Males develop longer pelvics than females, the difference apparent at 100 mm "SL" and becoming greater with size, the means for specimens over 150 mm "SL" being 13.2% and 10.5% of "SL" for males and females, respectively. Females also grow larger than males.

P. antarcticum is probably the dominant pelagic fish in the shelf waters about the continent. In the Ross and Weddell seas this species accounted for over 90% of both numbers and biomass of fishes (DeWitt 1970b; Hubold & Ekau 1987). Although not yet commercially exploited, small catches have been made and FAO keeps separate catch statistics for it (Hureau 1985f). Because of its abundance and possible commercial importance, *P. antarcticum* has been the subject of a number of studies on feeding and pelagic adaptations, although its morphology, from a systematic view, has been little studied.

Size-dependent vertical distribution has been observed in the Antarctic Peninsula (Kellermann 1986) and the Weddell Sea (Hubold 1984; Hubold & Ekau 1987). Larvae and postlarvae (8–30 mm SL) were collected mostly between the surface and 135 m; juveniles (33–110 mm) were at depths of 50–400 m; and adults were below 400 m. Hubold & Ekau (1987) proposed that by using vertical segregation *P. antarcticum* avoids intraspecific competition in regions of low diversity and interspecific competition in regions in which it is the most abundant pelagic fish species.

Length at sexual maturity was about 12.5 cm SL in the Weddell Sea (Hubold 1985). Spawning takes place from October to December around the continent (Kock *et al.* 1985). Kellermann (1986) suggested that the north-eastern Bellingshausen Sea and north-western Weddell Sea are spawning grounds for *P. antarcticum.* Hatching starts in mid-November in the Antarctic Peninsula (Kellermann 1989), South Orkney and South Shetland islands (Efremenko 1983), and in December at the Lazarev Sea (Gon pers. observ.). Size at hatching is about 10 mm SL (Kellermann 1989).

The food of *P. antarcticum* varies from place to place depending upon the prey organisms available. Postlarvae feed mainly on the eggs and larval stages of copepods. Juveniles feed mainly on copepods, but also take eggs and larval stages of euphausiids, polychaetes, and chaetognaths. As size increases, larger items are ingested (Kellermann & Kock 1984; Kellermann 1986, 1987). For adults in continental shelf waters away from the shelf edge (Ross Sea, southern Weddell Sea) *Euphausia crystallorophias* is the most important food by weight, with copepods, amphipods, and gastropods also consumed (the latter with some preference) when they are abundant (DeWitt & Hopkins 1977; Takahashi & Nemoto 1984; Hubold 1985). Near or over deeper water *Euphausia superba* becomes important or dominant, with other groups, including cumaceans and errant polychaetes, also eaten (DeWitt & Hopkins 1977; Daniels 1982; Takahashi 1983). During the winter, Daniels (1982) observed shoals of *Pleuragramma* feeding on amphipods under fast ice in the peninsular region. Although fishes, mostly larval and juvenile *P. antarcticum,* have been reported as a minor item of food, in McMurdo Sound, fish become a significant item with much of the feeding being cannibalistic (Eastman 1985b). Eastman speculates that McMurdo Sound is an extreme biotope because of heavy sea ice, reduced productivity and the absence of euphausiids. Because of their abundance in McMurdo Sound, larval and juvenile *P. antarcticum* may be an ecological substitute for the missing euphausiids (which are usually the principal prey of adults). *Pleuragramma antarcticum* is a significant item in the food of every vertebrate species that feeds in the pelagic realm of the Ross Sea (Eastman 1985b; Takahashi & Nemoto 1984). Takahashi & Nemoto consider *P. antarcticum* a primary link between crustaceans and icefishes (family Channichthyidae) in the Ross Sea where *Euphausia superba* is absent and where the dominant euphausiid, *E. crystallorophias,* is an important food only for *Chaenodraco wilsoni*.

Attains about 25 cm.

Genus ***Trematomus*** Boulenger, 1902

Body oblong, compressed posteriorly. Head broadened but not flattened, the interorbital area narrow to rather broad, its least width 5–33% HL. Eye diameter 20–37% HL. Mouth large, the maxilla extending to below anterior edge of eye or to middle of pupil, the upper jaw length 27–46% HL. Teeth conical, in 1 or 2 rows or bands; no enlarged or spaced canines, although there may be a few larger teeth anteriorly or along sides of jaws. Branchiostegal membranes usually broadly joined to each other and to isthmus, forming a broad free fold across isthmus, but in 1 species the membranes are joined only anteriorly and form a narrow free fold; branchiostegal rays 5–7 (usually 6). Gill rakers 17–26, not especially elongate, usually flattened in horizontal plane, not dentigerous, sometimes with bifid tips. Scapular foramen usually enclosed entirely within scapula; rarely lower edge of foramen touches edge of coracoid. Scales mostly ctenoid, but non-ctenoid scales usually present on ventrum and often on anterior dorsum and head. Upper lateral line with tubed scales sometimes reduced in extent; middle lateral line with tubed scales, often replaced by a line of pored scales. Preopercular-mandibular canal not joined to temporal canal and usually complete, but in some species it is divided into separate preopercular and mandibular sections (Fig. 1F); infraorbital canal complete or divided below eye; supraorbital canals usually connected by the coronal commissure with a median coronal pore; temporal canals with 5–6 pores; supratemporal canal usually complete across the head, but it may be divided into 2 or 3 sections (Fig. 1F). Branched caudal-fin rays 10–14; vertebrae (14–22)+(32–37) = 47–58.

Remarks: *Trematomus* includes small to moderate sized, benthic or epibenthic species that are the dominant fishes of the continental shelf regions of Antarctica. Most species are basically circum-continental, and only 2 are found as far north as South Georgia.

The composition of the genus *Trematomus* as recognised by Andersen (1984) differs from that of Balushkin (1982, 1984), and both differ from the genus as recognised here. Andersen (1984) places *T. bernacchii, T. hansoni,* and *T. tokarevi* in *Pagothenia* with *P. brachysoma* and P. *borchgrevinki* on the basis of their extensive series of cephalic pitlines and a divided supratemporal canal. According to Andersen (1984: 17) most other nototheniids lack pitlines altogether and a few species have only 1 or 2 of the 10 series that he found in the species of *Pagothenia*. Contrary to Andersen's observations, we have found pitlines on all of the species that we have examined (although these pitlines are often obscured by mucus, scales or dermal papillae), and we believe that the supratemporal canal character is insufficient since it may be complete or divided in 1 species. There are other trenchant differences between the species of *Trematomus* (as here defined) and those of *Pagothenia,* including cephalic canal configuration, scalation, and habit. Balushkin, on the other hand, restricted *Trematomus* to the type-species, *T. newnesi,* and created a new genus, *Pseudotrematomus,* for the remaining species. These 2 genera were distinguished on the basis of differences in the degree of ossification of the primary pectoral girdle, size and position of the scapular foramen, shape of the lower edge of the coracoid, degree of development of the postcoracoidal process, and that in *T. newnesi* the temporal lateral-line canal does not pass through the upper edge of the supracleithrum. We believe that Balushkin's arrangement is reasonable, but that further work needs to be done, especially with regard to the temporal canal and opercular series. For these reasons we choose not to recognise *Pseudotrematomus* as a valid genus.

KEY TO SPECIES

1a Occipital and interorbital regions of head without scales . . .2
1b Occipital area scaly; interorbital area more or less scaly (may be naked in some small specimens)....................4
2a P 24–26; ULL with 44–54 tubed scales; interorbital width 25–33% HL; LSS 76–85......................*T. newnesi*
2b P 29–30; ULL with 43 or fewer tubed scales; interorbital width less than 15% HL; LSS less than 70 3
3a Supratemporal canal divided into 3 segments, the middle segment with 3 pores, each lateral segment a short tube ending in a pore (Fig. 1f); temporal canal with 6 pores; D_2 35–37; (found at depths greater than 200 m) ....*T. tokarevi*
3b Supratemporal canal complete, with 3–4 pores (Fig. 1e); temporal canal with 5 pores; D_2 37–38; (found at depths less than 100 m) ....*T. nicolai*
4a P 20–21; ULL with 10–23 tubed scales; total GR in anterior (lateral) series of 1st arch 17–20 ....*T. scotti*
4b P 22 or more; ULL with 26 or more tubed scales; total GR in anterior series of 1st arch 19 or more 5
5a Scales present on preorbital and on at least proximal part of lower jaw 6
5b Lower jaw and preorbital naked (a few preorbital scales may be present on large *T. loennbergii*).....................7
6a D_2 36–38; A 34–36; distance from A origin to midbase of C fin 50–55% SL, about equal to distance from snout to A origin . ...*T. eulepidotus*
6b D_2 31–34, fewer than A rays, 34–37; distance from A origin to midbase of C about 56–60% SL, more than distance from snout to A origin (43–49% SL) ....*T. lepidorhinus*
7a Interorbital area at least partly naked; snout completely naked 8
7b Interorbital area completely scaly; snout partly or completely scaly (may be naked in small specimens)................9
8a LSS 58–68; infraorbital canal usually divided, the anterior section with 4–5 pores, the posterior section with 2–3 pores (rarely undivided and with 7 pores) (Fig. 1f); (Antarctica and nearby islands, including South Orkney and South Sandwich islands)...................................*T. bernacchii*
8b LSS 51–55; infraorbital canal usually undivided, with 7 pores (Fig. 1e); (South Georgia)......................*T. vicarius*
9a P 23–26; A 29–32; ULL with 30–38 tubed scales; LSS less than 60; interorbital width less than 15% HL.....*T. pennellii*
9b P 26–32; A 33–37; ULL with 38–47 tubed scales; LSS 60–80; interorbital width more than 15% HL 10
10a D_2 36–41; supratemporal canal divided into 3 segments, the middle one with 3 pores, each lateral segment with 1 pore (Fig. 1f); MLL without tubed scales (rarely with 1 or 2)...... ....*T. hansoni*
10b D_2 33–35; supratemporal canal undivided, with 3 pores (Fig. 1e); MLL with 6–19 tubed scales ....*T. loennbergii*

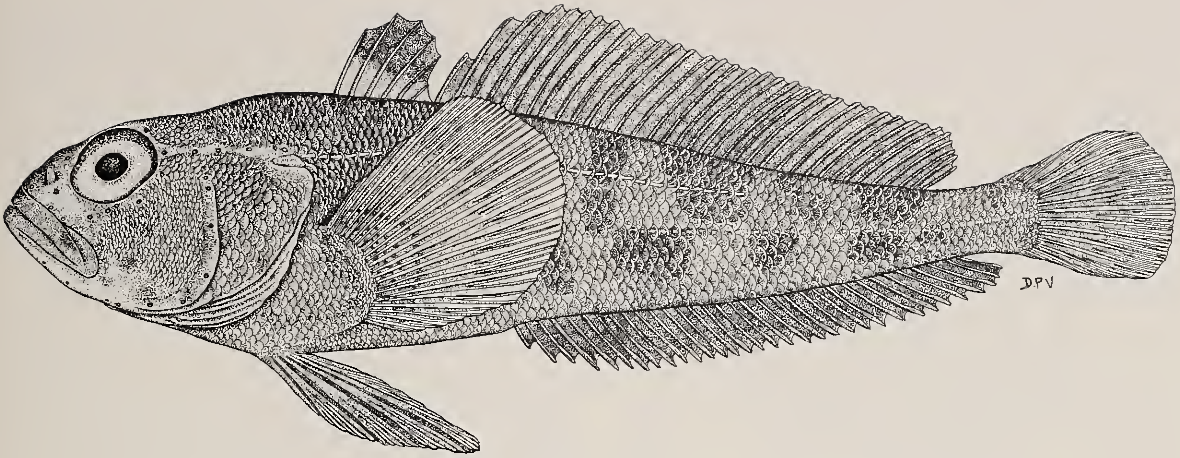


Fig. 40. *Trematomus bernacchii* RUSI 27675, 148 mm SL, Prydz Bay, off Davis Station

Trematomus bernacchii Boulenger, 1902
Emerald notothen
Fig. 40

Trematomus bernacchii Boulenger, 1902: 181, pl. 14, Cape Adare and Duke of York Island, Victoria Land. Syntypes: BMNH 1901.11.8.46–55.

Diagnosis: D III–VI+34–39; A 31–35; P 22–26; GR (7–10)+(14–16) = 21–25; ULL 26–41 tubed scales; LSS 58–68; branchiostegal rays 6 (rarely 5); vertebrae (17–18)+(34–35) = 51–52 (Eastman (1983) gives total vertebrae as 51–54). Body depth 3.8–5.3, head length 2.9–3.3, snout to anal-fin origin 1.8–2.0 and anal-fin origin to caudal-fin base 2.0–2.2 in SL. Eye diameter 3.1–4.0, interorbital width 6.3–9.1 and upper jaw length 2.2–2.6 in HL. Second dorsal fin with 2–6 more rays than anal fin.

Preopercular-mandibular canals separate, mandibular with 4, preopercular with 7 (rarely 8) pores; infraorbital canal usually divided into 2 segments with 5+3 pores (anterior segment located in the preorbital and 2nd suborbital bones), rarely divided into 3 segments, the 1st in the preorbital with 4 pores, the 2nd and 3rd segments each with 2 pores, and with the loss of 1 suborbital bone between the first 2 segments (some specimens from the Antarctic Peninsula have the infraorbital canal entire); supraorbital canal with 4 pores; coronal commissure with a single median pore (rarely, the coronal commissure is incomplete and with 1+1 closely-spaced pores); temporal canal with 5–6 pores; supratemporal canal divided into 3 sections, with 1+3+1 pores (median section rarely with 4 pores). Middle lateral line without tubed scales (rarely 1–2), but with a row of pored scales. Occipital region of head scaly; interorbital area with a median row of scales or the posterior part only scaly; snout, preorbitals and lower jaw naked.

Colour: In alcohol, ground colour pale brown with about 4 dark bars on dorsal part of body; indistinct dark blotches on lower part of body alternate with the dorsal bars to produce a chequered pattern; the pattern somewhat obscured in larger specimens where the dark dorsal bars have pale centres and their lower ends tend to form a zigzag pattern. Head without prominent markings. Median fins dusky, distal half of first dorsal and anal fins darkest. In life, body pale brown or pinkish-brown, darker dorsally with black or dark brown spots and bars. Median and paired fins without stripes or bars. Pectoral fins dark, with numerous light spots; 3 green spots anterior to pectoral-fin base (Hureau 1985f).

Otoliths

Diagnostic features: The obovate shape, the separate ostium and cauda, the extremely prominent crista inferior and the absence of the crista superior.

Intraspecific variation: Neglible, except for the sculpture of the margin.

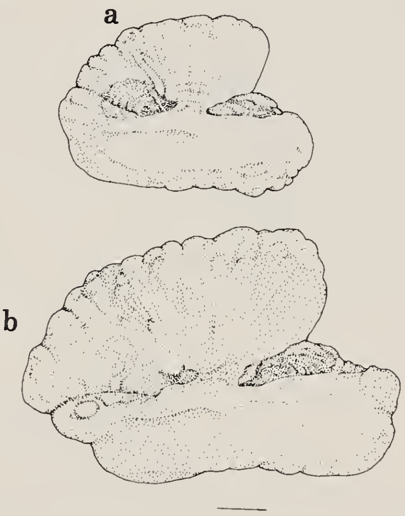
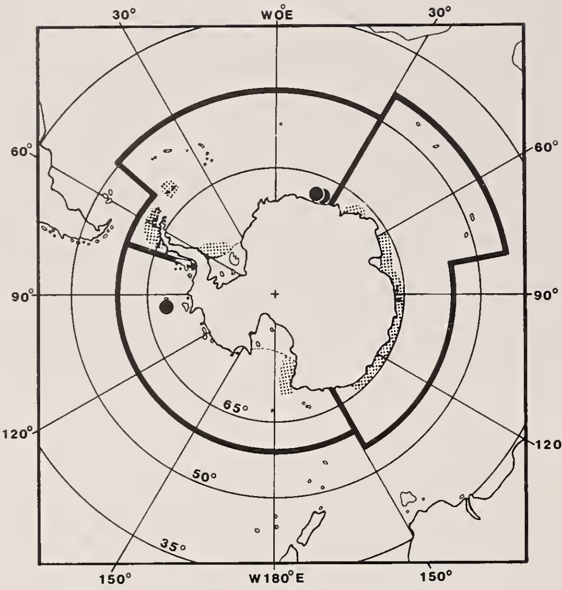


Fig. 41. Representative otoliths of *T. bernacchii*; fish lengths: (a) 27 cm and (b) 40 cm TL; scale bar 1 mm

Distribution: Found in nearshore and first slope waters of Antarctica (probably circum-Antarctic) and nearby islands, including Peter I, South Shetland, Elephant, and South Orkney islands. Although its depth range is from near surface to over 700 m (DeWitt 1971; Hureau 1985f), it is not found on the continental shelf. It is most common in the upper 200 m (Hureau 1970; Naito & Iwami 1982).



Distribution of *T. bernacchii*

Remarks: Length at sexual maturity in Adélie Land was about 175 mm SL for females and 145 for males (Hureau 1970). Spawning takes place in October–November in Adélie Land (Hureau 1970), Davis Sea (Butskaya & Faleeva 1987), and Lützow-Holm Bay (Kawaguchi *et al.* 1989), but in December–January at McMurdo Sound (Dearborn 1965). Observations on aquarium-reared fish showed that *T. bernacchii* stops feeding about a month before spawning (Sakakibara *et al.* 1989). Time of hatching is not known, as larvae have not yet been collected. The eggs are demersal, 3.5–4.0 mm in diameter (Dearborn 1965; Hureau 1970). Absolute fecundity was between 1,200–3,123 eggs (fish length for high value 281 mm TL, from Dearborn 1965) in all the localities mentioned above except Lützow-Holm Bay. Parental care was observed by Moreno (1980) in Palmer Archipelago. He found clusters of eggs inside large volcano sponges of which 3 were "guarded" by adult fishes. The fishes had their tails inside the sponges and reacted aggressively to divers approaching the sponges. The actual spawning was not observed and Moreno (1980) could present only circumstantial evidence to link the fishes with the egg clusters. An embryo extracted from the eggs, which were collected in February and were in an advanced state of development, measured 14 mm TL. Comparing the data of Dearborn (1965), Hureau (1970) and Moreno (1980) with that of Ekau (1989) for the hatching of *T. eulepidotus,* we surmise that embryonic development in *T. bernacchii* lasts throughout summer, hatching occurs towards the end of summer and early autumn, and size at hatching is about 14–16 mm TL.

Several studies indicate that *T. bernacchii* is primarily a benthic feeder, but (like most nototheniids) also opportunistic in that where suitable pelagic prey are available it will take them. In the area of the Antarctic Peninsula, Daniels (1982) reported that it feeds primarily on amphipods, with polychaetes, isopods, and nemertians being taken in smaller amounts. He also found a shift in diet of larger fish away from amphipods towards polychaetes, tunicates and isopods, although amphipods remained the single most important item in the diet. At the Palmer Archipelago, Moreno (1980) found it taking euphausiids and amphipods in about equal numbers and related the more pelagic diet to the fishes sitting well off the bottom on large sponges. In the region of Adélie Land, *T. bernacchii* feeds preferentially on polychaetes, gastropods, and isopods, with amphipods also taken in significant numbers (Hureau 1970). In Lützow-Holm Bay amphipods, euphausiids, and polychaetes predominated in the diet, with fish eggs also important when present; gastropods were not eaten (Naito & Iwami 1982).

Females attain about 35 cm TL and live 10+ years whereas males attain 28 cm TL and live 5+ years (Wohlschlag 1961; Hureau 1970).

Trematomus eulepidotus Regan, 1914
Blunt scalyhead
Fig. 42

Trematomus eulepidotus Regan, 1914a: 12, McMurdo Sound, Ross Sea. Holotype: BMNH 1913.12.4.68.

Diagnosis: D VI–VII+36–38; A 34–36; P 27–29; GR (7–10)+(13–16) = 21–26; ULL 42–48 tubed scales; MLL 11–21 tubed scales; LSS 68–75; branchiostegal rays 6; vertebrae (17–20)+37 = 54–57. Body depth 4.0–5.6, head length 3.3–3.6, snout to anal-fin origin 1.8–2.1, anal-fin origin to caudal-fin base 1.8–2.0 in SL. Eye diameter 2.9–3.6, interorbital width 4.0–5.0, and upper jaw length 2.4–2.7 in HL. Second dorsal-fin rays 0–3

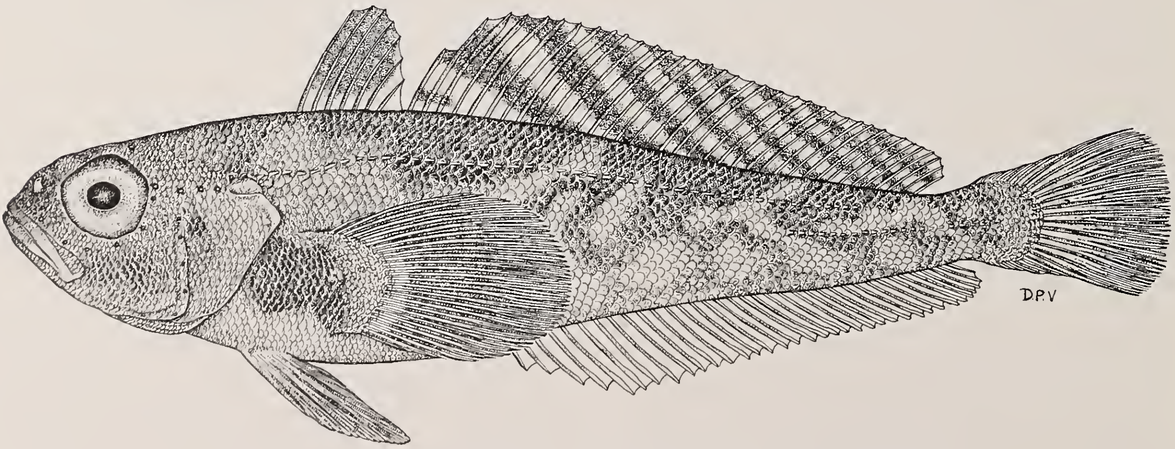


Fig. 42. *Trematomus eulepidotus* ADH S86008, 179 mm SL, Prydz Bay

more than anal-fin rays. Preopercular-mandibular canal with 10 pores; infraorbital canal with 6–8 pores; supraorbital canal with 4 pores; coronal commissure with a single median pore; temporal canal with 5–6 pores; supratemporal canal complete with 3 pores. Body and head almost entirely scaled, including snout, preorbitals, posterior part of maxilla, lower jaw, isthmus, branchiostegal membranes and proximal parts of branchiostegal rays.

Colour: In alcohol, ground colour buff, with a chequered pattern formed by staggered dark blotches along the dorsal, lateral and ventral parts of the body; ventral dark blotches may appear as short wavy horizontal dark marks. Snout, occipital region and sometimes interorbital area are dark.

Otoliths

Diagnostic features: The discoid to ovate shape, the separated ostium and cauda, the split crista superior which is knob-like above the anterior portion of the cauda, the presence of a horizontal groove in the crista inferior and the sinuate margin.

Ontogeny: The shape of the otolith changes from being discoid to ovate in fish greater than 23 cm TL, and the rostrum changes from being short and broad to slightly more elongate in fish larger than 22 cm TL.

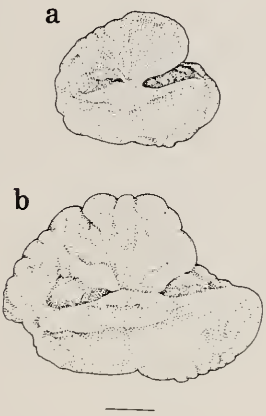
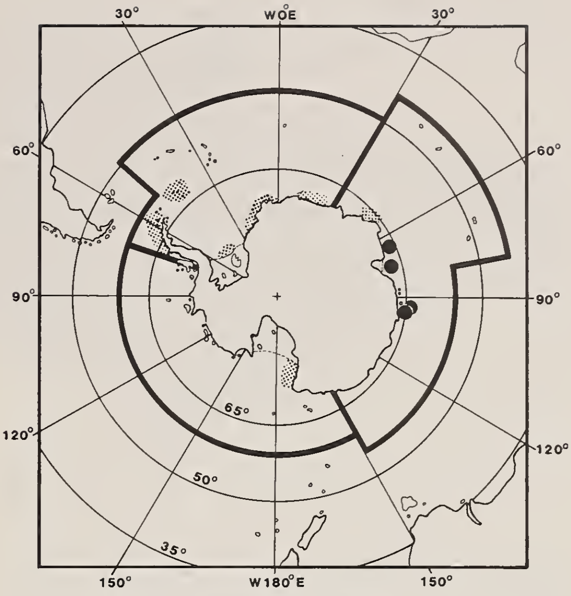


Fig. 43. Representative otoliths of *T. eulepidotus*; fish lengths: (a) 20 cm and (b) 32 cm TL; scale bar 1 mm



Distribution of *T. eulepidotus*

Distribution: Nearshore and continental shelf of Antarctica and nearby islands, including the South Orkneys. Depth range 70–550 m.

Remarks: A survey of the Weddell Sea midwater fish fauna during January-March 1985 showed that *T. eulepidotus* was the second most common nototheniid species and fifth most common of all fishes (Hubold & Ekau 1987). It was also abundant in the demersal fauna, second to *Chionodraco myersi* (Ekau 1989). During the same cruise a batch of about 2,000 eggs (4.2–4.6 mm in diameter) were collected from which live eggs were separated and observed in aquaria until hatching (Ekau 1989). As the eggs were at the gastrulation stage, he concluded that spawning takes place in summer. Incubation in the aquaria lasted 5–6 months and may be even longer in the natural environment, indicating that hatching occurs in winter. Live size at hatching in the experiment was 18.6 mm SL, but Ekau maintained that the embryos over-developed in the artificial conditions. By December and February postlarvae in the Weddell Sea reached 26 mm and 38 mm SL respectively and similar sizes were also recorded from the Scotia Sea (Kellermann 1989). In March, fishes 32.3–40.8 mm were collected at the Antarctic Peninsula (Efremenko 1984). Ekau (1989) suggested that the change from pelagic to benthic life occurs when juveniles are 60–70 mm SL. Absolute fecundity was 1,400–12,300 eggs (fish length unknown) in Weddell Sea fishes (Ekau in press).

Fishes collected in the Antarctic Peninsula and the South Shetland Islands (size range 18–34 cm) fed mostly on *Euphausia superba*. In the South Shetland Islands salps were also important and near Anvers Island nudibranchs were a frequent prey, but in low numbers. Amphipods, copepods, polychaetes and fishes were also taken (Tarverdiyeva & Pinskaya 1980). In the South Orkney Islands, the diet of smaller fishes (145–148 mm TL) included only crustaceans, mostly copepods (Targett 1981). In the Weddell Sea, stomachs of 63 fishes (9–28 cm SL) were analysed; euphausiids, copepods, and pteropods were the most important prey items, but other crustaceans, polychaetes, chaetognaths and fish were also present (Schwarzbach 1988).

Attains 34 cm TL.

Trematomus hansoni Boulenger, 1902
Striped notothen
Fig. 44; Pl 7, Fig. 1

Trematomus hansoni Boulenger, 1902: 180, pl. 13, Cape Adare and Duke of York Island, South Victoria Land. Syntypes: BMNH 1901.11.8.39–40.

Diagnosis: D V–VII+36–41; A 33–37; P 28–32; GR (6–10)+(15–17) = 23–26; ULL 38–47 tubed scales; MLL 0–2 tubed scales; LSS 60–72; branchiostegal rays 6; vertebrae (16–22)+(35–37) = 51–58. Body depth 4.0–5.3, head length 3.1–3.7, snout to anal-fin origin 1.8–2.1, anal-fin origin to caudal-fin base 1.8–2.1 in SL. Eye diameter 3.6–4.8, interorbital width 4.5–6.3, and upper jaw length 2.2–2.5 in HL. Second dorsal fin with 1–6 more rays than anal fin. Preopercular-mandibular canals undivided, with 9–11 pores; infraorbital canals may be undivided, with 7–8 pores, or divided with 5+3

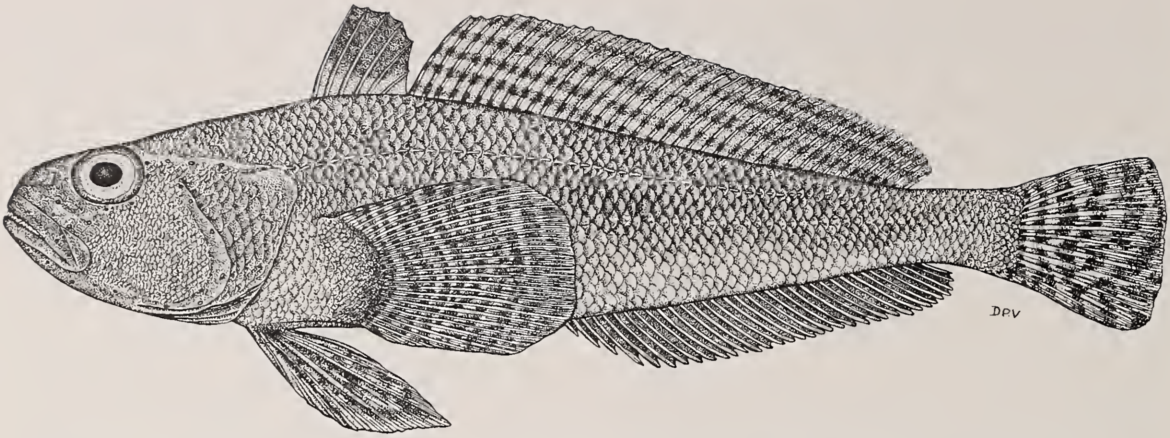


Fig. 44. *Trematomus hansoni* UMO 95, 24 cm SL, off Cape Armitage, Ross Island, McMurdo Sound

pores; supraorbital canal with 4 pores; coronal commissure with a single median pore; temporal canal with 5–6 pores; supratemporal canal divided, with 1+3+1 pores. Middle lateral line usually without tubed scales, but rarely 1–2 may be present. Iwami & Abe (1982) reported a specimen of *T. hansoni* from the South Shetland Islands that had the middle lateral lines with 31 and 27 tubed scales. Most scales on body weakly ctenoid; nonctenoid scales present on head, belly and breast, along anal fin base, and on dorsal part of body below first dorsal fin and anteriorly to head; occipital and interorbital areas scaly; posterior part of snout may be naked in small specimens; cheeks and operculum scaly; preorbitals and lower jaw naked.

Colour: In alcohol, ground colour light brown. Body with irregular horizontal, wavy, dark markings or vertical dark blotches and spots, especially anteriorly; head sometimes spotted, including upper surface of eye. First dorsal fin dusky to blackish. Second dorsal fin with 2–4 dark horizontal stripes, the outermost at distal edge of fin. Anal fin dusky, darkest toward distal edge. Pectoral fin with 3–6 irregular, somewhat indistinct crossbands. Caudal fin with 4–6 crossbands. Hureau (1985f) described the fresh colour as greenish-grey with large black crossbars; lower parts of head bluish-mauve; dorsal and anal fins with greyish-green rays and black membrane.

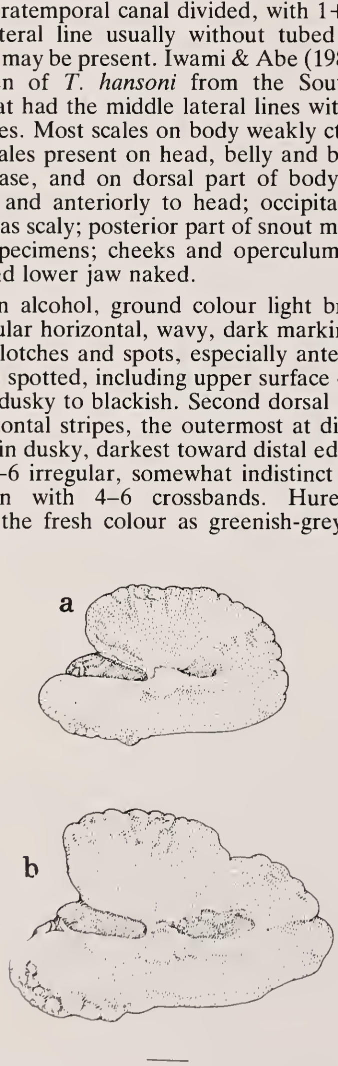


Fig. 45. Representative otoliths of *T. hansoni*; fish lengths: (a) 27 cm and (b) 38 cm TL; scale bar 1 mm

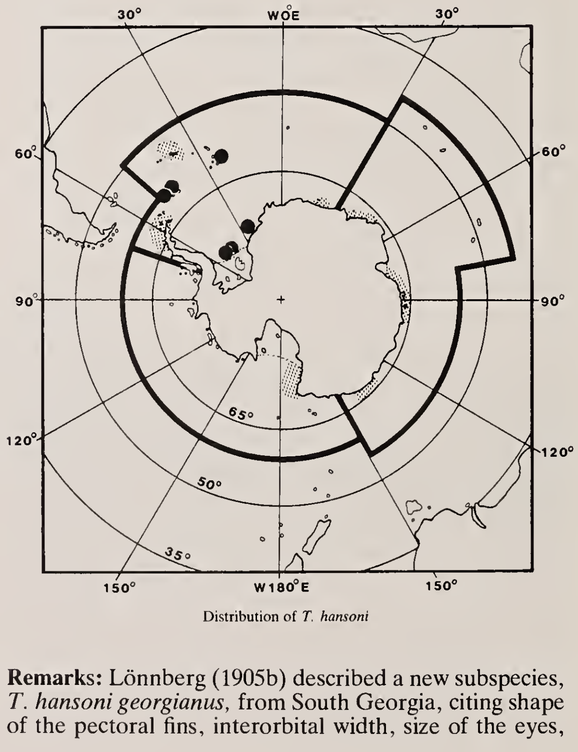
Otoliths

Diagnostic features: The oval to obovate shape, the separated ostium and cauda, the absence of the crista superior, the knob-like appearance of the crista inferior below the collum and the sinuate to entire margin.

Intraspecific variation: Neglible, except for ontogenetic changes.

Ontogeny: Otoliths of fish greater than 225 mm TL change from being generally entirely oval to obovate with a prominent rostral projection.

Distribution: Circum-Antarctic including nearby islands, South Orkneys and South Georgia. Depth range 5–550 m (DeWitt 1971; Hureau 1985f; Tiedtke & Kock 1989).



Distribution of *T. hansoni*

Remarks: Lönnberg (1905b) described a new subspecies, *T. hansoni georgianus*, from South Georgia, citing shape of the pectoral fins, interorbital width, size of the eyes, and number of rays in the dorsal and anal fins as distinctive characters. Subsequent authors have not recognised the South Georgian population as even subspecifically distinct. Our data, admittedly from small samples, indicate that there may be real differences between the population in South Georgia and that from the Ross Sea. The South Georgia material appears to have fewer dorsal spines (5–6, mean 5.83, vs 6–7, mean 6.45), fewer dorsal rays (36–38, mean 37.0, vs 38–40, mean 39.0), fewer pectoral-fin rays (29–30, mean 29.55, vs 29–31, mean 30.6), and fewer lateral scale series (61–67, mean 64.0, vs 60–72, mean 67.0). In addition, the infraorbital canals of the 2 samples differ: in the South Georgia sample, except for one side of 1 specimen, the canal is continuous; in all of the Ross Sea specimens the canal is divided into an anterior section with 5 pores and a posterior section with 3 pores. If these differences are evident in larger samples, especially for material from the Antarctic Peninsula, then recognition of the South Georgian population is probably warranted.

In Adélie Land, males reached sexual maturity at about 19 cm, females at 20 cm SL; spawning took place in January–February (Hureau 1970). Hatching time is not known, but judging from other species with similar size eggs, it probably occurs in winter. This assumption is corroborated by the finding of 31.3–43.5 mm long postlarvae in March in the Antarctic Peninsula (Efremenko 1984). Absolute fecundity was 7,000–12,000 eggs (fish length 26–30 cm SL) in Adélie Land (Hureau 1970) and 18,016–24,000 eggs (fish length 36–41 cm) in South Georgia (Sil'yanova 1982). Egg diameter was 3.0–3.5 mm in fishes from Adélie Land (Hureau 1970).

The diet of *T. hansoni* is varied and based primarily on benthic organisms. In Adélie Land polychaetes were preferred, with crustaceans and gastropods being of secondary importance (Hureau 1970). In South Georgia, Shust & Pinskaya (1978) found that *T. hansoni* fed mainly on polychaetes and mysids, but krill and ctenophores were also taken; Burchett *et al.* (1983) reported amphipods and fish eggs as the main prey items; Targett (1981) found only krill in the stomachs of this species. It appears, therefore, that *T. hansoni* is primarily an opportunistic feeder on a wide variety of invertebrates. It should be noted, that all the studies mentioned above included both juveniles and adults in their analysis.

Attains about 41 cm TL.

Trematomus lepidorhinus (Pappenheim, 1911)
Slender scalyhead
Fig. 46; Pl 7, Fig. 2

Notothenia lepidorhinus Pappenheim, 1911: 382, *Gauss* winter station, off Wilhelm II Land (approx. 66°45′S, 91°00′E). Holotype: ZMB 18872.

Diagnosis: D V–VI+31–34; A 34–37; P 26–30; GR (8–9) + (13–18) = 22–26; ULL 39–49 tubed scales; MLL 18–30 tubed scales; LSS 61–70; branchiostegal rays 6–7; vertebrae (15–16)+(36–37) = 51–52. Body depth 4.0–5.6, head length 3.4–3.7, snout to anal-fin origin 2.0–2.3, and anal-fin origin to caudal-fin base 1.7–1.8 in SL. Eye diameter 3.0–3.7, interorbital width 4.8–5.6, and upper jaw length 2.3–2.8 in HL. Anal fin with 2–4 more rays than second dorsal fin. All cephalic lateral line canals undivided; preopercular-mandibular canal with 10 pores, the canal not connected to temporal canal; infraorbital canal with 7–8 pores; supraorbital canal with 4 pores; coronal commissure with a single median pore; temporal canal with 5–6 pores; supratemporal canal with 3 pores. Scales on body ctenoid except for those on belly, breast and anterior to pectoral fins; head completely covered with mostly ctenoid scales, except for those on lower jaw and branchiostegal rays.

COLOUR: In alcohol, body with 6 dark crossbars dorsally, first in front of spinous dorsal fin, 2nd to 5th below second dorsal fin, 6th on caudal peduncle; bars become narrower ventrally, and some shift anteriorly to produce a chequered pattern. First dorsal fin blackish. Second dorsal fin with oblique dark stripes extending posteroventrally along fin. Anal fin dusky distally. Some specimens with all fins pale. Lining of mouth and gill cavity dark, showing through operculum and exposed ventral membranes. In life, body blue-grey with reticular branching, dark crossbars. Gill cover and shoulder region suffused with yellow. Iris chrome-yellow. Membrane between first 3 dorsal spines dark grey. Second dorsal fin with 5–6 faint crooked stripes (Pappenheim 1912).

Otoliths

DIAGNOSTIC FEATURES: The discoid (small fish) to ovate shape, the ostial and heterosulcoid sulcus acusticus, the well separated ostium and cauda, the well-developed

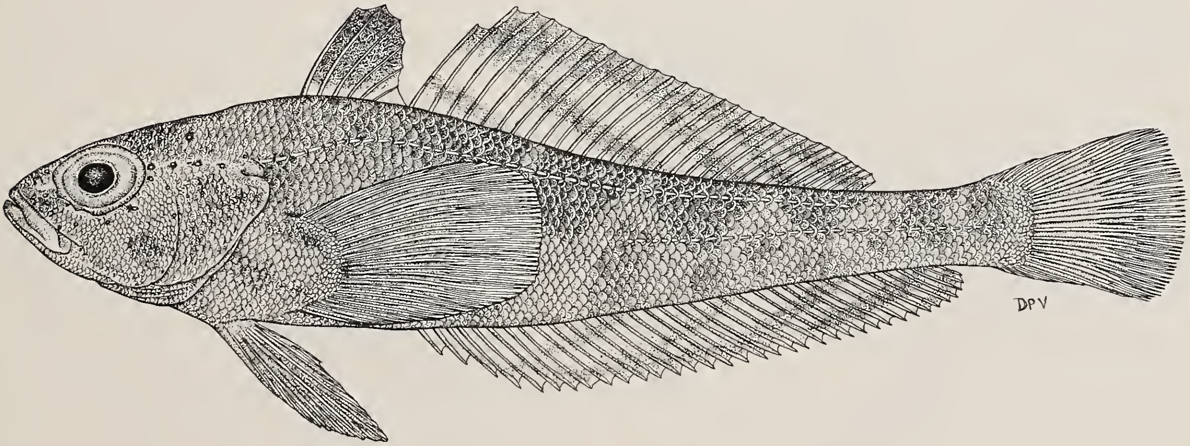


Fig. 46. *Trematomus lepidorhinus* ADH S86097, 153 mm SL, Prydz Bay

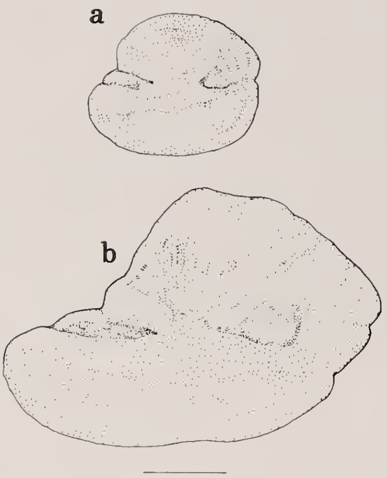
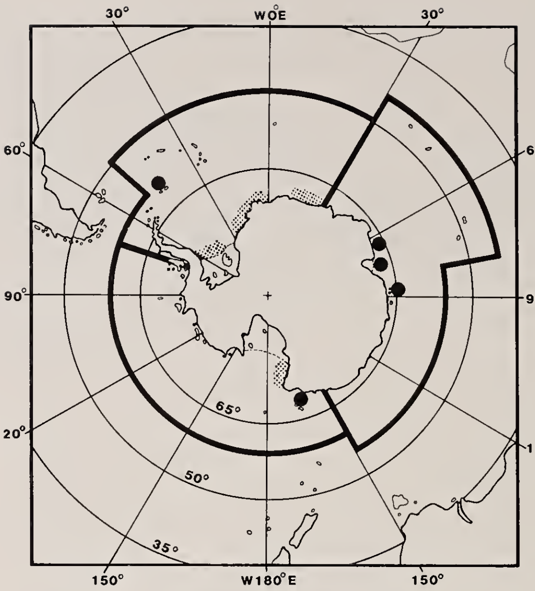


Fig. 47. Representative otoliths of *T. lepidorhinus*; fish lengths: (a) 116 mm and (b) 198 mm TL; scale bar 1 mm



Distribution of *T. lepidorhinus*

anterior section of the crista superior, the well-developed crista inferior below the entire sulcus acusticus and the distinct ventral groove below the crista inferior.

Intraspecific variation: Negligible, except for the general shape. The size of the rostrum increases with increasing fish size.

Distribution: Inner (nearshore) slope and continental shelf of Antarctica, except the Antarctic Peninsula. Tomo (1981) reported 2 specimens from the South Orkney islands. Depth range from 200 to over 800 m (DeWitt 1971; Permitin 1977).

Remarks: Little is known of the biology of *T. lepidorhinus*. According to Ekau (1988), spawning occurs in autumn in the Weddell Sea. Takahashi & Nemoto (1984), who examined 6 specimens from the Ross Sea, found only amphipods in the stomachs, of which 80% were the pelagic species *Themisto gaudichaudii*. In the Weddell Sea, stomachs of 68 specimens (fish length 7.2–23.6 cm SL) contained mostly amphipods, polychaetes and mysids; small specimens also fed on copepods (Schwarzbach 1988). The dominance of a pelagic amphipod in the diet provides further evidence that *T. lepidorhinus* often forages well off the bottom, as indicated by Eastman & DeVries (1982).

Attains 31 cm TL.

Trematomus loennbergii Regan, 1913
Deepwater notothen
Fig. 48

Trematomus loennbergii Regan, 1913: 263, pl. 8, fig. 4, south-west of Balleny Islands. Holotype: BMNH 1906.5.8.69.

Diagnosis: D V–VII+33–35; A 33–35; P 26–29; GR (6–10)+(13–15)=20–24; ULL 41–47 tubed scales; MLL 6–19 tubed scales; LSS 64–80; branchiostegal rays 5–6; vertebrae (16–18)+(33–37)=50–54. Body depth

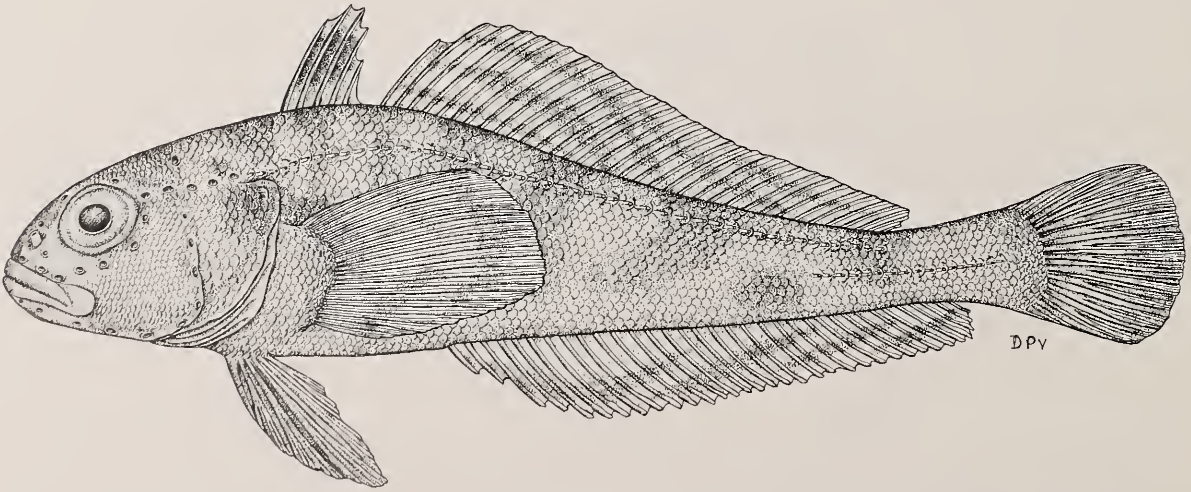


Fig. 48. *Trematomus loennbergii* USC-*Eltanin* Station 2070, 182 mm SL, Ross Sea (78°29′S, 165°39′W)

4.0–5.6, head length 3.4–3.7, snout to anal-fin origin 2.0–2.3, and anal-fin origin to caudal-fin base 1.7–1.9 in SL. Eye diameter 2.7–3.6, interorbital width 4.8–6.2, and upper jaw length 2.3–2.8 in HL. Second dorsal fin with 2 more to 1 less rays than anal fin. Cephalic lateral-line canals complete; preopercular-mandibular with 10 pores; infraorbital canal with 7 pores; supraorbital canal with 4 pores; coronal commissure with a single median pore; temporal canal with 5–6 pores; supratemporal canal with 3 pores. Head and body scaled, except for anterior parts of snout, lower jaw and isthmus; posterior part of preorbitals naked or scaly; scales ctenoid except on belly, chest, anterior to pectorals, and ventral part of head.

COLOUR: In alcohol, uniformly brown, without distinct markings. First dorsal fin blackish. Caudal fin blackish, especially distally. Other fins pale brownish-grey becoming darker distally. Lining of mouth and gill cavities blackish, showing through branchiostegal membranes and membranes of lower jaw. Regan's (1913) original illustration shows 6–7 crossbars on the body and some indistinct banding on the second dorsal and anal fins (the figure in Hureau (1985f) is probably taken from Regan). It is possible that specimens from shallower depths might show a more distinct colour pattern than those from deep water. In life, light brown or reddish, darker dorsally; 4–5 irregular crossbars from back to below midside. Indistinct dark blotch sometimes present on first dorsal fin. Lining of mouth and gill cavities blackish (Hureau 1985f).

Otoliths

DIAGNOSTIC FEATURES: The near discoid shape except for the prominent and distally rounded rostral projection, the ostial and heterosulcoid sulcus acusticus, the pit-like ostium and cauda, and the split V-shaped crista superior.

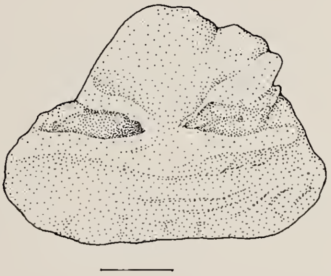
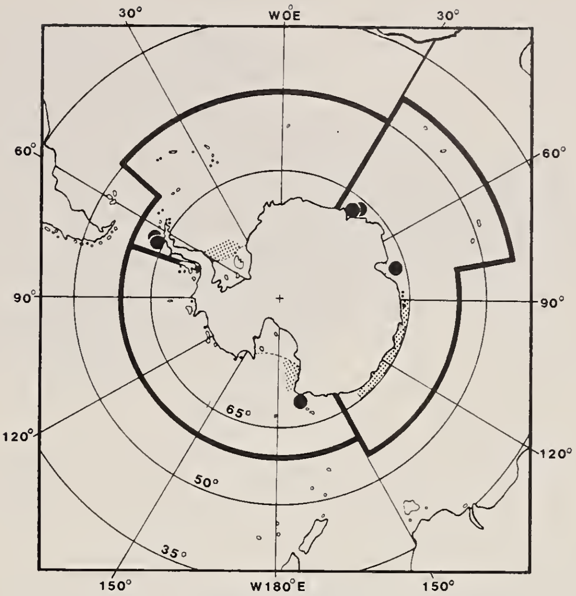


Fig. 49. Representative otolith of *T. loennbergii*; fish length 22 cm SL; scale bar 1 mm

Distribution: Continental circum-Antarctic, from nearshore (inner slope) down to deep parts of continental shelf. It has not been recorded from any of the Scotia Arc islands north of the Antarctic Peninsula (DeWitt 1971; Hureau 1985f). Depth range 65–832 m; it is most commonly found at depths greater than 300 m (DeWitt 1971; Naito & Iwami 1982).

Remarks: In the Weddell Sea, *T. loennbergii* spawns in autumn (Ekau 1988). Postlarvae, 25–30 mm long, were collected at the Antarctic Peninsula in March (Efremenko 1984). Eastman & DeVries (1982) found *T. loennbergii* to have a lower specific gravity than all other benthic notothenioids in McMurdo Sound, and they considered it to be an epibenthic species that often leaves the bottom to forage in the water column. Eastman (1985b) found that *T. loennbergii* feeds on amphipods (primarily *Orchomene plebs*), errant polychaetes, and, in lesser amounts, fishes. Hureau (1985f) cites isopods and other crustaceans as also being part of the diet.



Distribution of *T. loennbergii*

Attains about 30 cm SL.

Trematomus newnesi Boulenger, 1902
Dusky notothen
Fig. 50

Trematomus newnesi Boulenger, 1902: 177, pl. 11, Duke of York Island and Cape Adare, Victoria Land. Syntypes: BMNH 1901.11.8.3–6.

Diagnosis: D VI–VIII+33–36; A 32–34; P 24–26; GR (6–9) + (16–18) = 23–26; ULL 44–54 tubed scales; MLL with 3–19 tubed scales; LSS 76–85; branchiostegal rays 6 (rarely 7); vertebrae (18–20)+(34–36) = 53–55. Body depth 3.8–5.0, head length 2.9–4.3, snout to anal-fin origin 1.9–2.1, and anal-fin origin to caudal-fin base 1.8–1.9 in SL. Eye diameter 3.2–4.3, interorbital width 3.0–4.0, and upper jaw length 1.9–2.3 in HL. Second dorsal fin with 1–3 more rays than anal fin. Cephalic sensory canals complete, without any divisions or reductions; preopercular-mandibular canal with 9–11 pores; infraorbital canal with 7 (rarely 8) pores; supraorbital canal with 4 pores; coronal commissure with 1 pore; temporal canal with 5 (rarely 4) pores; supratemporal canal with 3 (rarely 4–5) pores. The temporal canal ends anterior to the upper end of the supracleithrum and does not pass through the latter. For this reason the upper lateral line appears to extend anteriorly to the upper end of the gill opening rather than slightly posterior to it as in other species. Most scales on body ctenoid; non-ctenoid scales present on mid-belly region, on chest, anterior to pectoral fins, upper anterior body, and anterior to first dorsal fin; head with non-ctenoid scales on cheeks, operculum, and in a small area in the angle between the temporal and supratemporal canals; rest of head naked.

COLOUR: Body and head brown to almost blackish, paler below. In some specimens a pale horizontal line extends along the scales of the middle lateral line. Belly bluish-

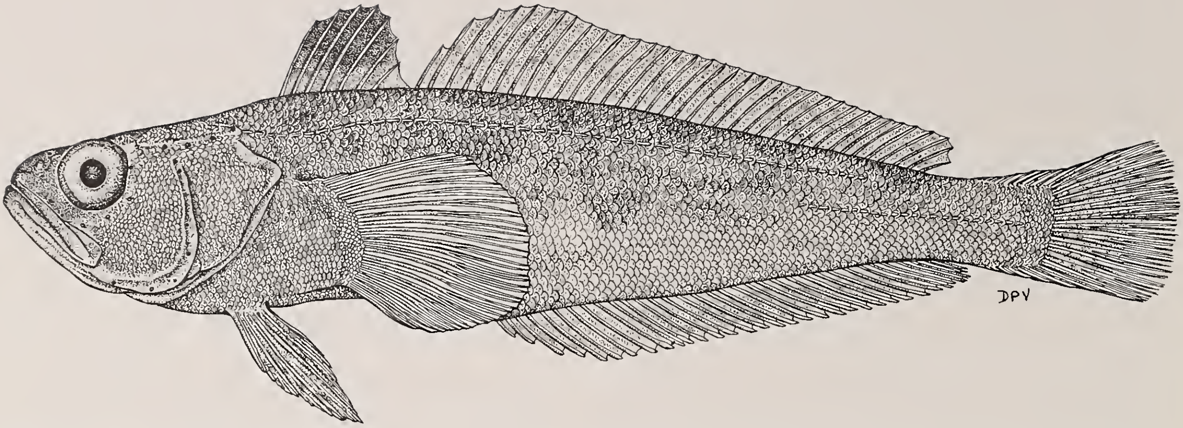


Fig. 50. *Trematomus newnesi* UMO 3252, 127.3 mm SL, South Orkney Islands, off Coronation Island (60°26.5′S, 46°22.8′W)

black, probably indicating the colour of the peritoneum. In some fish 4–5 faint bars cross back and extend ventrally to upper lateral line, continue to middle lateral line by blotches shifted anteriorly or posteriorly, and again onto lower half of body by a third series of shifted blotches, the whole giving a faint checkerboard effect; in others the middle and lower blotches become diffuse or are elongate, wavy horizontal dark lines. First dorsal fin dusky to blackish. Other vertical fins pale or only slightly dusky, sometimes with dark pigment forming a horizontal line, submarginal (second dorsal fin) or along middle of fin (anal fin).

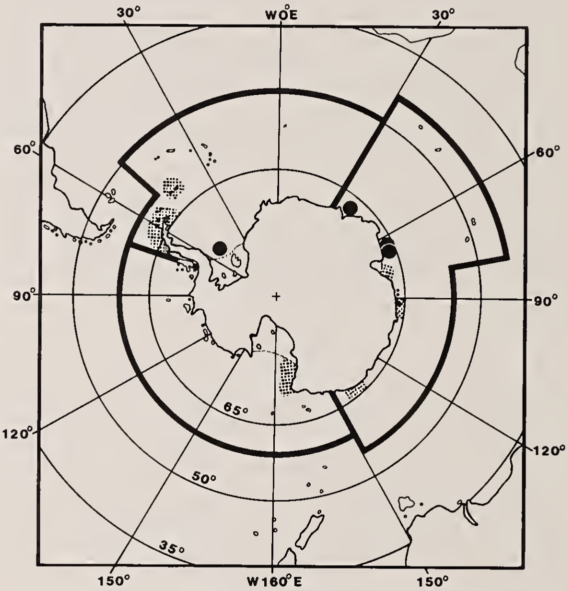
Otoliths

Diagnostic features: The oval to discoid shape, the separate ostium and cauda and the distinct and wide ventral groove below the crista inferior.

Intraspecific variation: Negligible, except for the sculpture of the margin.

Fig. 51. Representative otolith of *T. newnesi*; fish length 21 cm TL; scale bar 1 mm

Distribution: Probably circum-Antarctic; known from East Antarctica, Weddell Sea, Antarctic Peninsula, South Shetland Islands, Elephant Island and South Orkney Islands. Depth range 0–400 m (Tiedtke & Kock 1989).



Distribution of *T. newnesi*

Remarks: *Notothenia hodgsoni* Boulenger (1907) has been considered a synonym of *T. newnesi*. In fact, the syntypes of this species (at BMNH) include specimens of 3 species: *T. newnesi*, *T bernacchii* and *Pagothenia borchgrevinki*. The specimen illustrated by Boulenger (1907: pl. 2, figs. 2 & 2a; BMNH 1906.5.8.41) is *P. borchgrevinki*, as is clearly seen in the dorsal view of the head where a pair of coronal pores are shown rather than a single median coronal pore. For this reason, *N. hodgsoni* is here placed in the synonymy of *P. borchgrevinki*.

Little is known about the reproductive biology of *T. newnesi*. In the Antarctic Peninsula area, it spawns in less than 160 m on the shelf area from eastern Palmer Archipelago to the tip of the Peninsula (Radtke *et al.* 1989). Newly hatched larvae appear in the water column in the Antarctic Peninsula in September and October (Radtke *et al.* 1989). Size at hatching is 7.6 mm SL (Kellermann 1989). In the South Orkney Islands a 38.5 mm juvenile was collected in February (Efremenko 1984), and Everson (1969) found fishes 56–125 mm SL throughout the year. Radtke *et al.* (1989) suggested that young juveniles settle down to benthic life in March.

T. newnesi is usually found in shallow nearshore areas

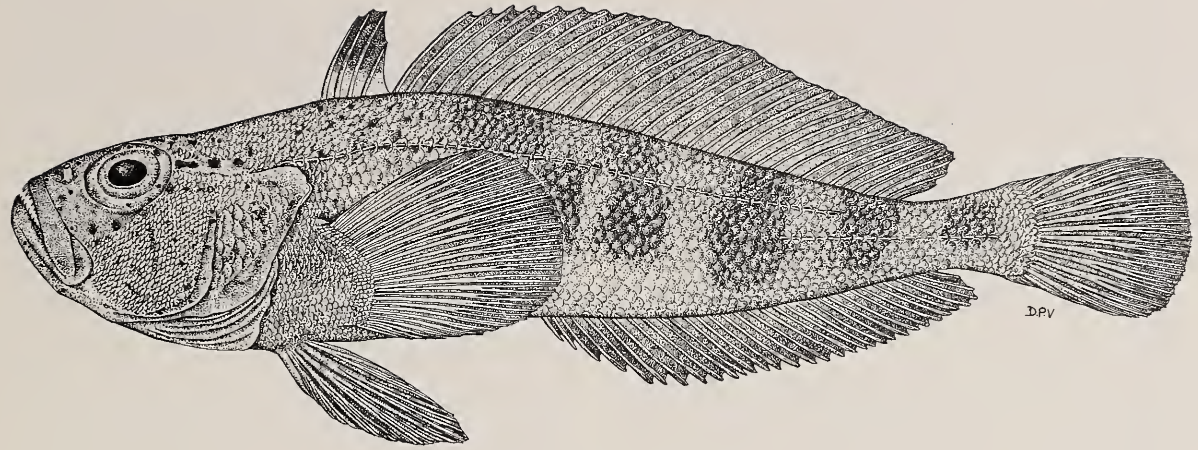


Fig. 52. *Trematomus nicolai* BMNH 1901.11.8.63, 195 mm SL, Cape Adare, Ross Sea

and may be common in the intertidal zone (Everson 1968; Hureau 1985f). A benthic and midwater feeder, in the Antarctic Peninsula *T. newnesi,* especially juveniles, are often seen feeding in the water column or at the undersurface of ice. They prey primarily on euphausiids and amphipods, with lesser amounts of polychaetes, gastropods, and isopods (Daniels 1982). In the South Orkney Islands *T. newnesi* of 13–19 cm TL fed exclusively on pelagic crustaceans with calanoid copepods being important in smaller fishes and euphausiids, mostly *E. superba,* in larger fish (Targett 1981). Such prey are consistent with an engibenthic habit.

Attains 20 cm TL.

Trematomus nicolai (Boulenger, 1902)
Spotted notothen
Fig. 52

Notothenia nicolai Boulenger, 1902: 184, pl. 15, Cape Adare and Duke of York Island, Victoria Land. Syntypes: BMNH 1901.11.8.63–64.

Diagnosis: D IV+37–38; A 32–33; P 29–30; GR (9–10) + (14–16) = 23–25; ULL 40–43 tubed scales; MLL 7–18 tubed scales; LSS 60–67; branchiostegal rays 6; vertebrae 18+(33–34) = 51–52 (Eastman (1983) gives a total vertebral range of 51–53). Body depth 4.3–4.5, head length 3.0–3.3, snout to anal-fin origin 2.0, anal-fin origin to caudal-fin base 1.9 in SL. Eye diameter 2.9–3.2, interorbital width 7.7–10.0, and upper jaw length 2.6 in HL. Anal fin with 4–6 fewer rays than second dorsal fin. Cephalic lateral line canals without any interruptions or losses; preopercular-mandibular canal with 10 pores; infraorbital canal with 7 pores; supraorbital canal with 4 pores; coronal commissure with a single median pore; temporal canal with 5 pores; supratemporal canal with 4 pores (the normal number is probably 3; the pore counts are from a single specimen). Most scales on body ctenoid; non-ctenoid scales present on midventral belly and chest, along anterior base of anal fin, anterior to pectoral fins, cheeks and opercles (except interopercles), and in the anterior angles between the temporal and supratemporal canals; rest of head naked.

Colour: In alcohol, body light to darker brown; upper parts of head and anterior epaxial region of body with dark blotches over an otherwise finely speckled skin; rest of body with 4–5 dark irregular crossbars. All fins more densely speckled distally (DeWitt & Tyler 1960).

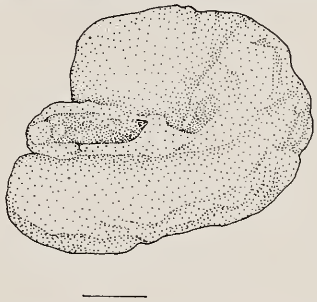
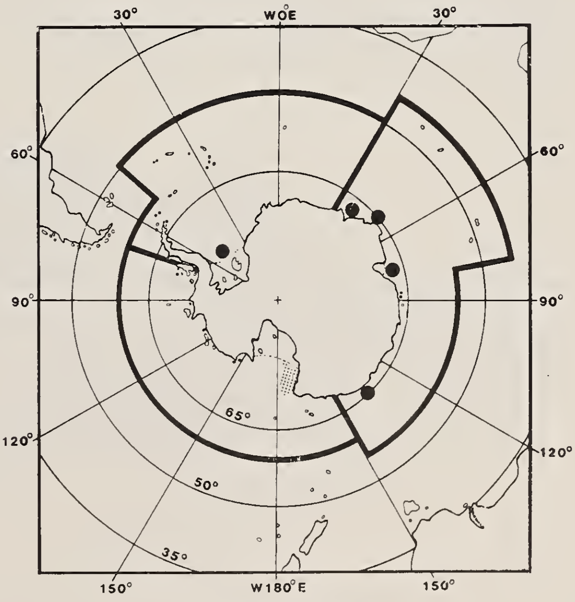


Fig. 53. Representative otolith of *T. nicolai*; fish length 22 cm SL; scale bar 1 mm



Distribution of *T. nicolai*

Otoliths

Diagnostic features: The near discoid to square shape, the ostial and heteromorph sulcus acusticus, the near equal sized and separated ostium and cauda, the prominent anterior colliculum which projects beyond the anterior margin and the short, broad and distally rounded rostrum.

Distribution: Known from a few localities in East Antarctica, but not from the Peninsula region and westward to the Ross Sea. Previous records from the islands of the Antarctic Peninsula (Lönnberg 1905b; Roule & Despax 1911) are misidentifications of *T. bernachii*. The record from the South Orkney Islands (Everson 1969) is probably *T. tokarevi* (Kock pers. comm.) Depth range 0–420 m (Ekau 1988).

Remarks: Eastman's (1985a) qualitative study of the food of *T. nicolai* indicates that it feeds primarily on amphipods, other fishes, and molluscan larvae, taking lesser amounts of polychaetes and mysids (there was also a large unidentified category). He concluded that it is a small benthic species that might capture some prey in the water column, but that it is not cryopelagic.

Attains about 36 cm TL.

Trematomus pennellii Regan, 1914
Sharp-spined notothen
Fig. 54; Pl 8, Fig. 1

Trematomus pennellii Regan, 1914a: 12, off Cape Adare, Victoria Land. Syntypes: BMNH 1913.12.4.61–65.

Trematomus centronotus Regan, 1914a: 12, McMurdo Sound.

Diagnosis: D IV–VI+32–35; A 29–32; P 23–26; branched C rays 10–12; GR (6–9)+(12–18) = 19–26; ULL 30–38 tubed scales; MLL with pored scales only; LSS (49)51–57; branchiostegal rays 6; vertebrae 18+(32–33) = 50–51 (Balushkin & Tarakanov (1987) give 17–19 abdominal vertebrae). Body depth 3.8–5.6, head length 2.9–3.4, snout to anal-fin origin 1.8–2.1, and anal-fin origin to caudal-fin base 1.9–2.2 in SL. Eye diameter 2.6–3.4, interorbital width 7.7–14.3, and upper jaw length 2.5–3.7 in HL. Dorsal fin spines become thick and stiff with growth. Anal fin with 1–5 fewer rays than the second dorsal fin. Cephalic sensory canals without interruptions or loss of sections; preopercular-mandibular canal with 10 pores; infraorbital canal with 7 pores; supraorbital canal with 4 pores (rarely 5; one type specimen of *T. centronotus* has a small 5th pore close behind the anteriormost pore of each canal); coronal commissure with a single median pore; temporal canal with 5–7 pores; supratemporal canal with 3 (rarely 4) pores. Scales ctenoid over most of body, on occipital region, interorbital area, posteromedial part of snout, and opercles; preorbitals and lower jaw naked; non-ctenoid scales on belly and chest, anterior to pectoral fins, and on cheeks.

Colour: In life, variable, sides of body with 4 double dark brown bars (last near caudal-fin base) on a grey-pink background, or with slightly greenish brown spots and bright pale zones with mauve reflections. Head greenish-brown, darker than trunk, especially snout and preorbitals, with small bright spots forming a zone of mauve reflections. Bases of pectoral fins golden. Thorax and abdomen with silvery glaze, sometimes with mauve reflections. Branchiostegal membranes, throat, most of lower jaw, and lower parts of operculum light coloured. First dorsal fin with black membranes, either near bases of spines or in the distal posterior region. Second dorsal fin may be variegated, with a broad light-green edge, or it may have yellowish rays with white spots and clear membranes with tiny black spots and a black margin. Anal fin with dark membranes, green or yellowish rays and sparsely scattered bright white or brown spots. Pectoral fins with yellowish grey rays. Pelvic fins clear, the rays marked with brown, or light brown basally, light green in the centre, and pale distally. Caudal fin light brown basally and distally, and light green centrally, or with rose-grey rays, the lower ones yellowish at their ends (Gosse 1961; Balushkin & Tarakanov 1987).

In alcohol, ground colour yellowish light brown. About 6 irregular dark bars on sides, the last at caudal-fin base; bars more or less divided into 3 segments: above the upper lateral line, between the latter and the middle lateral line, and below the middle lateral line; the middle segment sometimes displaced anteriorly. Sometimes the dark crossbars are disrupted by pale spots both within and between them such that the overall pattern is one of dark bars formed of roughly rectangular dark marks in a reticulate pattern. Pectoral fins may have 2 faint broad vertical dark bars. Membranes of first dorsal fin black. Second dorsal and anal fins dusky.

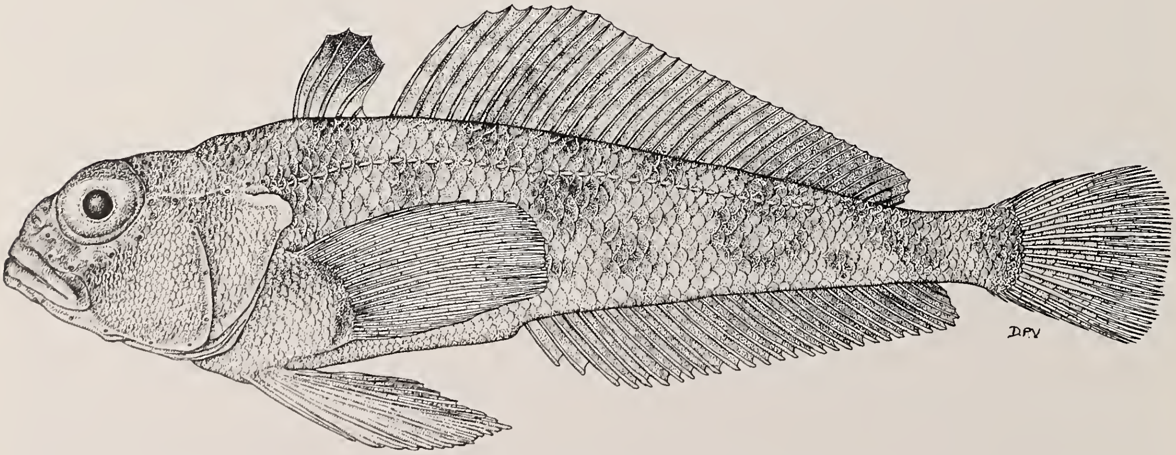


Fig. 54. *Trematomus pennellii* ADH S86080–81, 125 mm SL, MacRobertson Land (67°07.1′S, 66°27.1′E)

Otoliths

Diagnostic features: The ovate shape which is primarily as a consequence of the large and distally rounded rostrum, the ostial and heterosulcoid sulcus acusticus, the near equal sized and separated ostium and cauda, and the V-shaped dorsal area.

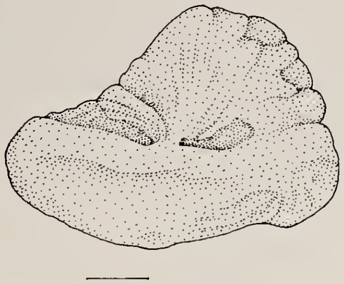


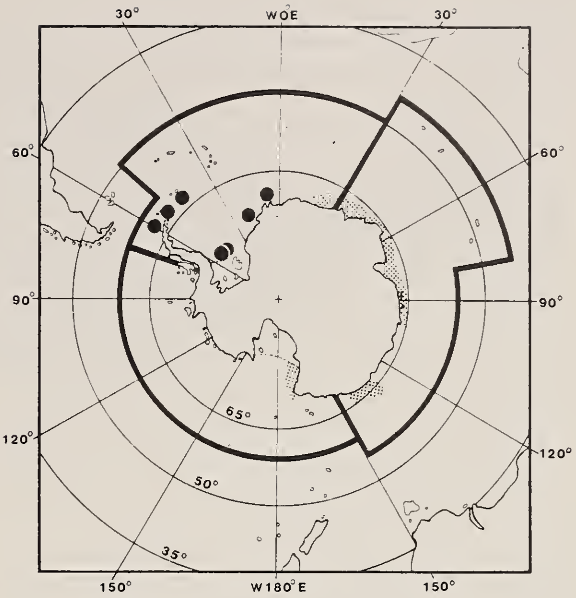
Fig. 55. Representative otolith of *T. pennellii*; fish length 190 mm SL; scale bar 1 mm

Distribution: A circum-Antarctic species extending along the Scotia Arc to the South Orkney Islands. It was long considered to be absent in the Peninsula region, but has been taken at several localities there in recent years. It is found at depths ranging from 0–732 m (DeWitt 1971; Balushkin & Tarakanov 1987).

Remarks: Balushkin & Tarakanov (1987) synonymised *T. centronotus* with *T. pennellii*. Sexual maturity is reached at about 18 cm SL (Gosse 1961) and spawning probably takes place in summer (Balushkin & Tarakanov 1987). In mid-January egg diameter was about 2.6 mm in females 18.5–22.5 cm SL (Gosse 1961).

Eastman (1985a) found that *T. pennellii* in McMurdo Sound is a typical benthic species; it feeds primarily on errant polychaetes, together with lesser amounts of amphipods, fish eggs and molluscs. Gosse (1961) mentioned sponges with long spicules in the stomachs of specimens from Breid Bay. In the Weddell Sea, stomachs of 36 fishes (4.6–22 cm SL) were examined; amphipods and polychaetes were the main prey items and isopods, gastropods, and fishes were of secondary importance (Schwarzbach 1988).

Attains about 24 cm SL.



Distribution of *T. pennellii*

Trematomus scotti (Boulenger, 1907)
Blackfin notothen
Fig. 56

Notothenia scotti Boulenger, 1907: 2, pl. 2, fig. 1, off Ross Ice Barrier, Ross Sea. Holotype: BMNH 1906.5.8.68.

Diagnosis: D V–VI+32–34; A 29–32; P 20–21; GR (6–7)+(10–14) = 17–20; ULL 10–23 tubed scales; MLL without tubed scales; LSS 48–53; branchiostegal rays 6 (rarely 5); vertebrae (14–15)+(32–34) = 47–48. Body depth 4.8–5.9, head length 3.1–3.6, snout to anal-fin origin 1.9–2.1, and anal-fin origin to caudal-fin base 1.9–2.1 in SL. Eye diameter 2.8–3.1, interorbital width 9.1–2.0, and upper jaw length 2.6–3.2 in HL. Second dorsal fin with 1–3 more rays than anal fin. Opercle with a distinct, blunt, posterior spine, as described by Voskoboynikova (1980). Cephalic sensory canals without interruptions or losses; preopercular-mandibular

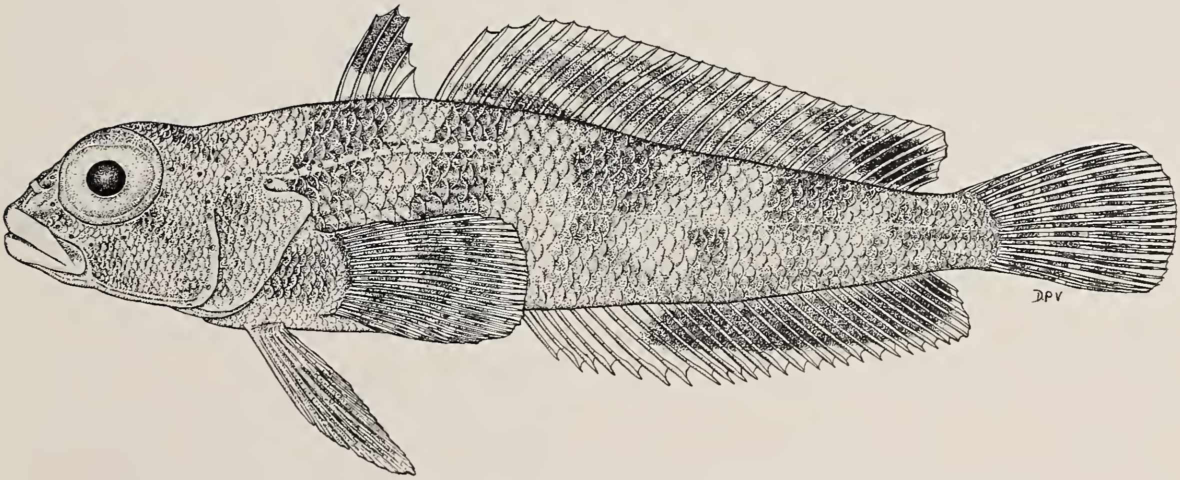


Fig. 56. *Trematomus scotti* ADH S86013, 116.9 mm SL, Prydz Bay (67°24.6′S, 74°33.6′E)

canal with 10 (rarely 11) pores; infraorbital canal with 7 pores; supraorbital canal with 4 pores; coronal commissure with 1 pore; temporal canal with 5–6 pores; supratemporal canal with 3 pores. Scales ctenoid over most of body and head; non-ctenoid scales present at ventral margins of cheeks, on midventral parts of belly and breast, and anterior to pectoral fins; occipital and interorbital regions fully scaled; snout naked or with only the posteriormost medial parts scaly; preorbital partly to fully scaled; cheeks and opercles scaled.

There is distinct sexual dimorphism in this species. Males larger than about 8 cm SL have a longer caudal fin and longer posterior rays in the second dorsal and anal fins. The dorsal- and anal-fin rays extend well beyond the connecting membranes and form a fringe which overlaps the caudal fin. The middle rays of the caudal fin are elongated, giving the fin an almost pointed shape. In females the rays of the dorsal and anal fins never overlap the caudal fin. For example, the caudal fin length and the lengths of the sixth from last dorsal- and anal-fin rays (in percent of SL) of a 12.5 cm SL male are as follows: 28.5, 20.8, and 16.2, respectively; for a 13.3 cm SL female these values are 21.2, 10.5, and 9.8, respectively.

Colour: In alcohol, pale grey-brown with 5 more or less irregular dark brown bars on body dorsally, the first 4 becoming progressively broader ventrally; the first extends down to pectoral-fin base; the second extends below midside, but the lowest part is offset anteriorly, sometimes even separated as a separate blotch; a narrow extra bar may be present between the broad 3rd and 4th bars; the latter extends to the anal-fin base, but may be broken into a series of blotches reaching almost to the caudal-fin base; 5th bar narrow, at base of caudal fin. First dorsal fin black distally, pale basally. Second dorsal fin dusky anteriorly, becoming darker posteriorly, ending with a large, black spot, and with the tips of the rays white; dark part of fin sometimes with pale bars. Anal fin similar except that anterior part of fin is distinctly pale and the dark pigment is in a distinct broad horizontal band which becomes intense black posteriorly, with the tips of rays white. The white ray tips of the second dorsal and anal fins are especially prominent in mature males where the rays have become very elongate. Caudal fin yellowish at base, fading to colourless distally, with 4–6 more or less distinct and regular vertical bars. Pectoral fins pale, with 3–4 distinct crossbars sometimes broken into a pattern of spots. Pelvic fins pale basally, with distal black pigment which sometimes is evenly distributed and sometimes is in the form of short crossbars or spots. An indistinct dark band posteroventrally from eye across cheek, sometimes continued onto opercles.

Otoliths

Diagnostic features: The ovate shape with a raised peak on the dorsal margin, the ostial and heterosulcoid sulcus acusticus, the clearly separated ostium and cauda, the split V-shaped crista superior and the anteriorly tapering rostrum.

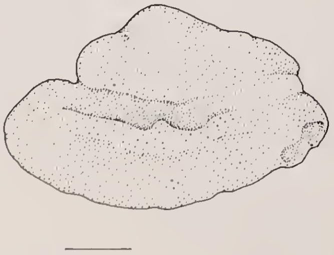
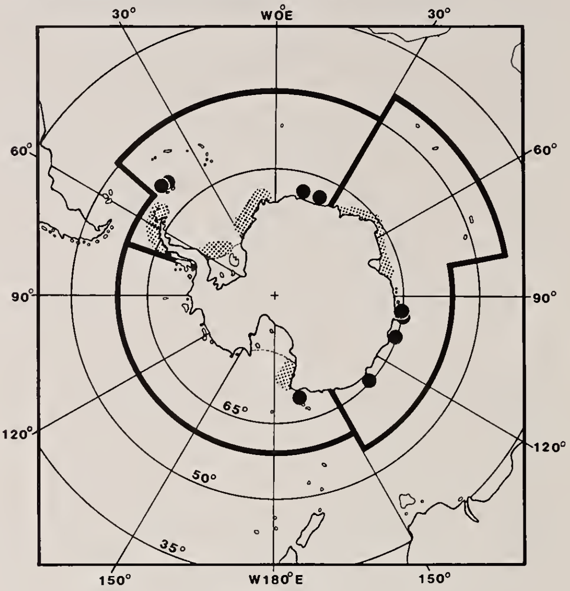


Fig. 57. Representative otolith of *T. scotti*; fish length 123 mm SL; scale bar 1 mm

Distribution: Circum-Antarctic, including the South Shetland and South Orkney islands, but not any other islands of the Scotia Arc. It is a near-shore and continental species, with a depth range of 20–793 m.



Distribution of *T. scotti*

Remarks: The sexual dimorphism described above is unique to the Nototheniidae as is the colour of the fins in which it occurs: intense black over the posterior parts of the dorsal and anal fins with the tips of the rays white. It seems likely that such a combination of structures and colour indicates some sort of sexual or territorial display.

In the Antarctic Peninsula and associated islands, hatching of larvae occurs in January. Size at hatching is about 8.0 mm SL (Kellermann 1989). By autumn, postlarvae attain 19.0 mm SL, and pelagic juveniles were captured from November to February (Efremenko 1984; Kellermann 1989). This indicates that the pelagic phase is long and juveniles change to benthic life at the end of the second summer (Kellermann 1989).

Daniels (1982) found that in the region of the Antarctic Peninsula *T. scotti* feeds primarily on polychaetes (both sedentary and errant), euphausiids, and amphipods, together with lesser amounts of a number of other groups. Similarly, isopods, amphipods, and polychaetes were the most important prey items in fishes from the South Orkney Islands (Targett 1981) and the Weddell Sea (Schwarzbach 1988). Despite small changes in the diet from one locality to another, even within a relatively small region (Daniels 1982), it appears that *T. scotti* is primarily a benthic feeder.

Attains about 160 mm SL.

Trematomus tokarevi Andriashev, 1978
Bigeye notothen
Fig. 58

Trematomus tokarevi Andriashev, 1978b: 600, Oates Land (69°36′S, 161°50′E). Holotype: ZIN 37573.

Diagnosis: D IV–VI+35–37; A 32–33; P 29–30; GR (8–9)+(16–17) = 25–26; ULL 33–39 tubed scales; MLL without tubed scales; LSS 52 & 60 (taken from figs. 1 & 2 in Andriashev, 1978b); branchiostegal rays 6; ver-

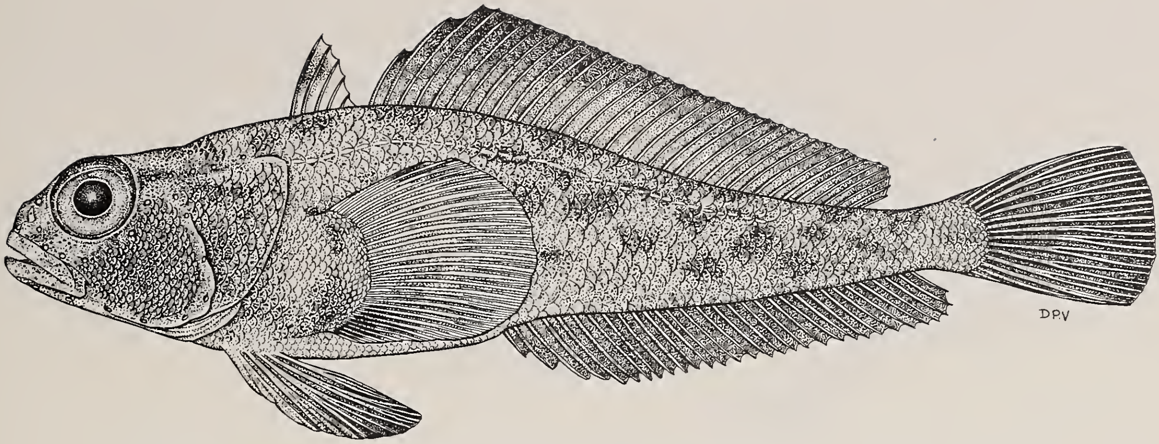


Fig. 58. *Trematomus tokarevi* ADH S87857, 144 mm SL, Prydz Bay (67°49.2′S, 74°04.6′E)

tebrae (16–18)+(34–35) = 51–53. Body depth 4.0–5.0, head length 3.4–3.6, and snout to anal-fin origin 1.9–2.0 in SL. Eye diameter 2.8–2.9 and interorbital width 11.1–14.3 in HL. Second dorsal fin always with more rays than anal fin, the dorsal-anal difference 5 in the holotype and at least 2 in the paratypes. Cephalic sensory canals complete and uninterrupted with the exception of the supratemporal canal; preopercular-mandibular canal with 10 pores; infraorbital canal with 7 pores; supraorbital canal with 4 pores; coronal commissure with a single median pore; temporal canal with 6 pores; supratemporal canal divided into 3 segments, with 1+3+1 pores. Nearly all scales on body weakly ctenoid; non-ctenoid scales on head, belly and breast. Anus concealed in a tubular, scaly, dermal lobe. Cheeks and opercles scaly, rest of head naked.

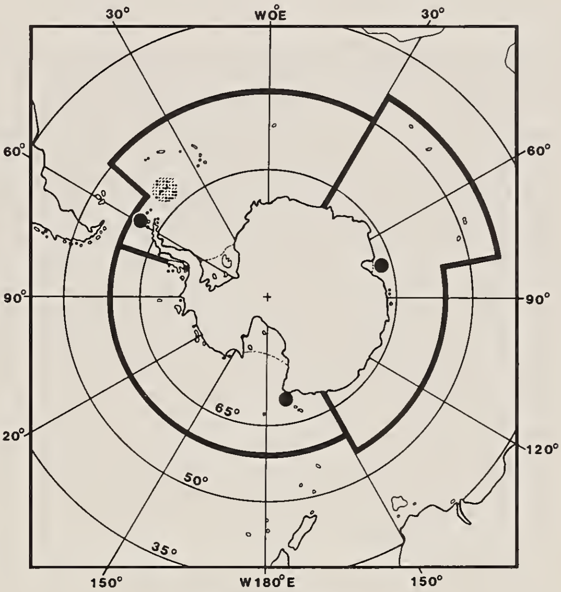
Colour: In life, body pale brownish-grey with a greenish hue dorsally, dove grey ventrally, with irregular and indistinct grey-brown streaks and spots. Pectoral fins pale, transparent, and without stripes, lilac-coloured at the base. First dorsal fin without a black spot. Second dorsal fin transparent, with indistinct, patchily distributed punctate marks. Anal fin pale grey. Pelvic fins brownish-grey. Caudal fin with dark membranes and pale rays. Buccal and gill cavities lilac-grey. Peritoneum brown-black. Dark spots on body are more distinct on small specimens. In alcohol, body pale brown with irregular dark markings; head darker. Pelvic, anal and caudal fins dark. Distal part of uppermost rays and lower third of pectoral fin dark. Front of first dorsal fin and tip of anterior rays of second dorsal fin dark.

Distribution: This species is probably circum-Antarctic since it has been obtained at 2 localities in East Antarctica (Oates Land and Shackleton Ice Shelf), and near the South Orkney and South Shetland islands (Takahashi 1983). It is a deep-water species, having been captured at depths ranging from 295 to 700 m.

Remarks: The diagnosis above is based on the original description of Andriashev (1978b) and a specimen from Prydz Bay (Fig. 58).

The ovaries of 2 females (18–18.5 cm) collected in February in the type locality had about 1,600 eggs, 2.5–2.7 mm in diameter, estimated to be at stage IV of maturity. Spawning probably takes place at the end of summer (Andriashev, 1978b).

Trematomus tokarevi is probably a small species, as the 2 largest specimens known (both adult females) were only 22.0 and 22.4 cm TL.



Distribution of *T. tokarevi*

Trematomus vicarius Lönnberg, 1905

Orange notothen

Fig. 59

Trematomus bernacchii vicarius Lönnberg, 1905b: 26, Cumberland Bay, South Georgia. Holotype: NRM SYD/1902211.3155.

Notothenia dubia Lönnberg, 1905b: 28, pl. 3, fig. 9, Cumberland Bay, South Georgia.

Diagnosis: D V–VI+34–37; A 31–34; P 23–24; GR (7–9)+(13–17) = 20–26; ULL 33–37 tubed scales; MLL usually without tubed scales, but 1 specimen had 2 tubed scales; LSS 51–55 (possibly 61 in 1 small specimen); branchiostegal rays 6; vertebrae 17+33 = 50 (one specimen). Body depth 4.0–5.9, head length 3.1–3.3, snout to anal-fin origin 2.0–2.2, and anal-fin origin to caudal-fin base 1.8–2.0 in SL. Eye diameter 3.6–4.8, interorbital width 7.1–7.7, and upper jaw length 2.3–2.9 in HL. Second dorsal fin with 2–4 more rays than anal fin. Cephalic sensory canals variable, in some completely

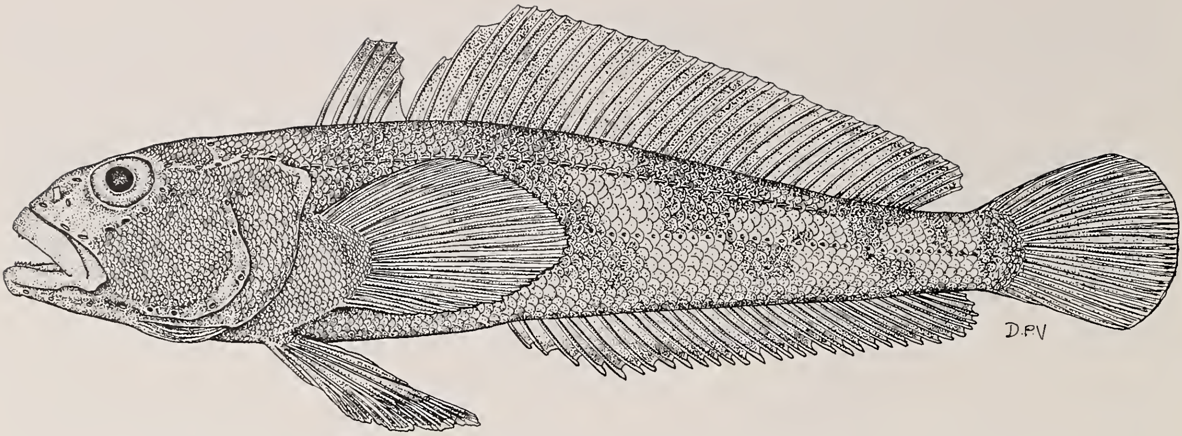


Fig. 59. *Trematomus vicarius* BMNH 1937.7.12.585, 151 mm SL, Cumberland Bay, South Georgia

normal, without any interruptions or losses, but in others with several interruptions; preopercular-mandibular canal usually with 10 pores (in some specimens with 4+7 pores); infraorbital canal almost always with 7 pores (rarely with 5+3 pores); supraorbital canal almost always with 4 pores; coronal commissure with a single median pore (rarely, the coronal commissure is narrowly interrupted between a pair of closely-spaced median pores); temporal canal with 5–6 pores; supratemporal canal usually with a 1+3+1 pores (as in *T. bernacchii*); in some, however, the canal is complete across the head and has 3–4 pores; in one specimen the canal was divided into a larger left segment with 3 pores and a short right segment with 1 pore). Most scales on body ctenoid, including the belly; non-ctenoid scales present on chest, anterior to pectoral fins, and on body below, and anterior to, first dorsal fin. On head, non-ctenoid scales present on occipital region, posterior and medial parts of interorbital area (may be naked in small specimens), opercles, and most or all of the cheeks; the snout, preorbital, and lower jaws are naked.

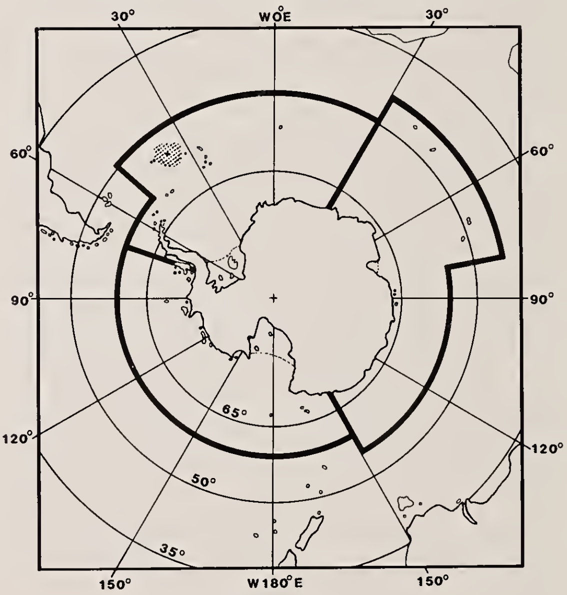
Colour (from a label with the holotype): "reddish-yellow with black vertical blotches on sides". The specimen has since faded considerably, but 4–5 dark bars are visible extending from the back in a nearly vertical, but slightly posterior direction. First dorsal fin brownish distally. Distal half of anal fin was probably dark.

Otoliths

Diagnostic features: The ovate shape, the robust relief of the medial face, the crista superior which is only developed above the ostium, the well-developed crista inferior and the presence of a narrow ventral area.

Fig. 60. Representative otolith of *T. vicarius*; fish length 31 cm TL; scale bar 1 mm

Distribution: Previously known only from Cumberland and Stromness bays, South Georgia, from depths of 20–240 m (Norman 1938; DeWitt 1971; Burchett *et al.* 1983). We here report 4 specimens from Rosita Harbour in the Bay of Isles, South Georgia. *T. vicarius* has the most restricted distribution of any nototheniid, even though it probably occurs in other South Georgian fjords. The shelf about South Georgia is one of the most heavily fished regions in the Antarctic, yet *T. vicarius* has never been captured outside these 3 bays.



Distribution of *T. vicarius*

Remarks: There is a minor discrepancy concerning the collection data for the holotype. In his original description, Lönnberg (1905b) gives "1 specimen caught on long-lines outside Boiler Harbour, Cumberland Bay, South Georgia, in a depth of 30 m. 19th of May 1902". When one of us examined the holotype he found in the mouth a label giving the following data: "Grytvigen, 20 m, bow net", together with the colour description above. Other than the depth and collection method (our notes say that a bow net is something like a fyke net), the data are the same since Grytvigen is the settlement at the head of Boiler Harbour (now called King Edward Cove).

Regan (1913) first placed *Notothenia dubia* in the synonymy of *T. vicarius,* although with a question mark. He compared a 50 mm TL syntype of *N. dubia* with a similar sized *T. bernacchii* and found just those differences that separate the latter from *T. vicarius* (see Norman 1938: 33). One of us examined the 3 syntypes and concluded that they were juveniles of *T. vicarius*. The specimen we have selected as lectotype (NRM SYD/1902225.3006) has the most salient characters in common with *T. vicarius*: mandibular canal with 4 pores separated from preopercular canal with 6 pores; infraorbital canal with 5+3 pores; supratemporal canal with 1+3+1 pores.

The biology of *T. vicarius* was studied by Burchett *et al*. (1983). Spawning takes place in May, at the bottom of deep fjords. Absolute fecundity was 11,598–15,924 eggs (fish length not specified) and egg diameter was about 3.8 mm. This species is a member of the deep-water fjord fauna and feeds primarily on fish eggs. Other (much less important) food items were amphipods, followed by decapods, fishes, isopods, polychaetes and nemertians.

Attains about 35 cm TL.

ARTEDIDRACONIDAE

Plunderfishes

by R. EAKIN

Body tapered, head large. Two separate dorsal fins, the first with 1 to 7 flexible spines, the second with 22–30 soft (segmented) rays; anal fin with 14–21 soft rays; pectoral fins large, with 14–22 rays; pelvic fins jugular, with 1 spine and 5 rays, the spine long and attenuated. Principal (branched) caudal-fin rays 8–11; 5 branchiostegal rays. Mouth large and protractile; jaws bearing small conical teeth; palate and vomer toothless. A single nostril on each side of snout. Opercle with a flattened hook. Gill membranes united and joined to isthmus but not forming a fold across it. Gill rakers rudimentary to well developed. Basisphenoid absent; Baudelot's ligament attached to first vertebra; medial extrascapular absent. Supratemporal canal with 2 pores; preopercular-mandibular canal with 9 pores.

Scales absent on body and head. Two lateral lines (upper and middle); upper with 2–28 tubular and 0–16 disc-shaped (perforated) scales; middle with 6–26 scales (disc-shaped, except for *Histiodraco* and *Pogonophryne* which often have tubular scales posteriorly). Mental barbel of variable length and structure, tapered to a point or expanded distally and often bearing papillae and/or tapered or rounded processes. Upper pectoral radial articulated with both scapula and coracoid, the lower 2 with coracoid. Four or 5 hypurals. Epipleural ribs 12–16, articulated with vertebral parapophyses, reduced or absent on first vertebra; pleural ribs 0–8, floating (may be rudimentary, beginning on fifth to eighth vertebra, or absent). Swim-bladder absent. Vertebrae 12–18 abdominal, 19–26 caudal, total 33–41.

Four genera and about 23–25 species of small to medium-size predatory benthic fish. Antarctic endemics and one species endemic to South Georgia. Revision by Norman (1938), as part of Harpagiferidae.

KEY TO GENERA

1a D_1 above base of P; first D spines 2–7 .... *Artedidraco*
1b D_1 above operculum; first D spines 1–3 2
2a Post-temporal ridges absent; MLL without tubular scales; A 14–16; P 16–18; C 8–10 .... *Dolloidraco*
2b Post-temporal ridges present; MLL often with tubular scales posteriorly; A 16–19; P 17–22; C 9–10.................. 3
3a Interorbital region narrow (bony width 2.2–3.5% SL); D_1 high, length of longest spine 19–32 % SL........... *Histiodraco*
3b Interorbital region wide (bony width 3.8–8.0% SL); D_1 low, length of longest spine 4.5–14 % SL .... *Pogonophryne*

Genus *Artedidraco* Lönnberg, 1905

First dorsal fin above base of pectoral fin. Head not or scarcely broader than deep. Post-temporal ridges not well developed. Snout shorter than orbit. Interorbital narrow. Mental barbel tapered or expanded distally. Jaws with small, conical teeth arranged in a multiserial band. Upper lateral line with tubular scales anteriorly, usually disc-shaped scales posteriorly; middle lateral line with disc-shaped scales. Pleural ribs rudimentary or absent. Five species confined to coasts of Antarctic Continent and islands north to South Georgia.

KEY TO SPECIES

1a ULL with 6 or more tubular scales, the row of tubular scales extending to below 3 or more rays of D_2................ 2
1b ULL with 2–8 tubular scales, the row of tubular scales not extending past first D ray 4
2a D_2 27–30................................ *A. shackletoni*
2b D_2 23–26 3
3a ULL with 18–21 tubular scales .... *A. orianae*
3b ULL with 6–16 tubular scales .... *A. mirus*
4a Depth of caudal peduncle 19.4–23.2% HL; P length 60.7–71.8% HL............................ *A. loennbergi*
4b Depth of caudal peduncle 22.9–30.2% HL; P length 73.6–87.9% HL............................ *A. skottsbergi*

Artedidraco loennbergi Roule, 1913

Fig. 1

Artedidraco loennbergi Roule, 1913: 4, Marguerite Bay (68°S, 70°20′W). Holotype: MNHN 1913-186.

Diagnosis: D II–III+25–28; A 18–21; P 14–16; GR (0–3) +(12–15); ULL 3–8 (tubular) + 11–15 (disc-shaped), ending under about 11th dorsal-fin ray; MLL 16–25; vertebrae 37–40. Body depth 4.7–8.5 and head length 2.8–4.3 in SL. Orbit diameter 2.7–3.5 and interorbital width 15.0–23.4 in HL. Mental barbel tapered or slightly expanded distally, 3.8–7.0 in HL.

Colour: In alcohol, head and body with dark brown markings on yellowish background. About 6–8 dark saddle-shaped patches at base of dorsal fins. A dark lateral band, made up of irregular spots, extends from head to caudal fin, with pale bands above and below it extending along upper and lower margins of caudal fin. First dorsal fin with some dark markings; second dorsal fin with dark bands on rays forming oblique stripes. Anal

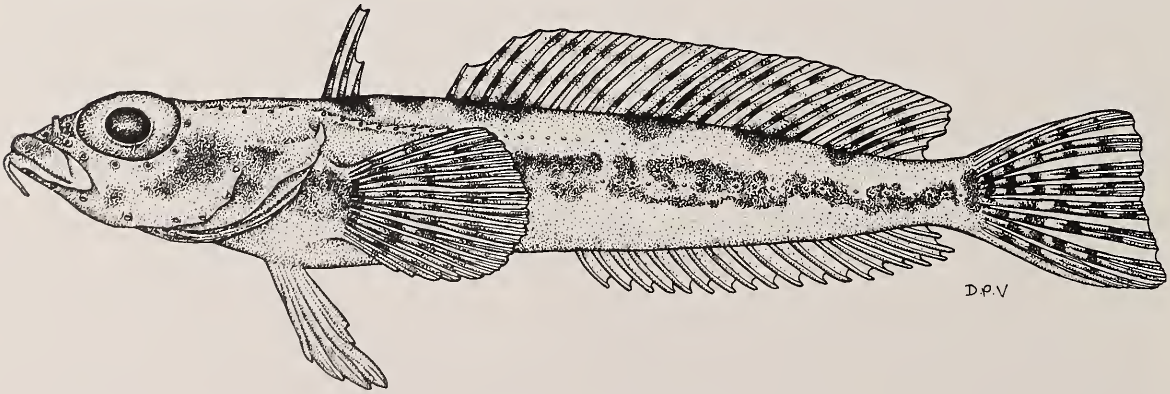


Fig. 1. *Artedidraco loennbergi* USC-*Eltanin* station 2075, 81 mm SL, Ross Sea (76°25′S, 170°24′W)

fin light or with some dark pigment basally, sometimes with some dark spots posteriorly. Caudal fin with about 6 vertical stripes, upper and lower margins light. Pectoral fins with about 2–3 wide vertical stripes and pelvic fins unspotted. Mental barbel light.

Otoliths

Diagnostic features: The oval to ovate shape; the ostial, heterosulcoid and shallow sulcus acusticus; the entire margin and the circuli-like ridges in the dorsal area.

Ontogeny: Geometric shape changes from oval with no rostrum in fish smaller than 50 mm SL to ovate with a prominent rostrum in fish larger than 60 mm SL.

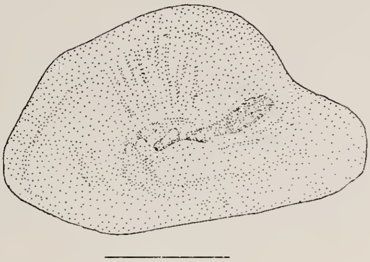
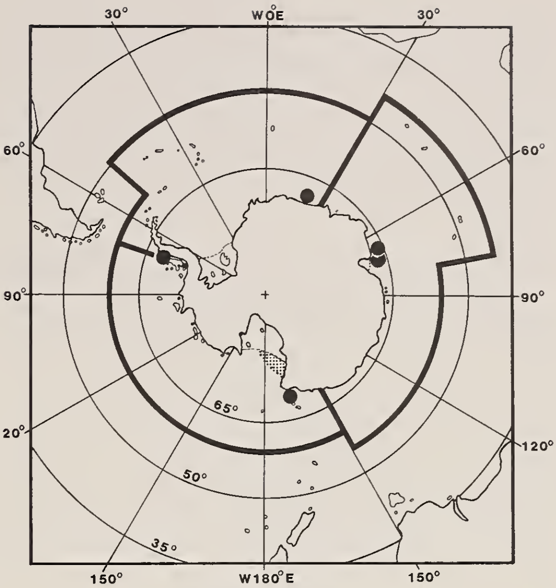


Fig. 2. Representative otolith of *A. loennbergi*; fish length 81 mm SL; scale bar 1 mm

Distribution: Circum-Antarctic: Antarctic Peninsula; East Antarctica (Ross Sea, Queen Maud Land, Graham Land, South Victoria Land). Near-shore (sublittoral) and continental shelf at 230–608 m.

Remarks: A food study by Wyanski & Targett (1981), based on analysis of stomach contents of fishes from the Ross Sea (334–608 m), showed that errant polychaetes and gammaridean amphipods were the most important food sources, with substantial amounts of isopods and lesser amounts of sedentary and unidentified polychaetes also present. Unidentified crustaceans, mysids, calanoid copepods, cumaceans, and pycnogonids were negligible sources of food. Similar results were obtained from fishes collected in the Weddell Sea (Schwarzbach 1987).

Attains 110 mm TL.



Distribution of *A. loennbergi*

Artedidraco mirus Lönnberg, 1905
Fig. 3

Artedidraco mirus Lönnberg, 1905b: 40, pl. 1, fig. 4, pl. 4, fig. 14, South Georgia. Syntypes: NRM SYD/ 1902192.1162; SYD/1902203.3161–2.

Diagnosis: D II*–III+23–25; A 16–19; P 14–18; GR (0–3)+(13–16); ULL 6–16 (tubular) + about 2 (disc-shaped), ending under about third dorsal-fin ray; MLL 6–19; vertebrae 33–36. Body depth 3.8–5.5 and head length 2.6–3.0 in SL. Orbit diameter 3.5–4.0 and interorbital width 6.7–11.5 in HL. Mental barbel tapered (female) or expanded distally (male), 3.0–5.7 in HL.

Colour: In alcohol, head and body yellowish with dark greyish-brown markings. Dark patches on cheeks, lips and anterior to eyes. Four to 6 wide, dark bars on body,

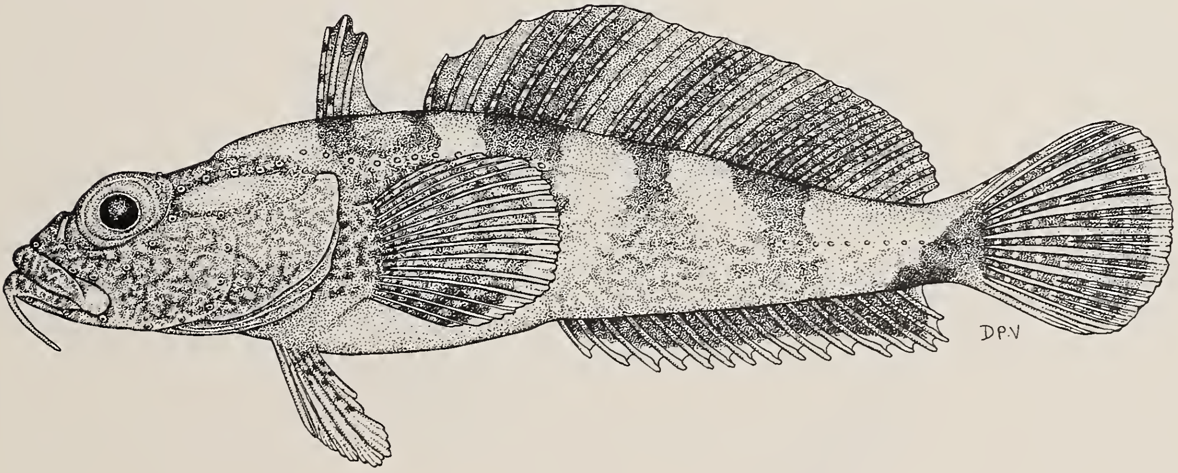


Fig. 3. *Artedidraco mirus* UMO station 10, 79 mm SL, South Georgia (53°47.8′S 37°26.7′W)

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* damaged fin? (ISH specimen 75.5 mm SL collected at 54°04′S, 36°17′W, 240–250 m, 30 January 1978 by *Walther Herwig*).

beginning near the base of first dorsal fin and ending on caudal peduncle; all but the last extend upward onto dorsal fins. Anterior 2 spines of first dorsal fin with dark bands; tip of fin with dark pigment. Rays of second dorsal fin may also have dark bands. Anal fin dark basally, light distally. Caudal fin with about 6 vertical stripes, light dorsally and ventrally. Pectoral fins with about 5 vertical stripes, and pelvic fins spotted medially. Mental barbel light.

Otoliths

Diagnostic features: The ovate shape, the ostial and heterosulcoid sulcus acusticus, the high and distinct collum which clearly separates the ostium and cauda, and the short and distally rounded rostrum.

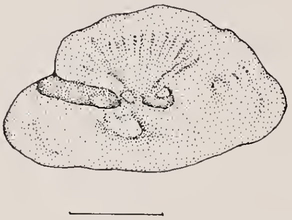
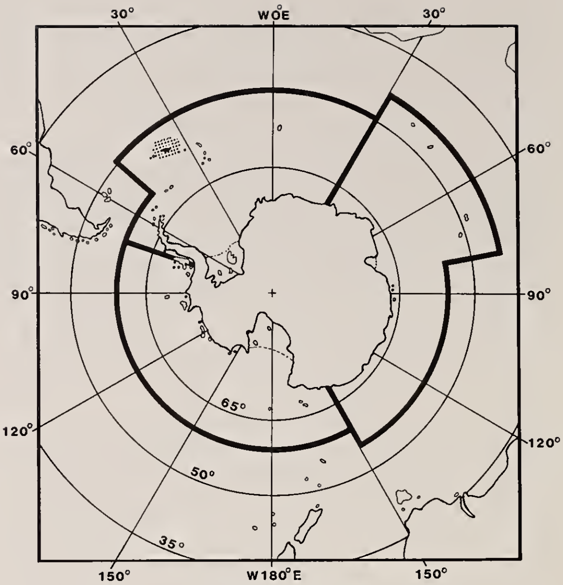


Fig. 4. Representative otolith of *A. mirus*; fish length unknown; scale bar 1 mm

Distribution: Known only from South Georgia. Near-shore (sublittoral) and continental shelf at 18–320 m, but with maximum abundance at less than 200 m. (Kock pers. comm.)

Remarks: A food study by Wyanski & Targett (1981), based on analysis of stomach contents of fishes from South Georgia (79–234 m), showed that mysids were the most important food item, with substantial amounts of errant polychaetes, gammaridean amphipods, and unidentified polychaetes also present. Isopods were a less important source of food, while unidentified crustaceans, gastropods, calanoid copepods, tanaids, fishes, cumaceans, caprellid amphipods, and foraminiferans were negligible sources of food.

Attains 125 mm TL.



Distribution of *A. mirus*

Artedidraco orianae Regan, 1914

Fig. 5

Artedidraco orianae Regan, 1914a: 12, Cape Adare. Holotype: BMNH uncataloged.

Diagnosis: D III–IV+23–26; A 16–19; P 15–18; GR (0–4)+(10–15); ULL 18–21 (tubular) + about 0–2 (disc-shaped), ending under about 13–15th dorsal-fin rays; MLL 16–18; vertebrae 35–37. Body depth 4.9–7.0 and head length 2.6–3.6 in SL. Orbit diameter 3.2–3.6 and interorbital width 10.0–17.8 in HL. Mental barbel expanded distally, 3.4–3.6 in HL.

Colour: In alcohol, head and body yellowish with dark greyish-brown markings, sometimes a few small, round spots. Large dark patches on cheeks and from anterior margin of eye to lips. About 4–5 wide, dark bars on back, extending upward onto dorsal fins; the first bar at level of first dorsal fin, the second bar at origin of second

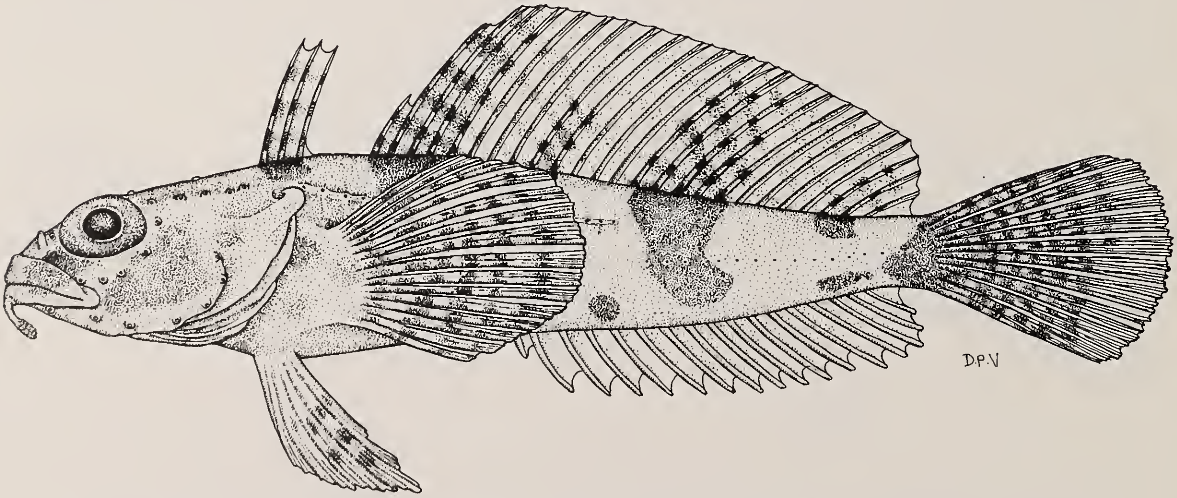


Fig. 5. *Artedidraco orianae* USC-*Eltanin* station 1933, 98 mm SL (73°22'S, 177°37'E to 73°22'S, 177°41'E)

dorsal fin, the last bar merges with blotches on caudal peduncle. Anal fin light, sometimes with a few spots, or dark. Caudal fin dark dorsally and ventrally and with as many as 6 dark vertical stripes. Pectoral fins with about 4–6 vertical stripes; pelvic fins with a few spots. Mental barbel light.

Otoliths

Diagnostic features: The ovate shape, the entire margin in association with the prominent crista inferior and the ventral area with horizontal grooves and ridges.

Ontogeny: It would appear that the ostium and cauda are not separated in larger fishes; more specimens are however required for verification.

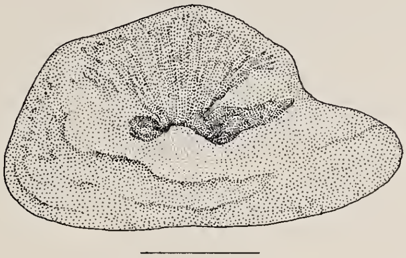
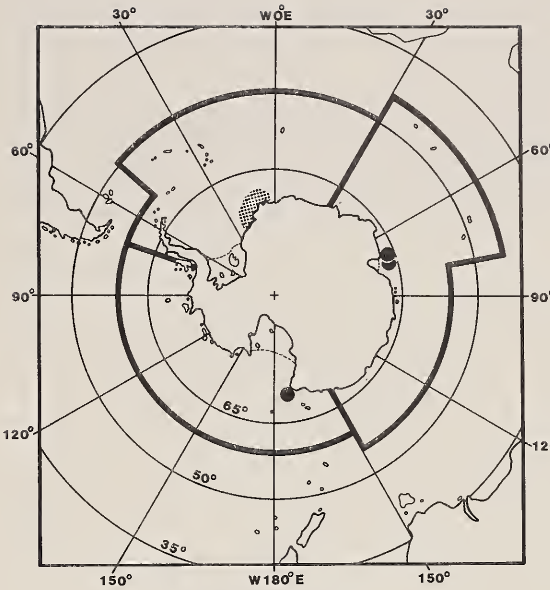


Fig. 6. Representative otolith of *A. orianae*; fish length 134 mm TL; scale bar 1 mm

Distribution: East Antarctica (Ross Sea, South Victoria Land, Weddell Sea). Near-shore (sublittoral) and continental shelf species at 82–801 m.

Remarks: A food study by Wyanski & Targett (1981), based on analysis of stomach contents of fishes from the Ross Sea (448–801 m), showed that gammaridean amphipods were the most important food item, with substantial amounts of errant polychaetes also present. Isopods and unidentified polychaetes were minor food sources, while unidentified crustaceans, cumaceans, hydroids, and calanoid copepods were negligible sources of food.

Attains 151 mm TL.



Distribution of *A. orianae*

Artedidraco shackletoni Waite, 1911
Fig. 7

Artedidraco shackletoni Waite, 1911: 15, pl. 2, off Cape Royds, McMurdo Sound. Holotype: CMC 208.

Diagnosis: D III–VII+27–30; A 18–21; P 15–18; GR (0–4)+(11–15); ULL 11–19 (tubular) + about 2–9 (disc-shaped), ending under about 7–16th dorsal-fin rays; MLL 9–22; vertebrae 38–41. Body depth 4.0–6.9 and head length 2.6–3.0 in SL. Orbit diameter 3.2–4.2, interorbital width 10.3–16.0 in HL. Mental barbel smoothly tapered, 2.6–4.9 in HL.

Colour: In alcohol, head and body light brown with sparsely distributed darker markings on cheeks, lips, and sides of body. Dorsal fins with dark bands on anterior spines and rays; remaining spines and rays unmarked. Anal fin dark basally, light distally, the posterior rays

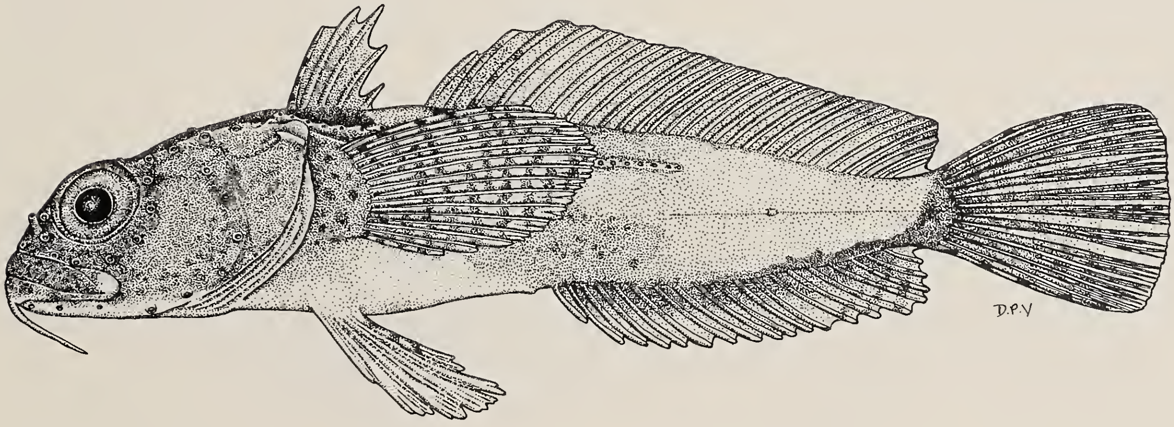


Fig. 7. *Artedidraco shackletoni* ISH 201/81, 85 mm SL (70°33.6'S, 07°27'W)

with some dark bands. Caudal fin with about 6 dark vertical stripes. Pelvic fins with some dark spots. Mental barbel light.

Otoliths

Diagnostic features: The near oval to ovate shape, the entire margin in association with the distinctly separated ostium and cauda and the robust crista inferior.

Ontogeny: Negligible, except that the rostrum becomes more prominent in fish larger than 80 mm TL.

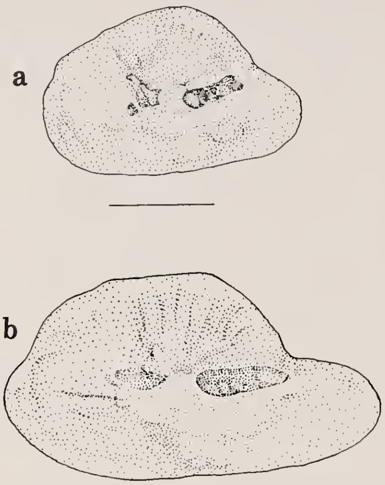


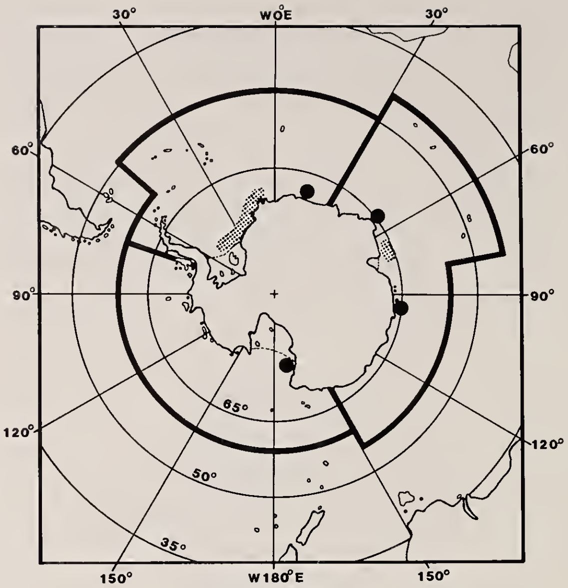
Fig. 8. Representative otoliths of *A. shackletoni*; fish lengths: 91 mm (a) and 129 mm (b) TL; scale bar 1 mm

Distribution: East Antarctica (Ross Sea, South Victoria Land, MacRobertson Land, Queen Mary Land, Weddell Sea, Queen Maud Land, Davis Sea, Enderby Land). Near-shore (sublittoral) and continental shelf at 56–460 m.

Remarks: One specimen had a single tubed scale in the middle lateral line of the left side (see species illustration).

Stomachs of fishes from the Weddell Sea contained primarily polychaetes and to a lesser extent isopods (Schwarzbach 1987).

Attains 146 mm TL.



Distribution of *A. shackletoni*

Artedidraco skottsbergi Lönnberg, 1905
Fig. 9

Artedidraco skottsbergi Lönnberg, 1905b: 48, pl. 2, fig. 7, pl. 4, fig. 15, south of Snow Hill Island, Antarctic Peninsula. Holotype: NRM SYD/1902041.3163.

Diagnosis: D II–IV+24–28; A 17–21; P 14–17; GR (1–5)+(13–16); ULL 2–6 (tubular) + about 1–16 (disc-shaped); MLL 11–26; vertebrae 36–39. Body depth 4.9–8.7 and head length 2.8–4.3 in SL. Orbit diameter 2.8–3.6 and interorbital width 13–21 in HL. Mental barbel smooth or finely papillose, 7–11 in HL.

Colour: In alcohol, head and body heavily spotted with dark brown on yellowish background. About 6–8 blotches at base of dorsal fins, sometimes continued on sides of body as bars. First dorsal fin with some dark markings and second dorsal fin with dark bands on rays forming oblique stripes; spotting darkest distally. Anal fin light, but posterior part darkly-spotted distally. Caudal fin with about 8 vertical stripes, upper and lower edges darkly spotted. Pectoral fins with about 5–7 vertical stripes and pelvic fins unspotted. Mental barbel light.

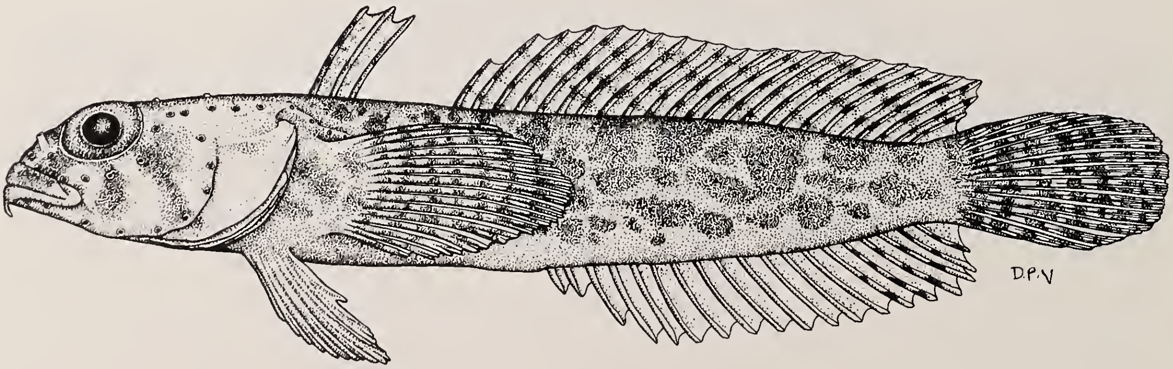


Fig. 9. *Artedidraco skottsbergi* USC-*Eltanin* station 1002, 81 mm SL (62°40′S, 54°45′W to 62°40′S, 54°44′W)

Otoliths

Diagnostic features: The ovate shape, the entire margin, the deep and ostial sulcus acusticus and the knob-like crista inferior below the collum.

Ontogeny: Rostrum of otoliths of fish smaller than 70 mm SL not as prominent as in larger fish.

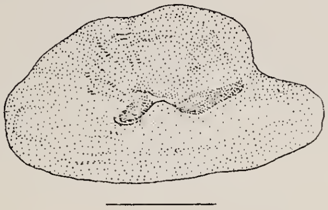
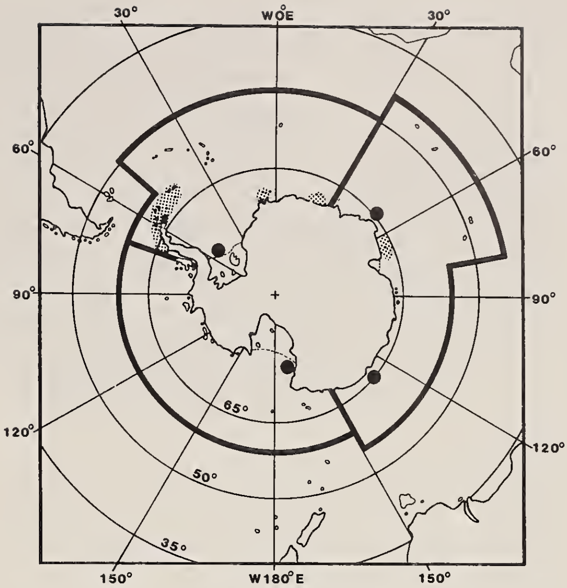


Fig. 10. Representative otolith of *A. skottsbergi*; fish length 101 mm TL; scale bar 1 mm

Distribution: Circum-Antarctic: Antarctic Peninsula; South Shetland Islands; South Orkney Islands (Kock pers. comm.); East Antarctica (Ross Sea, South Victoria Land, MacRobertson Land, Weddell Sea, Queen Maud Land, Enderby Land, Wilkes Land, Graham Land). Near-shore (sublittoral) and continental-shelf at 5–666 m.

Remarks: Daniels (1982) found this species to feed mainly on amphipods and polychaetes. A food study by Wyanski & Targett (1981), based on analysis of stomach contents of fishes from the Ross Sea, South Orkney and South Shetland islands, and Antarctic Peninsula (185–305 m), showed that errant polychaetes, gammaridean amphipods, and sedentary polychaetes were the major food sources, with unidentified polychaetes and isopods also present. Cumaceans, unidentified crustaceans, fecal pellets, mysids, and calanoid copepods were negligible sources of food. Weddell Sea fishes fed primarily on polychaetes, but amphipods and cumaceans were also important food items (Schwarzbach 1987).

Attains 106 mm TL.



Distribution of *A. skottsbergi*

Genus ***Dolloidraco*** Roule, 1913

First dorsal fin above operculum. Head not or scarcely broader than deep; post-temporal ridges not well developed. Snout shorter than orbit. Interorbital narrow. Mental barbel tapered or expanded distally. Upper lateral line with tubular scales anteriorly, usually disc-shaped scales posteriorly; middle lateral line with disc-shaped scales. Pleural ribs reduced. Low numbers of anal-fin rays (14–16) and caudal-fin rays (8–10 branched).

One species confined to the coasts of Antarctica.

Dolloidraco longedorsalis Roule, 1913
Fig. 11

Dolloidraco longedorsalis Roule, 1913: 6, Marguerite Bay. Syntypes: MNHN 1913–187–190; BMNH 1913. 4.25.1.

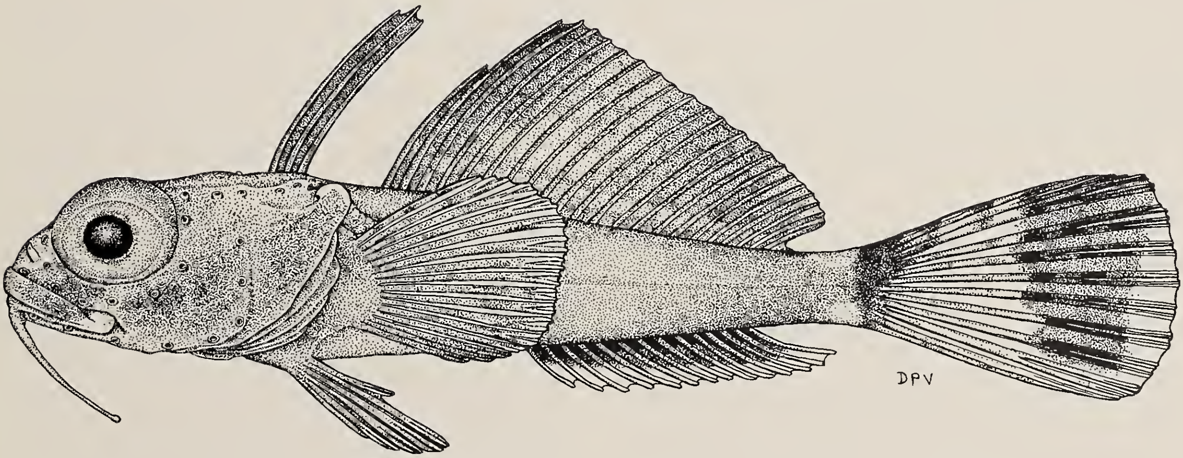


Fig. 11. *Dolloidraco longedorsalis* USC-*Eltanin* station 2047, 78 mm SL, Ross Sea (77°02.8′S, 178°09.5′W)

Diagnosis: D III–IV+22–25; A 14–16; P 16–18; GR (0–5)+(10–15); ULL 8–18 (tubular) + about 0–2 (disc-shaped), ending under about 11–12th dorsal-fin rays; MLL 7–20; vertebrae 34–36. Body depth 4.8–7.9 and head length 1.8–2.8 in SL. Orbit diameter 2.5–4.3 and interorbital width 14.0–28.3 in HL. Mental barbel either tapered or expanded (sexual dimorphism?), 2.2–3.3 in HL.

Colour: In alcohol head and body yellowish-brown, becoming darker posteriorly on body. Dark patches on cheeks below eyes and vertically across operculum. Dorsal fins dark. Anal fin dark basally, light distally. Caudal fin light with an incomplete oblique dark bar across its base and a broader and more distinct oblique bar distally, the 2 being connected by dark spots along the upper edge of fin. Pectoral fins with indistinct vertical stripes, the lower rays darker than the others. Pelvic fins dark basally. Mental barbel light.

Otoliths

Diagnostic features: The oval to ovate shape, the ostial and heterosulcoid sulcus acusticus, the separated ostium (elongate) and cauda (pit-like), and the entire margin.

Intraspecific variation: Negligible, except for variable development of crista inferior and the presence or absence of the antirostrum.

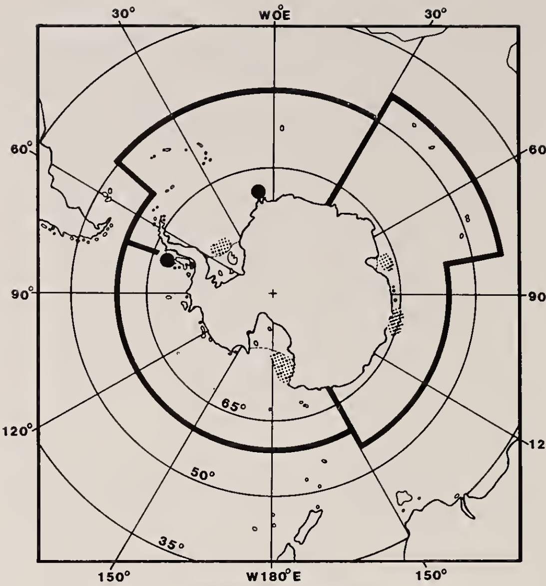
Ontogeny: The general shape of the otolith changes from oval to ovate with an increase in fish size and the rostrum becomes more elongate with increasing size.

Fig. 12. Representative otoliths of *D. longedorsalis*; fish lengths: 102 mm (a) and 135 mm (b) TL; scale bar 1 mm

Distribution: Circum-Antarctic: Weddell Sea, Graham Land, Queen Mary Land, South Victoria Land. Nearshore (sublittoral) and continental-shelf at 203–1,145 m (Ekau 1988).

Remarks: A food study by Wyanski & Targett (1981), based on analysis of stomach contents of fishes from the Ross Sea (565–826 m), showed that errant polychaetes were the most important food item, with gammaridean amphipods, isopods, sedentary polychaetes, and unidentified polychaetes also present. Calanoid copepods, unidentified crustaceans, cumaceans, hydroids, and mysids were negligible sources of food. Similar food taxa and importance were found in Weddell Sea fishes (Schwarzbach 1987).

Attains 137 mm TL.



Distribution of *D. longedorsalis*

Genus ***Histiodraco*** Regan, 1914

First dorsal fin above operculum. Head scarcely broader than deep; post-temporal ridges well developed. Snout shorter than orbit. Interorbital narrow. Mental barbel long and expanded distally with tapered processes. Upper lateral line with tubular scales anteriorly, usually disc-shaped scales posteriorly; middle lateral line with disc-shaped scales anteriorly, usually a few tubular scales posteriorly (or interspersed with disc-shaped scales). Pleural ribs rudimentary or absent, occurring irregularly.

One species confined to coasts of Antarctica.

Histiodraco velifer (Regan, 1914)

Fig. 13

Dolloidraco velifer Regan, 1914a: 12, McMurdo Sound (77°13′S, 164°18′E). Syntypes: BMNH 1913.12.4. 174–175.

Histiodraco velifer Regan, 1914b: 9, pl. 5, fig. 3.

Diagnosis: D II–III+23–26; A 15–18; P 18–21; GR (1–3)+(14–16); ULL 16–19 (tubular) + 0–3 (disc-shaped), ending under about 12–15th dorsal-fin rays; MLL 14–20 (may have a few tubular scales posteriorly or interspersed with disc-shaped scales); vertebrae 35–36. Body depth 3.3–6.6 and head length 2.2–3.0 in SL. Orbit diameter 3.1–3.8 and interorbital width 12–21 in HL. Mental barbel expanded distally with fringelike processes, 1.7–2.5 in HL.

Colour: In alcohol, head and body light brown with dark blotches laterally on body and less well defined markings on cheeks and lips. First dorsal fin unmarked and second dorsal fin with bands on rays forming oblique stripes. Anal fin unmarked and caudal fin with about 7 vertical stripes. Pectoral fins with about 9 vertical stripes and pelvic fins with 5 transverse stripes. Mental barbel light.

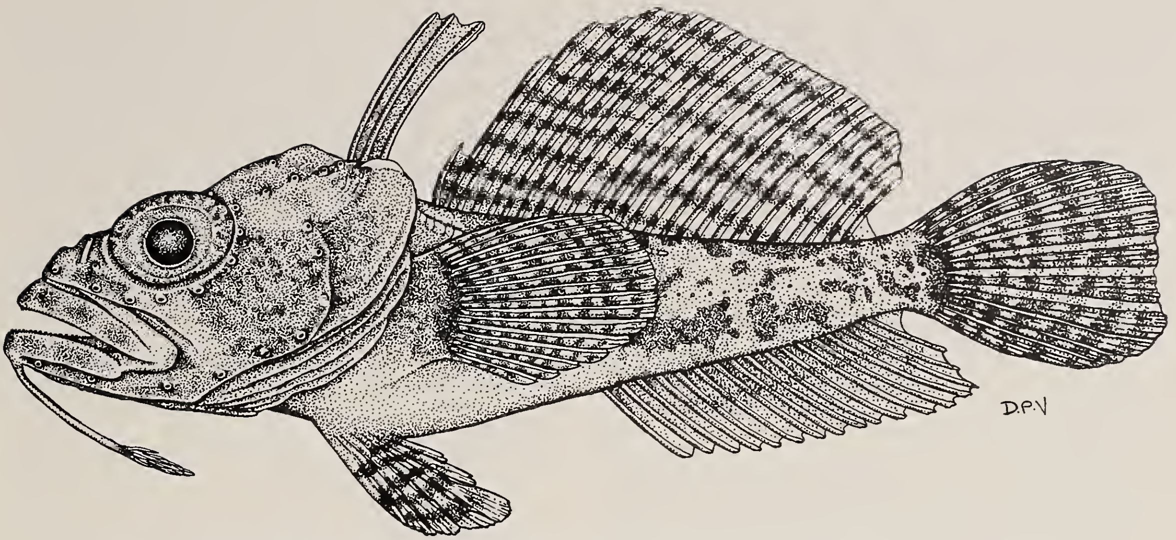


Fig. 13. *Histiodraco velifer* USC-*Eltanin* station 2036, 140 mm SL, Ross Sea (75°01′S, 168°23′E)

Otoliths

Diagnostic features: The ovate anterior shape, the entire margin, the ostial and heterosulcoid sulcus acusticus, the distinctly separated ostium and cauda and the crista superior which is only present over the ostium.

Intraspecific variation: Negligible, except for the variation in the definition of the colliculi.

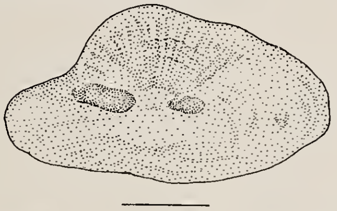
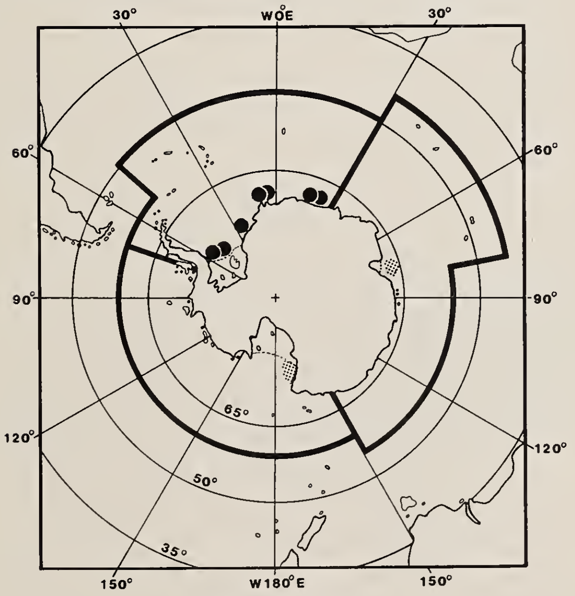


Fig. 14. Representative otolith of *H. velifer*; fish length 129 mm TL; scale bar 1 mm



Distribution of *H. velifer*

Distribution: East Antarctica (South Victoria Land, MacRobertson Land, Ross Sea, Weddell Sea). Nearshore (sublittoral) and continental-shelf at 210–667 m.

Remarks: This little-known species is rare in collections. It is most closely related to *Pogonophryne,* but has a narrower and less depressed head, a narrower interorbital space, and a higher first dorsal fin.

Biology unknown. Attains 192 mm TL.

Genus *Pogonophryne* Regan, 1914

Head wide and depressed. Post-temporal ridges poorly to well developed. Snout about as long as orbit. Interorbital space wide. Mental barbel tapered to a point or variously expanded distally, often with tapered or rounded, branched or unbranched, processes. Upper lateral line with tubular scales anteriorly, disc-shaped scales posteriorly; middle lateral line usually with disc-shaped scales anteriorly and tubular scales posteriorly (often interspersed with disc-shaped scales). Pleural ribs rudimentary or absent, occurring irregularly.

About 16–18 species confined to the coasts of Antarctica and islands north to the South Orkneys.

KEY TO SPECIES

1a Head and body with dark markings......................4

1b Head and body without dark markings...................2

2a Fins light in colour; GR on first gill arch 18–21; jaw width (measured across upper jaw between posterior extensions of the maxillaries with the mouth closed) about 18% SL 3

2b Fins dark basally and light distally; GR on first gill arch 12; jaw width about 25% SL ....*P. immaculata*

3a Fins largely white; GR on first gill arch 21; ULL pores 12 (tubular scales); mental barbel about 17% SL, terminal expansion about three times as wide as stalk; a deepwater form (more than 1,500 m) ....*P. albipinna*

3b Fins not white; GR on first gill arch 18; ULL pores 19 (tubular scales); mental barbel about 22% SL, terminal expansion about twice as wide as stalk; not a deepwater form (less than 1000 m) ....*P. dewitti*

4a Top of head with dark markings; D_2 25–29; vertebrae 36–39 5

4b Top of head without dark markings; D_2 23–26; vertebrae 35–37..15

5a Mental barbel greater than 16% SL 6

5b Mental barbel less than 16% SL 7

6a Stalk of mental barbel thick, terminal expansion consisting of unbranched (irregular) processes; longest spine of D_1 less than half as long as longest ray of D_2....... *P. macropogon*

6b Stalk of mental barbel thin, terminal expansion consisting largely of branched processes; longest spine of D_1 more than half as long as longest ray of D_2........................ 8

7a Eye not filling entire orbit anteriorly; mental barbel with a terminal expansion consisting of convoluted ridges or folds; P usually 18–19; GR on first gill arch usually at least 17 (16–20); D_2 rays often fewer than 27.................... 9

7b Eye filling entire orbit anteriorly; mental barbel without a terminal expansion consisting of convoluted ridges or folds; P usually at least 20; GR on first gill arch usually fewer than 17 (12–18); D_2 rays rarely fewer than 27.................. 10

8a Spots on top of head generally uniformly large, round, and sparsely distributed, generally following cephalic pores; terminal expansion of mental barbel less than twice as wide as stalk, its processes often flattened, palmate, and round tipped; upper jaw usually with one row of teeth posteriorly; longest spine of D_1 always shorter than longest ray of D_2; vertebrae 36–38 .... *P. mentella*

8b Spots on top of head rather small, round or irregular, and densely distributed, generally not following cephalic pores; terminal expansion of mental barbel at least twice as wide as stalk, its processes tapered to a point; upper jaw usually with 2 rows of teeth; longest spine of D_1 often nearly equal in length to longest ray of D_2 (especially so in specimens less than 170 mm SL); vertebrae 38–39 .... *P. lanceobarbata*

9a C dark with light dorsal and ventral borders (with or without vertical stripes); snout constricted; tip of tongue reaching oral valve .... *P. marmorata*

9b C with vertical stripes (not dark with light dorsal and ventral borders); snout not constricted; tip of tongue falling far short of oral valve .... *Pogonophryne* sp.

10a Mental barbel usually less than 6% SL, tapered and without a terminal expansion.................................. 11

10b Mental barbel usually greater than 6% SL, normally with a terminal expansion (if tapered, usually with some finger-like processes distally) 12

11a D_2 with deeply incised membrane between rays of anterior lobe..................................... *P. curtilemma*

11b D_2 without deeply incised membrane ....
.... *P. barsukovi* (*P. orcadensis*)

12a D_2 with 29 rays and a high anterior lobe, length of longest ray 35 % SL; terminal expansion of mental barbel less than 40% of barbel length and with short, thick, unbranched processes
.... *P. velifera*

12b D_2 with 26–28 rays and with or without an anterior lobe, length of longest ray 12–30% SL; mental barbel usually with a terminal expansion greater than 40% of barbel length and without short, thick, unbranched processes (barbel, if tapered, usually with some finger-like processes distally.......... 13

13a Terminal expansion of mental barbel smoothly flattened, without processes; snout constricted; jaw width less than 13% SL .... *P. platypogon*

13b Terminal expansion of mental barbel, if present, not flattened (tip, whether tapered or expanded, usually with processes); snout not constricted; jaw width greater than 15% SL 14

14a Ventral surface of head and abdomen uniformly coloured (without large, dark spots); dorsal surface covered with small, round or elongate brown spots; mental barbel with a thin, unmarked stalk and usually a terminal expansion with finger-like processes, some of which may be branched (tip may be tapered, especially in specimens greater than about 130 mm SL); interdorsal distance usually greater than 6% SL; opercular-subopercular distance (Fig. 15) usually less than 16% SL; vertebrae usually 37–38.............. *P. permitini*

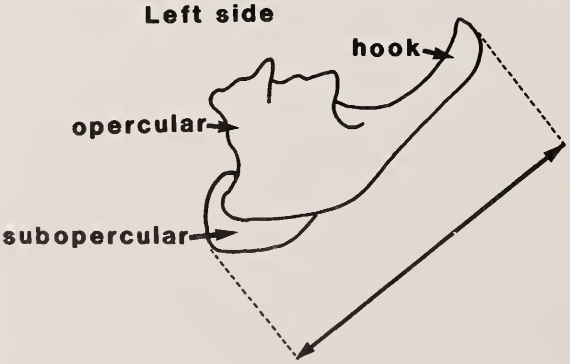


Fig. 15. Method of measuring opercular-subopercular distance in *Pogonophryne* species

14b Ventral surface of head and abdomen with large, conspicuous, dark spots; dorsal surface covered with dark, purplish-brown vermiculations and few round spots; mental barbel with a thick, mottled stalk and a terminal expansion with tapered processes, many of which are branched; interdorsal distance less than 6% SL; opercular-subopercular distance (Fig. 15) usually greater than 16% SL; vertebrae 36–37 ....
.... *P. ventrimaculata*

15a Mental barbel without a terminal expansion and entirely covered with papillae; jaws forming a wide, smoothly rounded arc.. *P. scotti*

15b Mental barbel normally with a terminal expansion, stalk not entirely covered with papillae; jaws somewhat constricted, maxillaries directed posteriorly at an angle to premaxillaries
.... 16

16a Mental barbel slender; terminal expansion flattened and either smooth ("leaflike") or covered with tapered processes, its length about 17–40% of barbel length (tip often tapered in specimens greater than about 100 mm SL); lower jaw narrow posteriorly in ventral view, ratio of interangular width to interdentary width (Fig. 16) less than 1.5:1; lower jaw usually with 1 row of teeth........................ *P. phyllopogon*

16b Mental barbel stout; terminal expansion consisting of densely packed, rounded processes, its length about 30–50% of barbel length; lower jaw wide posteriorly in ventral view, ratio of interangular width to interdentary width (Fig. 16) about 1.5–2:1; lower jaw with 1 or 2 rows of teeth (often 2 rows near symphysis)......................... *P. dolichobranchiata*

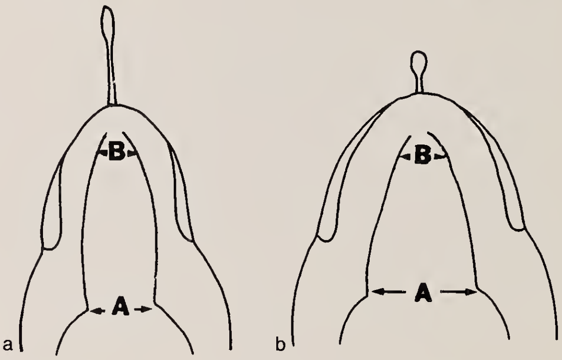


Fig. 16. Method of measuring interangular (A) and interdentary (B) distances in *P. phyllopogon* (a) and *P. dolichobranchiata* (b)

Pogonophryne albipinna Eakin, 1981
Fig. 17

Pogonophryne albipinna Eakin, 1981b: 153, figs. 4–5, Ross Sea (71°16′S, 171°45′E to 71°16′S, 171°35′E). Holotype: LACM 11353–1.

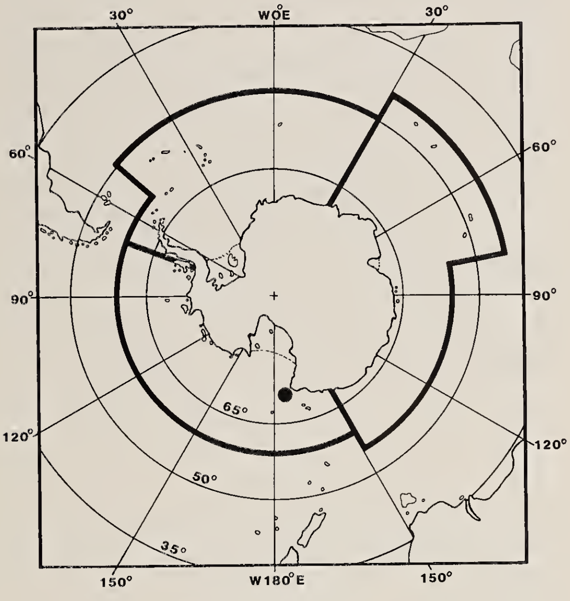
Pogonophryne sp. 1b Eakin, 1977: 14, fig. 8b.

Diagnosis: Based on juvenile holotype, 37.5 mm SL. D II+28; A 19 (last ray visible on radiograph); P 19; GR 5+16; ULL 22, ending under 18th dorsal-fin ray; MLL indistinct; vertebrae 37. Body depth 5.8 and head length 2.7 in SL. Orbit diameter 3.9 and interorbital width 5.5 in HL. Snout slightly flattened anteriorly in dorsal view. Lower jaw projecting slightly beyond upper; tooth patterns not determined due to small size of specimen. Mental barbel long (2.1 in HL); terminal expansion about 3 times as wide as stalk, its length about 40% barbel length, covered with densely packed, rounded, unbranched processes.

Colour: Freshly-caught specimen (from H.H. DeWitt, field notes), uniformly grey, darker along back near bases of dorsal fins. Branchiostegal membranes blackish. First dorsal fin blackish basally, white distally. Second dorsal and anal fins hyaline except for base which is blackish. Caudal and pectoral fins hyaline except for upper and lower rays of caudal which are white. Pelvic fins white. Mental barbel, corners of mouth, and dorsal and ventral parts of caudal peduncle white. Iris and area on cheek silvery.

In alcohol, head and body uniformly greyish-brown, without dark markings. Ventral surface dark grey from pelvic girdle to anus. Sides of head and body light golden brown. Fins light and unmarked. Mental barbel light.

Distribution: Known only from holotype collected at the northern edge of the Ross Sea at a depth of 1,565–1,674 m.



Distribution of *P. albipinna*

Remarks: This deep-water species belongs to the group of *Pogonophryne* characterised by being unspotted and having relatively high numbers of vertebrae and second dorsal-fin rays.

Biology unknown. The holotype is 48 mm TL.

Pogonophryne barsukovi Andriashev, 1967
Fig. 18

Pogonophryne barsukovi Andriashev, 1967: 392, figs. 1,1; 2,1; 3,1; Knox Coast (65°35′S, 109°12′E). Holotype: ZIN 37747.

Pogonophryne scotti (*non* Regan): Andriashev, 1958: 200.

Pogonophryne sp. Andriashev, 1964: 346, fig. 6c.

Diagnosis: D II+26–28; A 17–19; P 19–21; GR (2–3)+(12–14); ULL 20–27, ending under 18th–22nd dorsal-fin rays; MLL 9–18; vertebrae 38. Body depth 4.6–7.8 and head length 2.4–2.8 in SL. Orbit diameter 3.7–5.4 and interorbital width 5.6–7.8 in HL. Snout smoothly rounded anteriorly in dorsal view. Jaws relatively wide; lower jaw projecting slightly beyond upper; upper jaw with about 2 rows of teeth, irregular near symphysis; lower jaw with 1 row of teeth posteriorly, irregular near symphysis. Mental barbel short (5.2–12.0 in HL) and tapered to a point or rounded distally, sometimes with papillae and/or tapered, unbranched processes.

Colour: In alcohol, head and body covered dorsally and laterally with dark, chocolate-brown spots and vermiculations on yellowish-grey background; markings on top of head smallest, becoming larger on sides of head and body. Ventral surface brownish-grey and unspotted ("small and sparse brown-black pigment spots" on belly of holotype; Andriashev, 1967). First dorsal fin light or dark; second dorsal fin with oblique stripes (anterior third of fin with high, blackish lobe in males). Anal and pelvic fins dark basally, light distally. Caudal fin with 6–10 vertical stripes (often central stripes widest and upper margin of fin dark, forming T-shaped pattern), dark basally, light distally. Mental barbel whitish (some dark processes dorsally and distally on barbel of holotype; Andriashev, 1967).

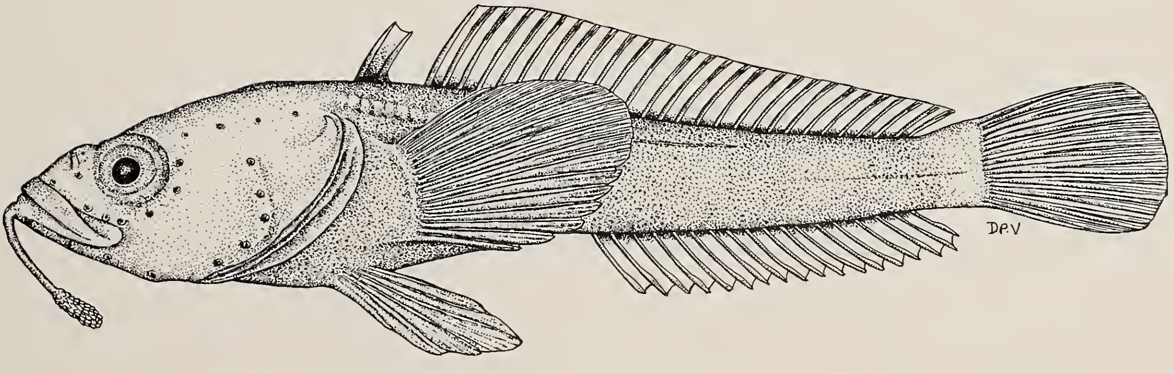


Fig. 17. *Pogonophryne albipinna* LACM 11353–1, 37.5 mm SL, holotype, juvenile

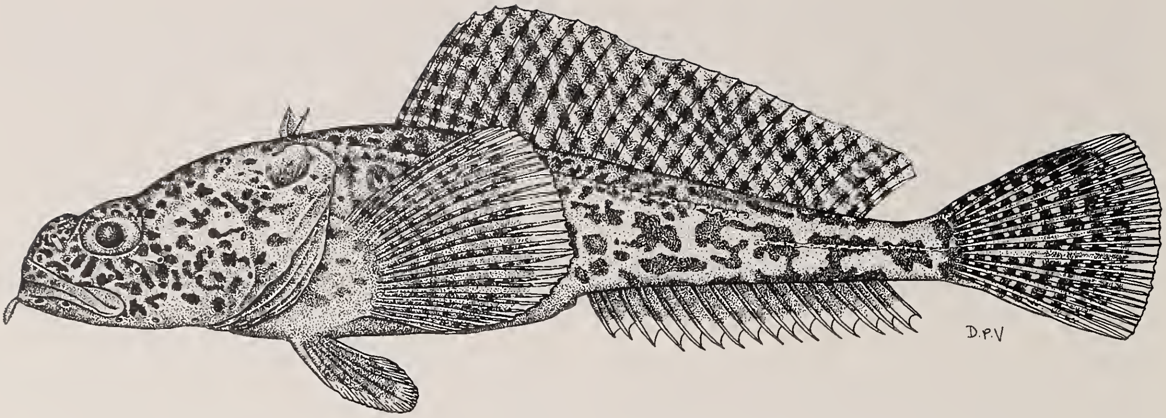


Fig. 18. *Pogonophryne barsukovi* ISH 265/81, 185 mm SL, female (60°52′S, 55°36′W)

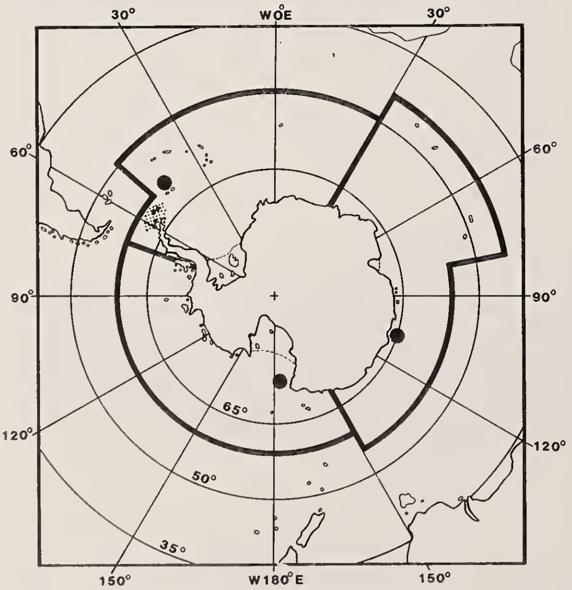
Otoliths

Diagnostic features: The generally ovate anterior shape, the ostial and heterosulcoid sulcus acusticus, the separated ostium and cauda and the pit-like shape of the cauda and the poorly developed cristae.

Intraspecific variation: There is some variation in the general shape of the otoliths, otherwise negligible.

Fig. 19. Representative otolith of *P. barsukovi*; fish length 166 mm SL; scale bar 1 mm

Distribution: East Antarctica (Knox Coast, Ross Sea, Queen Maud Land), South Shetland Islands, and South Orkney Islands at depths of 220–1,120 m.



Distribution of *P. barsukovi*

Remarks: Sexual dimorphism exists in *P. barsukovi* with regard to the height of the second dorsal fin. In males, rays of the anterior third of this fin are elongate, thus forming a distinct high lobe. Specimens examined so far exhibited individual variation in the height of this lobe, but not as high as in *P. orcadensis* (see below). *P. barsukovi* belongs to the group of *Pogonophryne* characterized by having dorsal spots and relatively high numbers of vertebrae and second dosal-fin rays. The black, "cirriform" processes on the mental barbel and the "rounded medial lobe" on the lower oral valve of the holotype, referred to by Andriashev (1967), have not been observed in other specimens. More examples of this relatively little-known species are needed to determine variation.

Biology unknown. Attains 25 cm TL.

Pogonophryne curtilemma Balushkin, 1988
Fig. 20

Pogonophryne curtilemma Balushkin, 1988: 127, figs. 1–2, Bransfield Strait (62°41′6″S, 58°32′W). Holotype: ZIN 48135.

Diagnosis: Based on Balushkin's (1988) description of the female holotype, 167 mm SL. D II+28 (first ray reduced and embedded in skin, but visible on radiograph); A 17; P 20; GR 1+12; ULL 24–25; MLL 14–15; vertebrae 37. Body depth 6.2 and head length 2.6 in SL. Orbit diameter 4.5 and interorbital width 7.6 in HL. Snout smoothly rounded in dorsal view. Upper jaw with 2 rows of teeth posteriorly and 3 rows at symphysis; lower jaw with 1 row of teeth posteriorly and 3 rows at symphysis. Mental barbel 7.6 in HL, slender, and smoothly tapered to a point, with no dermal appendages.

Colour: Head and body covered dorsally and laterally with dark, chocolate-brown spots and vermiculations; markings on top of head and anterior part of body smallest, becoming larger on sides of head and body; ventral surface of body dirty grey, head lighter (abdomen with small and sparse black pigment spots). First dorsal fin dark, with a black edge on first spine; second dorsal fin darker, with almost black rays anteriorly, and with oblique stripes (formed by 3–4 spots on each ray) posteriorly. Anal fin grey-black basally with a broad white border. Caudal fin with a wide, dark, T-shaped transverse band and dark spots on rays forming 6–7 irregular vertical bands (upper rays and membranes darker than lower; margin of fin light). Pectoral fin dark

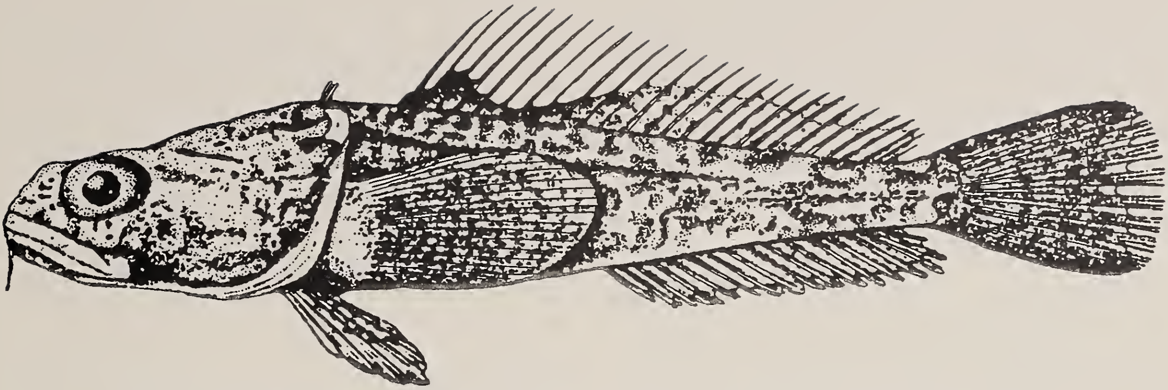
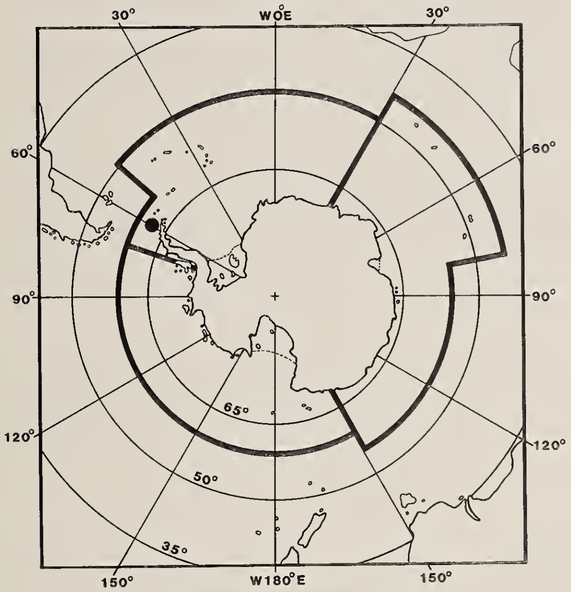


Fig. 20. *Pogonophryne curtilemma* ZIN 48135, 167 mm SL, holotype (from Balushkin 1988)

with numerous spots on rays forming vertical bands; margin lighter. Pelvic fins dark dirty grey basally, light distally (narrow white border dorsally, broader white margin ventrally). Mental barbel light with some dark pigment spots.

Distribution: West Antarctica (south-eastern part of Bransfield Strait), at depth of 195–205 m.



Distribution of *P. curtilemma*

Remarks: This species belongs to the group of *Pogonophryne* characterised by having dorsal spots on head and body, and a relatively high number of vertebrae and second dorsal-fin rays. The incised condition of the membrane of the second dorsal fin is unique to *P. curtilemma*. In most other respects it closely resembles *P. barsukovi* and *P. orcadensis*. Known only from the holotype.

Biology unknown. The holotype is 21 cm TL.

Pogonophryne dewitti Eakin, 1988

Fig. 21

Pogonophryne dewitti Eakin, 1988b: 434, figs. 1–2, South Shetland Islands (62°52′S, 59°27′W to 62°55′S, 59°15′W). Holotype: LACM 10485-3.

Pogonophryne sp. 1a Eakin, 1977: 14, fig. 8a.

Diagnosis: Based on juvenile holotype, 55.0 mm SL. D II+27; A 17; P 19–20; GR 3+15; ULL 19, ending under 15–17th dorsal-fin rays; MLL 17–19; vertebrae 37. Body depth 5.8 and head length 2.8 in SL. Orbit diameter 4.3 and interorbital width 6.1 in HL. Snout slightly flattened anteriorly in dorsal view. Lower jaw projecting slightly beyond upper; upper jaw with 1 (irregular) row of teeth posteriorly, 2–3 rows near symphysis; lower jaw tooth pattern not determined due to small size of specimen. Mental barbel very long (1.6 in HL); terminal expansion about twice as wide as stalk, its length about 40% barbel length, the surface with rounded, unbranched processes.

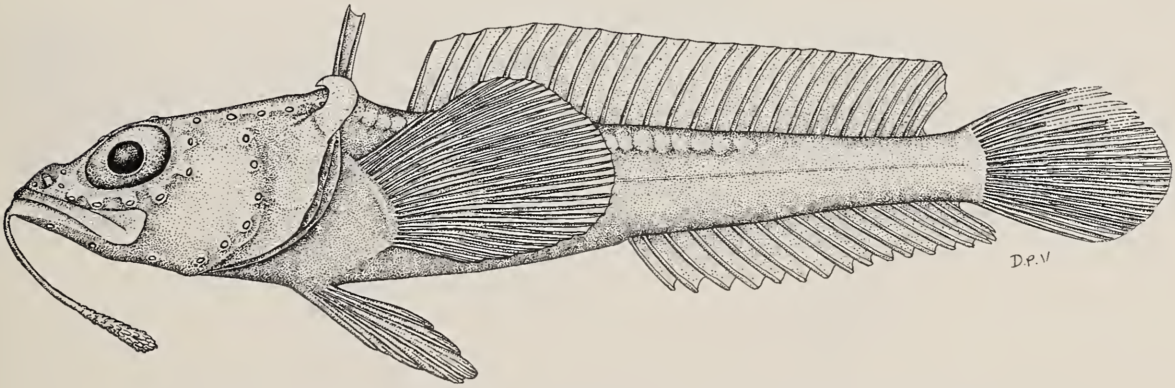
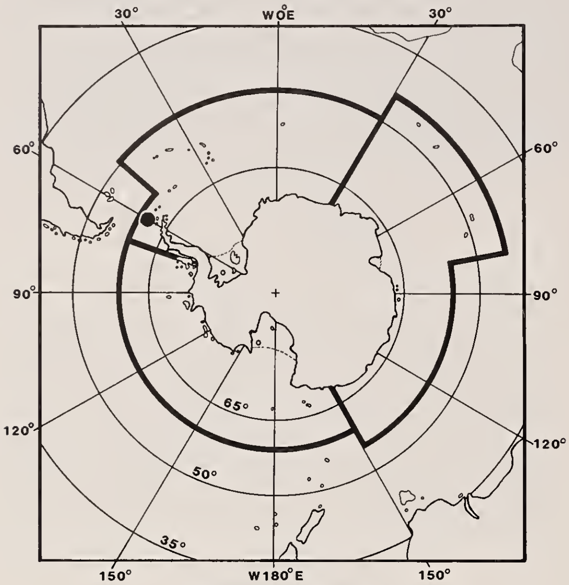


Fig. 21. *Pogonophryne dewitti* LACM 10485-3, 55 mm SL, holotype, juvenile

Colour: In alcohol, head and body uniformly yellowish-brown, without dark markings. Fins light and unmarked. Mental barbel light.

Distribution: Known only from holotype collected in the South Shetland Islands at a depth of 884–915 m.



Distribution of *P. dewitti*

Remarks: This species belongs to the group of *Pogonophryne* characterised by being unspotted and having relatively high numbers of vertebrae and second dorsal-fin rays.

Biology unknown. The holotype is 67 mm TL.

Pogonophryne dolichobranchiata
Andriashev, 1967
Fig. 22

Pogonophryne dolichobranchiata Andriashev, 1967: 406, figs. 6,1; 7,1; South Orkney Islands (60°37′S, 44°39′W). Holotype: ZIN 37887.

Diagnosis: D II+24–26; A 16–18; P 20–21; GR (2–3)+(14–17); ULL 22–27, ending under 17–20th dorsal-fin rays; MLL 10–19; vertebrae 35–37. Body depth 3.8–5.9 and head length 2.4–2.7 in SL. Orbit diameter 4.1–5.3 and interorbital width 4.8–7.1 in HL. Snout smoothly rounded in dorsal view, somewhat constricted, maxillaries directed posteriorly at an angle to premaxillaries. Lower jaw projecting beyond upper; upper jaw with 2 (sometimes irregular) rows of teeth; lower jaw with 1–2 (irregular near symphysis) rows of teeth. Mental barbel 3.1–8.8 in HL, proportionally shorter in larger specimens; terminal expansion about twice as wide as stalk, its length about 30–50% barbel length, covered with densely packed, rounded, unbranched processes.

Colour: In alcohol, head and body uniformly brownish dorsally with no large spots; dark greyish-brown markings laterally; dark saddle-shaped patches extending from base of about 4th to 8th dorsal-fin rays to upper lateral line on each side; sometimes similar markings at about 15th to 17th dorsal-fin rays. Ventral surface light and unspotted. First dorsal fin light or dark (or with dark markings); second dorsal fin with oblique stripes (anterior third of fin with high, blackish lobe in some specimens; pattern of occurrence undetermined). Anal fin light (sometimes dark basally). Caudal fin usually with 8–9 vertical stripes (sometimes 2 central stripes widest and upper margin of fin dark, forming T- or V-shaped pattern). Pectoral fins with 3–13 vertical stripes and pelvic fins light or with 3–9 transverse stripes. Mental barbel light. Some freshly-caught specimens reddish-brown.

Otoliths

Diagnostic features: The obovate shape, the pseudo-ostial and heterosulcoid sulcus acusticus, the split crista superior and the prominent crista inferior which joins the crista superior posteriorly and the prominent distally rounded rostrum.

Distribution: Ross Sea, Antarctic Peninsula, South Shetland Islands, and South Orkney Islands at depths of 214–538 m.

Remarks: This species belongs to the group of *Pogonophryne* characterised by being unspotted dorsally and having relatively low numbers of vertebrae and second dorsal-fin rays. Long gill filaments, described by Andriashev (1967) for the holotype, have not been observed in other specimens.

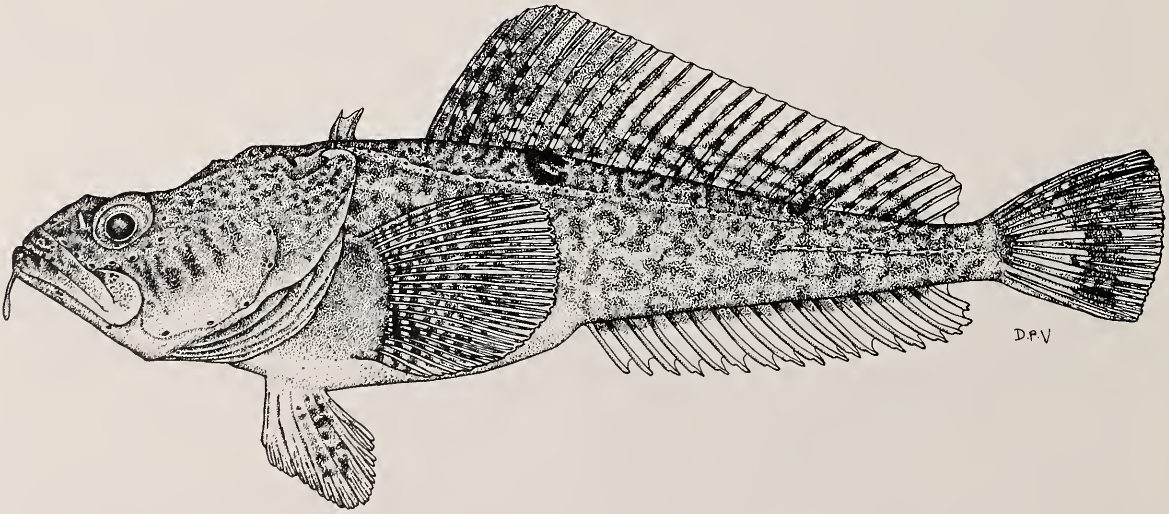


Fig. 22. *Pogonophryne dolichobranchiata* ISH 26/85, 23 cm SL (60°58.3′, 45°47.8′W)

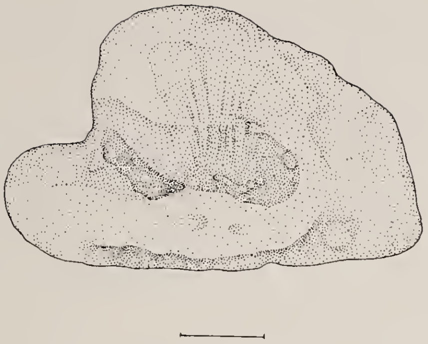
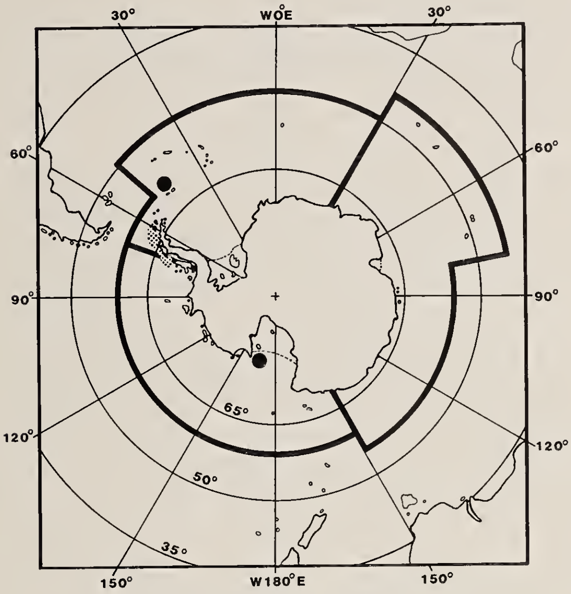


Fig. 23. Representative otolith of *P. dolichobranchiata*; fish length unknown; scale bar 1 mm



Distribution of *P. dolichobranchiata*

A food study by Wyanski & Targett (1981), based on analysis of stomach contents of fishes from the South Orkney Islands and the Ross Sea (274–538 m), showed that individuals over 100 mm SL fed primarily on mysids and to a lesser extent on shrimp (*Crangon antarcticus)* and fish. Gammaridean amphipods and calanoid copepods occurred in negligible amounts. One specimen under 100 mm SL fed exculsively on gammaridean amphipods.

Attains 30 cm TL.

Pogonophryne immaculata Eakin, 1981

Fig. 24

Pogonophryne immaculata Eakin, 1981c: 158, figs. 3–4, South Orkney Islands (60°43.4′S, 48°16.1′W to 60°48.2′S, 48°13.5′W). Holotype: USNM 218370.

Diagnosis: Based on female holotype, 200 mm SL. D II+27; A 18; P 20; GR 3+9; ULL 19–22, ending under 14–18th dorsal-fin rays; MLL 18–20; vertebrae 37. Body depth 4.8 and head length 2.5 in SL. Orbit diameter 5.1 and interorbital width 5.8 in HL. Snout smoothly rounded in dorsal view. Jaws very wide, lower projecting beyond upper; upper jaw with about 2 rows of teeth posteriorly, 2–3 rows near symphysis; lower jaw with 1 row of teeth posteriorly, 2 rows near symphysis. Mental barbel structure unknown (tip broken off Fig. 25).

Fig. 25. The stem of the mental barbel of *P. immaculata*

Colour: In alcohol, head and body brownish (lighter dorsally, darker laterally and ventrally) without dark markings. Fins dark basally, light distally.

Distribution: Known only from holotype collected at the South Orkney Islands at a depth of 2,473–2,542 m, the deepest record for the genus.

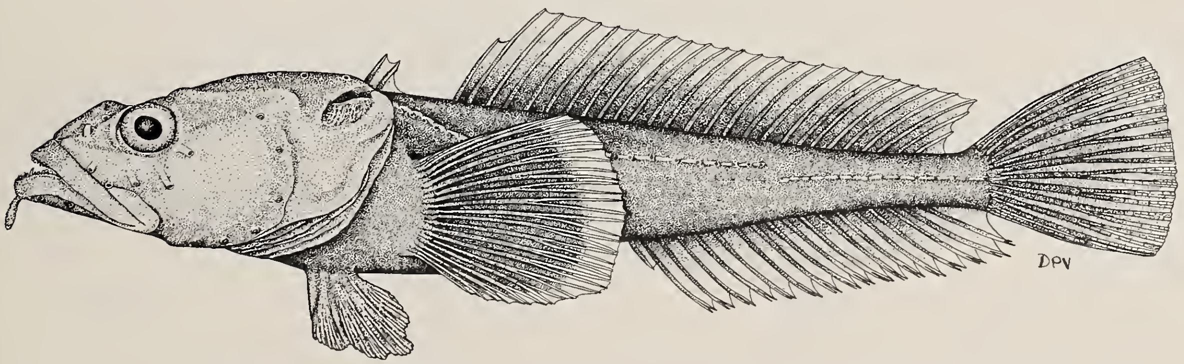
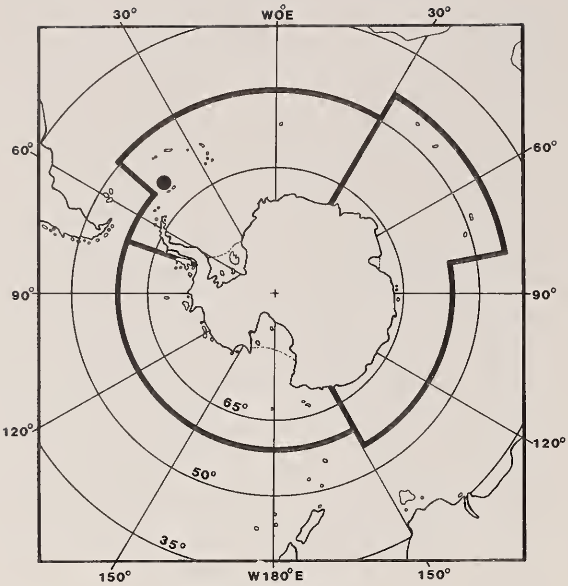


Fig. 24. *Pogonophryne immaculata* USNM 218370, 200 mm SL, holotype



Distribution of *P. immaculata*

Remarks: This deep-water species belongs to the group of *Pogonophryne* characterised by being unspotted and having relatively high numbers of vertebrae and second dorsal-fin rays.

Biology unknown. The holotype is 25 cm TL.

Pogonophryne lanceobarbata Eakin, 1987

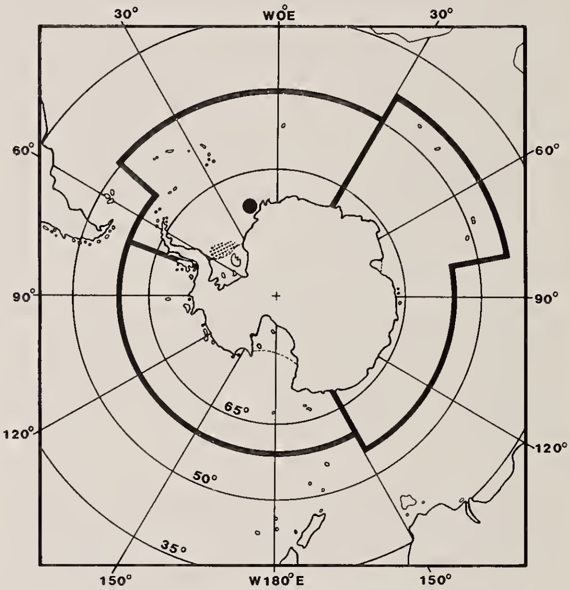
Fig. 26

Pogonophryne lanceobarbata, Eakin, 1987: 59, figs. 1–2, Weddell Sea (77°28.9′S, 41°26.6′W). Holotype: ISH 79/85.

Diagnosis: D II+27–29; A 17–19; P 20–21; GR (2–3)+(13–16); ULL 22–26, ending under 13th–22nd dorsal-fin rays; MLL 10–19; vertebrae 38–39. Body depth 5.3–7.2 and head length 2.3–2.5 in SL. Orbit diameter 3.9–5.0 and interorbital width 6.3–8.5 in HL. Snout smoothly rounded in dorsal view. Jaws narrow; lower jaw projecting greatly beyond upper; upper jaw often with 2 rows of teeth in smooth arciform pattern, sometimes 1 row posteriorly; lower jaw with 1 row of teeth posteriorly, 2–3 irregular rows near symphysis. Mental barbel long (1.4–1.7 in HL); lance-shaped terminal expansion about twice as wide as stalk, its length 26–66% barbel length, the surface with rather long, tapered, branched or unbranched processes. Dorsal-fin spines more than half as long (in small specimens about as long) as longest dorsal-fin rays.

Colour: In alcohol, head and body covered dorsally and laterally with dark brown spots and vermiculations on yellowish-grey background; markings on top of head smallest, becoming larger on sides of head and body. Ventral surface greyish or blackish and unspotted. First dorsal fin light or dark and second dorsal fin with oblique stripes. Anal fin light or with some dark pigment basally or faint dark bands on rays. Caudal fin with 5–7 vertical stripes, darker centrally and lighter dorsally, ventrally, and distally. Pectoral fins unmarked or faintly spotted, sometimes forming 1–6 vertical stripes. Pelvic fins light, or dark basally and light distally, sometimes spotted forming 2–3 transverse stripes. Terminal expansion of mental barbel lighter than stalk.

Distribution: Known only from the Weddell Sea and the Ross Sea (Eakin, 1987) at depths of 233–667 m.



Distribution of *P. lanceobarbata*

Remarks: This species belongs to the group of *Pogonophryne* characterised by having dorsal spots and relatively high numbers of vertebrae and second dorsal-fin rays.

Biology unknown. Attains 25 cm TL.

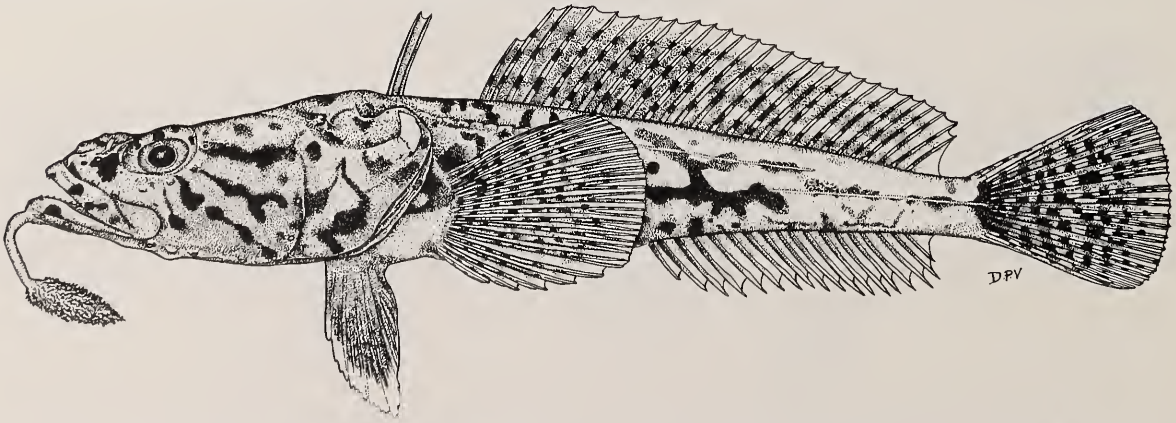


Fig. 26. *Pogonophryne lanceobarbata* ISH 78/85, 153 mm SL, paratype, female, Weddell Sea (77°17.6′S, 41°24.4′W)

Pogonophryne macropogon Eakin, 1981
Fig. 27

Pogonophryne macropogon Eakin, 1981b: 150, figs. 1–2, Ross Sea (74°19′S, 176°39′W to 74°20′S, 176°34′W). Holotype: LACM 11402–4.

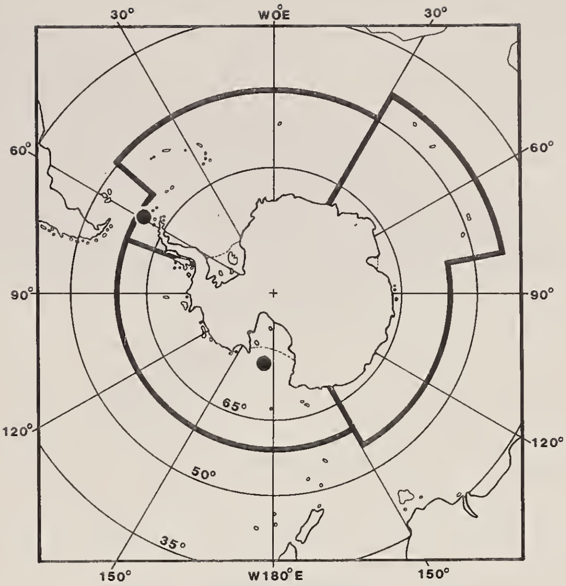
Pogonophryne sp. (similar to *P. permitini)* Eakin, 1977: 8, fig. 3.

Diagnosis: Based on holotype (male, 274 mm SL) and a specimen (213 mm SL) reported by Balushkin (1987). D II+27–28; A 17–18; P 19–20; GR (2–3)+(13–15); ULL 24–27, ending under 22nd–23rd dorsal-fin rays; MLL indistinct; vertebrae 38–39. Body depth 4.3 and head length 2.5–2.6 in SL. Orbit diameter 4.3–4.5 and interorbital width 5.8–6.0 in HL. Snout smoothly rounded in dorsal view. Lower jaw projecting beyond upper; upper jaw with 1 row of teeth posteriorly, 2–3 rows near symphysis; lower jaw with 1 row of teeth posteriorly, 2–3 rows near symphysis. Mental barbel of holotype very long (1.7 in HL) and thick; terminal expansion about twice as wide as stalk, its length 65% of barbel length, with irregular (unbranched), flattened processes. The barbel of Balushkin's specimen is about half as long, 3.3 in HL.

COLOUR: Freshly-caught specimen (from H.H. DeWitt, field notes), dark purplish-brown markings on light grey background. Margin of second dorsal fin whitish. Pectoral, anal fins and posterior margin of caudal fin pale orange-pinkish (almost flesh colour), margin of pectoral fins paler. Expanded portion of mental barbel flesh coloured.

In alcohol, head and body densely covered dorsally and laterally with dark brown spots and vermiculations on yellowish background. Ventral surface light and unspotted. First dorsal fin with dark spot on membrane and second dorsal fin with oblique stripes. Anal fin light and caudal fin with 9 vertical stripes, light distally. Pectoral fins with 9–10 vertical stripes, light distally, and pelvic fins light. Stalk of mental barbel mottled, terminal expansion light.

Distribution: Known from the holotype collected in the Ross Sea at a depth of 831–836 m, and from a specimen collected at the South Shetland Islands at a depth of 570–583 m (Balushkin 1987).



Distribution of *P. macropogon*

Remarks: This species belongs to the group of *Pogonophryne* characterised by having dorsal spots and relatively high numbers of vertebrae and second dorsal-fin rays.

Biology unknown. Attains 34 cm TL.

Pogonophryne marmorata Norman, 1938
Fig. 28

Pogonophryne marmoratus Norman, 1938: 51, fig. 31, South Shetland Islands (60°49.4′S, 52°40′W). Holotype: BMNH 1937.7.12.289.

Pogonophryne marmorata Andriashev, 1967: 401–404, figs. 1,6; 2,5; 5,1.

Diagnosis: D II–III (rarely I, damage?) + 25–28; A 16–18; P 17–20; GR (2–4)+14–17); ULL 18–25, ending under 16th-21st dorsal-fin rays; MLL 9–19; vertebrae 36–38. Body depth 4.2–7.3 and head length 2.2–2.5 in

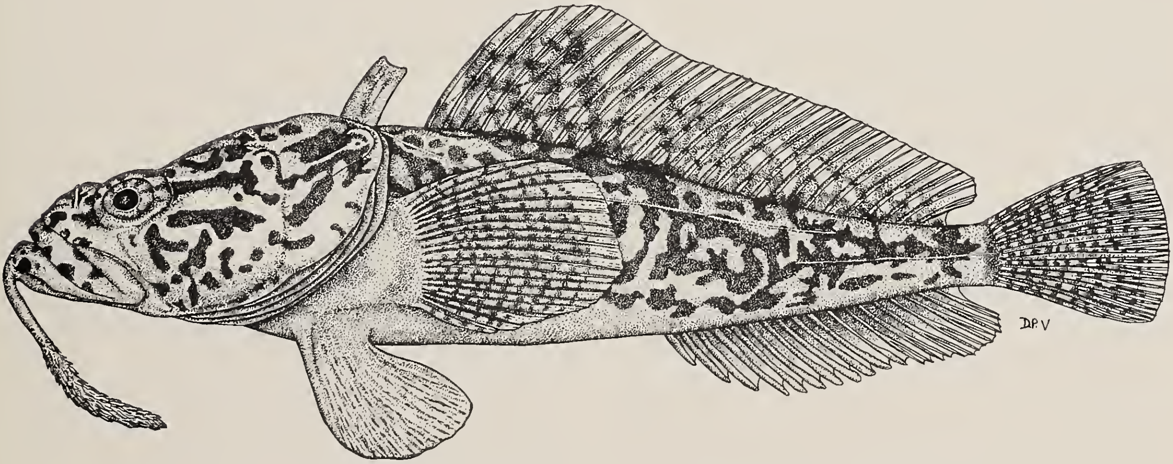


Fig. 27. *Pogonophryne macropogon* LACM 11402–4, 27 cm SL, holotype

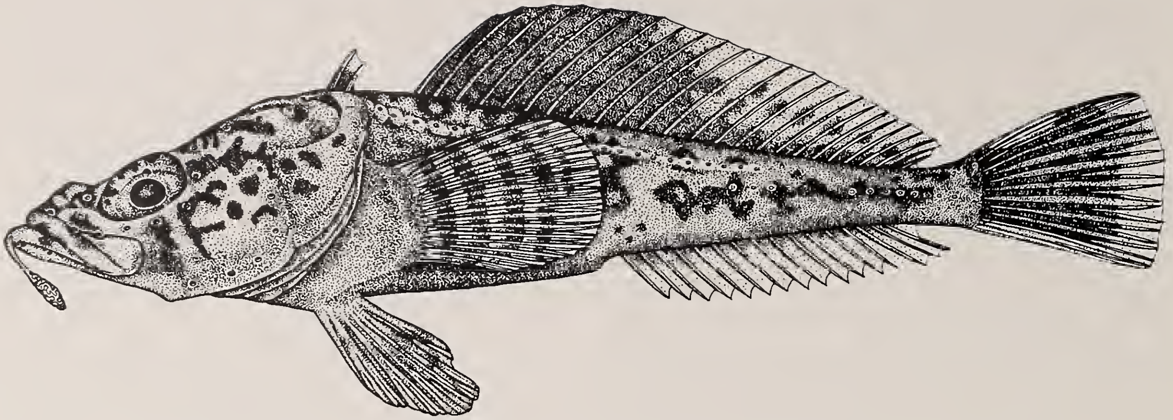


Fig. 28. *Pogonophryne marmorata* 176 mm (65°18′S, 91°41′E) (redrawn from Andriashev 1967)

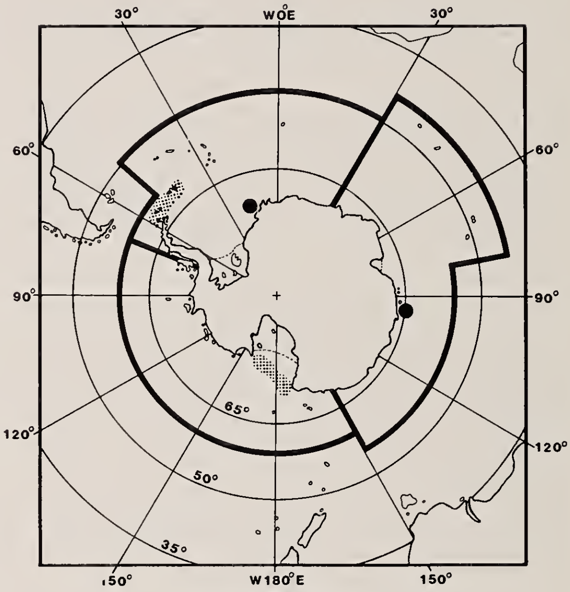
SL. Orbit diameter 3.3–4.9, and interorbital width 7.1–11.0 in HL. Snout slightly flattened anteriorly in dorsal view, noticeably constricted. Lower jaw projecting greatly beyond upper; upper jaw with 1–2 rows of teeth posteriorly, 2–4 rows near symphysis; lower jaw with 1 uniform row of teeth posteriorly, 2–3 rows near symphysis. Mental barbel rather short (2.5–4.6 in HL), proportionally longer in smaller specimens; terminal expansion about 2.5–3.0 times as wide as stalk, its length 30–60% barbel length, the surface with convoluted ridges or folds.

Colour: In alcohol, head and body covered dorsally and laterally with brown spots and vermiculations on yellowish background; markings smallest on top of head, becoming larger on sides of head and body. Ventral surface light or dark and unspotted ("fairly intense black pigment spots and markings" on belly; Andriashev, 1967). First dorsal fin light, dark, or with dark markings; second dorsal fin with oblique stripes or indistinct patches, anterior third sometimes dark (especially in larger specimens) or with a high, dark anterior lobe. Anal fin light, sometimes dark basally. Caudal fin usually uniformly dark centrally, with light dorsal and ventral borders, but sometimes with 3–8 vertical stripes (often indistinct due to dark colour of fin). Pectoral fins with 3–7 vertical stripes and pelvic fins light or with some dark markings (either indistinct or forming 2–4 transverse stripes). Mental barbel light.

Distribution: East Antarctica (Ross Sea, Davis Sea, Queen Maud Land), South Shetland Islands, and South Orkney Islands at depths of 140–1,405 m.

Remarks: This species belongs to the group of *Pogonophryne* characterised by having dorsal spots and relatively high numbers of vertebrae and second dorsal-fin rays. The "excavation" on the tongue, referred to by Andriashev (1967), has not been observed in other specimens.

Norman's (1938) description of *P. marmorata* ends with the following comment: "Regan (1914: 9) has suggested that the coloured drawing of a fish from the Bransfield Straits, 849 metres, reproduced by Lönnberg as *Artedidraco skottsbergi*, 'seems rather to represent a *Pogonophryne*', and it seems probable that the fish in question belonged to the species described above (*P. marmorata*). The barbel is shown without a terminal expansion but this may be due to the fact that the sketch was prepared in a hurry. Alternatively, the form of the barbel may differ in the sexes, as in *Artedidraco mirus*."



Distribution of *P. marmorata*

Since sexual dimorphism in barbel structure has not been shown so far in *Pogonophryne,* it is most likely that the specimen referred to by Regan (1914b) was illustrated incorrectly, or the barbel was damaged or broken off. If such were not the case, it may have represented *P. barsukovi,* then unknown to science. The latter and *P. curtilemma* are the only known dorsally spotted species with a tapered barbel.

A food study by Wyanski & Targett (1981), based on analysis of stomach contents of fishes from the Ross Sea, South Shetland and South Orkeny islands (160–1,405 m), showed that individuals over 100 mm SL fed primarily on mysids and to a lesser extent on isopods. Gammaridean amphipods occurred in negligible amounts. Fish under 100 mm SL fed almost exclusively on gammaridean amphipods. Also included were substantial amounts of isopods and negligible amounts of caprellid amphipods, errant polychaetes, and unidentified polychaetes. Unidentified crustaceans and foraminiferans represented negligible food sources for *P. marmorata*. The figure of *P. marmorata* in Fischer & Hureau (1985: 248, fig. 10) represents *P. mentella*.

Attains 21 cm TL.

Pogonophryne mentella Andriashev, 1967

Fig. 29

Pogonophryne mentella Andriashev, 1967: 404, figs. 1,5; 2,3; 5,2; Davis Sea (65°18′S, 91°41′E). Holotype: ZIN 37743.

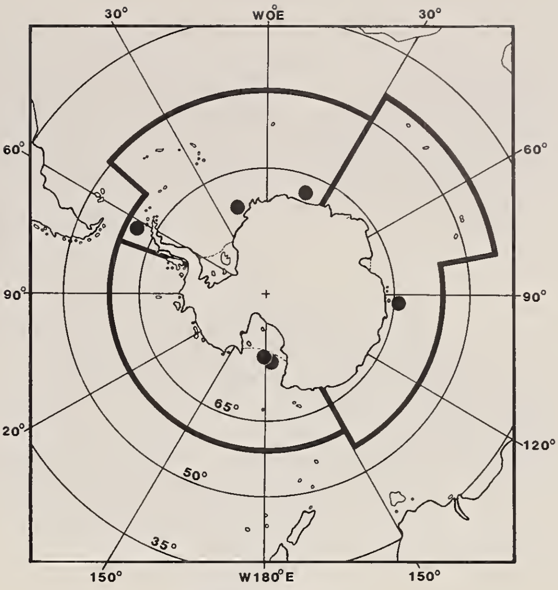
Pogonophryne sp. ("large-spotted") Barsukov & Permitin, 1959: 380.

Diagnosis: D II–III+27–29; A 17–19; P 19–21; GR (2–3)+(13–16); ULL 19–26, ending under 18th–21st dorsal-fin rays; MLL 8–20; vertebrae 36–38. Body depth 4.6–8.3 and head length 2.3–2.6 in SL. Orbit diameter 3.7–4.4 and interorbital width 6.1–8.5 in HL. Snout slightly flattened anteriorly in dorsal view, slightly constricted. Lower jaw projecting, sometimes greatly, beyond upper; upper jaw with 1–2 rows of teeth posteriorly, 2–3 rows near symphysis; lower jaw with 1 row of teeth posteriorly, 2–3 rows near symphysis (single shortened row in holotype). Mental barbel long (1.4–2.5 in HL); terminal expansion less than twice as wide as stalk, its length 25–40% barbel length, the surface with somewhat flattened, often branched (palmate), rounded or pointed processes.

COLOUR: In alcohol, head and body covered dorsally and laterally with brown spots and vermiculations on yellowish background; markings on top of head generally large, round, and sparsely distributed, generally following cephalic pore pattern (1 spot per pore), becoming elongate and irregular on sides of head and body. Ventral surface light or dark and unspotted ("dense black pigment spots" on belly of holotype; Andriashev, 1967). First dorsal fin light or with dark markings and second dorsal fin with oblique stripes (incomplete in holotype). Anal fin light ("with several indistinct patches" posteriorly in holotype; Andriashev, 1967) and caudal fin with 5–6 vertical stripes ("dark patch at base" in holotype; Andriashev, 1967). Pectoral fins variable (light or dark, with or without vertical stripes) and pelvic fins dark basally, light distally. Mental barbel light (in fresh specimens, with an orange tinge).

Distribution: East Antarctica (Ross Sea, Davis Sea, Queen Maud Land) and South Shetland Islands at depths of 210–1,116 m.

Remarks: This species belongs to the group of *Pogonophryne* characterised by having dorsal spots and relatively high numbers of vertebrae and second dorsal-fin rays. More specimens of this relatively little-known species are needed to determine variation.



Distribution of *P. mentella*

Biology unknown. Attains 21 cm TL.

Pogonophryne orcadensis Tomo, 1981

Fig. 30

Pogonophryne orcadensis Tomo, 1981: 58, figs. 40–41, South Orkney Islands. Holotype: IAA 6.

Diagnosis: Based on holotype. D II+28; A 18; P 19; ULL 25; MLL 15; Body depth 4.7 and head length 2.7 in SL. Orbit diameter 3.8 and interobital width 5.9 in HL. Lower jaw projecting beyond upper. Mental barbel very short (12 in HL), covered with papillae and without a terminal expansion.

COLOUR: Grey-brown, darkly marked dorsally and laterally with irregular patches and spots, the latter densely distributed on the head. First dorsal fin dark and second dorsal fin with a dark anterior lobe. Caudal fin with dark dorsal and medial areas forming a T-shaped pattern.

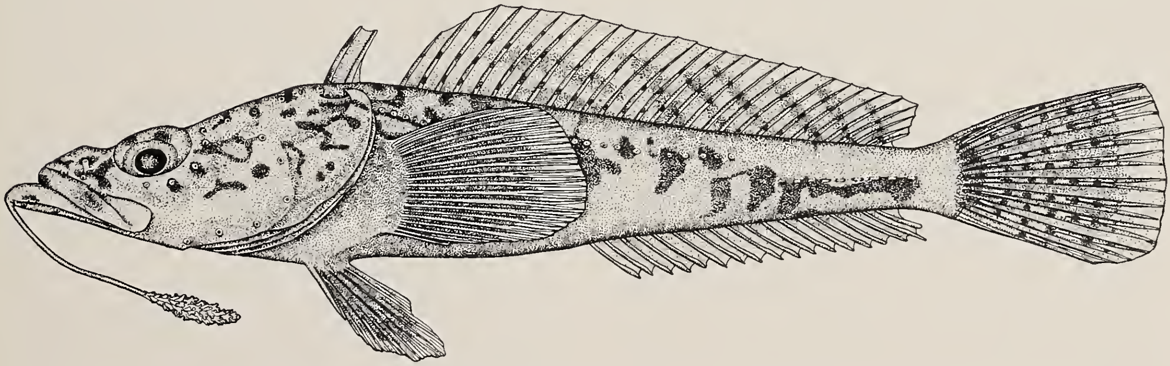


Fig. 29. *Pogonophryne mentella* ZIN 37743, 132 mm, holotype (redrawn from Andriashev 1967)

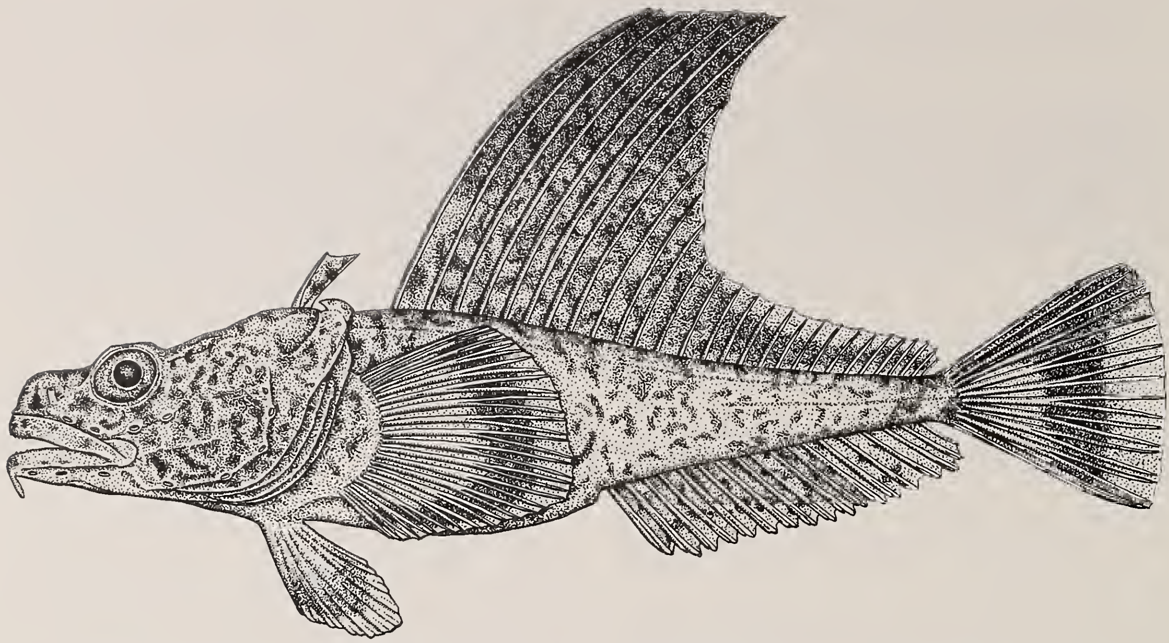
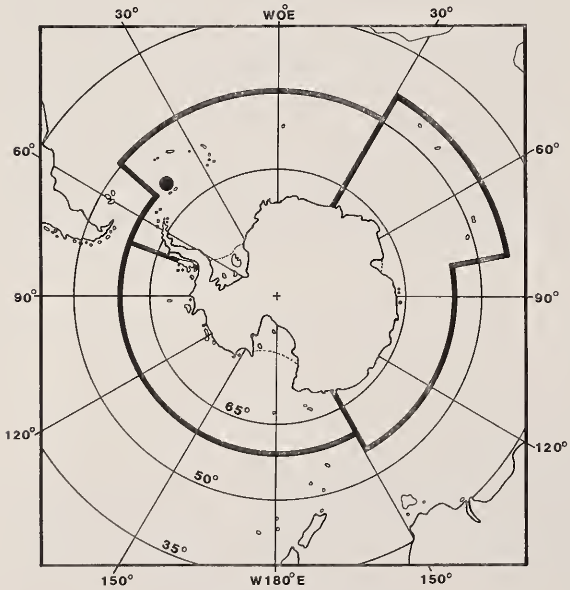


Fig. 30. *Pogonophryne orcadensis* IAA 6, 23 cm TL, holotype (redrawn from Tomo 1981, figs. 40, 41)

Pectoral fins with a dark median patch, light basally and distally. Pelvic fins with dark markings.

Distribution: Known only from the holotype collected in the South Orkney Islands at a depth of 200–400 m.



Distribution of *P orcadensis*

Remarks: This species, based on Tomo's (1981) description of the holotype, may be conspecific with *P. barsukovi* (Eakin & Kock 1984). Sexual dimorphism probably exists with regard to the height of the anterior third of the second dorsal fin as in *P. barsukovi* and *P. scotti*.

Biology unknown. The holotype is 23 cm TL.

Pogonophryne permitini Andriashev, 1967

Fig. 31

Pogonophryne permitini Andriashev, 1967: 395, figs. 1,4; 2,4; 3,2; Davis Sea (65°18′S, 91°41′E). Holotype: ZIN 37744.

Pogonophryne sp. ("fine-spotted") Barsukov & Permitin, 1959: 380.

Diagnosis: D II–III+25–28; A 16–19; P 18–22; GR (0–3)+(9–15); ULL 15–28, ending under 16–20th dorsal-fin rays; MLL 7–21; vertebrae 36–39. Body depth 4.3–7.9 and head length 2.3–2.7 in SL. Orbit diameter 2.9–4.6 and interorbital width 5.1–9.3 in HL. Snout smoothly rounded anteriorly in dorsal view. Lower jaw projecting slightly or not projecting beyond upper; upper jaw with 1–2 rows of teeth posteriorly, 2–3 rows near symphysis; lower jaw with 1 row of teeth posteriorly, 2–3 rows near symphysis. Mental barbel variable: normally expanded distally but tapered and proportionally shorter in specimens larger than about 130 mm SL (2.7–5.6 in HL); terminal expansion, when present, usually about twice as wide as stalk, its length 40–60% barbel length, the surface with rounded, fingerlike processes which may be branched or unbranched.

COLOUR: In alcohol, head and body covered dorsally and laterally with brown spots and vermiculations on yellowish background; markings on top of head smallest, becoming larger on sides of head and body. Ventral surface usually light and unspotted (rarely with a few dark, rounded spots on abdomen). First dorsal fin light or with dark markings and second dorsal fin with oblique stripes. Anal fin light (some faint stripes or dark basally in large specimens) and caudal fin with 6–11 vertical stripes. Pectoral fins with 5–9 vertical stripes (very faint on small specimens) and pelvic fins light, or dark basally and light distally, sometimes with transverse stripes. Mental barbel light.

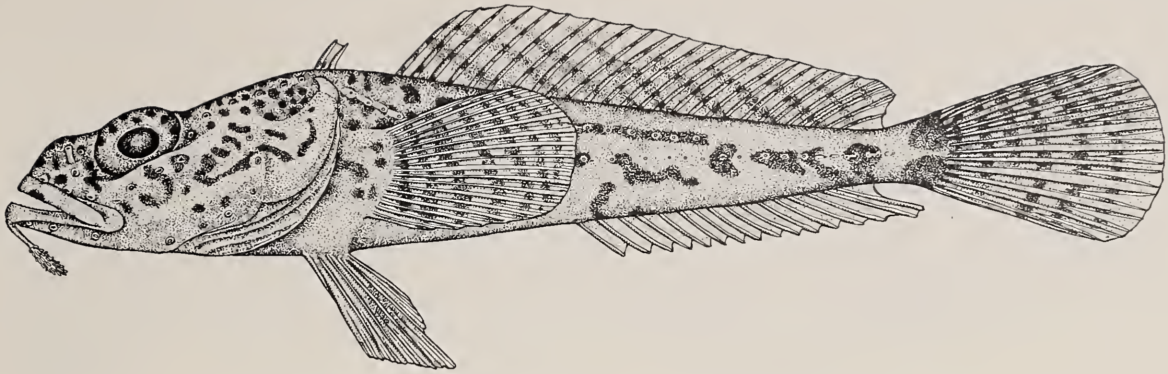
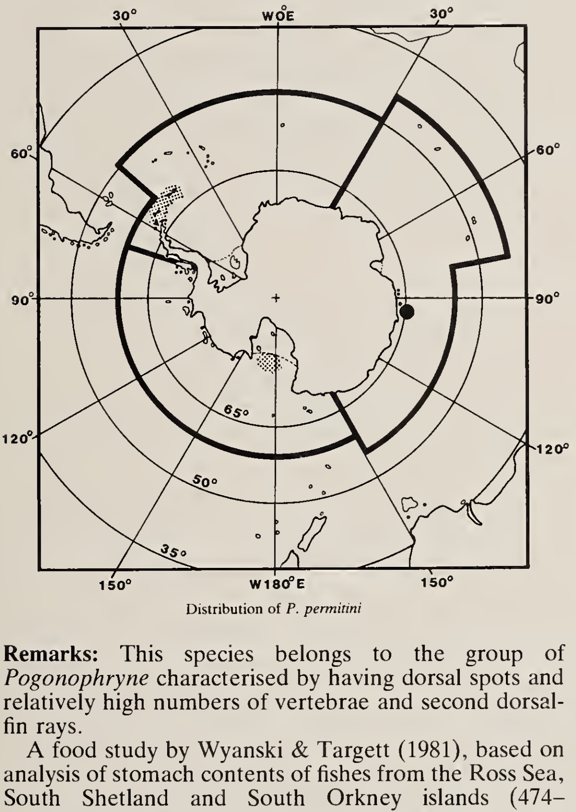


Fig. 31. *Pogonophryne permitini* ZIN 37744, 126 mm, holotype (redrawn from Andriashev 1967)

Distribution: East Antarctica (Davis Sea, Ross Sea, Weddell Sea), South Shetland Islands, and South Orkney Islands at depths of 430–1,120 m.



Distribution of *P. permitini*

Remarks: This species belongs to the group of *Pogonophryne* characterised by having dorsal spots and relatively high numbers of vertebrae and second dorsal-fin rays.

A food study by Wyanski & Targett (1981), based on analysis of stomach contents of fishes from the Ross Sea, South Shetland and South Orkney islands (474–1,120 m), showed that individuals over 100 mm SL consumed more isopods and fewer gammaridean amphipods than did those under 100 mm SL. Octopods, errant polychaetes, and unidentified polychaetes occurred in lesser amounts. Fish eggs, *Euphausia* sp., fishes, unidentified crustaceans, and calanoid copepods occurred in negligible amounts. Fish under 100 mm SL fed primarily on gammaridean amphipods. Also included were unidentified polychaetes, sedentary polychaetes, unidentified crustaceans, *Euphausia* sp., isopods, and calanoid copepods. Fishes from the Weddell Sea fed primarily on amphipods. Other important prey items were isopods, mysids and polychaetes (Schwarzbach 1987).

Attains 21 cm TL.

Pogonophryne phyllopogon Andriashev, 1967
Fig. 32

Pogonophryne phyllopogon Andriashev, 1967: 409, figs. 6,2; 7,2, South Orkney Islands (60°49′S, 44°17′W). Holotype: ZIN 37886.

Diagnosis: D I–III+23–26; A 15–18; P 19–21; GR (2–3)+(12–18); ULL 13–27, ending under 12th-22nd dorsal-fin rays; MLL 8–16; vertebrae 35–37. Body depth 3.5–7.6 and head length 2.1–2.6 in SL. Orbit diameter 3.5–5.2 and interorbital width 4.9–8.7 in HL. Snout smoothly rounded in dorsal view. Lower jaw projecting greatly beyond upper; upper jaw usually with 2 rows of teeth; lower jaw usually with 1 row of teeth, sometimes becoming irregular (multiple) near symphysis. Mental barbel slender, proportionally shorter in specimens larger than about 80 mm SL (1.9–8.6 in HL); terminal expansion about 1.5–2.0 times as wide as stalk, its length 20–40% barbel length, and flattened (leaflike or covered with tapered, unbranched processes).

Colour: In alcohol, head and body uniformly brownish dorsally with no large spots; dark greyish-brown markings laterally; dark saddle-shaped patches extending from bases of about 4th to 6th dorsal-fin rays to upper lateral line on each side (most noticeable on large specimens); sometimes similar markings at about 15th to 20th dorsal-fin rays. Ventral surface light and unspotted. First dorsal fin light or dark or with dark markings and second dorsal fin with oblique stripes, usually uniform in height and colour (sometimes with a dark anterior lobe). Anal fin light (sometimes dark basally in large specimens) and caudal fin usually with 5–8 vertical stripes (sometimes a central stripe, or stripes, widest and upper margin of fin dark, forming T-shaped pattern). Pectoral fins with 7–13 vertical stripes and pelvic fins light or with 6–9 transverse stripes (most conspicuous on large specimens). Mental barbel light or with some dark markings.

Otoliths

Diagnostic features: The triangular shape, the pseudo-ostial to medial and heterosulcoid sulcus acusticus, the unimorph colliculum, the well developed posterior sec-

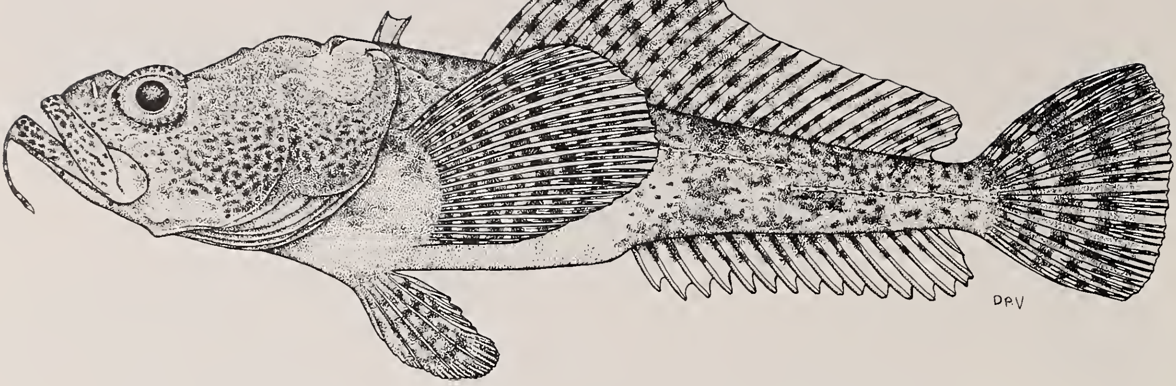


Fig. 32. *Pogonophryne phyllopogon* ISH 116/85, 168 mm SL (72°53.7′S, 19°29.3′W)

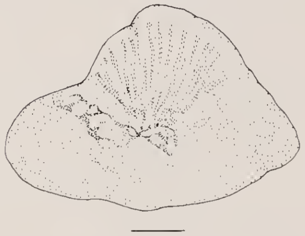
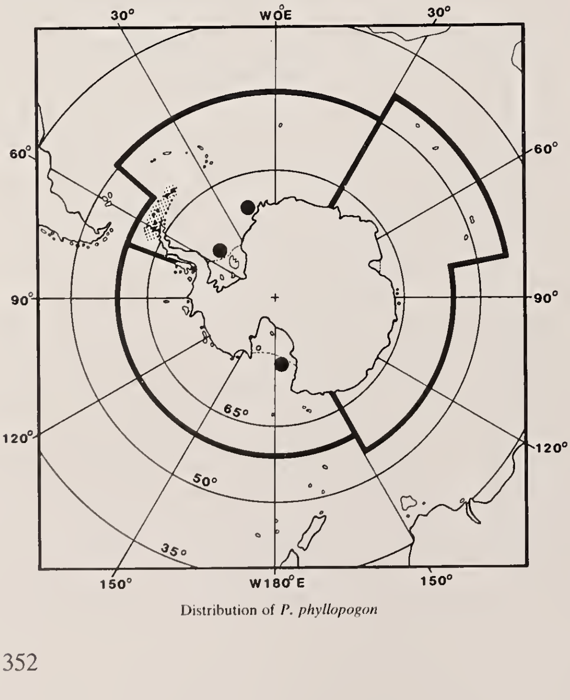


Fig. 33. Representative otolith of *P. phyllopogon*; fish length 152 mm SL; scale bar 1 mm

tion of the crista superior and the relatively well developed crista inferior in relation to *Pogonophryne scotti*.

Distribution: East Antarctica (Ross Sea, Weddell Sea), Antarctic Peninsula, South Shetland Islands, and South Orkney Islands at depths of 100–536 m.



Distribution of *P. phyllopogon*

Remarks: This species belongs to the group of *Pogonophryne* characterised by being unspotted dorsally and having relatively low numbers of vertebrae and second dorsal-fin rays. The "leaflike" terminal expansion of the mental barbel, described by Andriashev (1967) for the holotype, may be smoothly flattened or bear tapered processes on its surface (Eakin & Kock 1984).

Fishes from the Weddell Sea fed mostly on amphipods, but isopods, mysids and polychaetes were also important (Schwarzbach 1987).

Attains 27 cm TL.

Pogonophryne platypogon Eakin, 1988
Fig. 34

Pogonophryne platypogon Eakin, 1988a: 1, fig. 1, Queen Maud Land (70°11.65′S, 03°0′W). Holotype: RUSI 25503.

Diagnosis: Based on juvenile holotype, 61 mm SL. D II+27; A 17; P 19; GR 3+13; ULL 19–22, ending under 17–19th dorsal-fin rays; MLL about 12; vertebrae 36. Body depth 6.4 and head length 2.4 in SL. Orbit diameter 3.6 and interorbital width 8.9 in HL. Snout slightly flattened anteriorly in dorsal view; snout and jaws very narrow. Lower jaw projecting greatly beyond upper; upper jaw with 1 (irregular) row of teeth posteriorly, 2 rows near symphysis; lower jaw with 1 row of teeth posteriorly, 2 rows near symphysis. Mental barbel 6.6 in HL; terminal expansion smoothly flattened and without processes, about twice as wide as stalk, its length 42 % of barbel length.

Colour: In alcohol, head and body covered dorsally and laterally with dark brown markings on greyish-yellow background; markings on head smallest (greatly reduced dorsally in region anterior to first dorsal fin, resulting in pale or faded appearance), becoming more elongate and irregular on body. Ventral surface light and unspotted. First and second dorsal fins with some dark markings on spines and rays (membranes destroyed due to poor preservation of specimen?). Anal fin light (membranes destroyed) and caudal fin with 6 vertical stripes. Pectoral fins with 4 (irregular) vertical stripes and pelvic fins with some dark markings on 3–4 inner rays and membranes.

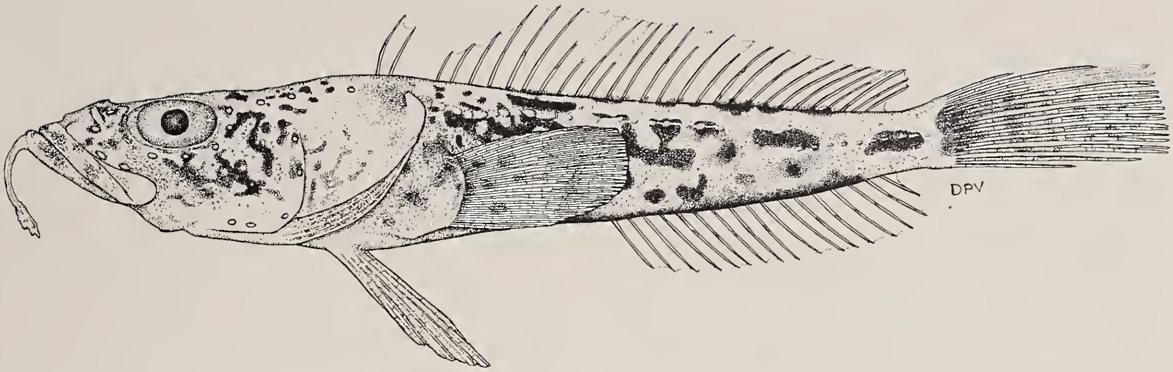
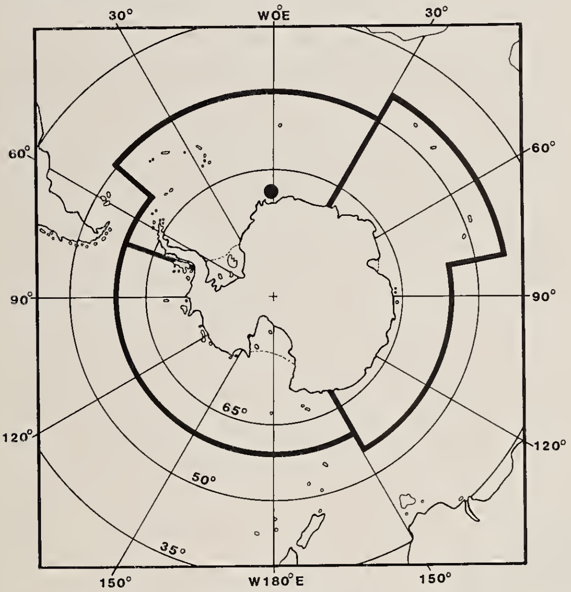


Fig. 34. *Pogonophryne platypogon* RUSI 25503, 61 mm SL, holotype, juvenile

Mental barbel light with some very small dark markings on terminal expansion.

Distribution: Known only from holotype collected off Queen Maud Land at a depth of 360 m.



Distribution of *P. platypogon*

Remarks: This species belongs to the group of *Pogonophryne* characterised by having dorsal spots and relatively high numbers of vertebrae and second dorsal-fin rays. It is the only dorsally spotted species with a smoothly flattened terminal expansion on the mental barbel and is distinguished from all other known species of the genus in having very narrow jaws.

Biology unknown. The holotype is 80.5 mm TL.

Pogonophryne scotti Regan, 1914
Fig. 35

Pogonophryne scotti Regan, 1914a: 13, Ross Sea (74°46.4′S, 178°23.4′E). Holotype: BMNH 1913.12.4.176.

Diagnosis: D II–III+25–26; A 16–18; P 19–22; GR (0–3) +(13–18); ULL 21–27, ending under 17–24th dorsal-fin rays; MLL 8–14; vertebrae 35–36. Body depth 3.6–6.3 and head length 2.4–2.8 in SL. Orbit diameter 4.2–5.3 and interorbital width 4.6–5.9 in HL. Snout wide and smoothly rounded in dorsal view. Lower jaw projecting beyond upper; upper jaw wth 1–3 rows of teeth; lower jaw with 1 row of teeth posteriorly, 2–3 rows near symphysis. Mental barbel slender 5.5–8.0 in HL, covered with papillae, and tapered to a point or rounded distally.

Colour: In alcohol, head and body uniformly brownish dorsally with no large spots; dark greyish-brown markings laterally; dark saddle-shaped patches extending

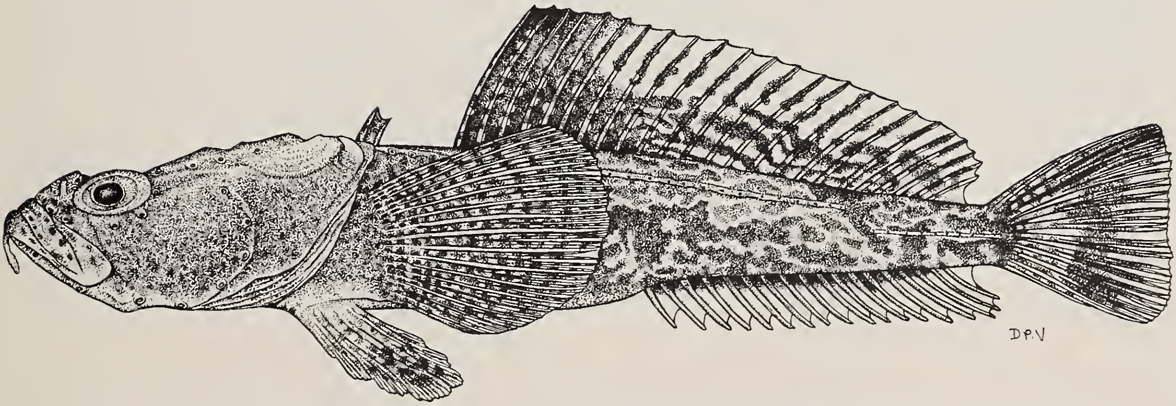


Fig. 35. *Pogonophryne scotti* ISH 30/85, 23 cm SL, female, Elephant Island (61°20.4′S, 56°9.1′W)

from bases of about 3rd to 8th dorsal-fin rays to upper lateral line on each side; sometimes similar markings at about 15th to 20th dorsal-fin rays. Ventral surface light or dark and unspotted. First dorsal fin light or dark and second dorsal fin with oblique stripes (anterior third of fin with high blackish lobe in males). Anal fin light distally, dark basally. Caudal fin usually with about 5 vertical stripes, 2 central stripes being widest and upper margin of fin dark, forming T- or V-shaped pattern. Pectoral fins with 4–13 vertical stripes and pelvic fins with 7 transverse stripes. Mental barbel light ("with blackish pigment spots forming 4 or 5 indistinct rings" on barbel of holotype; Andriashev 1967).

Otoliths

Diagnostic features: The near triangular shape, the pseudo-ostial and heterosulcoid sulcus acusticus and the single unimorph colliculum.

Intraspecific variation: Negligible, except for the definition and development of the cristae.

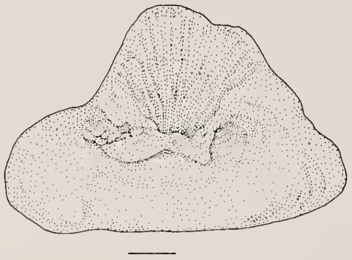
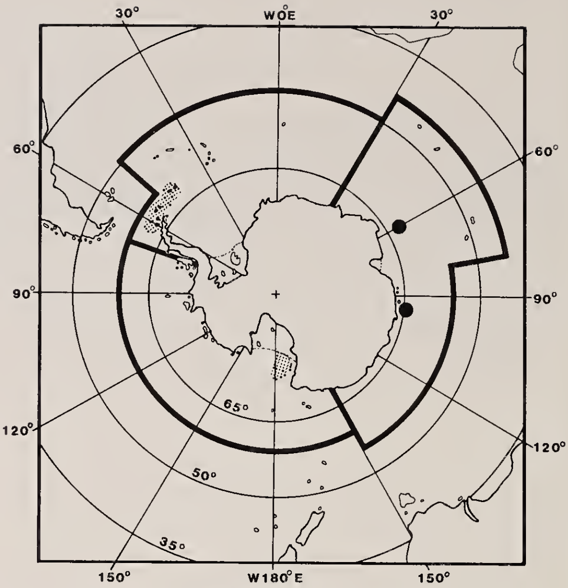


Fig. 36. Representative otolith of *P. scotti*; fish length 27 cm SL; scale bar 1 mm



Distribution of *P. scotti*

Distribution: East Antarctica (Davis Sea, Ross Sea), South Shetland Islands and South Orkney Islands at depths of 110–1,180 m.

Remarks: Sexual dimorphism exists in *P. scotti* with regard to the height of the second dorsal fin. In males, rays of the anterior third of this fin are elongate, thus forming a distinct high lobe. The height of the lobe may vary individually, but not as high as in *P. orcadensis*. This species belongs to the group of *Pogonophryne* characterised by being unspotted dorsally and having relatively low numbers of vertebrae and second dorsal-fin rays. More examples (especially small specimens) of this relatively little-known species are needed to determine variation.

Biology unknown. Attains 31 cm TL.

Pogonophryne velifera Eakin, 1981
Fig. 37

Pogonophryne velifera Eakin, 1981c: 156, figs. 1–2, South Orkney Islands (61°49.6'S, 43°36.2'W to 61°48.1'S, 43°38.2'W). Holotype: USNM 220011.

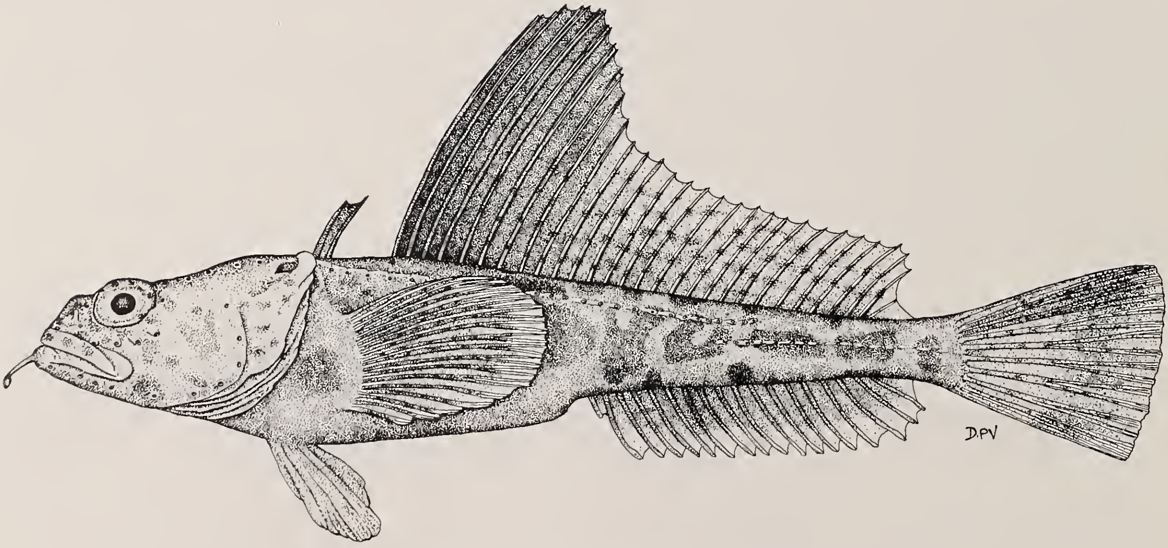


Fig. 37. *Pogonophryne velifera* USNM 220011, 161 mm SL, holotype

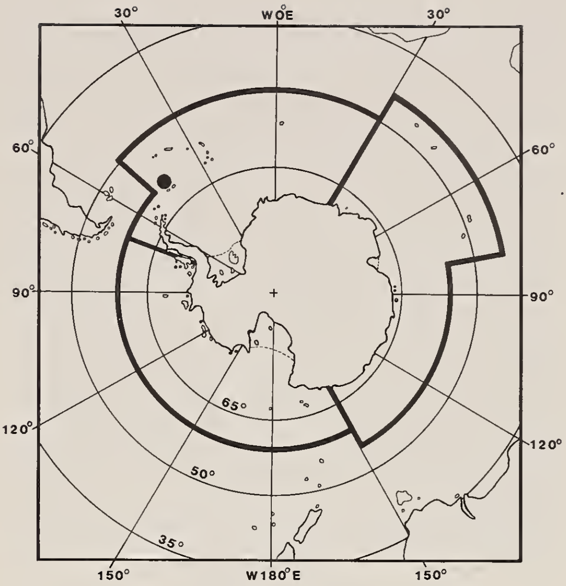
Diagnosis: Based on male holotype, 161 mm SL. D II+29; A 18; P 19–20; GR 2+11; ULL 27–28, ending under 22nd dorsal-fin ray; MLL 16–20; vertebrae 38. Body depth 3.9 and head length 2.7 in SL. Orbit 3.9 and interorbital width 6.9 in HL. Snout smoothly rounded in dorsal view. Lower jaw projecting beyond upper; upper jaw with 1 row of teeth posteriorly, 2 rows near symphysis; lower jaw with 1 row of teeth posteriorly, 2 rows near symphysis. Mental barbel 5.6 in HL; terminal expansion about twice as wide as stalk, its length about one-third of barbel length (difficult to determine due to damage?), the surface with short, rounded, unbranched processes.

Colour: In alcohol, head and body covered dorsally and laterally with dark brown spots and vermiculations on yellowish-grey background; markings on top of head smallest, becoming larger on sides of head and body. Ventral surface light and unspotted. First dorsal fin dark and second dorsal fin with oblique stripes posteriorly, high blackish lobe anteriorly. Anal fin dark basally, light distally. Caudal fin with about 4 faint vertical stripes anteriorly and wide, dark median stripe and dark upper third forming T-shaped pattern. Pectoral fins dark basally, light distally, with faint vertical stripes and pelvic fins dark basally, light distally, without stripes. Mental barbel light.

Distribution: Known only from holotype collected in the South Orkney Islands at a depth of 567–591 m.

Remarks: This species belongs to the group of *Pogonophryne* characterised by having dorsal spots and relatively high numbers of vertebrae and second dorsal-fin rays. The very high lobe of the second dorsal fin is similar to those of *P. barsukovi* (males) and *P. orcadensis*. The mental barbel of the holotype appears damaged (terminal expansion broken?) since the original observations were made (Eakin 1981c).

Biology unknown. The holotype is 21 cm TL.



Distribution of *P. velifera*

Pogonophryne ventrimaculata Eakin, 1987
Fig. 38

Pogonophryne ventrimaculata Eakin, 1987: 66, figs. 1–3, Weddell Sea (73°11.4′S, 20°34.1′W). Holotype: ISH 46/85.

Diagnosis: D II+27–28; A 17; P 20–21; GR (2–3)+(11–14); ULL 21–27, ending under 19th–22nd dorsal-fin rays; MLL 9–14; vertebrae 36–37. Body depth 4.7–6.8 and head length 2.4–2.5 in SL. Orbit diameter 4.2–5.5 and interorbital width 6.0–6.6 in HL. Snout smoothly rounded anteriorly in dorsal view. Lower jaw

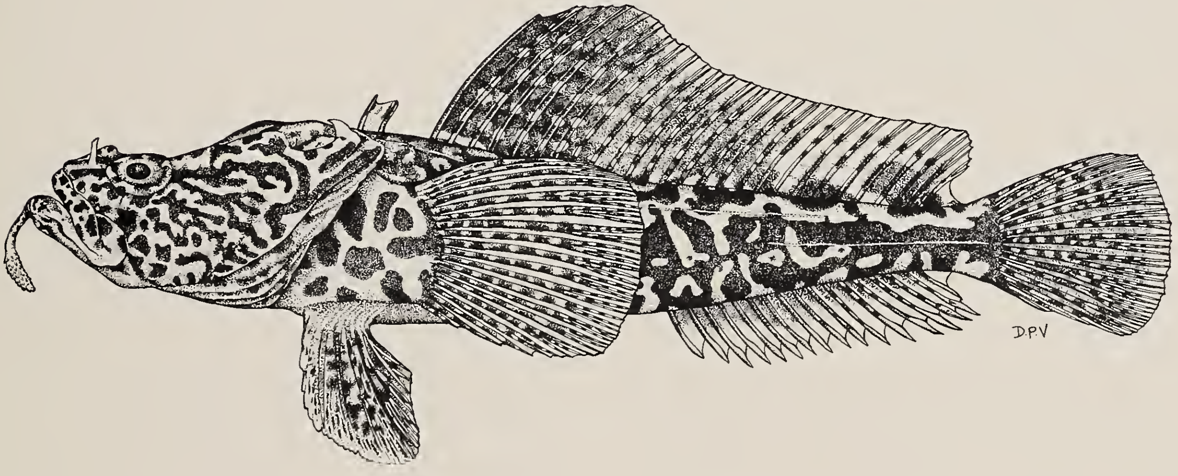
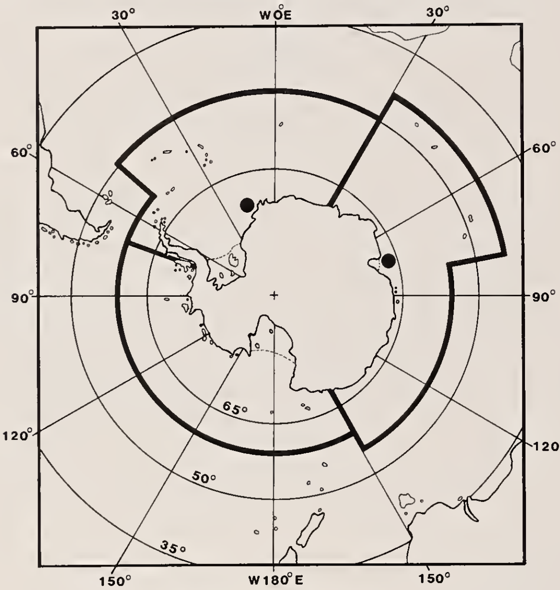


Fig. 38. *Pogonophryne ventrimaculata* ISH 115/85, 199 mm SL, paratype, Weddell Sea (72°53.1′S, 19°29.3′W)

projecting beyond upper; upper jaw often with 2 rows of teeth in smooth, arciform pattern, sometimes 1 row posteriorly; lower jaw with 1 row of teeth posteriorly, 2 rows near symphysis. Mental barbel thick 3.2–3.8 in HL; bushy terminal expansion about twice as wide as stalk, its length 50–66 % of barbel length, covered with densely packed, tapered processes which may be branched or unbranched.

Colour: In alcohol, head and body densely covered dorsally and laterally with very dark purplish-brown vermiculations (few spots) on yellowish-grey background. Ventral surface light with large, round, dark spots. All fins boldly marked with dark bands on rays. First dorsal fin with stripes and second dorsal fin with oblique stripes. Anal fin with oblique stripes basally, light distally (very faint in small specimen) and caudal fin with 7–9 vertical stripes. Pectoral fins with 4–10 vertical stripes and pelvic fins with 5–9 transverse stripes, light distally and laterally. Stalk of mental barbel mottled, terminal expansion light (yellowish).

Distribution: Known only from the Weddell Sea and East Antarctica (Prydz Bay) at depths of 247–460 m.



Distribution of *P. ventrimaculata*

Remarks: This species belongs to the group of *Pogonophryne* characterised by having dorsal spots and relatively high numbers of vertebrae and second dorsal-fin rays. It is the only species of the genus with conspicuous ventral spots.

Biology unknown. Attains 26 cm TL.

Pogonophryne sp. Eakin & Kock, 1984

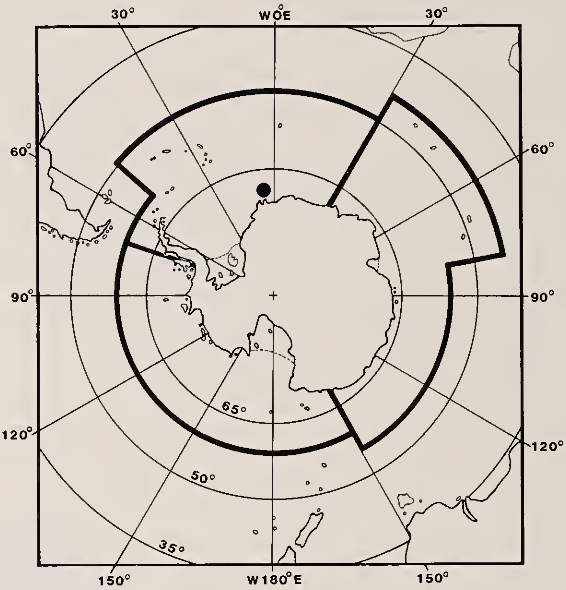
Pogonophryne sp. Eakin & Kock, 1984: 34, figs. 9–10, off Atka Iceport, Western Queen Maud Land (70°29.0′S, 7°16.5′W) ISH 233/81.

Pogonophryne sp. 3 Kock *et al.*, 1984: 107.

Diagnosis: Based on female specimen, 74.0 mm SL. D II+26; A 17; P 18–19; GR 2+14; ULL 17, ending under 12–13th dorsal-fin rays; MLL 18 (left); vertebrae 37. Body depth 4.9 and head length 2.4 in SL. Orbit diameter 3.6 and interorbital width 7.8 in HL. Snout smoothly rounded anteriorly in dorsal view, not constricted; Lower jaw projecting slightly beyond upper. Mental barbel 3.3 in HL; terminal expansion about 2.5 times as wide as stalk, its length 45% barbel length, the surface with convoluted ridges (as in *P. marmorata*).

Colour: In alcohol, head and body covered dorsally and laterally with rather sparsely distributed brown spots and vermiculations on yellowish background; markings smallest on top of head, becoming larger (elongate and irregular) on sides of head and body. Ventral surface light, unspotted. First dorsal fin light and second dorsal fin with oblique stripes. Anal fin light and caudal fin with 6 vertical stripes. Pectoral fins with 5 vertical stripes and pelvic fins with 4 transverse stripes; mental barbel light.

Distribution: Known only from a single specimen collected off Western Queen Maud Land at a depth of 340 m.



Distribution of *Pogonophryne* sp.

Remarks: This specimen appears to represent an undescribed species, exhibiting certain characteristics of *P. marmorata* (mental barbel structure, relatively low numbers of second dorsal-fin rays and pectoral fin rays, and slight development of the hollow orbit anterior to the eye), but lacking the distinctive constricted snout and jaws and the dark/light pattern of the caudal fin of that species. The tongue appears short, the tip not reaching the oral valve; there is no sign of damage, but the significance of this feature is not known.

Biology unknown. The specimen is 95 mm TL.

HARPAGIFERIDAE

Spiny plunderfishes

by J.-C. HUREAU

Body relatively short and compressed, without scales. Head large and wide. Usually 2 separate dorsal fins, the first with 2–5 flexible spines, often inserted over the base of the pectoral fin, the second with a long base and 18–26 soft-rays; in some individuals the 2 dorsal fins may be fused or separated only by a notch. Anal fin without spine and with 16–19 soft-rays. Pectoral fins large and fanlike, with 15–18 rays. Pelvic fins well developed, jugular, with 1 short and blunt spine and 5 branched rays. Caudal fin rounded, with 9–14 branched rays. Gill membranes broadly united to isthmus; branchiostegal rays 6. Mouth terminal, slightly oblique; maxilla reaching to below eye; upper jaw protractile. Jaws equal, bearing small, conical teeth in bands; no distinct canines; palatines and vomer toothless. A single nostril on each side of snout. No mental barbel. Opercle and subopercle with strong spines. Gill rakers (1–2)+(7–10), developed or reduced to a few rudimentary knobs near angle of arch. Body naked, except for lateral-line scales; 2 lateral lines. Vertebrae (11–13)+(22–25) = 34–37. Ribs well ossified. Swim-bladder absent. Second basibranchial bone cartilaginous (Iwami & Abe 1984) Uroneural separate from fifth hypural (Andersen 1984; Hureau 1986). Basisphenoid absent. Baudelot's ligament attached to first vertebra. Small extrascapular present. Upper pectoral radial articulated with both scapula and coracoid; lower 2 radials articulated with coracoid (Eakin 1981a).

Harpagiferids are small benthic fishes feeding on small crustaceans. Most species are littoral, but some occur to depths of 180 metres (Hureau *et al.* 1980). They grow slowly, maturing at about 75 mm TL and 3 to 5 years old (North & White 1987), and have rather high fecundity (70–100 eggs/g total weight) (Daniels 1983). Nesting and guarding of eggs have been observed (Daniels 1978, 1979; Kock 1985).

Harpagiferids are generally restricted to sub-Antarctic islands, but 1 species is found along the Antarctic Peninsula and another occurs at the southern tip of South America. Although of no commercial importance, harpagiferids play an important ecological role as frequent prey for higher predators (other fish and birds).

One genus with 6 species in the Southern Hemisphere. The 6 species are closely related and sometimes difficult to distinguish from each other. Fin ray counts and body proportions do not help in species identification. Taxonomic revisions were done by Norman (1938), Nybelin (1947), Hureau *et al.* (1980), and Hureau (1985e).

The terminology of the cephalic sensory canals is explained in the family Nototheniidae above.

Genus *Harpagifer* Richardson, 1844

Head broader than deep. Snout about as long as eye. Interorbital region of moderate width. Upper lateral line short, with 11–24 tubular scales and 0–8 perforated scales; middle lateral line with 17–26 perforated scales. Pores of cephalic sensory canals: preopercular-mandibular 10, supraorbital 4, temporal 5, supratemporal 3, and a single coronal pore; 0–2 knobs on supraorbital ridge.

KEY TO SPECIES

1a No spine or knob on supraorbital ridge; some specimens with a slight swelling above rear part of orbit (Fig.1a); opercular spine with 2 equal, short branches (Fig. 2a); ULL 14–17 tubular scales .... *H. bispinis*

1b One or 2 knobs or spines above each orbit; opercular spine with 2 unequal branches; ULL 15–24 tubular scales 2

2a Supraorbital ridge with 1 knob bearing a simple fleshy tentacle in juveniles and a multilobed tentacle in adults (Fig. 1b); cephalic pores at the end of raised tubes (Fig. 3) .... *H. palliolatus*

2b Supraorbital ridge with 2 knobs or well-developed spines; tentacle absent; cephalic pores simple, not at the end of raised tubes 3

3a Posterior knob of supraorbital ridge developed as a spine (Fig. 1c); opercular spine bifid, the posterior branch acute and much longer than medial branch (Fig. 2c); anterior dorsal spines smooth, without verrucae (Fig. 4a) ......*H. spinosus*

3b Posterior knob of supraorbital ridge not developed as a spine but often bigger than anterior one; opercular spine bifid but not as above; anterior dorsal spines with verrucae (Fig. 4b). 4

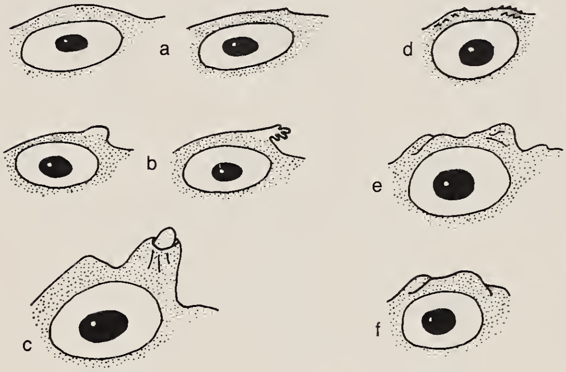


Fig. 1. Lateral view of the left eye showing types of the supraorbital thickening in species of *Harpagifer*. (a) *bispinis*; (b) *palliolatus*; (c) *spinosus*; (d) *kerguelensis*; (e) *antarcticus*; and (f) *georgianus*.

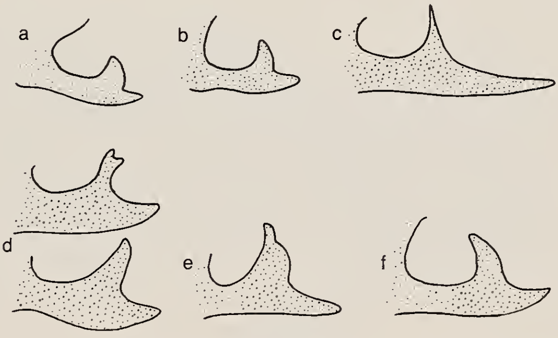


Fig. 2. Dorso-lateral view of the left opercular spine in species of *Harpagifer*. (a) *bispinis*; (b) *palliolatus*; (c) *spinosus*; (d) *kerguelensis*; (e) *antarcticus*; and (f) *georgianus*.

4a Supraorbital knobs rather low and granulated (Fig. 1d); posterior branch of opercular spine not longer than medial branch (Fig. 2d) . . . . *H. kerguelensis*

4b Supraorbital knobs distinct (Figs. 1e & f); posterior branch of opercular spine longer than medial branch (Figs. 2e & f) 5

5a Posterior supraorbital knob larger (higher) than anterior one (Fig. 1e); head rather short 31–41% SL . . . . . . *H. antarcticus*

5b Both supraorbital knobs low, but the anterior one more elongate (Fig. 1f); head rather long 35–43% SL . . . . *H. georgianus*

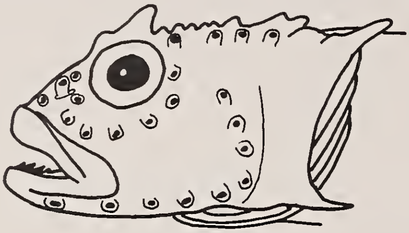


Fig. 3. Lateral view of the head of *H. palliolatus*.

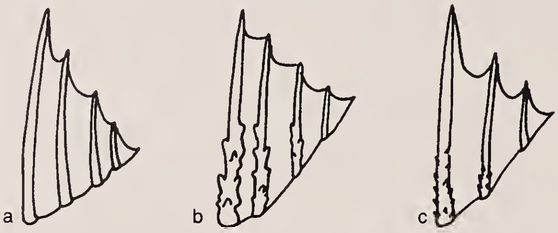


Fig. 4. Different aspects of the first dorsal-fin spines in species of *Harpagifer*. (a) smooth spines; (b) spines with knobs or verrucae; and (c) spines with tiny spinules.

Harpagifer antarcticus Nybelin, 1947
Antarctic spiny plunderfish
Fig. 5

Harpagifer bispinis antarcticus Nybelin, 1947: 42, pl. IV, figs. 5–8, Port Lockroy, Wiencke Island, Antarctic Peninsula; and Candlemas Island, South Sandwich Islands. Syntypes: ZMUO and GNM.

Diagnosis: D 0-V/21–25; A 16–19; P 15–18; GR 2+8; ULL 17–22 tubular scales; vertebrae (11–13)+(22–25). Body depth 21–23.5%, head length 31–41%, interorbital width 7–8.5%, predorsal distance 31–34%, and preanal distance 54–55% SL. Supraorbital ridge with 2 low knobs (Fig. 1e), posterior one more developed than anterior one. Opercular spine bifid, medial branch shorter than posterior branch and slightly curved forward (Fig. 2e). Proximal half of first dorsal spine with some rounded lateral knobs or verrucae (Fig. 4b).

Colour: In alcohol, variable, dark to black with irregular markings on sides of body. Pectoral and caudal fins crossed by black stripes. Live specimens often have areas of pink pigment matching the colour of coraline algae; on the other hand, some fish can be nearly white (M.G. White, BAS, pers. comm.)

Otoliths

Diagnostic features: The oval to fusiform shape, the clearly separated ostium and cauda and the bulbous central portion of the crista inferior.

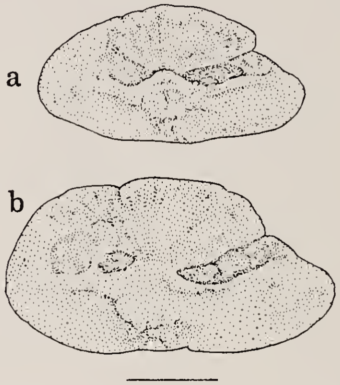


Fig. 6. Representative otoliths of *H. antarcticus*; fish lengths: (a) 84 mm and (b) 118 mm TL; scale bar 1 mm

Distribution: Atlantic sector of Southern Ocean along the coasts of Antarctic Peninsula, South Shetland, South Orkney and South Sandwich islands. Depth range 0–5 m.

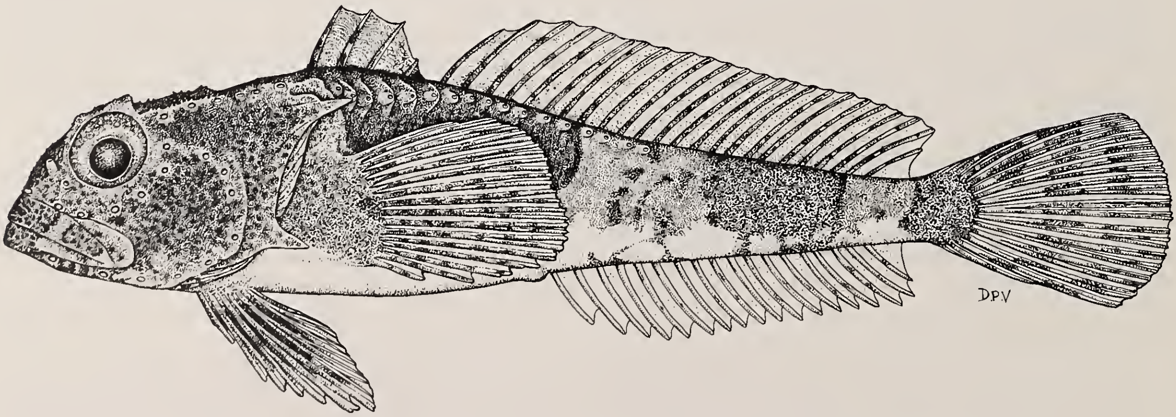
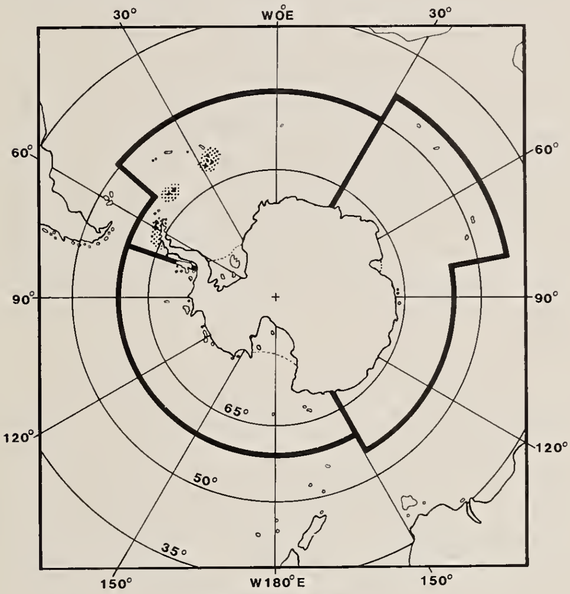


Fig. 5. *Harpagifer antarcticus* MNHN uncatalogued, 76.0 mm SL, South Orkney Islands

Remarks: *Harpagifer antarcticus* is a coastal fish, living in shallow waters on rocky bottoms. Demographic characteristics of this species were studied by Daniels (1983). It is a slow-growing species, with annual growth increments for both sexes between 4–10 mm. Maximum age is 9 years for a fish of 95 mm SL (Daniels 1983). In addition to slow growth, long life and high survivorship, *H. antarcticus* is iteroparous and devotes a great deal of time to parental care (Daniels 1978, 1979). It is also a specialized feeder; according to Duarte & Moreno (1981) 75% of the fish they studied fed on amphipods, mainly *Gondogeneia antarctica*. The selection for *G. antarctica* may be attributed to its active swimming behaviour and to the fact that *H. antarcticus* is an ambush hunter. *H. antarcticus* prefers shallow water and rubble bottom habitats in cobble substrate coves; it is usually found only under rocks and rarely under algal fronds (Daniels & Lipps 1982). At Signy Island, larvae (5–8 mm) were observed in open water; older ones apparently live on sandy bottoms (M.G. White, BAS, pers. comm.)

Attains 95 mm SL.



Distribution of *H. antarcticus*

Harpagifer bispinis (Schneider, 1801)

Magellanic spiny plunderfish

Fig. 7

Batrachus bispinis Schneider in Bloch & Schneider, 1801: 45, "Mare terram del fuego". Holotype: ZMB?

Harpagifer bispinis: Richardson, 1844b: 11, pl. VII, figs. 1–3.

Diagnosis: D III-IV/18–25; A 16–18; P 15–16; GR 2+8; ULL 14–17 tubular scales; vertebrae (11–13)+(22–25). Body depth 18–24%, head length 31–40%, interorbital width 5–7%, predorsal distance 31–36%, and preanal distance 52–57% SL. Top of head smooth except for a small swelling above rear edge of eye in some specimens (Fig. 1a). Opercular spine bifid, both branches short and rounded, not acute (Fig. 2a). First dorsal spine without verrucae, but smooth or with numerous tiny spinules (Fig. 4c).

COLOUR: In alcohol, variable, usually with dark blotches or irregular cross-bars. Dorsal, pectoral and caudal fins mostly with small dark spots, often united to form narrow bars.

Otoliths

DIAGNOSTIC FEATURES: The oval to ovate shape, the clearly separated ostium and cauda, the bulbous central portion of the crista inferior and the well-developed anterior colliculum.

Intraspecific variation: Negligible, except for sculpture of dorsal margin.

Fig. 8. Representative otolith of *H. bispinis*; fish length 86 mm TL; scale bar 1 mm

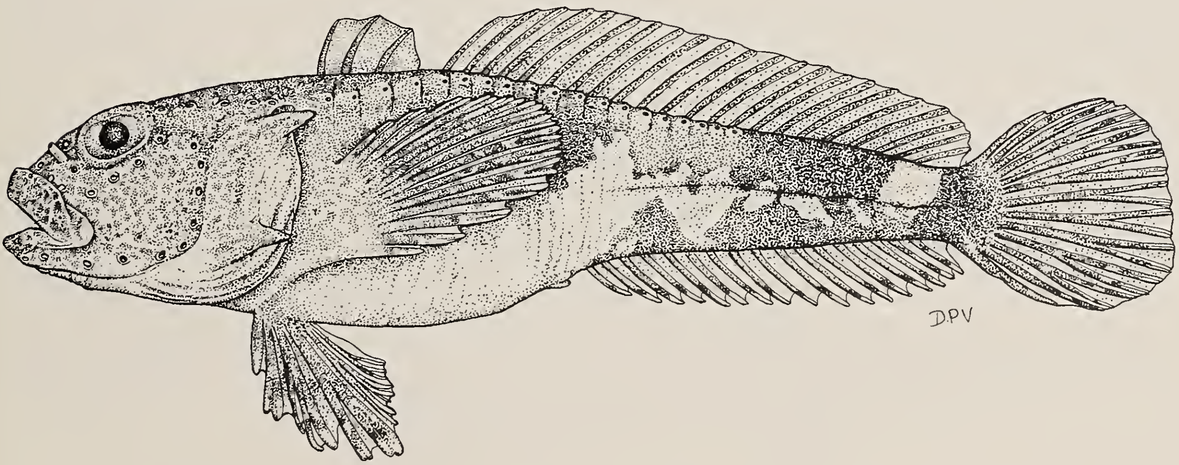
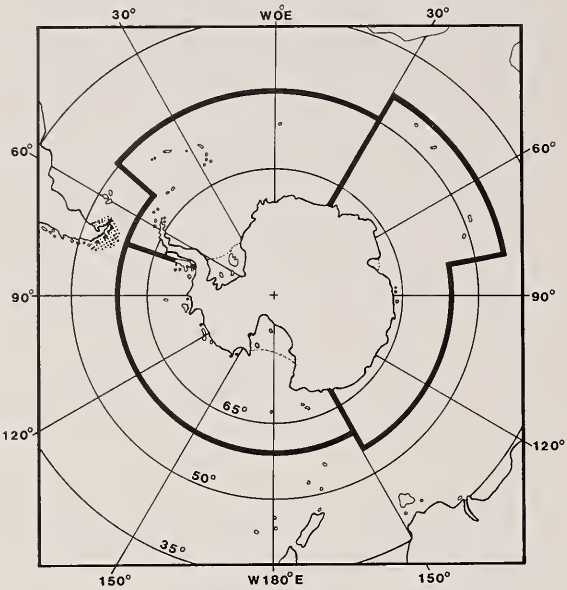


Fig. 7. *Harpagifer bispinis* BMNH 1936.8.26.916, 57.0 mm SL, female, Tierra del Fuego

Distribution: Along the coasts of Straits of Magellan, south of Chile and Argentina, Patagonian Region and Staten Island. Mainly in shallow, inshore waters, but may be found as deep as 40–50 m.



Distribution of *H. bispinis*

Remarks: Like most of the Harpagiferidae, *H. bispinis* is mainly a littoral species, occurring in tide pools, under rocks and among the kelp.

Biology unknown. Attains about 70 mm SL.

Harpagifer georgianus Nybelin, 1947
South Georgia spiny plunderfish
Fig. 9

Harpagifer bispinis georgianus Nybelin, 1947: 39, pl. IV, figs. 1–4, South Georgia, Cumberland Bay. Syntypes: GNM.

Harpagifer marionensis Nybelin, 1947: 72, Marion Island.

Harpagifer georgianus georgianus: Hureau *et al.*, 1980: 298; Hureau, 1985e: 283.

Diagnosis: D III-V/22–25; A 16–19; P 15–18; GR 2+8; ULL 15–23 tubular scales; vertebrae (11–13)+(22–25). Body depth 18–24%, head length 35–43%, interorbital width 6–8% (10–12 in specimens smaller than 40 mm SL), predorsal distance 30–37%, and preanal distance 48–59% SL. Supraorbital ridge with 2 knobs or swellings (Fig. 1f), the anterior swelling often more elongate, the posterior one rounded, knob-like. Opercular spine bifid (Fig. 2f), the branches subequal, relatively short and acute; medial branch slightly curved forwards. Upper part of head covered with verrucae. First and second dorsal spines bearing rounded knobs or verrucae (Fig. 4b).

Colour: In life, variable, greyish-black with irregular blotches or cross-bars. Creamy or pale and without cross-bars at Macquarie Island. At Marion Island, some specimens had red mottling on the body and pale ochre undersurfaces (Blankley 1982).

Otoliths

Diagnostic features: The fusiform shape with a distinct notch in the posterodorsal margin, the ostial and heterosulcoid sulcus acusticus, the near equal sized ostium and cauda which are distinctly separated from each other, the heteromorph colliculi, the V-shaped crista superior, and the prominent distally rounded rostrum.

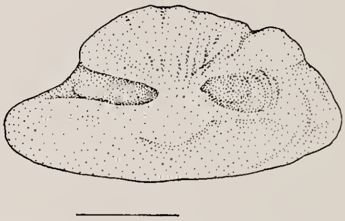


Fig. 10. Representative otolith of *H. georgianus*; fish length unknown; scale bar 1 mm

Distribution: Along the coasts of South Georgia, Prince Edward Islands, and Macquarie Island. Mainly a littoral species, *H. georgianus* also occurs down to 40 m around South Georgia and in 90 m at Macquarie Island.

Remarks: Nybelin (1947) proposed the name *marionensis* for the specimens from Marion Island, but the shapes of the supraorbital knobs and of the opercular spine place them very close to *H. georgianus*. I examined 2 different sets of specimens from Macquarie Island, one caught in the littoral zone by hand and the other caught with a trawl in 36 and 90 metres. From the characteristics of these specimens, I am inclined to consider both lots as *H. georgianus*.

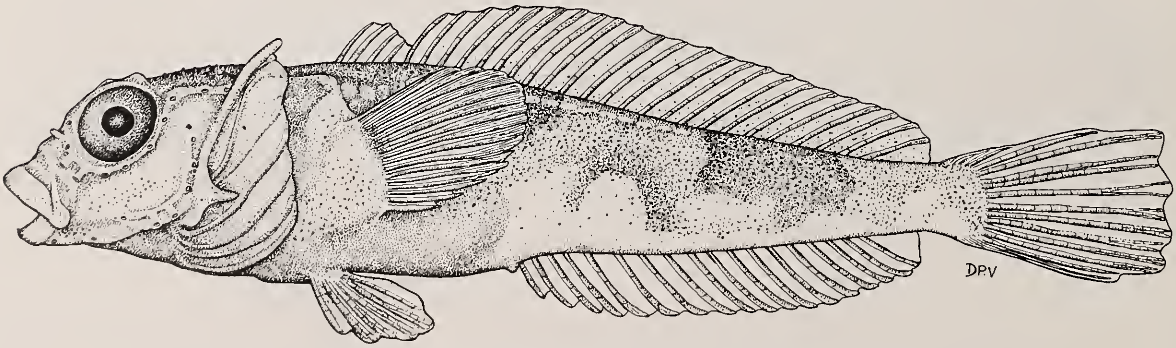
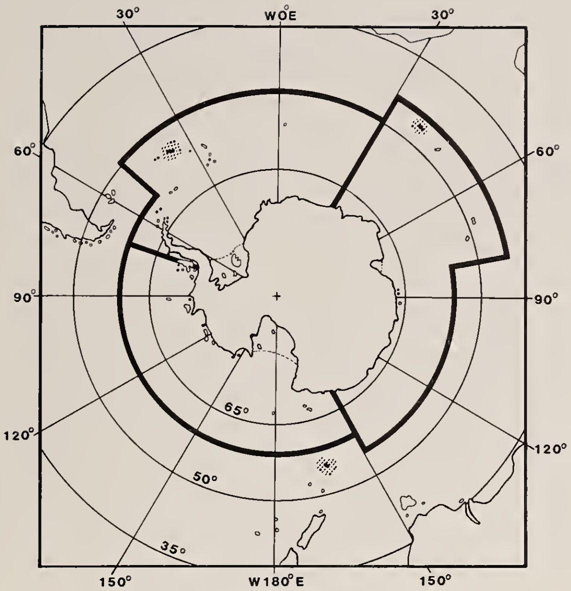


Fig. 9. *Harpagifer georgianus* RUSI 26288, 30.8 mm SL, Marion Island



Distribution of *H. georgianus*

In a study of this species at Marion Island, Blankley (1982) found it abundant in the intertidal zone; fishes were observed spending most the time lying motionless on the bottom; they were usually single individuals, but infrequently up to 3 fishes were seen at close proximity to each other; amphipods, isopods and polychaetes formed the bulk of the diet, with amphipods being the major prey item (76.8%).

Attains over 70 mm SL.

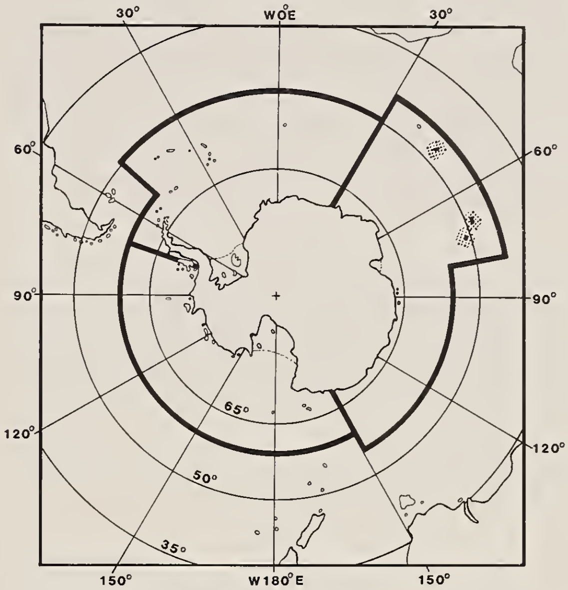
Harpagifer kerguelensis Nybelin, 1947
Kerguelen spiny plunderfish
Fig. 11

Harpagifer bispinis kerguelensis Nybelin, 1947: 42, pl. V, figs. 1–2, Kerguelen Islands. Apparently no types were designated; study material not mentioned in original description which is probably based on Norman (1938).

Diagnosis: D III-IV/22–23; A 17–18; P 15–17; GR 2+8; ULL 20–24 tubular scales; vertebrae (11–13)+(22–25). Depth of body 18–20%, head length 36–43%, interorbital width 5–10%, predorsal distance 32–39%, and preanal distance 47–60% SL. Supraorbital ridge with 2 low knobs or swellings (Fig. 1d), often lightly granulated, the anterior one elongate. Opercular spine bifid (Fig. 2d), the posterior branch shorter than medial branch, which sometimes is also bifid. Upper part of head, dorsal spines and anterior soft-rays of dorsal fin covered with rounded knobs or verrucae (Fig. 4b), especially in large adults.

Colour: In life, variable, greyish-black with irregular blotches or cross-bars; sometimes large pink areas on body and head.

Distribution: Littoral waters of Kerguelen and Crozet Islands; littoral and deeper waters of Heard Island, down to 80 m.



Distribution of *H. kerguelensis*

Remarks: This species is found under rocks on the beaches or in tide-pools, but it may also live down to a few metres depth within the kelp and other algae. *H. kerguelensis* is distinct from *H. spinosus,* which also occurs at the Kerguelen and Crozet Islands, but in deeper water (below 80 m).

Biology unknown. Attains over 60 mm SL.

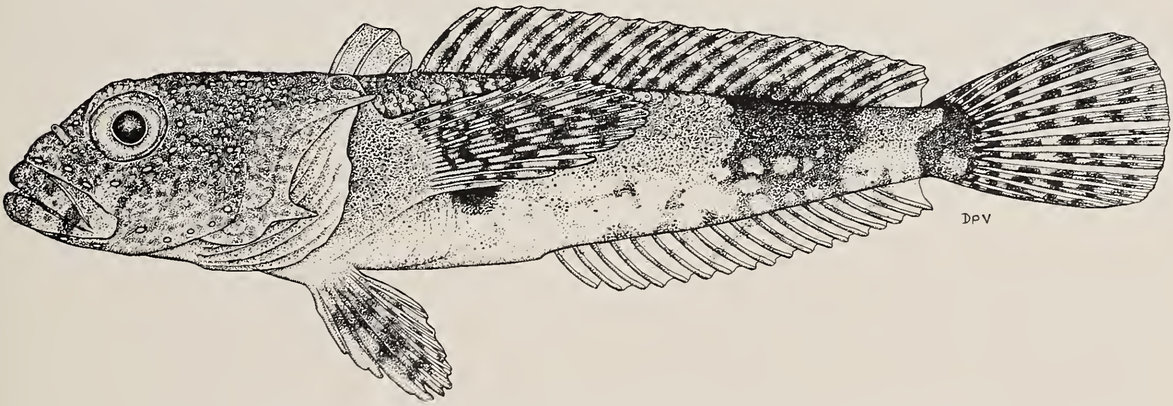


Fig. 11. *Harpagifer kerguelensis* MNHN 1985–556, 47.0 mm SL, Kerguelen Islands

Harpagifer palliolatus Richardson, 1845
Crested spiny plunderfish
Fig. 12

Harpagifer palliolatus Richardson, 1845: 20, pl. XII, figs. 5–7, Falkland Islands. Holotype: BMNH uncatalogued.

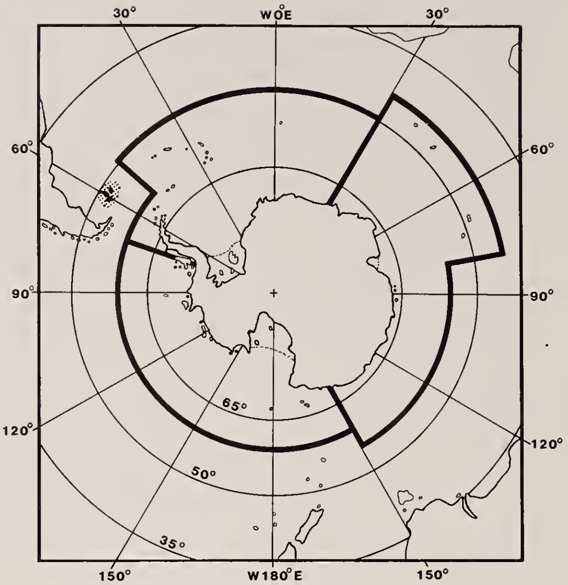
Harpagifer bispinis palliolatus: Nybelin, 1947: 39, pl. III, figs. 5–12.

Harpagifer georgianus palliolatus: Hureau *et al.*, 1980: 298–305, fig. 6; Hureau 1985e: 283, fig. 1.

Diagnosis: D II-V/21–25; A 16–19; P 15–17; GR 2+8; ULL 11–17 tubular scales; vertebrae (11–13)+(22–25). Body depth about 22%, head length 36–38%, interorbital width 7.5–10%, predorsal distance 32.5–35%, and preanal distance 53–59% SL. A single knob above rear part of eye (Fig. 1b), ending in a fleshy tentacle or, in half-grown and adult specimens, a mutilobed flap. Cephalic pores, especially on preopercle, at end of raised tubes. Opercular spine bifid (Fig. 2b), its branches short and rounded. First dorsal spine smooth, without any rounded knobs but sometimes with numerous tiny spinules (Fig. 4c).

Colour: In life, variable, greyish-black or brilliant orange on body and anal fin, with dark blotches or irregular cross-bars; dorsal, pectoral and caudal fins mostly with dark spots, often forming narrow bars; sometimes 1 whitish streak from symphysis of upper jaw across middle of head and back to caudal peduncle; maxilla white.

Distribution: This species is endemic to the Falkland Islands. Common in the littoral zone, under rocks, but may be found as deep as 40–50 m.



Distribution of *H. palliolatus*

Remarks: *Harpagifer palliolatus,* described by Richardson in 1845, was considered a subspecies of *H. bispinis* by Nybelin (1947: 39) or of *H. georgianus* by Hureau (1985e). This taxon is given full species recognition here because of the presence of tubular cephalic pores and a single knob bearing a tentacle above each eye (all the other species have either 2 knobs or none on the supraorbital crest, and no species has a tentacle above the eye).

Biology unknown. Attains over 70 mm SL.

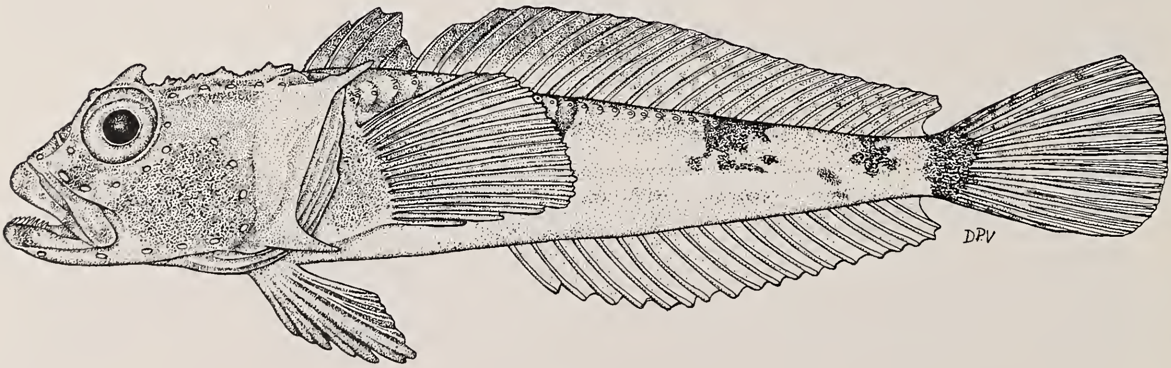


Fig. 12. *Harpagifer palliolatus* MNHN uncatalogued, 72.0 mm SL, Beauchéne Island, Falkland Islands

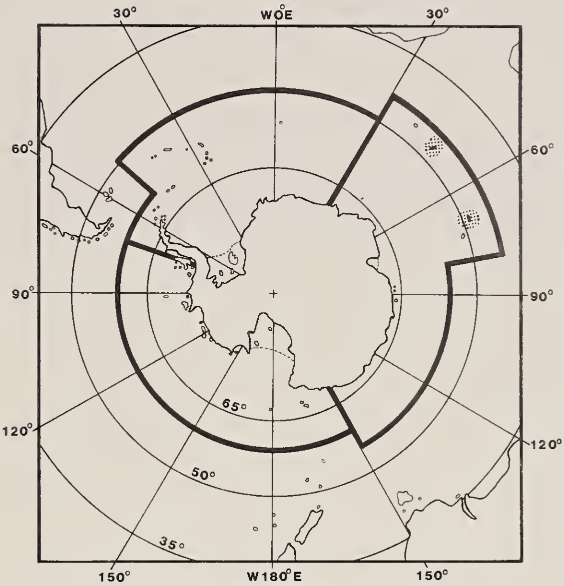
Harpagifer spinosus Hureau, Louis, Tomo & Ozouf, 1980
Deep-water spiny plunderfish
Fig. 13

Harpagifer spinosus Hureau, Louis, Tomo & Ozouf, 1980: 301, fig. 9, Crozet Islands, Chenal des Orques (46° 24′S—51° 59′E). Holotype: MNHN 1977–0571.

Diagnosis: D III-IV/23–24; A 17–19; P 15–18; GR 2+(7–10); ULL 16–24 tubular scales; vertebrae (11–12)+(24–25). Body depth 15–19%, head length 30–44%, interorbital width 6.6–9.0%, predorsal distance 30–35%, and preanal distance 50–56% SL. Supraorbital ridge with 2 distinct knobs (Fig. 1c), the posterior one developed into a long spine. Opercular spine bifid (Fig. 2c), both branches acute, posterior one much longer than medial one. A ridge with 4–5 spines on top of head behind each eye; last spine on each ridge directed medially. No verrucae on head or dorsal-fin spines.

Colour: In alcohol, variable, blackish with irregular blotches. Fins with small dark spots, often forming cross-bars; first dorsal fin black.

Distribution: Deep water (80–180 m) around Crozet and Kerguelen Islands.



Distribution of *H. spinosus*

Remarks: *Harpagifer spinosus* is a distinctive species, living at the same Islands as *H. kerguelensis* but in deeper water. It has not been found around Heard Island; several specimens caught in 62–80 m off the south-west coast of the island were clearly *H. kerguelensis*.

Biology unknown. Attains over 80 mm SL.

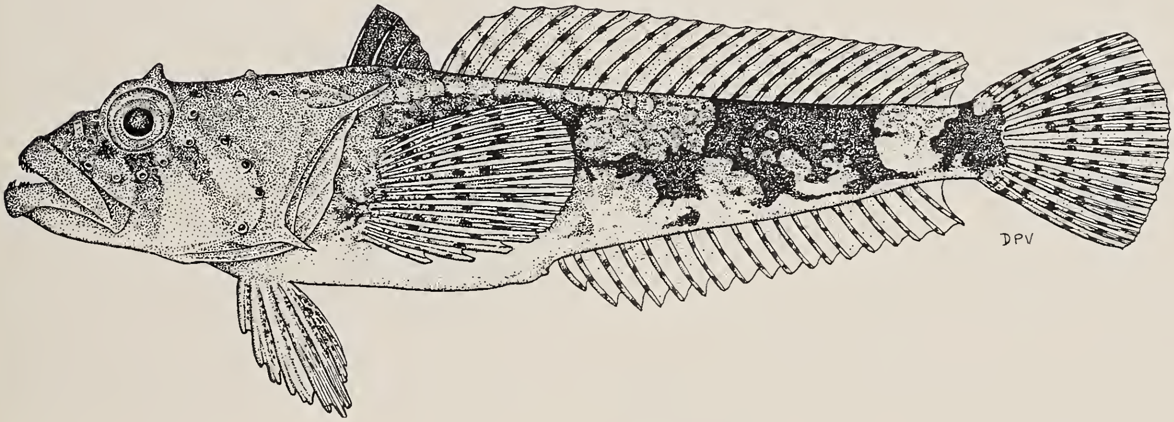


Fig. 13. *Harpagifer spinosus* MNHN 1977–0571, holotype, 68.2 mm TL

BATHYDRACONIDAE

Dragonfishes

by O. GON

Body long, slender to robust, subcylindrical or somewhat depressed anteriorly and compressed posteriorly. A single long-based dorsal fin without spines; anal fin usually shorter than dorsal fin, also without spines; pectoral fins well developed; pelvic fins with 1 spine and 5 branched rays, their origin anterior to pectorals. Head moderate to large, depressed in some species. Snout long and spatulate to slightly depressed, short and pointed. Mouth large, maxilla not reaching beyond level of centre of eye; premaxillary ascending process short; jaws usually with small, conical teeth and sometimes canines; palatines without teeth; vomer also edentate (except in *Vomeridens*). A single external nostril; internal nares present in *Gymnodraco* and *Psilodraco* (H.H. DeWitt pers. comm.) Opercle unarmed or bearing a hooked or spinous process directed posteriorly. Branchiostegal membranes united and attached to isthmus; branchiostegal rays 6–8. Body with scales (usually ctenoid), bony plates or naked; 1, 2, 3 or 5 lateral lines, of tubular, perforated or imperforated scales; lateral lines sometimes connected to each other (Fig. 1). Swim-bladder absent. Vertebrae 45–79. A pair of small bones attached to the anterolateral region of the ethmoid cartilage are unique to bathydraconid fishes (Iwami 1985). No basisphenoid. Cartilage between epihyal and ceratohyal I-shaped. First basibranchial ossified, second basibranchial cartilaginous.

Ten genera and 15 species of small benthic fishes endemic to the Southern Ocean. Most species are found over the Antarctic continental shelf and slope, but some are known from Antarctic and sub-Antarctic Islands. Bathydraconids occur from shallow, inshore waters down to about 3,000 m. No commercial value.

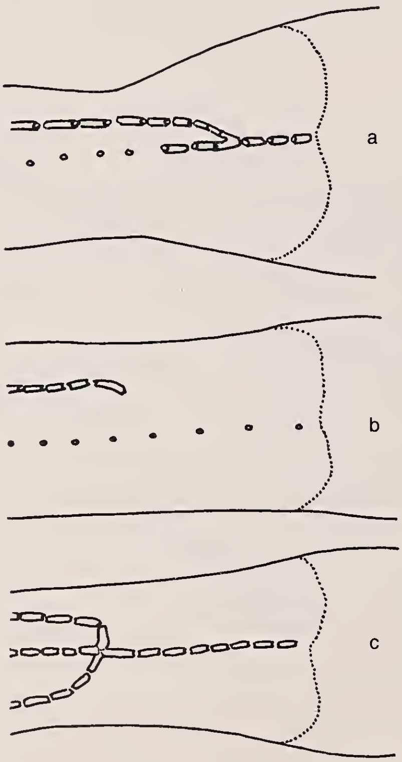


Fig. 1. The posterior end of the lateral lines of some Bathydraconidae: (a) *Parachaenichthys georgianus*; (b) *P. charcoti*; and (c) *Racovitzia glacialis*

Taxonomic revisions were done by Regan (1913) and Norman (1938). DeWitt & Hureau (1979) did a brief generic revision. Limited osteological studies, mainly in relation to other notothenioid families, were carried out by Eakin (1981a) and Iwami (1985).

The terminology of head sensory canals is explained in the family Nototheniidae above. GRA refers to the outer, or lateral, gill rakers of the first gill arch. GRP refers to the inner, or mesial, gill rakers of the first gill arch.

KEY TO GENERA

1a Body covered with normal cycloid or ctenoid scales; 1–3 LL 2
1b Body naked, except for LL scales; 2 or 5 LL 6
1c Body quadrangular, with a dorsal and ventral series of serrated bony plates on each side; a single LL .... *Prionodraco*
2a A single LL of tubular scales extending from angle of opercle, along mid-body or slightly above it, at least to rear third of body .... *Bathydraco*
2b Two or 3 LL of tubular and/or perforated scales (sometimes embedded in skin, or obscured by mucus in preserved fish) 3
3a ULL with less than 10 tubular scales; MLL of perforated scales only, extending from C base to tip of P fin; cephalic coronal pore absent .... *Akarotaxis*
3b ULL with more than 20 tubular scales; MLL, if present, with tubular scales; coronal pore present 4
4a MLL absent; LLL close above A base, its length variable; more than 40 D rays .... *Gerlachea*
4b MLL present; LLL present or absent; 31–37 D rays 5
5a P 29–32; LLL absent; teeth usually present on vomer in specimens larger than 10 cm SL .... *Vomeridens*
5b P 24–25; LLL usually present on specimens greater than 11 cm SL; no teeth on vomer .... *Racovitzia*
6a Canine teeth present on upper or both jaws; snout pointed and sometimes depressed; opercle with a strong ridge ending in a hooked process which sometimes has 1–2 spiny points 7
6b Canine teeth absent; snout long and spatulate; opercle with a strong, flat ridge splitting to a number of subridges ending in spiny points 8
7a Snout about as long as eye diameter, and not noticeably depressed; 5 LL of imperforated scales .... *Psilodraco*
7b Snout about twice eye diameter and depressed; 2 LL, the upper with tubular scales .... *Gymnodraco*
8a D 61–66; ULL ending under rear half of D fin .... *Cygnodraco*
8b D 42–46; ULL extending beyond last D ray .... *Parachaenichthys*

Genus *Akarotaxis* DeWitt & Hureau, 1979

Body covered with ctenoid scales. Two lateral lines. Posterodorsal end of opercle with a small hook. Gill rakers well-developed. Jaws with small, conical teeth in bands. Branchiostegal rays 6. Monotypic, rare.

Akarotaxis nudiceps (Waite, 1916)

Fig. 2

Bathydraco nudiceps Waite, 1916: 27, pl. 1, fig. 3, off Shackleton Ice Shelf (65°20′S, 95°27′E). Holotype: SAMA F369.

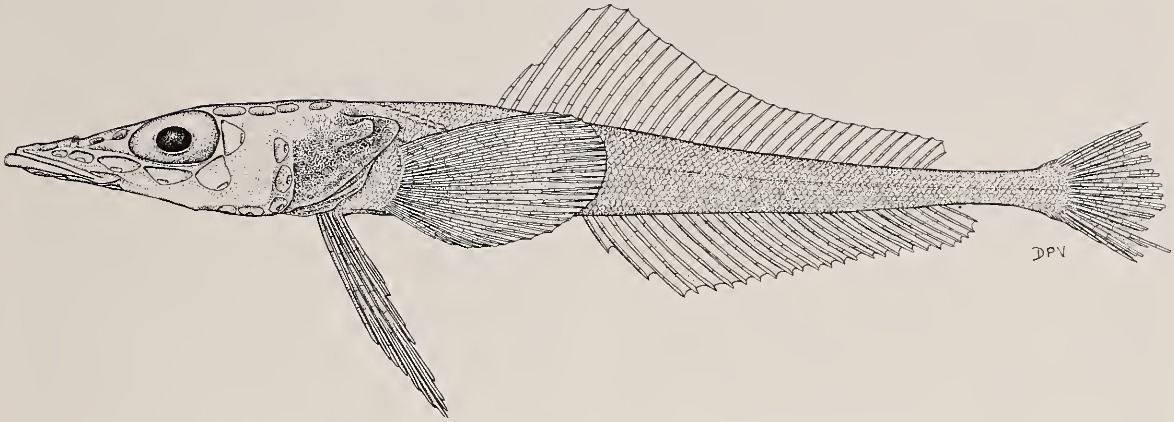


Fig. 2. *Akarotaxis nudiceps* ISH 134/80, 112.9 mm SL (75°47′S, 53°33′W)

Bathydraco wohlschlagi DeWitt & Tyler, 1960: 175, figs. 2–4, south-west Ross Sea.

Diagnosis: D 29–33; A 25–28; P 22–24; GRA (7–9)+(15–21); GRP (3–4)+(13–19); ULL 3–9 tubular scales; vertebrae (16–17)+(31–33). Body depth at pectoral fin base 6.7–9.9, body depth at anal-fin origin 9.3–11.5 and head length 2.8–3.1 in SL. Snout length 3.0–3.2, eye diameter 3.5–3.9, interorbital width 10.9–13.9 and upper jaw length 2.6–3.0 in HL. Head depth at preopercle ridge 2.5–3.3 and head width 2.0–2.8 in HL. Distances from snout to dorsal-fin origin 2.1–2.4, to pelvic-fin insertion 3.1–3.4, and to anal-fin origin 1.8–2.0 in SL. Scales mostly ctenoid. Upper lateral line with tubular scales anteriorly, followed by perforated scales. Middle lateral line of perforated scales only. Cephalic sensory canals greatly enlarged, pores arranged as follows: preopercular-mandibular 8–9; infraorbital 7; supraorbital 3–4; temporal 3–5; supratemporal 0–3. Supratemporal canal complete across head. Supraorbital canals joined through a large coronal space; coronal pore absent. Anteriormost infraorbital pore in front of nostril.

Colour: In alcohol, body brown with darker head. Opercle dark brown. Dorsal fin pale, other fins dusky. Mouth cavity pale to dusky, gill chamber dark brown.

Otoliths

Diagnostic features: The generally triangular shape with the squared-off and indented dorsal margin, the well-developed cristae and the presence of the dorsal and ventral areas.

Intraspecific variation: Otolith shape, sculpture of margin and the development of the crista superior are variable.

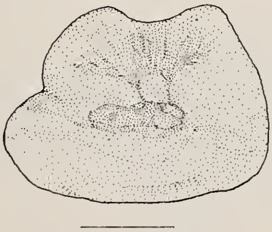
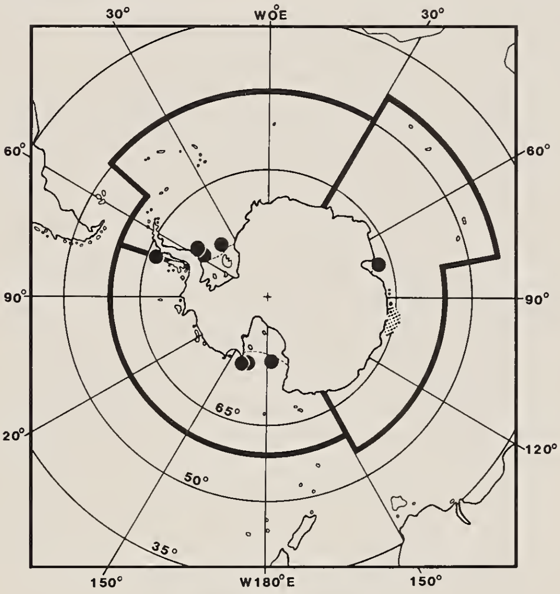


Fig. 3. Representative otolith of *A. nudiceps*; fish length 128 mm SL; scale bar 1 mm

Distribution: Antarctic continental shelf and west of Adelaide Island at the Antarctic Peninsula. Depth range 371–915 m.



Distribution of *A. nudiceps*

Remarks: *B. wohlschlagi* was recognised as a junior synonym of *B. nudiceps* by DeWitt (1971). The morphological similarity of *A. nudiceps* to species of *Bathydraco*, *Racovitzia* and *Vomeridens* requires caution in identifying these species. The short tubular section of the upper lateral line and the absence of the coronal pore distinguishes *A. nudiceps* from all other bathydraconid species. Variation exists in the number of pores of the cepahlic sensory canals. The holotype has no pores in the supratemporal canal and only 3 pores in the supraorbital and temporal canals (DeWitt & Hureau 1979). DeWitt & Tyler (1960) found no pores in the temporal and supratemporal canals and 3 pores in the supraorbital canal. Judging from the 6 specimens examined for this study, the prevailing pore numbers for these canals probably are: 4 supraorbital; 5 temporal; and 3 supratemporal.

Biology unknown, but a 115 mm female collected in mid-January had stage V ovaries with eggs of about 2.3 mm in diameter (in preservative). Spawning may take place during middle to late summer.

Attains 130 mm SL.

Genus *Bathydraco* Günther, 1878

Body long and slender. Snout long and spatulate; interorbital space narrow. Mouth large; jaws with bands of small, conical teeth; no teeth on vomer and palatines. Cephalic sensory canals enlarged, with pores arranged as follows: preopercular-mandibular 9, infraorbital 7, supraorbital 3–4, temporal 5–6, supratemporal 3; supraorbital canals connected to each other; coronal pore present. Scales mostly ctenoid, but cycloid scales may be present at base of caudal and/or pectoral fins as well as between pelvic-fin bases and on anterior end of isthmus. A single lateral line of tubular scales, at about mid-body level. No spines or hooked process on opercle. Gill membranes united, joined to isthmus anteriorly and forming a narrow fold over it; branchiostegal rays 6–8 (usually 7). Five species of small fishes, inhabiting deep water from 500—2,600 m.

No information exists on the the biology of *Bathydraco* species. Recent taxonomic review by DeWitt (1985).

KEY TO SPECIES

1a GRA on lower limb of first gill arch 20–24; total GRA 27–33; tubular LL scales 37–45; LL ends under posterior third of D base.. *B. scotiae*

1b GRA on lower limb of first gill arch 9–19; total GRA 15–26; tubular LL scales 51–67; LL ends at C base 2

2a Head length 2.7–3.0 in SL; A 28–30; opercle mostly naked, scales restricted only to uppermost part of bone .... *B. macrolepis*

2b Head length 2.9–3.6 in SL; A 30–34; at least upper half of opercle covered with scales 3

3a Scales restricted to upper half of opercle; total GR (anterior + posterior series) on lower limb of first arch 25–34; body pale brown without any distinct markings (sometimes indistinct blotches present anteriorly above LL in *B. antarcticus)* 4

3b Scales cover most of opercle surface; total GR (anterior + posterior series) on lower limb of first arch 20–28; distinct dark bars and blotches present on body and sometimes on head .... *B. marri*

4a Eyes bulging prominently into dorsal profile of head; distance from tip of snout to D origin 36.8–43.8% SL; A origin at about midbody level ....*B. antarcticus*

4b Eyes hardly bulging into dorsal profile of head which is nearly straight; distance from tip of snout to D origin 33.8–40.7% SL; A origin in advance of midbody level...........*B. joannae*

Bathydraco antarcticus Günther, 1878

Fig. 4

Bathydraco antarcticus Günther, 1878: 18, south of Heard Island (60°52′S, 80°20′E). Holotype: BMNH 1887.12.7.13.

Diagnosis: D 34–39; A 31–33; P 21–23; GRA (3–7)+(11–19); GRP (2–4)+(11–15); LL 56–65; vertebrae (17–18)+(34–35)=51–53. Body depth at pectoral fin base 8.6–11.9, body depth at anal-fin origin 10.3–13.1 and head length 2.9–3.6 in SL. Snout length 2.9–3.4, eye diameter 3.7–4.5, interorbital width 13.5–17.9 and upper jaw length 2.6–3.3 in HL. Head depth at level of preopercle edge 3.0–3.5 and head width 2.0–2.7 in HL. Distances from snout to dorsal-fin origin 2.4–2.7, to pelvic-fin insertion 3.5–4.2 and to anal-fin origin (SnA) 1.9–2.1 in SL. Eyes bulging prominently into dorsal profile of head. Scales on opercle restricted to upper half.

Colour: In alcohol, body and head pale brown. Indistinct dusky markings sometimes present above lateral line from pectoral fin base and may reach posteriorly as far as end of dorsal-fin base. Nostrils dark. Lining of mouth cavity and gill chamber dark, showing through operculum and branchiostegal membranes. Anterior third of dorsal fin dark brown. Distal half to three-fourths of anal fin membrane dark anteriorly, becoming dusky on posterior half of the fin. Pelvic and caudal fins dusky to dark.

Otoliths

Diagnostic features: The ovate to slightly fusiform shape, the domed dorsal margin, the ostial and homosulcoid sulcus acusticus and the prominent, distally rounded to squared off rostrum.

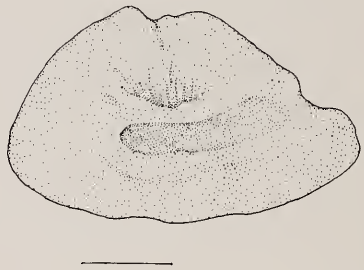


Fig. 5. Representative otolith of *B. antarcticus*; fish length unknown; scale bar 1 mm

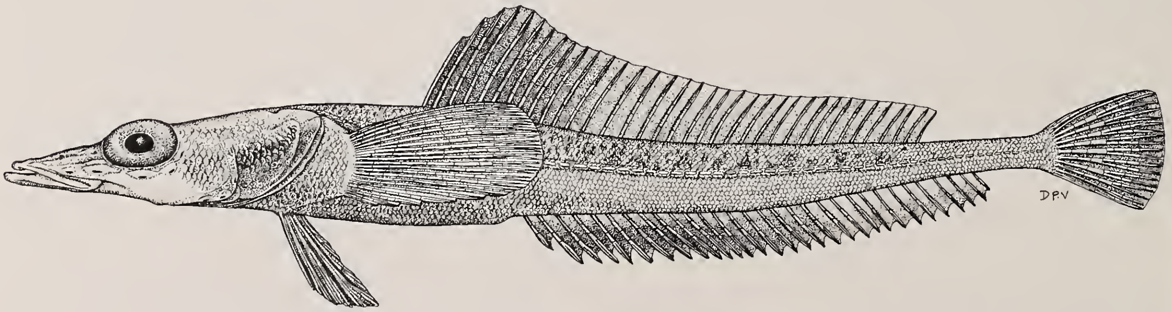
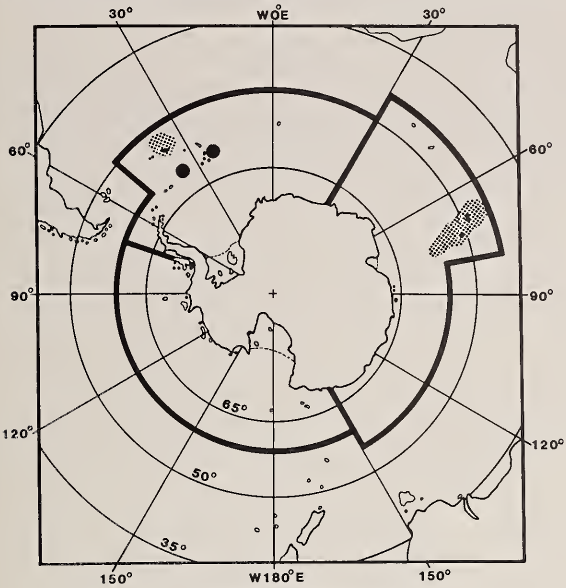


Fig. 4. *Bathydraco antarcticus* MNHN 1985–454, 183 mm SL, Kerguelen Islands

Distribution: Slopes of the Scotia Sea Islands and the Kerguelen-Gaussberg Ridge. Depth range 340–2,400 m.



Distribution of *B. antarcticus*

Remarks: DeWitt (1985) separated *B. antarcticus* and *B. macrolepis* from *B. marri* and *B. joannae* using head length and preanal distance. These proportions were larger in the former 2 species and did not overlap with those of the latter 2. My measurements of 15 specimens of *B. antarcticus,* mostly from the Kerguelen Islands, showed a considerable overlap of the head length proportion with *B. joannae* and *B. marri* of DeWitt (1985). In most of my fishes the anal-fin origin was slightly in front of midbody level (mean SnA = 48% SL; range 45–53% SL), thus showing some overlap with DeWitt's data for *B. joannae* (45–50% SL). Similarly, an overlap was observed in the predorsal distance, 36.8–42.2% SL in my *B. antarcticus* compared to 35.5–40.7% SL in *B. joannae* (DeWitt 1985). Although not used in his key, DeWitt (1985) showed no overlap in the latter character between the 2 species. A study of a larger sample of *B. antarcticus* is necessary to establish the validity and usefulness of these characters for separating this species from *B. joannae*.

Attains about 24 cm SL.

Bathydraco joannae DeWitt, 1985

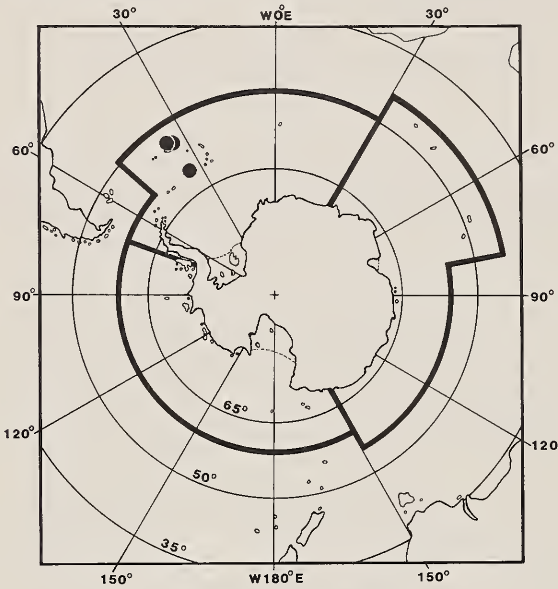
Fig. 6

Bathydraco joannae DeWitt, 1985: 304, fig. 1 (53°35′S, 36°28′W to 53°34′S, 36°47′W). Holotype: LACM 10606–10.

Diagnosis: D 33–38; A 30–34; P 20–24; GRA (4–7)+(13–17); GRP (1–4)+(12–16); LL 55–67; vertebrae (16–18)+(34–38)=51–54. Body depth at pectoral-fin base 9.7–11.8, body depth at anal-fin origin 11.5–13.3 and head length 3.1–3.6 in SL. Snout length 3.0–3.3, eye diameter 3.8–4.7, interorbital width 12.6–15.5 and upper jaw length 2.8–3.2 in HL. Distances from tip of snout to dorsal-fin origin 2.6–2.9, to pelvic-fin insertion 3.6–4.2 and to anal-fin origin 2.1–2.2 in SL. Dorsal profile of head straight or interrupted by slightly bulging eyes. Scales on opercle restricted to upper half or two-thirds of its surface.

Colour: In alcohol, body and head pale brown or brown with no markings. Nostrils dark. Mouth cavity and gill chamber dark, the dark lining of the latter shows through opercle. Anus dark brown to black. Dorsal and anal fins dark on anterior third to two-thirds and gradually become paler posteriorly. Pelvic and caudal fins dusky to dark.

Distribution: Upper slope of the Scotia Sea islands, between 600–1,800 m.



Distribution of *B. joannae*

Remarks: *Bathydraco joannae* is very similar to *B. antarcticus*. I found no non-overlapping meristic or morphometric characters for separating these species. The characters used by DeWitt (1985) need to be re-evaluated since he examined only seven specimens of *B. antarcticus* compared to 64 of *B. joannae* (see also Remarks for *B. antarcticus*). Complicating the issue is the fact that in the Scotia Sea both species are sympatric

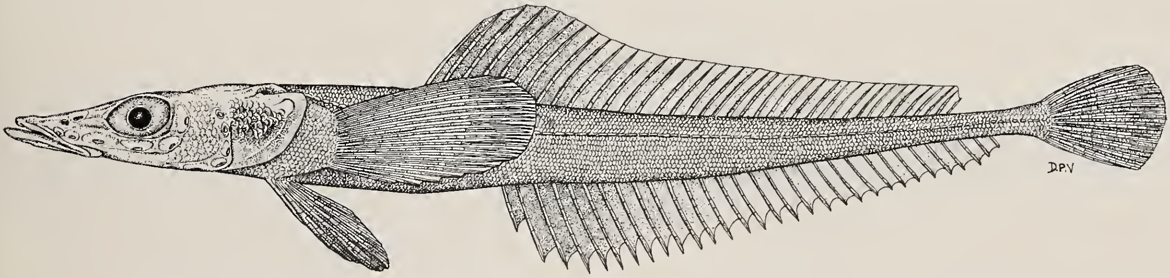


Fig. 6. *Bathydraco joannae* MNHN 1982–129, paratype, 171 mm SL (53°35′S, 36°28′W)

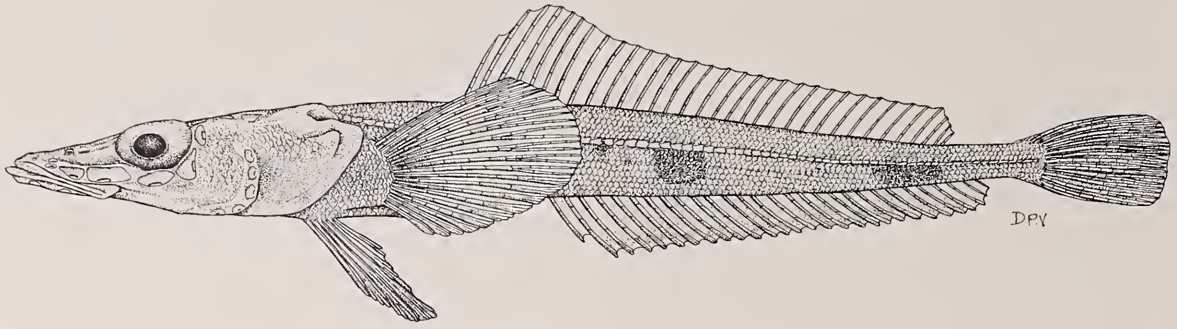
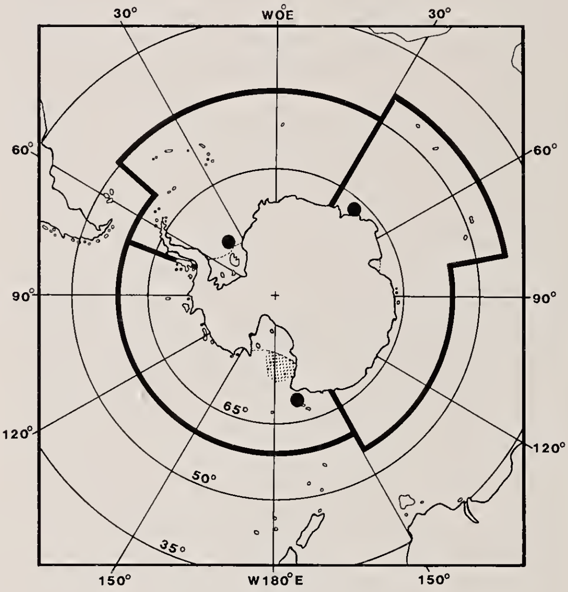


Fig. 7. *Bathydraco macrolepis* MNHN 1982–128, 170 mm SL (72°57.7′S, 174°23.6′E)



Distribution of *B. macrolepis*

and show about 50% overlap in their vertical distribution (DeWitt 1985).

Attains about 20 cm SL.

Bathydraco macrolepis Boulenger, 1907
Fig. 7

Bathydraco macrolepis Boulenger, 1907: 4, pl.1, fig. 3, south-west of Balleny Islands. Holotype: BMNH 1906.5.8.70.

Diagnosis: D 32–35; A 28–30; P 21–23; GRA (3–8)+(9–15); GRP (1–3)+(11–13); LL 51–59; vertebrae (16–17)+(32–34)=48–51. Body depth at pectoral-fin base 9.1–11.2. Body depth at anal-fin origin 11.0–12.2 and head length 2.7–3.0 in SL. Snout length 3.0–3.2, eye diameter 4.0–4.3, interorbital width 15.3–18.3 and upper jaw length 2.7–2.9 in HL. Distances from snout to dorsal-fin origin 2.1–2.4, to pelvic-fin insertion 3.2–3.5 and to anal-fin origin 1.8–1.9 in SL. Scales on opercle restricted to above level of opercular spine.

Colour: In alcohol, body pale brown with 3–4 indistinct darker bands evident mostly on lower half of body. Caudal fin and distal half of pelvic fins dark. Nostrils dusky.

Distribution: Antarctic continental shelf and slope probably circum-Antarctic. DeWitt (1985) presented a disjunct vertical distribution for *B. macrolepis*, 450–950 m and 1,750–2,100 m, but no explanation was offered. Since *B. macrolepis* is relatively rare, this discontinuity may be attributed to inadequate sampling.

Remarks: *B. macrolepis* differs from its other congeners in having a larger head and a smaller number of anal-fin rays. DeWitt (1985) used similar anterior body proportions to group this species with *B. antarcticus*, but my measurements of a larger sample of *B. antarcticus* show that the latter is more closely related to *B. joannae* and *B. marri* (see also Remarks for *B. antarcticus*). It should be noted that *B. macrolepis* is sympatric with *B. marri* on the Antarctic continental shelf and shares with the latter the upper range of its vertical distribution.

Attains about 25 cm SL.

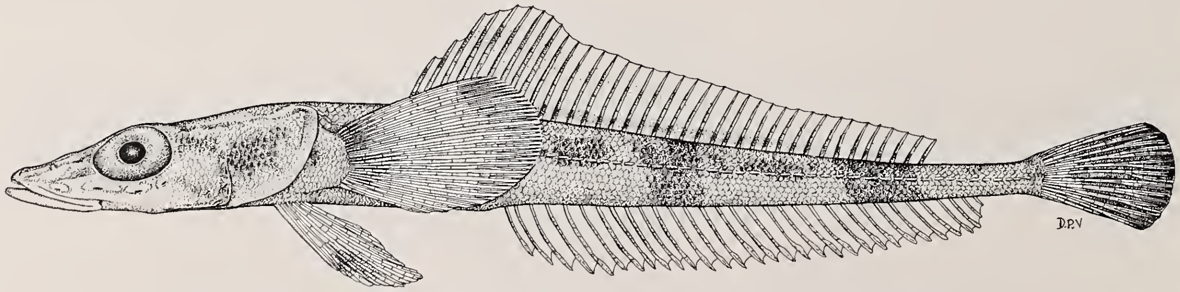


Fig. 8. *Bathydraco marri* MNHN 1982–130, 138.5 mm SL (73°22′S, 177°37′E)

Bathydraco marri Norman, 1938
Fig. 8

Bathydraco marri Norman, 1938: 55, fig. 33 (76°09.6′S, 168°40′E). Holotype: BMNH 1937.7.12.671.

Diagnosis: D 33–38; A 30–33; P 21–23; GRA (2–8)+(9–15); GRP (1–4)+(8–14); LL 51–61; vertebrae (16–18)+(33–36)=50–53. Body depth at pectoral-fin base 9.7–11.1, body depth at anal-fin origin 11.1–13.4 and head length 3.1–3.6 in SL. Snout length 3.0–3.4, eye diameter 3.3–4.4, interorbital width 12.7–17.8 and upper jaw length 2.8–3.0 in HL. Distances from snout to dorsal-fin origin 2.4–2.7, to pelvic-fin insertion 3.8–4.2 and to anal-fin origin 2.0–2.2 in SL. Most of opercle covered with scales.

Colour: In alcohol, body brown with 2 wide, dark vertical bars sometimes encircling body. Dark irregular marks usually present on body. Dorsal fin striped anteriorly. Caudal fin dark; pectoral and pelvic fins dusky and anal fin pale. Mouth cavity and gill chamber dusky to dark.

Otoliths

Diagnostic features: The triangular shape, the ostial and generally homomorph sulcus acusticus, the separated ostium and cauda, the split V-shaped crista superior and the bold crista inferior particularly below the mid region of the sulcus and the large and distally rounded rostrum.

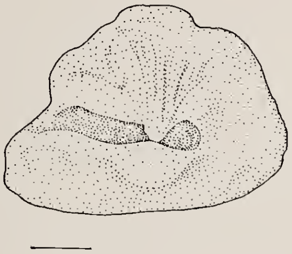
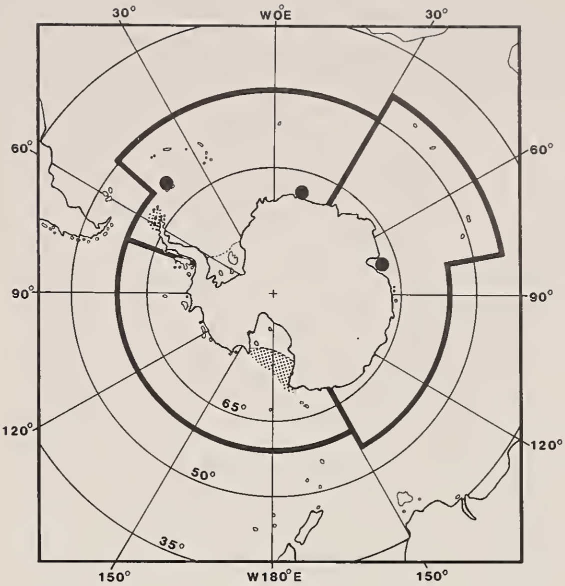


Fig. 9. Representative otolith of *B. marri*; fish length 196 mm SL; scale bar 1 mm

Distribution: Antarctic continental shelf, South Shetland and South Orkney islands. Depth range 300–1,250 m.

Remarks: Despite the similarity in body proportions (DeWitt 1985), *B. marri* can easily be distinguished from *B. antarcticus* and *B. joannae* by its distinctive colour pattern and its lower number of gill rakers. Separation from the sympatric and similarly coloured *B. macrolepis* may be more difficult. In addition to the characters given in the key above, the posterior section of the lateral line of *B. marri* runs along the middle of the body, whereas in *B. macrolepis* the front part of this section runs 1 scale row above the middle of the body (DeWitt 1985). See also Remarks for *B. macrolepis*.



Distribution of *B. marri*

Attains about 23 cm SL.

Bathydraco scotiae Dollo, 1906
Fig. 10

Bathydraco scotiae Dollo, 1906b: 65, Weddell Sea (71°22′S, 16°34′W). Syntypes: BMNH 1912.7.1.52; NMSZ 1921.143.0475.

Diagnosis: D 38–40; A 31–33; P 22–23; GRA (7–9)+(20–24); GRP (3–5)+(16–18); LL 37–45; vertebrae (17–19)+(36–38)=53–56. Body depth at pectoral-fin base 9.6 and head length 3.1–3.3 in SL. Snout length 2.8–3.1, eye diameter 4.5–4.8, interorbital width 10.0–16.7 and upper jaw length 2.7–3.1 in HL. Distances from snout to dorsal-fin origin 2.5–2.7, to pelvic-fin insertion 3.6 and to anal-fin origin 2.0. Lateral line incomplete, ending under posterior third of dorsal-fin base. Scales on opercle restricted to its uppermost part.

Colour: In alcohol, body darkish brown with 2 vertical bars. Nostrils dark. Dorsal fin dusky anteriorly. Anal fin dusky, with a pale margin. Pectoral and pelvic fins dusky. Mouth cavity and gill chamber dark.

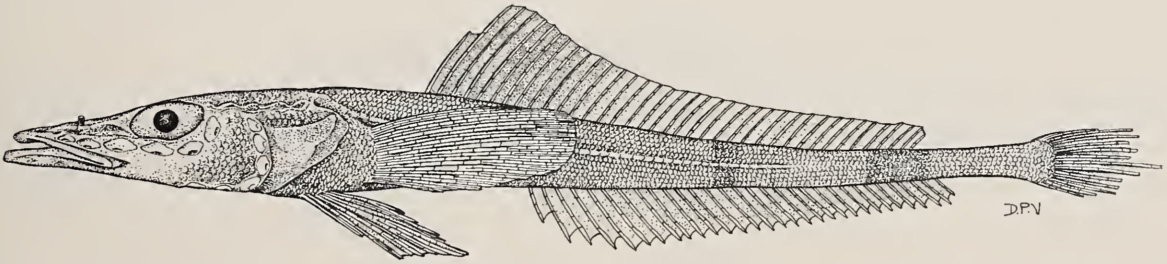
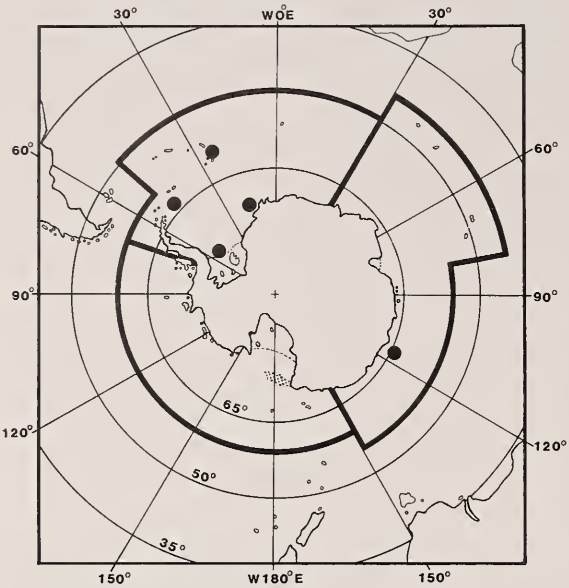


Fig. 10. *Bathydraco scotiae* BMNH 1912.7.1.52, syntype, 111.8 mm SL, off Coats Land (77°22′S, 16°34′W)

Distribution: Antarctic continental slope and slopes of the South Orkney and the South Sandwich islands. Depth range 2,100–2,950 m. Probably circum-Antarctic, the paucity of records may be attributed to inadequate sampling at these great depths.



Distribution of *B. scotiae*

Remarks: In addition to the characters given in the key above, *B. scotiae* differs from its other congeners in having more dorsal-fin rays and vertebrae. Using these characters, as well as the incomplete lateral line, DeWitt (1985) recognised *B. scotiae* as the sister group of the remaining species of *Bathydraco*.

Attains about 170 mm SL.

Genus *Cygnodraco* Waite, 1916

Body naked except for lateral-line scales. Two lateral lines; middle lateral line of perforated scales only. Opercle with a strong, flat ridge diverging posteriorly to sub-ridges ending in spiny points. Gill rakers reduced to small, dentigerous knobs. Jaws with a narrow band of small, conical teeth. Branchiostegal rays 6. Monotypic; rare.

Cygnodraco mawsoni Waite, 1916

Fig. 11; Pl. 8, Fig. 2

Cygnodraco mawsoni Waite, 1916: 33, pl. 3, fig. 1, off Drygalski Island (65°42′S, 92°10′E). Holotype: SAMA F372.

Diagnosis: D 61–66; A 36–38; P 23–25; GRA (2–3)+(14–20); GRP 0+(12–13); ULL 87–103 tubular scales; MLL 37–50 perforated scales; vertebrae 77–79. Body depth at dorsal-fin origin 6.0–7.9, body depth at anal-fin origin 11.7–16.4 and head length 2.5–2.7 in SL. Snout length 2.1–2.2, eye diameter 5.2–6.4 and upper jaw length 2.5–2.8 in HL. Distances from snout to dorsal-fin origin 2.4–2.6, to pelvic-fin insertion 2.7–3.1 and to anal-fin origin 1.5–1.7 in SL. Snout long and spatulate. Interorbital space narrrow, less than 4% HL. Cephalic sensory canals not enlarged, pores minute and arranged as follows: preopercular-mandibular 10; infraorbital 7; supraorbital 4; temporal 6; supratemporal 3; coronal pore present. Nostril in front of anteriormost infraorbital pore.

COLOUR: In alcohol, brown all over, with some pale vertical bars and saddles on body. Paired fins brown, unpaired fins distinctly darker. Nostrils pale.

Otoliths

DIAGNOSTIC FEATURES: The ovate shape with a highly domed dorsal margin, the thin dorsal half and the pronounced thicker ventral half, the ostial and heterosulcoid sulcus acusticus, the separated ostium and cauda and the anterior colliculum which projects beyond the anterior margin and the large and distally rounded rostrum.

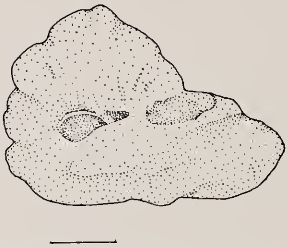


Fig. 12. Representative otoliths of *C. mawsoni*; fish length 41 cm SL; scale bar 1 mm

Distribution: Antarctic continental shelf, probably circum-Antarctic. Depth range 112–300 m.

Remarks: Body proportion changes resulting from growth in *Cygnodraco mawsoni* involve mostly the head and trunk, which become deeper and wider in large specimens. In 7 specimens (including the holotype) 22–41 cm SL, the ranges of proportional measurements of the head were as follows: head depth 8.9–15.2% and head width 7.3–14.1% SL, both measured at preopercle edge. The greatest changes seem to occur in fishes larger than 30 cm SL and this is also visually apparent in comparing Waite's (1916) illustration of the holotype

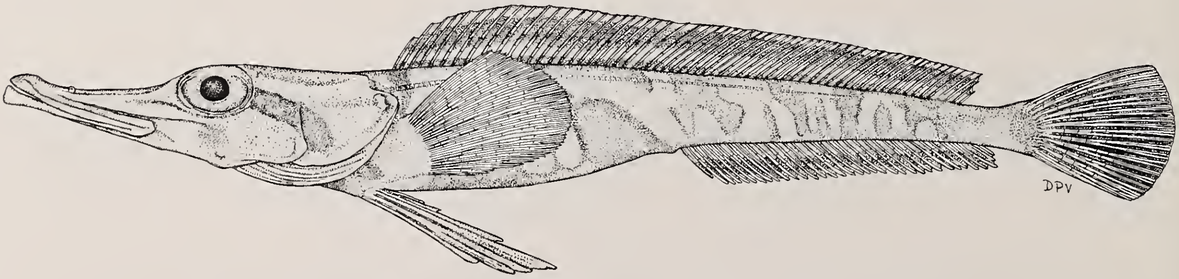
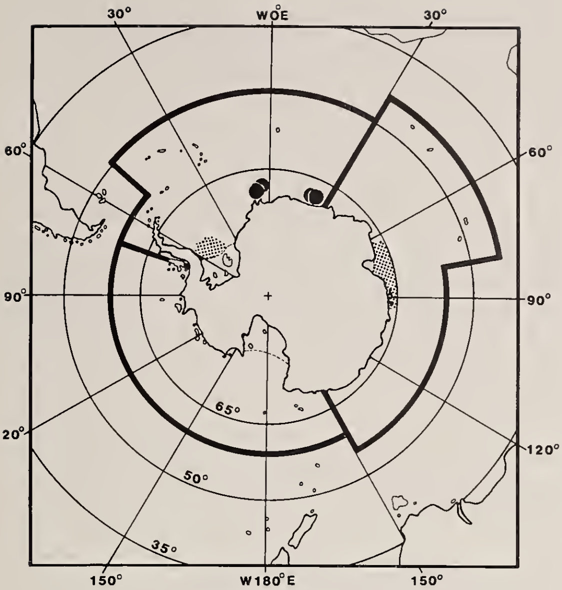


Fig. 11. *Cygnodraco mawsoni* IRSNB 16698, 28 cm SL (70°19′S, 24°26′E)



Distribution of *C. mawsoni*

(41 cm SL) with the specimen (28 cm SL) illustrated here (Fig. 11). In addition, the reverse trend has been observed with regard to pelvic-fin length which was 23.3% SL in the smallest fish and 16.2% SL in the largest one. The tubular scales of the upper lateral line are sometimes followed by a number of spaced perforated scales.

In the Weddell Sea, specimens larger than 20 cm TL were adults and those larger than 26 cm TL were breeding. Spawning appears to occur in autumn or early winter (Kock *et al.* 1984). In the same area, *C. mawsoni* feeds mainly on benthic and benthopelagic organisms such as fishes (*Trematomus* spp.), the decapod *Crangon antarcticus*, mysids, gammarid amphipods and polychaete worms (Kock *et al.* 1984). Gon (1987b) described the post-larva of *C. mawsoni* (Pl. 9, Fig. 1), specimens of which were collected at the upper 60 m over the edge of the continental shelf and may be associated with krill concentrations.

Attains over 41 cm SL.

Genus *Gerlachea* Dollo, 1900

Body and cheek covered with cycloid scales. Two lateral lines. Opercle without spines or hooks. Gill rakers reduced to small, dentigerous knobs. Jaws with small, conical teeth in bands. Branchiostegal rays 6. Monotypic; rare.

Gerlachea australis Dollo, 1900

Fig. 13

Gerlachea australis Dollo, 1900b: 196 (71°14′S, 89°14′W). Holotype: IRSNB 2.

Diagnosis: D 44–48; A 34–36; D 26–28; GRA (0–1)+(9–12); GRP 0+(3–6); ULL 80–96; LLL 23; vertebrae 62–64. Body depth at pectoral fin base 9.2–12.2, body depth at anal-fin origin 10.0–14.4 and head length 3.0–3.3 in SL. Snout length 2.2–2.5, eye diameter 4.2–5.1, interorbital width 12.4–18.1 and upper jaw length 3.0–3.2 in HL. Distances from snout to dorsal-fin origin 2.4–2.8, to pelvic-fin insertion 3.2–3.7 and to anal-fin origin 1.6–1.9 in SL. Body and cheek covered with small cycloid scales; opercle naked except for 2–3 rows of scales on upper part; on cheek, scales reach forward to fourth infraorbital pore. Two lateral lines with tubular scales, the upper near dorsal-fin base and the lower near anal-fin base; middle lateral line (on caudal peduncle) absent. Snout long and spatulate. Maxilla reaches to second infraorbital pore or slightly behind it. Cephalic sensory canals not enlarged, pores small and arranged as follows: preopercular-mandibular 10; infraorbital 5+3; supraorbital 4; temporal 6; supratemporal 2+2; coronal pore present. Nostril in front of anteriormost infraorbital pore.

COLOUR: In alcohol, body brown with 4–5 dark brown vertical bars. Bars may vary in length and depth. Opercle and ventral part of head pale brown. A large dark spot on pectoral fin base. Dorsal fin black anteriorly, but pigment gradually becoming a basal stripe posteriorly. Distal edge of anteriormost anal-fin rays dark, but otherwise anal fin pale. Caudal and pelvic fins dark. Pectoral fin dusky. A dark, diagonal stripe across cheek. Tips of jaws black.

Otoliths

DIAGNOSTIC FEATURES: The ovate shape with the generally straight ventral margin, the separate ostium and cauda, the split crista superior and the bold crista inferior below which is a distinct ventral groove.

Fig. 14. Representative otolith of *G. australis*; fish length 23 cm TL; scale bar 1 mm

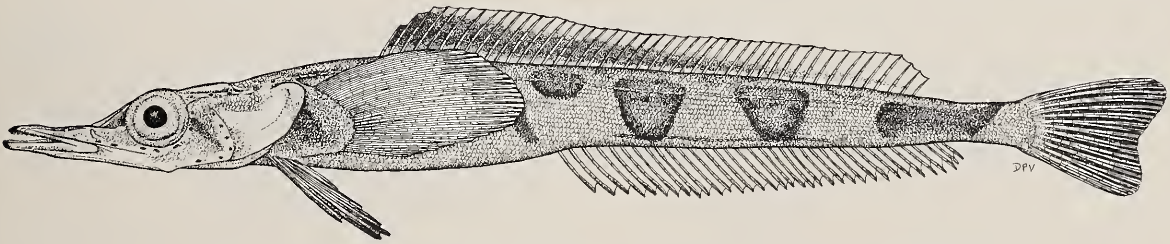
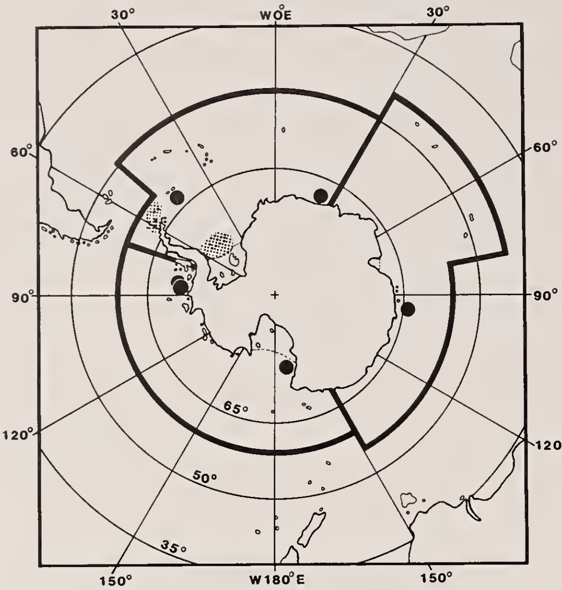


Fig. 13. *Gerlachea australis* MNHN 1982–1280, 167 mm SL, Elephant Island

Intraspecific variation: Negligible, except for the definition of the postero-dorsal notch.

Distribution: Antarctic Peninsula, Elephant Island and Antarctic continental shelf. Depth range 200–670 m.



Distribution of *G. australis*

Remarks: Gill rakers (knobs) usually absent from upper limb of first gill arch. The lower lateral line is apparently absent in specimens smaller than 120 mm SL. In addition, of the 15 specimens examined for this study, only 1 had a complete lower lateral line. In the others, no such line was detected, but it was difficult to ascertain whether the line was invisible due to loss of scales, or it was genuinely absent. A similar difficulty was apparently experienced by Kock *et al.* (1984). The supratemporal and infraorbital sensory canals are interrupted. The former lacks the medial section, and in the latter a section of the canal, between pores 5 and 6, is open, but the extent of the opening may vary individually. Predictably, some specimens may be found with this section closed, namely a continuous canal.

Gerlachea australis spawns in the autumn or early winter and hatching probably occurs in spring. In the Weddell Sea the breeding stock consisted of specimens larger than 200 mm SL (Kock *et al.* 1984). Eggs of 2.5–3.0 mm in diameter were measured by Roule *et al.* (1913), but there was no indication of the gonad's state of maturity. *G. australis* feeds mostly on pelagic crusteans. North of the South Shetland Islands it was feeding only on *Euphausia superba* (Takahashi 1983) whereas in the Weddell Sea the main food items were *Euphausia* sp. and *Hyperiella antarctica*; *E. crystallorophias* and other amphipods were also taken (Kock *et al.* 1984).

The locality and depth of capture of the holotype of *G. australis* given by Dollo (1900b) were provisional. The correct data were stated in Dollo (1904).

Attains about 24 cm SL.

Genus **Gymnodraco** Boulenger, 1902

Body naked except for lateral line scales. Two lateral lines; middle lateral line with perforated scales only. Opercle with a strong ridge ending in a spine and a hooked process. Subopercle with a spine; preopercle edge smooth. Gill rakers reduced to small knobs. Both jaws with canine teeth at symphysis. Branchiostegal rays 6. Monotypic

Gymnodraco acuticeps Boulenger, 1902

Fig. 15

Gymnodraco acuticeps Boulenger, 1902: 186, pl. 17, Cape Adare. Syntypes: BMNH 1901.11.8.82–84.

Gymnodraco victori Hureau, 1963: 334, Adélie Land.

Diagnosis: D 27–30; A 23–26; P 19–24; GRA (1–4)+(9–18); ULL 9–17; vertebrae 48–50. At pectoral fin base, body depth 7.0–10.4 in SL and body width 0.6–0.9 in the depth. Head length 2.5–2.9 in SL. Snout length 2.5–3.0, eye diameter 4.8–6.5, interorbital width 6.3–7.8 and upper jaw length 2.3–2.6 in HL. Distances from snout to dorsal-fin origin 1.7–1.9, to pelvic-fin insertion 2.7–3.6 and to anal-fin origin 1.7–1.9 in SL. Body depressed anteriorly and compressed posteriorly. Head depressed and triangular with long, pointed snout. Jaws with large canines at symphysis, followed by a single series of small compressed teeth with slightly curved tips. Lower jaw projecting in front of upper jaw, its anterior canines exposed. Upper lateral line reaches area below dorsal-fin origin and middle line extends forward to middle of pectoral fin. Cephalic sensory canals normal, pores small and arranged as follows: Preopercular-mandibular 10, infraorbital 5+3, supraorbital 4, temporal 5, supratemporal 1+1. Coronal pore present. Nostril above and slightly in front of anteriormost infraorbital pore.

Colour: In alcohol, body brown to dark brown, but paler on ventral surface. Head and body with small spots and dark blotches respectively which may fade in time. Fins dark brown to dusky. Anus darker than area around it.

Otoliths

Diagnostic features: The discoid to oval shape and the medial and poorly defined sulcus acusticus.

Intraspecific variation: The sculpture of the margin is highly variable. The antirostrum and the excisura ostii

Fig. 15. *Gymnodraco acuticeps* MNHN 1962–791, 24 cm SL, Adélie Land

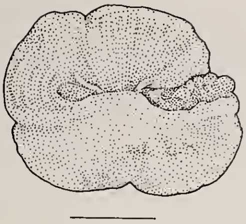
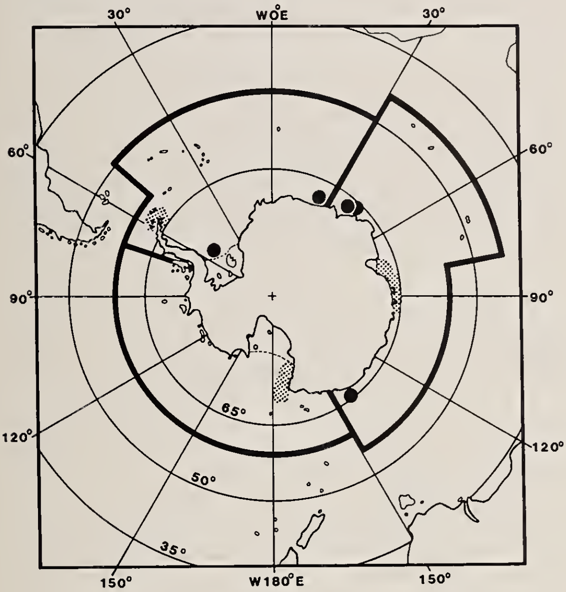


Fig. 16. Representative otolith of *G acuticeps*; fish length 26 cm TL; scale bar 1 mm

are either present or absent and the anterior colliculum can project beyond the anterior margin.

Ontogeny: The sculpture of the margins changes from entire to gently lobed in specimens larger than 200 mm TL. The sulcus acusticus also becomes slightly better defined in larger specimens.

Distribution: Antarctic Peninsula, South Shetland Islands and the Antarctic continental shelf. Probably circum-Antarctic, but so far no records exist from West Antarctica. Depth range 0–550 m.



Distribution of *G. acuticeps*

Remarks: There is little doubt that *Gymnodraco victori* Hureau, 1963, is a junior synonym of *G. acuticeps* Boulenger, 1902. Hureau (1963) described *G. victori* from 4 specimens which he compared to 6 specimens of *G. acuticeps* from Adélie Land as well as Boulenger's (1902) types. Hureau (1963) separated *G. victori* from *G. acuticeps* using the arrangement of the canine teeth at the lower jaw symphysis, otolith morphology, vertebral count, lengths of upper jaw, snout and dorsal-fin base, predorsal distance and the position of the nostril. In this study 5 specimens of *G. victori* (including syntypes) from Adélie Land were compared with 19 specimens of *G. acuticeps* (including 3 syntypes) from various Antarctic localities. Unlike Hureau (1963, 1985a) and Hureau & Arnaud (1964), I found no consistency in the arrangement of the canines of the lower jaw. The largest tooth may be either in the front or the rear of the canine group and the arrangement can differ from one side of the jaw to the other of the same fish. The vertebral count and morphometric characters of *G. victori* were within the range found in *G. acuticeps*. Otoliths of fishes identified as *G. acuticeps* by J.-C. Hureau and K.-H. Kock, and described by Hecht (1987: pl. 29, fig. 104), show greater similarity to Hureau's *G. victori* than to his *G. acuticeps* (Hureau 1963: figs. 1, 2 respectively). Unfortunately, Hureau (1963) did not provide the lengths of the fishes from which his otoliths were taken. Comparing his otolith of *G. acuticeps* with the illustrations in Hecht (1987), it was probably taken from a fish much longer, and thus older, than his specimen of *G. victori*.

Although *G. acuticeps* has been collected at over 400 m depth (Takahashi 1983), it is usually found in much shallower depths, mostly in the upper 50 m (Norman 1938; Hureau 1963; Eastman & DeVries 1982; Naito & Iwami 1982; Williams 1988a). Using the Gonado-somatic Index, Hureau (1963) found that *G. acuticeps* in Adélie Land spawned during September. In the Bransfield Strait, hatching probably occurs in spring (16 mm larvae were collected in mid-November) and the presence of juveniles as by-catch of krill fishery in February/March (Slosarczyk & Rembizsewski 1982) indicates that pelagic development is likely to end in the autumn (Kellermann 1989). The number of eggs per ovary pair was about 5,000 and ripe eggs were 3 mm in diameter. Takahashi (1983) examined a few stomachs of *G. acuticeps* collected north of the South Shetland Islands and found that they contained only *Euphausia superba*. In McMurdo Sound, however, *G. acuticeps* fed on (by order of importance) fishes, amphipods, fish eggs and polychaetes. The fish species included *Pleuragramma antarcticum, Pagothenia borchgrevinki* and *Trematomus nicolai* (Eastman 1985b). Early life history stages of *G. acuticeps* were described by Regan (1916a) and Efremenko (1983).

Attains about 34 cm SL.

Genus ***Parachaenichthys*** Boulenger, 1902

Body naked except for lateral-line scales. Snout long and spatulate. Jaws with a polyserial band of small, caniniform teeth. Cephalic sensory canals normal, pores small and arranged as follows: Preopercular-mandibular 10, infraorbital 7–9, supraorbital 6–7, temporal 6, supratemporal 3–4, coronal pore present. Nostril well in front of anteriormost infraorbital pore. Opercle with a strong ridge diverging posteriorly to subridges ending with spines. Gill rakers reduced to spiny knobs. Branchiostegal rays 6. Two species.

Remarks: Variation in the number of infraorbital pores is apparently common, and counts may differ on the 2 sides of a single fish. Of the 14 specimens of *Parachaenichthys* counted for this study, three had 9 pores, two had 7 pores, and the remaining fishes had 8 pores. Three specimens had a different count on each side of the head. In addition, one fish had 7 supraorbital pores and two had 4 supratemporal pores. *Parachaenichthys* is also unique among the bathydraconid genera in that the median supratemporal pore opens anteriorly instead of posteriorly.

KEY TO SPECIES

1a ULL and posterior part of MLL connected to each other (Fig. 1a); both LL with tubular scales; maxilla reaches slightly beyond second infraorbital pore (2.8–3.0 in HL) ....*P. georgianus*

1b MLL not connected to ULL, its scales small, well spaced and embedded in skin (Fig. 1b); maxilla reaches to third infraorbital pore or beyond it (2.2–2.7) in HL.........*P. charcoti*

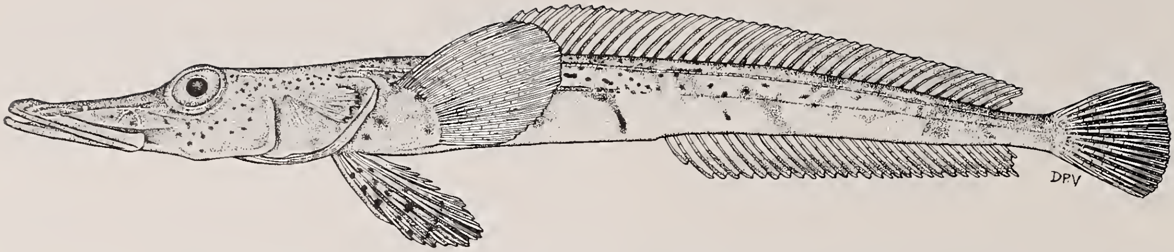


Fig. 17. *Parachaenichthys charcoti* MNHN 1982–1277, 21 cm SL, Elephant Island

Parachaenichthys charcoti (Vaillant, 1906)
Fig. 17

Chaenichthys charcoti Vaillant 1906b: 247, Booth Wandel Island. Holotype: MNHN 06–144.

Diagnosis: D 42–44; A 29–32; P 21–23; GRA (1–2)+(11–13); GRP 0+(8–12); ULL 106–114; vertebrae 62–63. Body depth at pectoral-fin base 8.0–12.9, at anal-fin origin 11.1–14.5 and head length 2.6–2.8 in SL. Snout length 1.9–2.5, eye diameter 5.6–7.1 and upper jaw length 2.2–2.7 in HL. Distances from snout to dorsal-fin origin 2.1–2.2, to pelvic-fin insertion 3.2–3.3 and to anal-fin origin 1.6–1.7 in SL. Upper lateral-line scales tubular. Middle lateral line extending forward to rear edge of pectoral fin, its scales small, perforated, well spaced and embedded in skin.

Colour: In alcohol, body and head pale to dark brown, but paler on lower sides and ventral surface. Body and head with dark spots of variable size. Larger fish are darker and with less distinct spots. Anal and dorsal fins pale to dusky in young fish, but become progressively darker from back to front with growth. Pectoral fin pale; caudal fin blackish; pelvic fins spotted proximally and black distally.

Otoliths

Diagnostic features: The oval to triangular shape, the entire margin, the clearly separated ostium and cauda, the crista superior which is only developed above the ostium and the notch in the ventral margin on the lateral side.

Intraspecific variation: Negligible, except for the anterior colliculum which sometimes projects beyond the anterior margin.

Ontogeny: The otolith is oval in fish smaller than 150 mm TL, whereafter the shape tends to become somewhat triangular, with the ventral margin forming the base of the triangle.

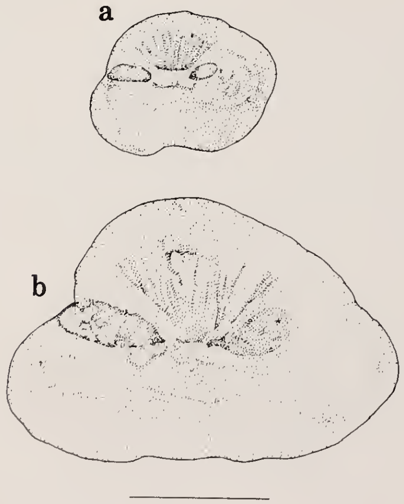
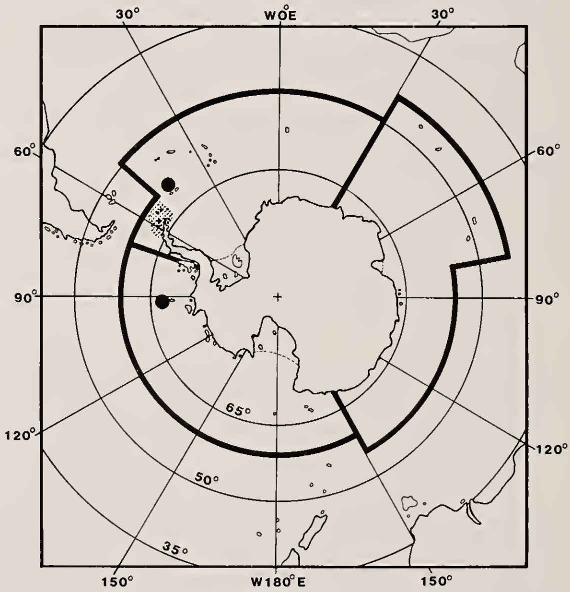


Fig. 18. Representative otoliths of *P. charcoti*; fish lengths: (a) 105 mm and (b) 205 mm TL; scale bar 1 mm

Distribution: South Orkney, South Shetland and Elephant Islands, and tip of Antarctic Peninsula to 65°S. Depth range 5–400 m. Nybelin (1951) described a 38.0 mm TL postlarva from Peter I Island. Nybelin's (1951) reasoning for identifying his specimen as *P. charcoti* is valid. Peter I Island, however, is far to the southwest from the known range of *P. charcoti*. Considering that no captures of this species from Peter I Island, or the south-west Antarctic Peninsula and the Bellingshausen Sea, have been reported subsequent to Nybelin (1951), his extension of the range of *P. charcoti* to this Island and his acceptance of *P. charcoti* as part of the Island's fauna remain to be confirmed.



Distribution of *P. charcoti*

Remarks: The opercular ridge of *P. charcoti* usually ends in more than 3 spines. Little is known of the biology of this uncommon species. Kellermann (1989) reported the occurrence of larvae with yolk (23–32 mm TL) in the shelf waters of the northern end of the Antarctic Peninsula from late October to early December. Small juveniles (45–58 mm TL) were encountered between Palmer Archipelago and Elephant Island from mid-January to mid-March. Assuming a similar size at hatching (11 mm SL) to *P. georgianus* and longer incubation time in the Peninsula area, Kellermann (1989) concluded that hatching may occur in late winter. Targett (1981) reported that the stomach of a specimen caught in the South Orkney Islands contained only fishes.

Attains about 42 cm SL.

Parachaenichthys georgianus (Fischer, 1885)

Fig. 19; Pl. 9, Fig. 2

Chaenichthys georgianus Fischer, 1885: 50, pl. 1, figs. 1–2, South Georgia. Lectotype: ZMH 409.

Diagnosis: D 43–46; A 30–33; P 21–23; GRA (2–4)+(15–19); GRP 0+(11–15); ULL 108–112 tubular scales; MLL 4–9 tubular scales; vertebrae 59–61. Body depth at pectoral fin base 9.8–12.5, at anal-fin origin 12.0–14.6 and head length 2.5–2.7 in SL. Snout length 2.0–2.3, eye diameter 5.8–7.0 and upper jaw length 2.8–3.0 in HL. Distance from snout to dorsal-fin origin 1.6–1.7 in SL. Middle lateral line consists of a short section of tubular scales on caudal peduncle and a longer, anterior section of small, perforated, and well spaced scales embedded in skin. Tubular section of middle lateral line connected to end of upper lateral line.

Colour: In alcohol, pale to dark brown, but paler on ventral surface. Body and upper part of head with dark spots of variable size which are less distinct in larger and darker fishes. Caudal and pelvic fins blackish, the latter frequently spotted. In small fish, dorsal and anal fins dark posteriorly, the former frequently with series of spots in front. In both fins dark pigment advances forward with growth.

Otoliths

Diagnostic features: The ovate shape, the elongate and prominent rostrum, the sinuate to crenate dorsal and ventral margins, the robust crista inferior with a distinct horizontal groove and the split crista superior.

Distribution: Insular shelf of South Georgia and South Sandwich Islands. Depth range 5–270 m.

Remarks: The opercular ridge of *P. georgianus* usually ends in 2 or 3 spines. Permitin (1973) studied some reproductive parameters in specimens collected as by-catch in trawls around South Georgia. He found that mature eggs are large, 2.4–3.4 mm in diameter (preserved), and bright red. One female had 14,090 eggs per ovary pair. Burchett *et al.* (1983), however, measured eggs of 4.0 mm and fecundity of 19,658–23,910 eggs.

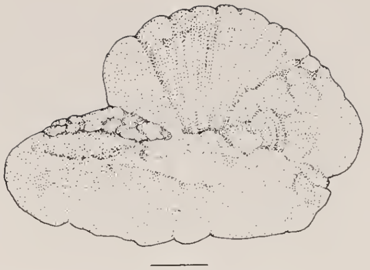
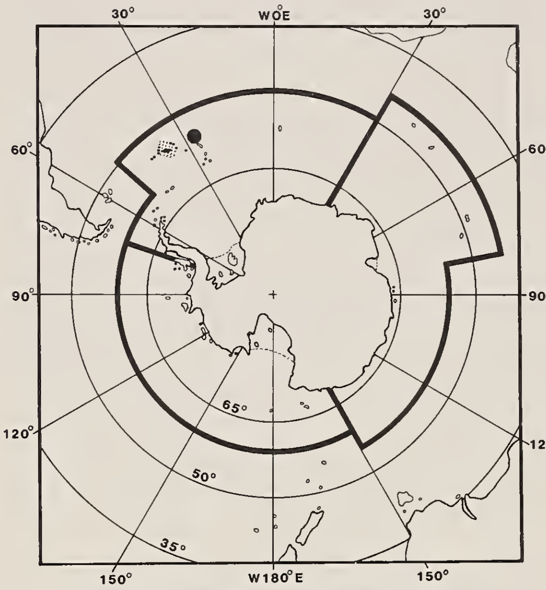


Fig. 20. Representative otolith of *P. georgianus*; fish length 51 cm TL; scale bar 1 mm



Distribution of *P. georgianus*

Spawning takes place from end of summer to early winter (Permitin 1973; North & White 1987). The eggs are benthic (Permitin 1973) and hatching occurs throughout winter (Burchett *et. al.* 1983; North & White 1987). *P. georgianus* feeds on fishes, mysids, *Crangon antarcticus* and *Chorismus antarcticus*. The presence of prey species in the stomachs and their relative importance varied as a result of trophic relationships within fish communities in the South Georgia area (Targett 1981). Early life history stages of *P. georgianus* were described by Efremenko (1983).

Attains about 59 cm SL.

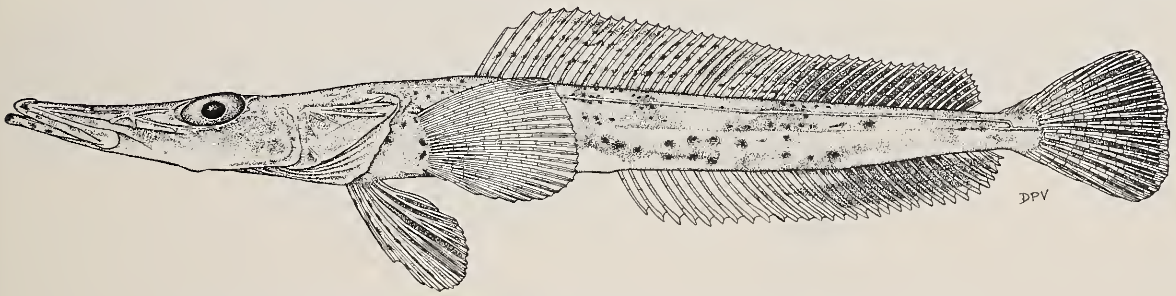


Fig. 19. *Parachaenichthys georgianus* ISH 343/76, 21 cm SL (54°05′S, 36°51′W)

Genus *Prionodraco* Regan, 1914

Body naked except for bony plates and lateral-line scales (see Remarks). Two lateral lines; middle lateral line of perforated scales only. Opercular ridge ends in a flat hooked spine. Jaws with small conical teeth in bands. Branchiostegal rays 6. Monotypic.

Prionodraco evansii Regan, 1914
Fig. 21

Prionodraco evansii Regan, 1914a: 13, Ross Sea (74°25′S, 179°03′E) and McMurdo Sound (76°56′S, 164°12′E and 77°13′S, 164°18′E). Syntypes: BMNH 1913.12.4.177–180.

Diagnosis: D 34–38; A 28–33; P 21–24; GRA (2–7)+(14–18); GRP (2–3)+(12–14); ULL 12–17; vertebrae 49–51. Body depth at pectoral fin base 7.9–10.1 and head length 3.1–3.5 in SL. Body width 0.8–1.1 in its depth. Snout length 2.9–3.3, eye diameter 2.9–3.7 and upper jaw length 2.7–3.0 in HL. Distances from snout to dorsal-fin origin 2.4–2.6, to pelvic-fin insertion 3.4–4.3 and to anal-fin origin 1.9–2.1 in SL. Some jaw teeth may be enlarged. Body quadrangular, with a series of bony plates at each angle; plates V-shaped, with a serrated edge and a posteriorly pointing spine. Upper lateral line of tubular scales, incomplete, reaching level of anterior dorsal-fin rays. Middle lateral line of perforated scales, extending from caudal-fin base to pectoral fin base. Cephalic sensory canals slightly enlarged, pores arranged as follows: Preopercular-mandibular 10, infraorbital 7, supraorbital 4, temporal 5–6 and supratemporal 3. Coronal pore present.

Colour: In alcohol, generally brown with dark spots of variable size on body and top of head. A large, black spot between 4th and 8th dorsal-fin rays. Dorsal and anal fins with a dark band along their distal margin. Caudal and pelvic fins with dusky cross-bars. Distal third or half of anterior pelvic-fin rays dark brown.

Otoliths

Diagnostic features: The fusiform shape, the homosulcoid sulcus acusticus, the crista superior which is only present over the ostium and the distinct ventral groove.

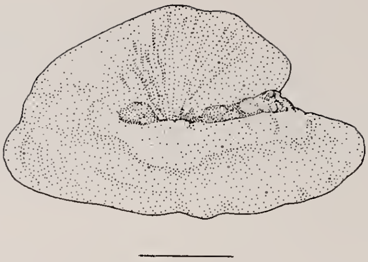
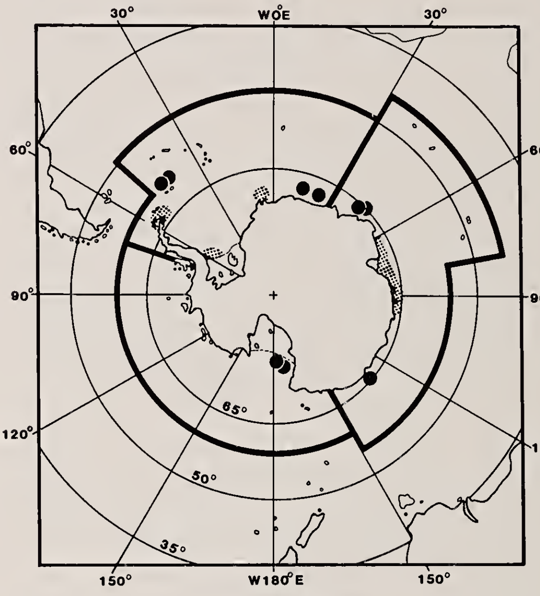


Fig. 22. Representative otolith of *P. evansii*; fish length 143 mm TL; scale bar 1 mm

Distribution: South Orkney and South Shetland Islands, tip of Antarctic Peninsula north of 65 °S and the Antarctic continental shelf. Probably circum-Antarctic. Depth range 70–550 m.



Distribution of *P. evansii*

Remarks: Posteriormost middle lateral-line scales are small and cycloid, but become progressively larger anteriorly and bear ctenii. Frequently, the anteriormost scales

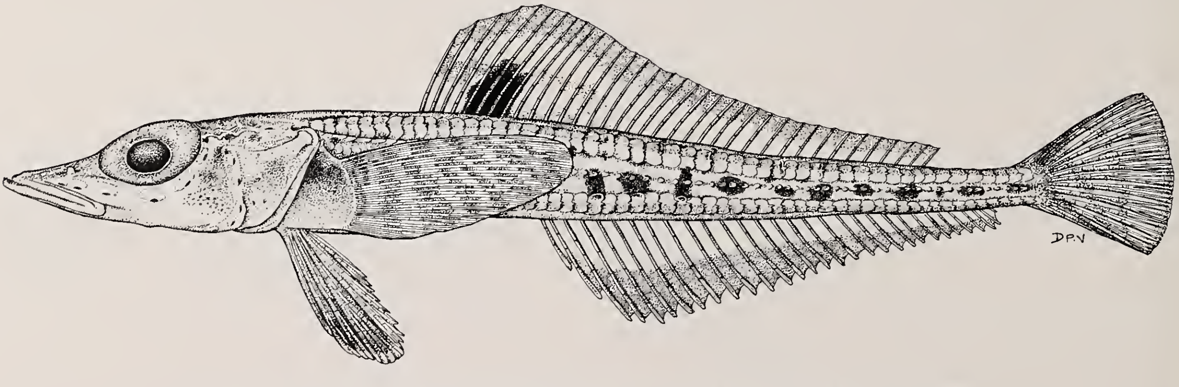


Fig. 21. *Prionodraco evansii* IRSNB 15119, 93.5 mm SL (63°34′S, 132°55′E)

are not perforated or pitted. They are overlapping and appear to be identical with body scales of scaled bathydraconid genera. In addition, ctenoid scales, either scattered or arranged in a few short series, were found on the anterior part of the body, under the pectoral fin and medially to the ventral series of plates, on most of the 15 specimens examined for this study.

In the Weddell Sea, *P. evansii* matures at about 100 mm SL. Spawning apparently takes place during autumn and early winter (Kock *et al.* 1984). At the northern end of the Antarctic Peninsula hatching probably occurs in spring and size at hatching is about 12 mm TL (Kellermann 1989). *P. evansii* feeds primarily on polychaetes and benthic crustaceans (Daniels 1982; Kock *et al.* 1984). In the Weddell Sea, both prey groups showed similar frequency of occurrence, with Amphipoda as the most important crustacean taxon (Kock *et al.* 1984). Along the west coast of the Antarctic Peninsula, Cumacea was the most important food taxon followed by Amphipoda and Euphausiacea (Daniels 1982). Early life history stages of *P. evansii* are still undescribed, but captures of post-larvae from the Weddell Sea have been reported (Kellermann & Kock 1984; Kock *et al.* 1984; Kellermann 1989).

Attains about 150 mm SL.

Genus ***Psilodraco*** Norman, 1937

Body naked, except for 5 lateral lines of imperforated scales. Opercle with a strong ridge ending in a short flat spine and a flat hooked process. Gill rakers reduced to small, dentigerous knobs. Canines present behind symphysis of upper jaw. Branchiostegal rays 6. Monotypic.

Remarks: Norman (1938) described *Psilodraco* as having 3 lateral lines of imperforated scales, but DeWitt & Hureau (1979: in key) contended that the scales are perforated. Recently, Voskoboynikova & Balushkin (1988) discovered 2 additional lateral lines in *Psilodraco*, one along dorsal-fin base and another along anal-fin base, and confirmed the presence of imperforated scales in all 5 sensory lines.

In the species diagnosis below LL_1–LL_5 refer to the lateral lines from the dorsalmost to the ventralmost respectively. LL_2–LL_4 represent the lateral lines termed ULL, MLL and LLL respectively in other bathydraconid genera.

Psilodraco breviceps Norman, 1937
Fig. 23

Psilodraco breviceps Norman 1937c: 476, South Georgia. Holotype: BMNH 1937.7.12.738.

Diagnosis: D 28–30; A 27–29; P 26–28; GRA (1–2)+(6–12); GRP 2+(7–11); LL_1 32–66; LL_2 24–47; LL_3 21–42; LL_4 3–22; LL_5 39–63; vertebrae 45–47. Body depth at pectoral fin base 5.2–6.2 in SL and body width 1.0–1.5 in the depth. Head length 3.0–3.5 in SL. Snout length 2.9–3.7, eye diameter 2.9–3.8, interorbital width 8.4–10.1 and upper jaw length 2.3–2.5 in HL. Distances from snout to dorsal-fin origin 2.0–2.1, to pelvic-fin insertion 3.1–3.9 and to anal-fin origin 1.7–1.9 in SL. Body compressed. Snout pointed, not greatly produced and slightly depressed. Jaws with a polyserial band of caniniform teeth; outer series enlarged. Cephalic sensory canals not enlarged, pores small and arranged as follows: Preopercular-mandibular 4+(6–7) (rarely 9); infraorbital 4+2; supraorbital 5–6; temporal 5; supratemporal 1+1; coronal pore absent. Nostril above and slightly in front of anteriormost infraorbital pore.

COLOUR: In alcohol, body and head dark brown and finely spotted, but paler on ventral surface. Fins pale.

Otoliths

DIAGNOSTIC FEATURES: The subquadrate shape, the ostio-caudal sulcus acusticus, the split crista superior, and the continuous and broad crista inferior below the entire sulcus acusticus.

Fig. 24. Representative otolith of *P. breviceps*; fish length 150 mm TL; scale bar 1 mm

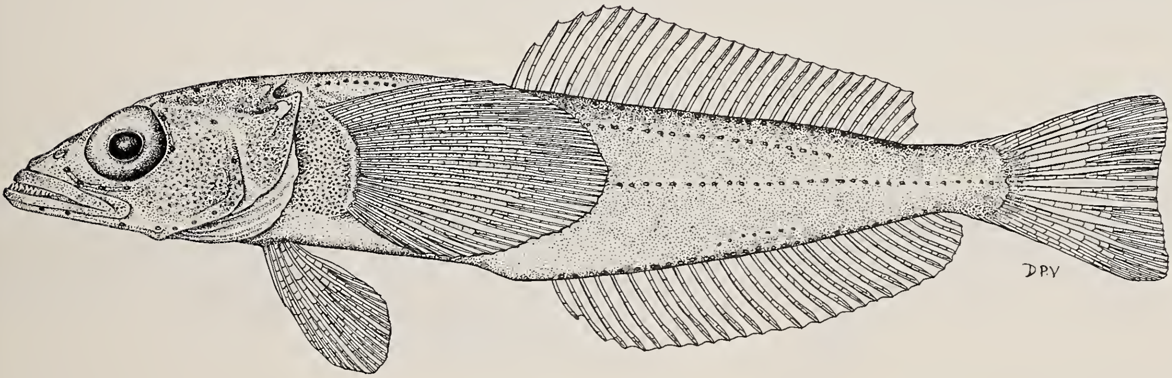
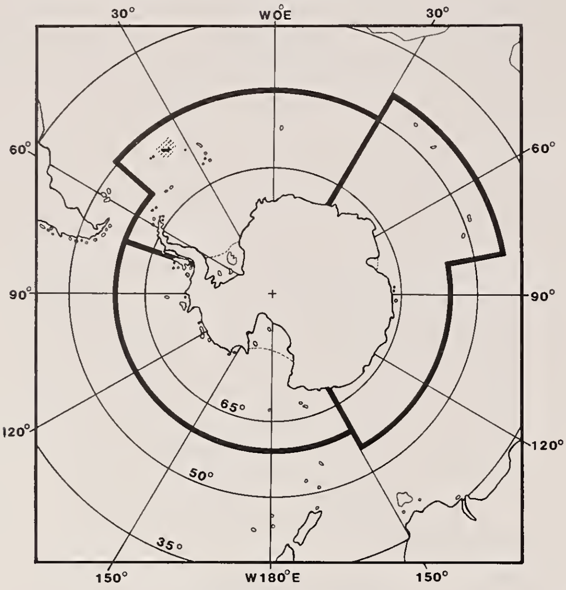


Fig. 23. *Psilodraco breviceps* ISH 666/78, 165 mm SL, South Georgia Island (54°04′S, 36°17′W)

Distribution: Endemic to the insular shelf of South Georgia Island, between 60–345 m.



Distribution of *P. breviceps*

Remarks: Unlike all other bathydraconid genera, the preopercular-mandibular sensory canal of *P. breviceps* is usually divided into 2 segments. The first segment, with 4 pores, runs along the lower jaw and the second segment, with 6 pores, follows the contour of the preopercle. Two of the 14 specimens examined had a continuous canal of 9 pores. Variation in the number of pores was observed in the preopercular segment which had 7 pores in one fish. Five pores represent the common condition of the supraorbital canal. Occasionally, a sixth pore opens at the posterior end of this canal, at its joint with the temporal canal. This condition was observed on both sides of the head in 3 specimens. Two other specimens had 6 pores only on one side of the head.

Permitin (1973) counted 1,340 eggs in one female. At the beginning of maturity (stage III) egg diameter was 0.4–0.9 mm. Spawning apparently takes place during autumn and early winter (Permitin 1973). Judging from the capture of 16.9 mm larvae in August (Efremenko 1983), hatching probably occurs in winter. The larvae of of *P. breviceps* were described by Efremenko (1983).

Attains about 20 cm SL.

Genus *Racovitzia* Dollo, 1900

Body covered with small, ctenoid scales. Three lateral lines of tubular scales. Opercle with a strong ridge ending in either a rounded point or a few serrations. Jaws with small, conical teeth in bands. Branchiostegal rays 7. Monotypic

Racovitzia glacialis Dollo, 1900

Fig. 25

Racovitzia glacialis Dollo, 1900c: 318 (71°19′S, 87°37′W). Holotype: IRSNB 3.

Aconichthys harrissoni Waite, 1916: 30, pl. 2, fig. 1, off Shackleton Ice Shelf (65°06′S, 96°13′E).

Diagnosis: D 33–37; A 28–31; P 23–25; GRA (2–5)+(8–14); GRP (0–3)+(8–11); ULL 78–91; MLL 7–15; LLL 5–22; vertebrae 52–54. Body depth at pectoral fin base 9.3–13.2 in SL and body width 0.8–1.0 in the depth. Head length 3.1–3.4 in SL. Snout length 2.9–3.4, eye diameter 3.6–4.6 and upper jaw length 2.8–3.2 in HL. Distances from snout to dorsal-fin origin 2.1–2.3, to pelvic-fin insertion 3.4–3.9 and to anal-fin origin 1.8–1.9 in SL. Body elongate and slender, only slightly compressed. Head slightly depressed, snout long and spatulate. A few rows of scales on upper part of opercle and preopercle. Cephalic sensory canals slightly enlarged, pores arranged as follows: Preopercular-mandibular 10; infraorbital 7; supraorbital 4; temporal 5–6; supratemporal 3; coronal pore present. Nostril immediately behind anteriormost infraorbital pore.

COLOUR: In alcohol, body and head brown, but paler on lower half of body and ventral surface of head. Irregular spots and lines on upper half of body and top of head; markings on body sometimes form dark saddles. Lower half of body usually without markings or with faint ones. Pectoral-fin base dark. Dorsal-fin rays spotted. Anal fin with a dark distal band gradually fading anteriorly. Pectoral fin with 2–4 bars and pelvic fins dusky with blackish anterior rays. Caudal fin dusky, its lowermost rays black and a black spot at base of uppermost rays.

Otoliths

DIAGNOSTIC FEATURES: The generally triangular shape, the ostial and homosulcoid sulcus acusticus, the clearly separated crista superior into anterior and posterior sections and the ventral groove below the crista inferior.

Intraspecific variation: The geometric shape is somewhat variable, but there is hardly any variation in the medial microstructure.

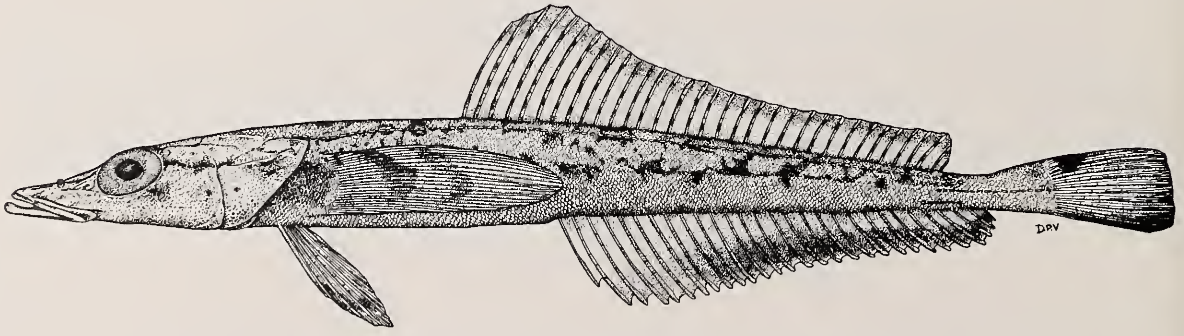
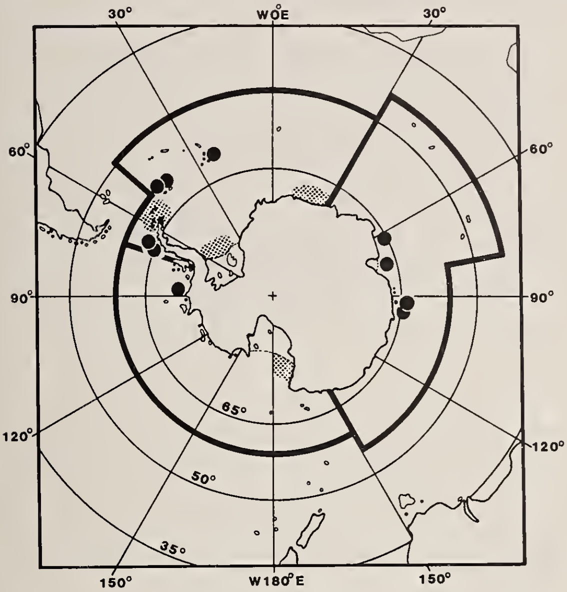


Fig. 25. *Racovitzia glacialis* ISH 163/85, 197 mm SL, South Orkney Islands (60°55.3′S, 46°45.4′W)

Fig. 26. Representative otolith of *R. glacialis*; fish length 23 cm SL; scale bar 1 mm

Distribution: Circum-Antarctic on continental shelf. Insular shelf of the South Sandwich Islands, South Orkney Islands, Elephant Island and South Shetland Islands. Depth range 219–610 m.



Distribution of *R. glacialis*

Remarks: The common condition of the temporal sensory canal is of 6 pores. In specimens with counts of 5 pores, the posteriormost sixth pore was absent or could not be found due to damaged skin. DeWitt (1964b) and DeWitt & Hureau (1979) suggested that the middle and lower lateral lines develop later than the upper lateral line, that the lower line is usually absent in fishes smaller than 130 mm SL, and that both lateral lines increase in length with age. In this study, the smallest fish with a distinct lower lateral line was 111 mm SL. In smaller specimens the lower line was absent, but so were most scales of the other 2 lines. I suspect that the development of the middle and lower lateral lines is completed at a much earlier stage, but their deciduous scales are often lost in the nets. The lateral lines of *R. glacialis* may be either separate or connected to each other. A vertical tube connects the rear end of the upper and lower lines to the middle line. A connection may be present on one side of a fish but absent on the other. In cases of both upper and lower lines connected to the middle line, the connections are opposite each other (Fig. 1c). The most common condition appears to be a connection between the upper line and the middle line. The gill rakers are normal in young fishes, but are slowly resorbed with growth to become elevated projections slightly higher than wide.

Little is known of the biology of *R. glacialis*. Kellermann (1989) reported 12–13 mm TL larvae from the Bransfield Strait in the second half of November and suggested that hatching occurs in spring. The presence in summer of both larvae and juveniles led Kellermann (1989) to propose that pelagic development in *R. glacialis* is long and stretches throughout winter to the second summer. Waite (1916) reported that the stomach of his holotype contained amphipods. Takahashi (1983) found only *Euphausia superba* in the stomach of a single fish caught north of the South Shetland Islands. The dependence on krill is also indicative from the association of juvenile *R. glacialis* with krill concentrations in oceanic waters off the ice edge of the north-west Weddell Sea (Kellerman & Kock 1984).

Attains 24 cm SL.

Genus ***Vomeridens*** DeWitt & Hureau, 1979

Body covered with ctenoid scales. Two lateral lines of tubular scales. Opercle with no spines or hooks. Gill rakers well developed. Jaws with small, conical teeth in bands. Branchiostegal rays 6. Monotypic; rare.

Vomeridens infuscipinnis (DeWitt, 1964)

Fig. 27

Racovitzia infuscipinnis DeWitt, 1964b: 502, Weddell Sea (77°42′S, 41°04′W). Holotype: SU 58571.

Diagnosis: D 31–34; A 31–32; P 29–32; GRA (including rudiments) (3–5)+(12–14)=15–18; GRP (1–2)+(10–13); ULL 47–51; MLL 8–15; vertebrae 53–55. At

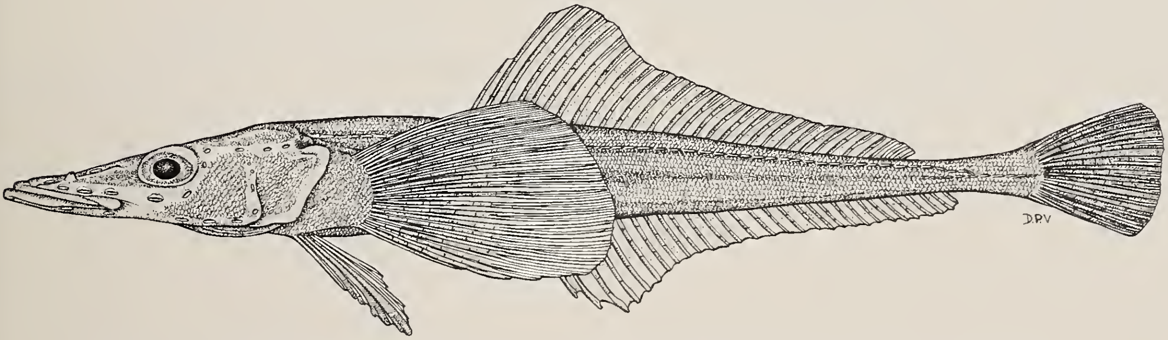


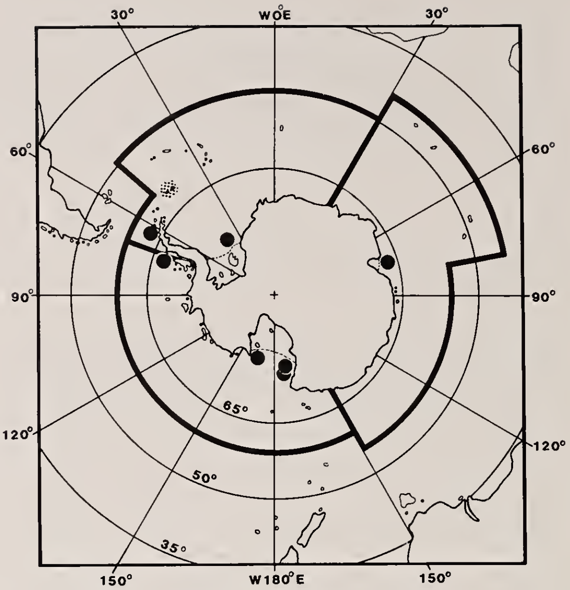
Fig. 27. *Vomeridens infuscipinnis* USC-*Elatanin* station 2104, 178 mm SL (77°33′S, 163°02.5′W)

pectoral-fin base, body depth 8.0–9.6 in SL and body width 0.9–1.1 in its depth; body depth at anal-fin origin 8.4–10.1 and head length 3.1–3.3 in SL. At preopercle edge, head depth 2.6–3.1 and head width 2.7–3.1 in HL. Snout length 2.6–2.7, eye diameter 4.2–5.0, interorbital width 9.4–12.2 and upper jaw length 2.5–2.9 in HL. Distances from snout to dorsal-fin origin 2.1–2.3, to pelvic-fin insertion 3.5–3.7 and to anal-fin origin 1.9–2.0 in SL. No teeth on palatines; vomer usually with teeth in specimens larger than 10 cm SL. Patches of scales present on opercle and preopercle. Cephalic sensory canals and pores enlarged, pores arranged as follows: preopercular-mandibular 10; infraorbital 7; supraorbital 4; temporal 5–6; supratemporal 2+2; coronal pore present. Nostril behind anteriormost infraorbital pore.

Colour: In alcohol, body and head brown, abdomen somewhat darker. Pelvic fins dusky and caudal fin dark brown. Other fins pale.

Distribution: Weddell and Ross seas, South Orkney Islands and Antarctic Peninsula. Possibly circum-Antarctic on the continental shelf. Depth range 500–813 m.

Remarks: DeWitt (1964b) and DeWitt & Hureau (1979) described the supratemporal canal of *V. infuscipinnis* as composed of 2 separate segments, each with a single pore. Two *Eltanin* specimens examined for this study had 2 pores in each segment of this canal. In addition, one of these specimens (160 mm SL) had no vomerine teeth. Young *V. infuscipinnis,* which lack vomerine teeth, closely resemble small *Racovitzia glacialis* in which the third (lower) lateral line may have not yet developed. The latter species differs in having 7 branchiostegal rays, a complete supratemporal canal with 3 pores, and fewer pectoral-fin rays.



Distribution of *V. infuscipinnis*

Biology unknown. Attains 22 cm SL.

CHANNICHTHYIDAE

Icefishes

by T. IWAMI & K.-H. KOCK

Body elongate and tapered. Head depressed; snout depressed and spatulate, with a single nostril. Two separate dorsal fins, first with 3–15 weak spines and the second with 26–47 soft rays. Anal-fin rays 24–49. Pectoral fin large and fanlike, with 19–27 rays. Pelvic fins jugular, broad or elongate, I,4 or I,5. Principal branched caudal-fin rays 11–12. Gill membranes narrowly united to isthmus or forming a fold over it; branchiostegal rays 6–9. Mouth large and not protractile; teeth in both jaws small, conical, in narrow bands. Opercular bones usually with radiating ridges terminating in branched or simple spines; upper part of cleithrum not bifurcate; spines on sub- and interopercles present or absent. Two or three lateral lines of tubular scales or bony plates; body otherwise naked. Gill rakers dentigerous or vestigial; two pharyngobranchials. Vertebrae, 22–31 abdominal; 25–43 caudal; total 49–71. Ribs not ossified. Basisphenoid absent. Swim-bladder absent.

The Channichthyidae are unique among vertebrates in the complete, or nearly complete lack of haemoglobin in their blood cells. Antarctic endemics; only one species, *Champsocephalus esox,* occurs in the Patagonian–Falkland region. Eleven genera and 15 (Hureau 1985) or 16 species of primarily benthic fish, but showing a rather active vertical migration to feed on pelagic prey. Some species are commercially exploited. Taxonomic revisions by Regan (1914b), Norman (1938), Iwami (1985), and Hureau (1985c).

Unless specified otherwise, fish lengths are given as the total length (TL).

Remarks: Richardson (1844b: 15, pl. 8, fig. 3) described *Pagetodes* from a fish found frozen on board the *Terror* in the Ross Sea. Unfortunately, the specimen was lost to the ship's cat who ate it before a proper drawing and description could be prepared. The illustration in Richardson (1844b), although showing a fish with a single dorsal fin, represents a channichthyid fish. Regan (1913) suggested that it can be related to either *Cryodraco* or *Pagetopsis* and Norman (1938) preferred the former genus. It is impossible, however, to relate it to any known genus with certainty. *Pagetodes* is therefore treated herein as a *nomen dubium* within the family Channichthyidae.

KEY TO GENERA

1a	Third V ray longest	2
1b	First or second V ray longest	6
2a	LL with bony plates; small tubercles on dorsal surface of head	*Channichthys*
2b	LL without bony plates; no tubercles on dorsal surface of head	3
3a	Rostral spine present	4
3b	Rostral spine absent; 2 LL	*Champsocephalus*
4a	Two LL	*Pagetopsis*
4b	Three LL	5
5a	GR developed as dentigerous patches	*Pseudochaenichthys*
5b	GR developed as non-dentigerous low knobs	*Neopagetopsis*
6a	No spines on subopercle and interopercle	7
6b	Subopercle and interopercle each with a spine at junction.	10
7a	Two LL	8
7b	Three LL	9
8a	MLL absent; ULL and LLL present; opercular spine not branched	*Dacodraco*
8b	ULL and MLL present; LLL absent; opercular spine well developed and branched	*Chaenocephalus*
9a	A rays more than 40	*Cryodraco*
9b	A 33–34	*Chionobathyscus*
10a	V I,5	*Chionodraco*
10b	V I,4	*Chaenodraco*

Genus *Chaenocephalus* Regan, 1913

Rostral spine reduced to a low knob. Gill rakers vestigial. Branchiostegal rays 2 (on epihyal) + 4 (on ceratohyal) = 6. Dorsal hypohyal cartilaginous. First infraorbital bone with dorsal expansion. Opercle with 3–4 developed spines on posterodorsal corner; subopercle and interopercle without spines. Two lateral lines without bony plates. Pelvic fins elongate, their distal ends thickened; second ray longest. Dorsal fins separated. Caudal fin rounded. Monotypic.

Chaenocephalus aceratus (Lönnberg, 1906)
Blackfin icefish
Fig. 1; Pl. 9, Fig. 3

Chaenichthys aceratus Lönnberg, 1906: 40, Cumberland Bay, South Georgia Island. Holotype: NRM SYD/1904508.3001.

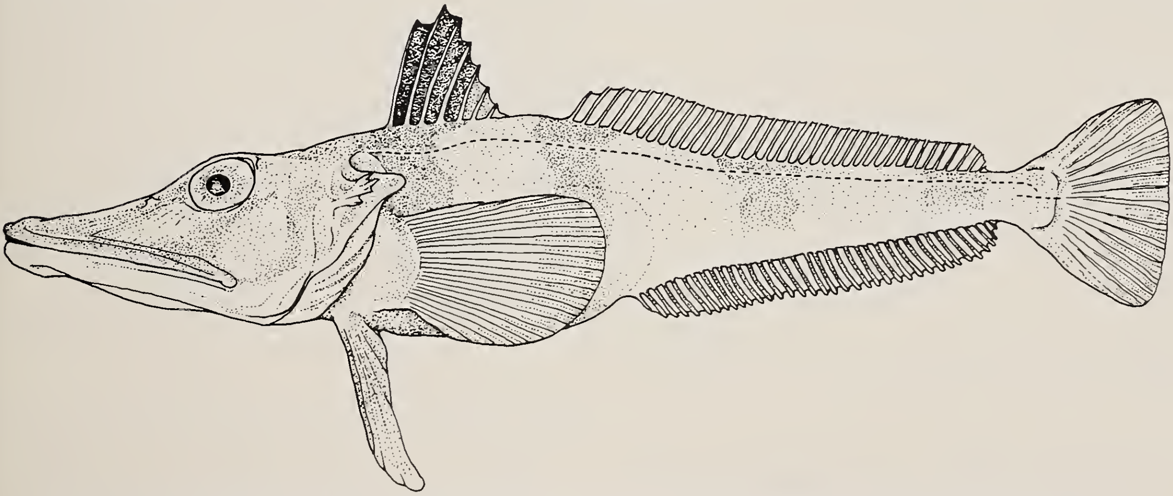


Fig. 1. *Chaenocephalus aceratus* IBUT 82–702, 45 cm SL, off South Shetland Islands (61°15′S, 55°02′W)

Chaenocephalus aceratus Regan, 1913: 288, pl. 11.

Chaenocephalus bouvetensis Nybelin, 1947: 51, pl. 6, figs. 1–2, Bouvet Island.

Diagnosis: D V–IX+37–42; A 36–40; P 23–26; branched C rays 11; lower GR 4–6; vertebrae 60–64. Depth of body 10.7–17.8% and head length 33.0–42.2% SL. Snout length 45.8–56.6%, eye diameter 13.8–23.3%, and interorbital width 15.6–23.0% HL. Pelvic fins elongate, extending over anal-fin rays, and becoming proportionally shorter with growth, 45.2 (113 mm SL) to 19.3 (455 mm SL) %SL; in large fish pelvic-fin rays reach anterior anal-fin rays; in small specimens (less than 150 mm SL), they reach 20th anal-fin ray or beyond it. Maxilla extending to below middle of eye or farther posteriorly. Jaws equal anteriorly. Preopercular-mandibular canal not joined to temporal canal. Upper lateral line ending behind last dorsal-fin ray; middle lateral line restricted to caudal peduncle. Supraorbital ridges well developed and crenulated in large specimens.

COLOUR: In life, body greyish, pale ventrally, with 4–5 dark cross-bars on sides of body. First dorsal fin dusky to blackish; other fins pale to dusky. In juveniles, cross-bars on body yellowish-green.

Otoliths

DIAGNOSTIC FEATURES: The poorly-defined sulcus acusticus, the thick ventral half and the comparatively thin and flat dorsal half.

Ontogeny: The most apparent ontogenetic feature is the change in the sculpture of the dorsal margin, from entire to lobed to crenulate in fish larger than 25 cm SL. The excisural angle becomes more acute with an increase in fish size, and the shape changes from square to fusiform.

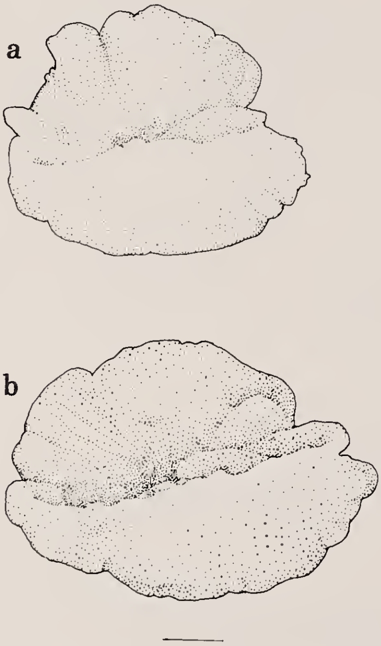
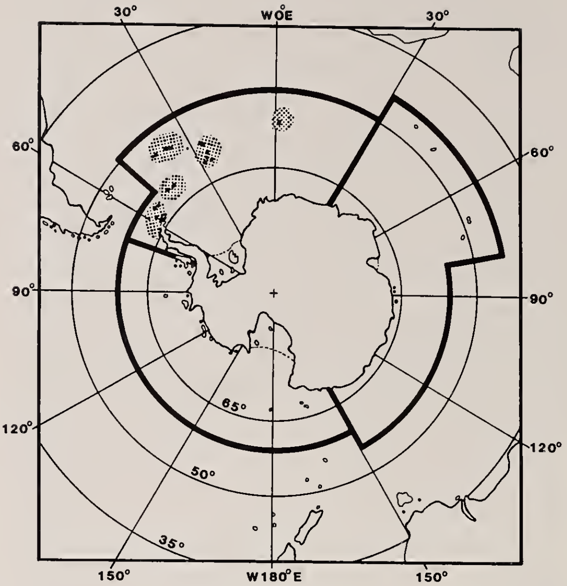


Fig. 2. Representative otoliths of *C. aceratus*; fish lengths: (a) 58 cm, (b) 65 cm TL; scale bar 1 mm

Distribution: Vicinity of Bouvet Island, Scotia Sea Islands, and northern part of Antarctic Peninsula. Depth range 5–770 m (Hureau 1985c).



Distribution of *C. aceratus*

Remarks: Nybelin (1947) described *Chaenocephalus bouvetensis* from 2 photographs, using the size of the head, eye, spinous dorsal fin, and pectoral fin as diagnostic characters to distinguish *bouvetensis* from *aceratus*. Detailed morphological studies (Kock 1981; Gubsch 1982) showed that Nybelin's (1947) proportional measurements do not justify a separate species for Bouvet Island fishes.

Length at first spawning around South Georgia is 58.4 cm in females and 47.5 cm in males (Gubsch 1982). Around Elephant Island, it was slightly lower, 57.1 cm and 45.7 cm respectively (Kock 1989). Spawning occurs from March to May in the coastal water of South Georgia and from May to June at Elephant Island (Kock 1989). In fishes from both Islands, the diameter of ripe eggs was 4.4–4.7 mm (Permitin 1973; Riehl & Kock 1989). Eggs are apparently demersal (Permitin 1973). Absolute fecundity was 3,082–22,626 oocytes in fishes 48–73 cm in length around South Georgia (Lisovenko & Sil'yanova 1980; Kock 1981); 4,499–15,174 oocytes in fish of 52–67 cm around the South Orkney Islands (Kock 1981); 6,711–19,672 oocytes in fish of 51–66 cm from Elephant Island (Kock 1989), and 6,375–12,450 oocytes in fish of 53–61 cm from the South Shetland Islands (Kock 1982). Hatching takes place in the spring (August-October) (Efremenko 1983; Slosarczyk 1987). Postlarvae in South Georgia were 10–30 mm SL in September and 51–77 mm SL in February (North 1988).

Post-larval stages and juveniles 26–35 cm (age classes III–IV) feed primarily on pelagic organisms (krill, mysids). Older juveniles and adults are bottom dwelling, feeding mostly on fish and, to a lesser extent, krill (Permitin & Tarverdiyeva 1972; Kock 1981; Gubsch 1982). Among the fishes consumed, channichthyids and nototheniids were most frequent, occasionally bathydraconids or muraenolepids were present (Kock 1981; Takahashi 1983).

A study of the parasites of *C. aceratus* showed that at least 4, apparently separate, populations exist in the Scotia Sea region, in the South Shetland, Elephant, South Orkney, and South Georgia islands (Siegel 1980).

Chaenocephalus aceratus is a by-catch species in the trawl fishery mainly around South Georgia. Reported annual catches were mostly in the order of several hundred tonnes, but exceeded 1,000–2,000 tonnes in the 1977–78, 1978–79, 1979–80, and 1984–85 seasons. Actual catches may have been higher as catches of this species are recorded only by Poland and East Germany, but not by the Soviet Union.

Females attain 75 cm and males 58 cm TL.

Genus *Chaenodraco* Regan, 1914

Tip of snout with an antrorse rostral spine. Gill rakers dentigerous. Branchiostegal rays 2 (on epihyal) + 4 (on ceratohyal) = 6; dorsal hypohyal cartilaginous. Opercular bones with developed spines; subopercle and interopercle each with a spine at their juncture. Three lateral lines without bony plates. Pelvic fins with 1 spine and 4 soft rays, the 2 outer rays longest. Bases of first and second dorsal fins more or less contiguous. Caudal fin truncate or slightly rounded. Monotypic.

Chaenodraco wilsoni Regan, 1914

Spiny icefish

Fig. 3

Chaenodraco wilsoni Regan, 1914a: 14, McMurdo Sound. Holotype: BMNH 1913.12.4.180.

Chaenodraco fasciatus Regan, 1914a: 14, McMurdo Sound (77°13′S, 164°18′E).

Diagnosis: D V–VIII, 38–42; A 32–36; P 21–24; branched C rays 11; lower GR 12–16; vertebrae (22–26)+(36–39)=60–63. Body depth 13.5–17.7%, head length 29.2–35.1%, and pelvic-fin length 24.1–31.6% SL. Snout length 39.3–45.4%, eye diameter 21.6–26.8%, and interorbital width 24.9–31.3% HL. Supraorbital ridge not crenulated. Middle lateral line restricted to caudal peduncle; lower lateral line originating from in front of anal-fin origin to above 6th anal ray. Maxilla extending to below anterior third of eye. Opercular bones with 2 upper and 3 lower spines. Preopercular–mandibular canal not joined to temporal canal. Pelvic fins extending beyond anal-fin origin.

Colour: In life, pale grey, whitish ventrally. Five dark cross-bars on sides of body; often additional blotches between bars. An oblique dark spot on first dorsal fin, and a series of small, dark spots forming stripes on second dorsal fin.

Otoliths

Diagnostic features: The dorsoventrally oval shape; the prominent distally rounded rostrum, pseudo-rostrum and pseudo-antirostrum; the clearly defined excisura ostii and pseudo-excisura ostii; the acutely constricted collum; and the well developed colliculli.

Ontogeny: The excisura ostii and the pseudo-excisura ostii become deeper and the crista inferior becomes less distinct with an increase in the fish size.

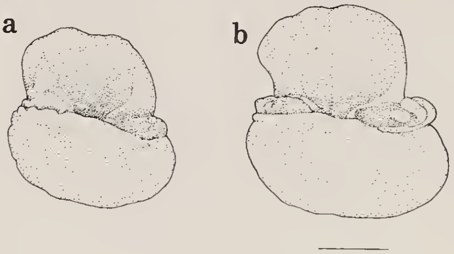


Fig. 4. Representative otoliths of *C. wilsoni*; fish lengths: (a) 24 cm, (b) 31 cm TL; scale bar 1 mm

Distribution: Circum-Antarctic on Antarctic continental shelf. Northernmost records from vicinity of South Orkney Islands and Antarctic Peninsula. Depth range 200–800 m; postlarvae and pelagic juveniles also in the upper 100 m.

Remarks: *C. wilsoni* matures at about 23 cm and probably spawns in the austral summer (Pszeniczkov 1988). Fecundity was 393, 406, and 862 eggs in specimens of 26.3, 29.0, and 27.5 cm SL respectively. Egg size was 4.4–4.9 mm (Gerasimchuk & Trozenko 1988). Pelagic juveniles inhabited nearshore surface waters in December off South Orkney Islands (Efremenko 1979b) and in November off Elephant Island (about 30 m depth). Juveniles and sub-adults are often caught along with krill in late January and February in the Scotia Sea region (Rembiszewski *et al.* 1978; Slosarczyk & Rembiszewski

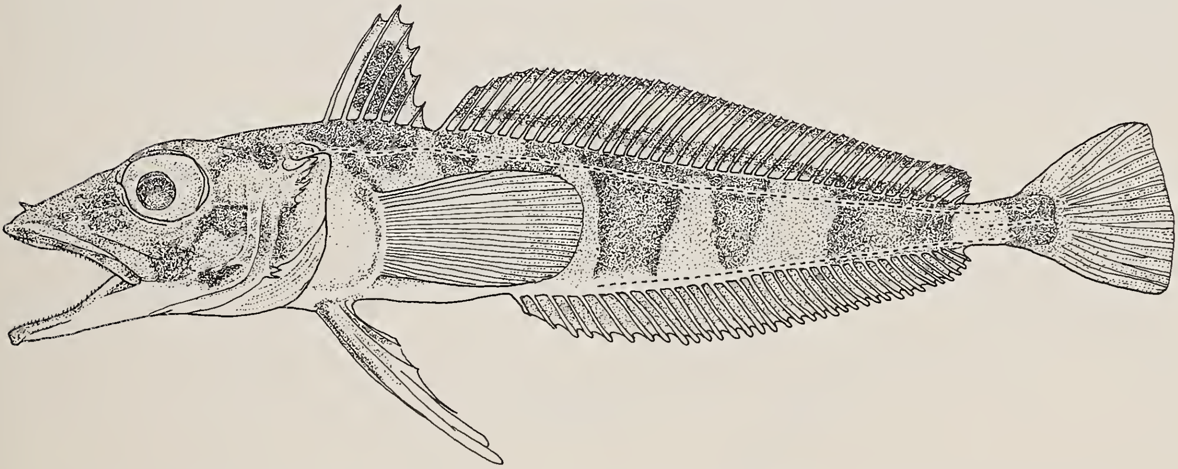
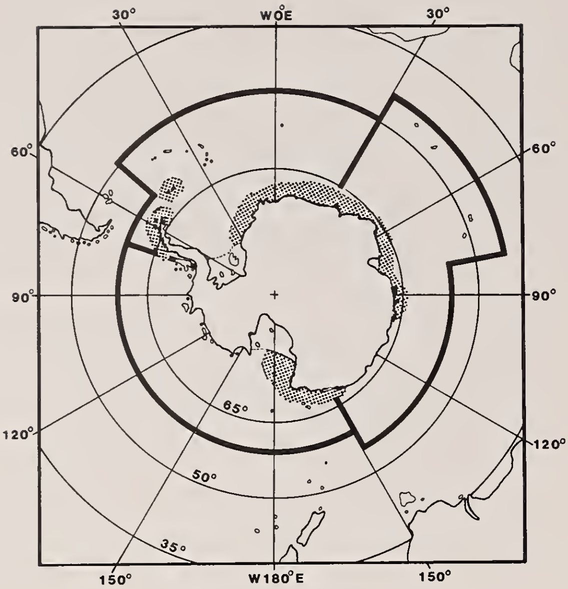


Fig. 3. *Chaenodraco wilsoni* IBUT 82–0914, 24 cm SL, off South Shetland Islands (63°12′S, 58°57′W)



Distribution of *C. wilsoni*

1982; Kellermann & Kock 1984; Slosarczyk 1987). Adults feed mainly on krill and fishes. *Euphausia crystallorophias* and *Pleuragramma antarcticum* were found in stomachs of specimens collected in the Ross Sea (Takahashi & Nemoto 1984).

Catches of *C. wilsoni* have been reported from 2 fishing seasons north and north-east of Joinville Island (FAO Subarea 48.1): 1978–79, 10,130 and 1979–80, 4,320 tonnes respectively. Since 1984–85, the species is taken regularly in an exploratory fishery by the Soviet Union off the coast of the Antarctic continent in the Indian Ocean sector (FAO Division 58.4.2). Depending on the ice conditions and the availability of fish concentrations, catches fluctuated between 270 tonnes (1984–85) and 1,816 tonnes (1987–88).

Attains 43 cm TL.

Genus ***Champsocephalus*** Gill, 1862

Rostral spine absent. Gill rakers well developed and dentigerous. Lower jaw not projecting. Branchiostegal rays usually 2 (on epihyal) + 5 (on ceratohyal) = 7; dorsal hypohyal ossified. Opercular bones usually with 3 radiating ridges terminating in spinous points; subopercle and interopercle without spines. Two lateral lines without bony plates (lower line absent). Bases of first and second dorsal fins more or less contiguous. Middle rays of pelvic fins longest. Caudal fin emarginate. Two species adapted to pelagic mode of life.

KEY TO SPECIES

1a P 22–24; A 31–35; head depth much shorter than snout length..*C. esox*
1b P 25–28; A 35–40; head depth slightly longer than snout length..*C. gunnari*

Champsocephalus esox (Günther, 1861)
Northern icefish
Fig. 5

Chaenichthys esox Günther, 1861: 89, Port Famine. Holotype: BMNH, stuffed specimen.

Champsocephalus esox Gill, 1862: 510.

Diagnosis: Based on specimens from the Patagonian-Falkland region. D IX–X+32–37; A 31–35; P 22–24; lower GR 10–18; vertebrae (27–29)+(29–31)=58–59. Body depth 12.0–13.2%, head length 26.3–34.1%, and pelvic-fin length 15.7–20.4% SL. Snout length 33.8–47.6%, eye diameter 12.9–14.4% and interorbital width 16.0–26.2% HL. Head depth much shorter than snout length. Upper lateral line ending below last dorsal-fin ray; middle lateral line relatively long, originating behind mid-length of second dorsal-fin base. Maxilla extending to below anterior third of eye or to about middle of pupil. Preopercular-mandibular canal not joined to temporal canal. Pelvic fins not reaching anal-fin origin. Caudal fin emarginate.

Colour: Body whitish, with irregular dark brown bars; bars sometimes broken into irregular dark blotches interconnected with yellowish regions. Dorsal fins brown, anal fin dusky with whitish margin. Pelvic and pectoral fins yellow-brown; proximal half of pelvic fins paler. Caudal fin dark brown.

Distribution: Patagonian-Falkland region, Straits of Magellan; rarely at South Georgia. Depth range 50–250 m.

Remarks: *Champsocephalus esox* does not normally occur south of the Antarctic Convergence (Norman 1937a; DeWitt 1971). Despite the active fishing around South Georgia, the 3 specimens from South Georgia reported by DeWitt *et al.* (1976) and Targett (1981) are the only records of this species from CCAMLR area.

In the Patagonian region *C. esox* is trawled from January to March, but no fish are caught during the winter (Hart 1946; Norman 1937a; Nakamura 1986e). One of the specimens collected at South Georgia preyed heavily on krill, *Euphausia superba,* which comprised about 90% of the total weight of the stomach contents; the rest was fish (Targett 1981).

Attains 35 cm SL.

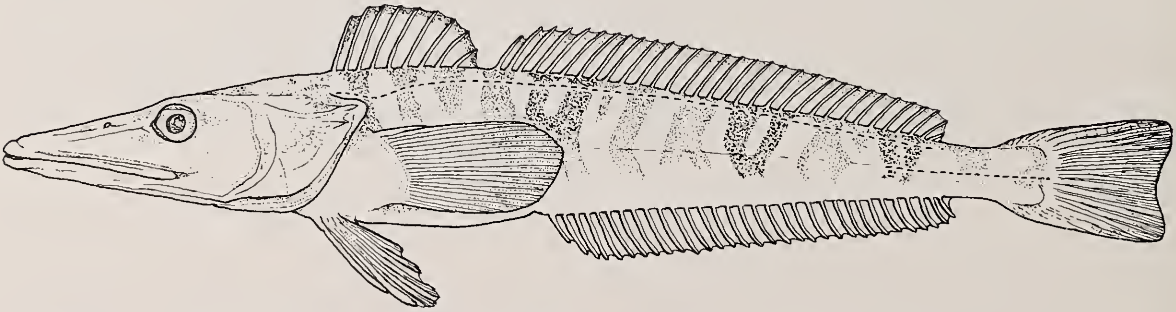
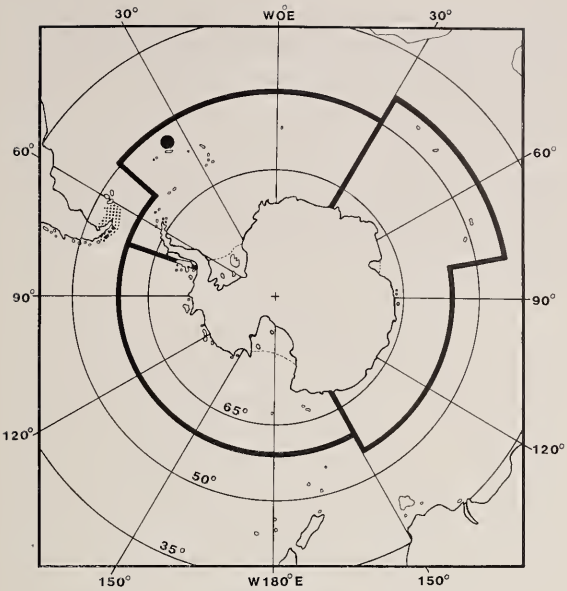


Fig. 5. *Champsocephalus esox* BMNH 1936.8.26.931–940, 152 mm SL, off Falkland Islands (51°01.5′S, 60°31′W)



Distribution of *C. esox*

Champsocephalus gunnari Lönnberg, 1905
Mackerel icefish
Fig. 6; Pl. 10, Fig. 1

Champsocephalus gunnari Lönnberg, 1905b: 37, Cumberland Bay, South Georgia. Syntypes: NRM SYD/1902224.3158 and SYD/1902809.9297.

Diagnosis: D VII–X+35–41; A 35–40; P 25–28; branched C rays 12; lower GR 11–20; vertebrae 58–64. Depth of body 10.9–15.0%, head length 26.3–33.5% and pelvic-fin length 15.8–20.4% SL. Snout length 33.8–47.6%, eye diameter 16.2–26.4% and interorbital width 16.0–29.5% HL. Head depth slightly greater than snout length. Upper lateral line ending behind last second dorsal-fin ray; middle lateral line relatively long, originating behind mid-length of second dorsal-fin base. Maxilla extending to below anterior third of eye. Teeth of both jaws small, forming 2 series of narrow bands. Caudal fin emarginate.

Colour: In life, body pale silvery grey with purplish tinge, whitish ventrally. Head and back dark, a series of irregular dark cross-bars on side of body, 4 bars usually darker then others. Young fish more silvery. Dorsal and anal fins darker or blackish in adult fishes.

Otoliths

Diagnostic features: The generally discoid shape and the anterior and posterior projections of the colliculi beyond the anterior and posterior margins.

Intraspecific variation: Negligible, except for the anterior and posterior projections of the colliculi which in some specimens are more prominent than in others.

Ontogeny: The most apparent ontogenetic features are the collicular projections. In specimens smaller than 23 cm TL the projections are absent, whereafter they become more prominent with an increase in the fish length. The geometric shape also changes with the development of the collicullar projections.

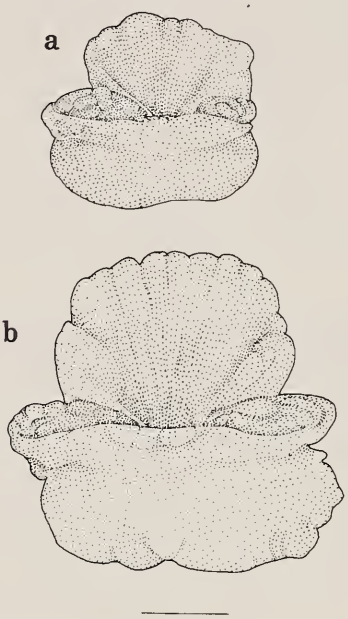


Fig. 7. Representative otoliths of *C. gunnari*; fish lengths: (a) 24 cm, (b) 50 cm TL; scale bar 1 mm

Distribution: Islands of the Scotia Sea, including northern part of Antarctic Peninsula; Kerguelen, Heard, and Bouvet islands. Depth range, from the surface to 700 m.

Remarks: Sexual dimorphism exists in the size of the first dorsal fin which is distinctly higher in adult males than in adult females; the second dorsal and anal fins of mature males have a distinctive white margin.

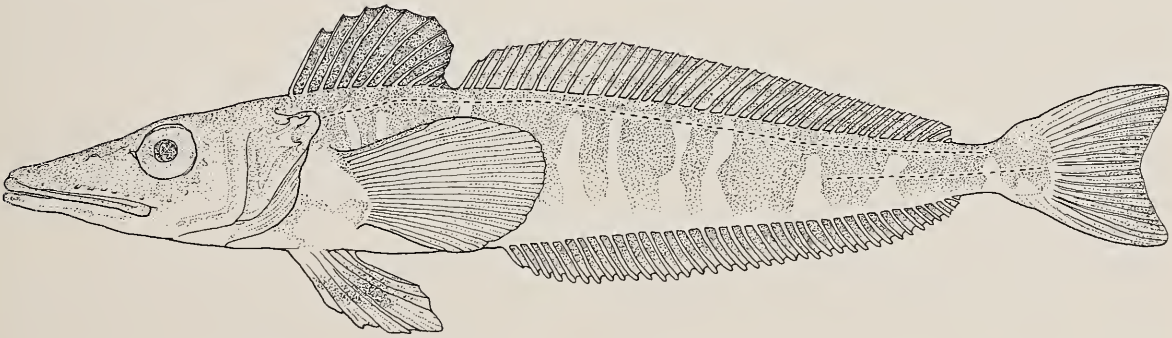
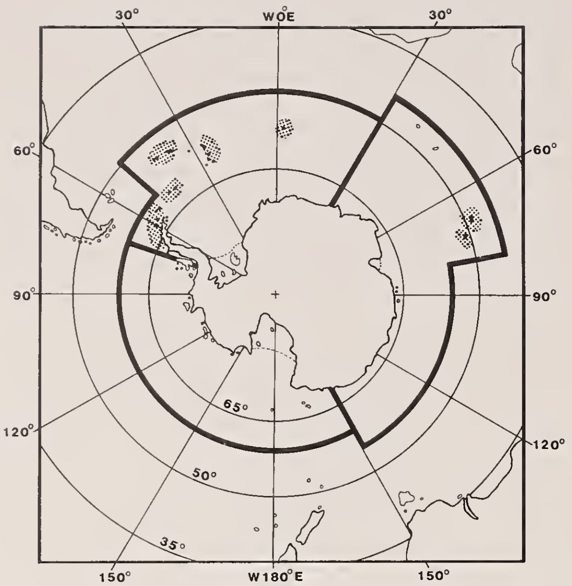


Fig. 6. *Champsocephalus gunnari* IBUT 81–447, 29 cm SL, off South Shetland Islands (62°31′S, 62°06′W)



Distribution of *C. gunnari*

C. gunnari spawns in the fjords and coastal waters of South Georgia from March to May (Olsen 1955; Lisovenko & Sil'yanova 1980; Kock 1981; Sosinski 1981). Spawning off Elephant Island probably occurs in May–June (Kock 1989). In the Indian Ocean sector, spawning takes place in May–June on Skif Bank and in August–September around the Kerguelen Islands (Duhamel 1987b). Length at first spawning was about 25 cm in South Georgia, Kerguelen Islands and Skif Bank, but about 35 cm around South Orkney Islands and in the South Shetland-Elephant Islands region (Sosinski 1981; Kock in press). Absolute fecundity was 1,564–31,045 eggs in fishes of 22–57 cm from South Georgia (Kock 1981). It rarely exceeds 10,000 eggs in other populations. Absolute fecundity obviously follows a latitudinal trend. It was highest around the Kerguelen Islands and lowest around Elephant Island and the South Shetland Islands (Kock in press). Egg diameter was 2.6–3.2 mm on Skif Bank and around the Kerguelen Islands (Duhamel 1987b), 3–4 mm around South Georgia (Lisovenko & Sil'yanova 1980), and 3.5–4.1 mm around Elephant Island (Kock 1989). Although oil droplets are absent, the thin chorion of the egg may indicate that the eggs are benthopelagic or pelagic (Permitin 1973; Riehl & Kock 1989). Hatching apparently occurs from August to October around South Georgia (North 1988) and in October around the Kerguelen Islands (Duhamel 1987b). In the Antarctic Peninsula (Elephant Island), larvae were not observed before early January (Kellermann 1989).

In South Georgia, *C. gunnari* feeds mainly on krill, the amphipod *Themisto gaudichaudii*, and mysids; occasionally myctophids are also taken. In more southern areas, krill makes up more than 95% of the diet (Permitin & Tarverdiyeva 1978; Kock 1981; Tarverdiyeva 1982; Takahashi 1983). In the Kerguelen Islands area, the main food items were euphausiids, hyperiids and myctophid fishes (Duhamel & Hureau 1985).

Based on morphological and meristic features and patterns of infestation by parasitic copepods, 5–6 populations of *C. gunnari* have been identified: South Georgia, South Orkney, South Shetland Islands, and possibly Elephant Island in the Atlantic Ocean sector; Skif Bank and the Kerguelen Islands in the Indian Ocean sector (Siegel 1980; Kock 1981; Duhamel 1987b). The dynamics of the Kerguelen Islands and Skif Bank populations follow a distinct three year cycle which was not apparent in the Atlantic populations.

C. gunnari is a target species in a fishery with annual catches of 100,000–140,000 tonnes in fishing grounds of the Atlantic sector and 50,000–70,000 tonnes prior to the regulation of fishing in the Kerguelen Islands area. The fishery for this species has been regulated by total allowable catches (TACs) since 1979/80 in the Kerguelen Islands and 1987/88 around South Georgia.

Attains 66 cm TL in South Georgia, and 45 cm TL in Kerguelen Islands.

Genus *Channichthys* Richardson, 1844

Rostral spine pointing posteriorly and well developed. Dorsal surface of head with small tubercles. Gill rakers dentigerous. Branchiostegal rays usually 2 (on epihyal) + 4 (on ceratohyal) = 6; dorsal hypohyal cartilaginous. Opercle with 5–7 strong spines; posterior angle of subopercle and posteroventral angle of interopercle with short and somewhat blunt spines. Two lateral lines with bony plates; plates may be present elsewhere on the side of the body. Third pelvic-fin ray longest. First dorsal fin high, its rays with small tubercles in large specimens; bases of dorsal fins well separated. Caudal fin rounded. Probably monotypic, the status of *C. velifer* is discussed below.

Channichthys rhinoceratus Richardson, 1844
Unicorn icefish
Fig. 8

Channichthys rhinoceratus Richardson, 1844a: 461, Kerguelen Islands. Holotype: BMNH uncatalogued.

Chaenichthys rhinoceratus Richardson, 1844b: 12, pl. 5, figs. 1–3.

Chaenichthys rugosus Regan, 1913: 287, Kerguelen Islands.

?*Chaenichthys velifer* Meissner, 1974: 50, figs. 1–3, Kerguelen Islands.

Diagnosis: VI–XI+30–35; A 27–34; P 18–23; branched C rays 11; lower GR 8–14; vertebrae (21–24)+(29–34) = 53–58. Depth of body 10.5–16.5%, head length 37.3–41.3%, and pelvic-fin length 12.5–19.6% SL. Snout length 44.4–49.8%, eye diameter 12.9–18.7%, and interorbital width 12.7–19.6% HL. Maxilla extending to below anterior third of eye or beyond. Preopercular-mandibular canal not joined to temporal canal. Upper lateral line ending behind last second dorsal-fin ray; middle lateral line usually restricted to caudal peduncle, but sometimes with isolated plates along middle of body. Interorbital region relatively narrow and strongly concave. Supraorbital ridges developed and crenulated in large specimens. Lower part of posterior margin of subopercle serrated in large specimens. Pelvic fins not reaching anus.

Colour: Exhibits remarkable individual variation. In life, generally pale brown, with darker spots and reticulations; often with reddish patches. Four dark cross-bars on side of body of small specimens. First dorsal fin blackish, with or without small dots; other fins pale to dusky.

Otoliths

Diagnostic features: The near discoid shape, the pit-like collum, and the well developed homomorph colliculi.

Intraspecific variation: Negligible, except for the presence or absence of pseudorostrum and pseudoantirostrum.

Ontogeny: The sulcus acusticus becomes deeper and the colliculi, the rostrum, the antirostrum, as well as the dorsal area become more prominent and larger with growth.

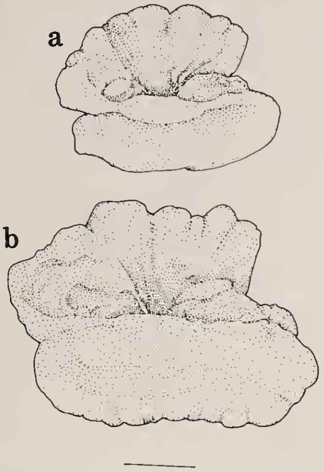
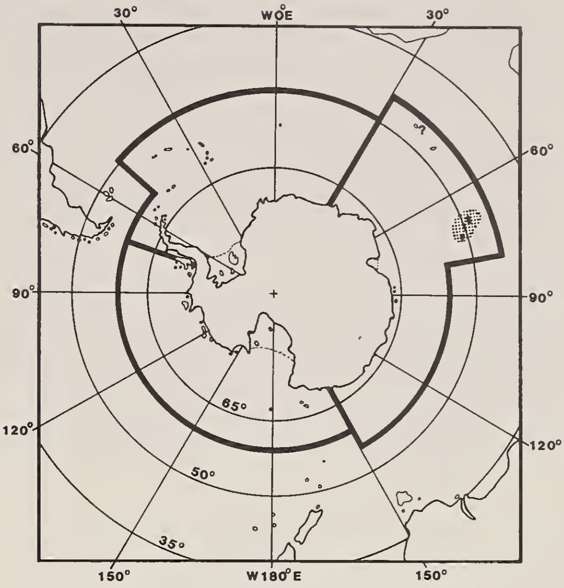


Fig. 9. Representative otoliths of *C. rhinoceratus*; fish lengths: (a) 24 cm, (b) 50 cm TL; scale bar 1 mm

Distribution: Endemic to Kerguelen-Heard plateau, from nearshore to more than 750 m depth (Hureau 1964, 1985c; Meissner & Kratky 1978; Williams 1983). A trawl survey of sub-Antarctic Islands from Bouvet in the Atlantic Ocean to Kerguelen and Heard Islands in the Indian Ocean indicated that channichthyid fishes might be absent from the Prince Edward and Crozet Islands (Duhamel *et al.* 1983). However, otoliths referrable to *C. rhinoceratus* were found in the stomach contents of gentoo penguins nesting on Marion Island, showing the presence of this species in the vicinity of the Prince Edward Islands (Gon & Klages 1988). It has not been established whether these fishes were part of a resident population or only occasional visitors.

Remarks: Fishes of the genus *Channichthys* show remarkable intraspecific variation. One form had been described as a different species, *C. rugosus* (Regan, 1913), but Hureau (1964) placed it in the synonymy of *C. rhinoceratus* based on a detailed study of meristic characters. Hureau (1985c) regarded *C. velifer* as a valid species, but mentioned that it is often considered a junior synonym of *C. rhinoceratus*.



Distribution of *C. rhinoceratus*

Meissner (1974) distinguished *C. velifer* from *C. rhinoceratus* by the shape of the first dorsal fin and the presence or absence of series of bony plates on the side of the body. *C. velifer* has 10–11 dorsal-fin spines of which 4 (3rd–6th or 4th–7th) and occasionally 3 (4th–6th) are longest. In contrast, *C. rhinoceratus* has 6–9 dorsal-fin spines of which 2 (2nd–3rd or 3rd–4th) or rarely 3 (2nd–4th) spines are longest. In addition, *C. velifer* has a single median series of bony plates restricted to the posterior part of the side of the body (Meissner 1974). A morphometric comparison of the 2 species is presented below:

	rhinoceratus	*velifer*
As % SL		
Depth of body	10.5–16.5	11.1–15.7
Head length	37.3–41.3	37.3–39.5
Pelvic fin length	12.5–19.6	14.6–17.5
As % HL		
Snout length	44.4–49.8	45.0–47.3
Eye diameter	12.9–18.7	14.0–16.2
Interorbital width	12.7–19.6	15.2–18.3
D_1	VI–IX	X–XI
D_2	30–35	30–33
A	27–34	29–31
P	18–23	19–21

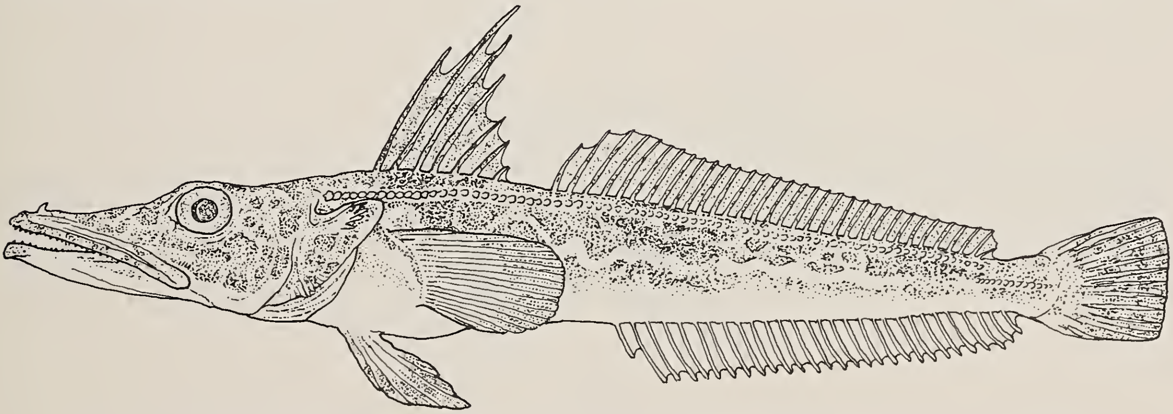


Fig. 8. *Channichthys rhinoceratus* MTUF 24882, 32 cm SL, off Kerguelen Islands (47°56′S, 68°09′E)

The morphometric similarity and the fact that most of the *velifer*-like specimens examined in this study were females suggest sexual dimorphism. Moreover, the shape of the first dorsal fin and the condition of the median series of bony plates are not always correlated as described by Meissner (1974).

Absolute fecundity range is 6,000–14,000 eggs (Hureau 1966b). Sexual maturity is reached at 36–38 cm length (Duhamel 1981). In January *C. rhinoceratus* migrates into shallow water and spawns in February; the spent fish return to deeper water in June (Hureau 1966b; Kock *et al.* 1985).

Fishes are the main food item in the diet of *C. rhinoceratus* (Hureau 1966b; Williams 1983). At Heard and McDonald islands the diet included nototheniid and harpagiferid fishes as well as algae (Williams 1983).

C. rhinoceratus is caught with bottom trawls as by-catch in the fishery for *Champsocephalus gunnari*.

Attains about 58 cm TL.

Genus *Chionobathyscus* Andriashev & Neelov, 1978

Rostral spine reduced to a small knob. Gill rakers vestigial. Branchiostegal rays 2 (on epihyal) + 4 (on ceratohyal) = 6; dorsal hypohyal cartilaginous. Opercle terminating with 3–4 branched spines; subopercle and interopercle without spines. Three lateral lines without bony plates. Pelvic fins elongate and their distal tips enveloped in thick skin, the second ray longest. Bases of dorsal fins separate. Monotypic.

Chionobathyscus dewitti Andriashev & Neelov, 1978

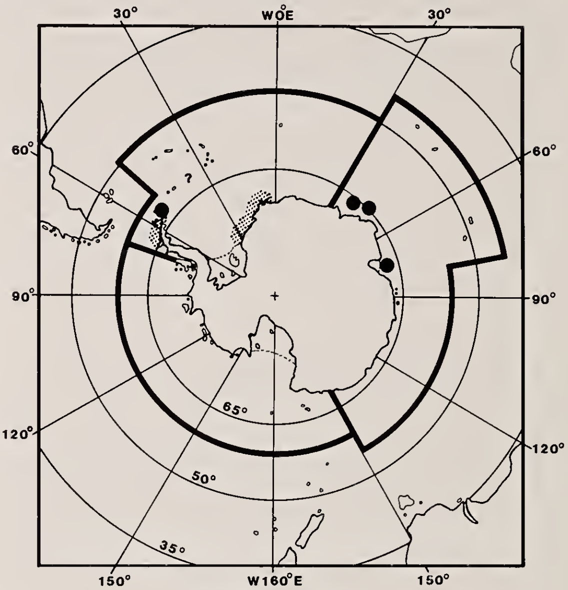
Fig. 10

Chionobathyscus dewitti Andriashev & Neelov, 1978: 8, figs. 1–2, Gunnerus Bank (67°31′S, 33°05′E). Holotype: ZIN 43260.

Diagnosis: D V–VI+39–40; A 33–34; P 24–26; branched C rays 11; lower GR 3–10; vertebrae (25–28)+(32–36)=59–61. Body depth 16.5–20.8%, head length 33.3–36.9%, and pelvic fin length 25.9–30.5% SL. Snout length 44.9–49.4%, eye diameter 17.5–19.6%, and interorbital width 28.9–33.3% HL. Supraorbital ridges not crenulated. Maxilla extending to below middle of eye. Preopercular-mandibular canal not joined to temporal canal. Jaws equal anteriorly or lower jaw slightly projecting. Upper lateral line extending beyond last second dorsal-fin ray; lower lateral line originating above 3rd to 10th anal-fin ray.

Colour: In life, greyish in juveniles, dark grey in adults; belly whitish. Five dark cross-bars on sides of body. First dorsal fin blackish. Posterior portion of pectoral and caudal fins dusky; other fins pale or slightly dusky.

Distribution: Probably circum-Antarctic on the continental shelf and slope. Depth range 500–2,000 m, a few records of juveniles exist from shallower depths (Slosarczyk & Rembiszewski 1982; Tiedtke & Kock 1989; M. Takahashi pers. comm.)



Distribution of *C. dewitti*

Remarks: The postlarvae of *Chionodraco myersi* from the Prydz Bay area reported by Gon (1988) represent this species (Gon pers. comm.) (See Pl. 10, Fig. 2).

Little is known of the biology of *C. dewitti*. Specimens in prespawning condition were captured at 2,000 m in the Weddell Sea in February. Stomachs of specimens (24–28 cm SL) from the South Shetland Islands contained the remains of fish and krill (M. Takahashi pers. comm.) The scarcity of records of this species do not necessarily indicate rarity and could be attributed to the

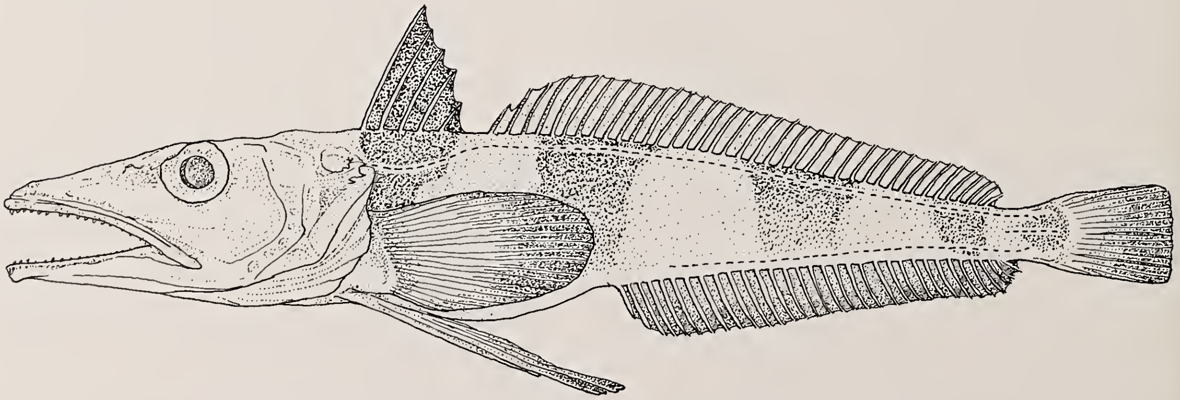


Fig. 10. *Chionobathyscus dewitti* IBUT 82–393, 25 cm SL, off South Shetland Islands (61°23′S, 55°11′W)

depth range of the species and possible misidentification of juveniles with *Chionodraco* spp., *Chaenodraco wilsoni*, or *Chaenocephalus aceratus* (in the Peninsula region). A relatively large number of juveniles were caught with krill at the Bransfield Strait (south of the South Shetland Islands) during February and March (Slosarczyk & Rembiszewski 1982).

Attains 60 cm TL.

Genus *Chionodraco* Lönnberg, 1906

Rostral spine present or reduced to a small median knob. Gill rakers dentigerous or vestigial. Jaws equal anteriorly or lower jaw projecting. Branchiostegal rays usually 2 (on epihyal) + 4 (on ceratohyal) = 6 (rarely 7); dorsal hypohyal cartilaginous. Opercle with well developed spines; subopercle and interopercle each with a pair of spines at their juncture. Three lateral lines without bony plates. Dorsal-fin bases separated. Two outermost pelvic-fin rays longest. Tips of pelvic fins of adults enveloped in thick skin. Caudal fin more or less rounded.

Three species; 2 circum-Antarctic and 1 restricted to west Antarctica. Recently revised by DeWitt & Hureau (1979).

KEY TO SPECIES

1a Rostral spine present; preopercular-mandibular canal not joined to temporal canal 2
1b Rostral spine vestigial; preopercular-mandibular canal joined to temporal canal . . . .*C. myersi*
2a GR vestigial; lower GR 2–7 . . . .*C. hamatus*
2b GR dentigerous; lower GR 8–14 . . . .*C. rastrospinosus*

Chionodraco hamatus (Lönnberg, 1905)
Fig. 11

Chaenichthys rhinoceratus subsp. *hamatus* Lönnberg, 1905b: 47, Snow Hill Island (64°36′S, 57°42′W). Holotype: NRM SYD/1902041.3160.

Chionodraco hamatus Lönnberg, 1906: 99.

Chionodraco kathleenae Regan, 1914a: 13, Ross Sea (74°25′S, 179°03′E).

Diagnosis: D V–VIII+38–42; A 33–38; P 21–24; V I+5; branched C rays 11; lower GR 2–11; vertebrae (22–26)+(36–39)=58–63. Head length 34.7–41.2% SL. Snout length 44.1–51.8%, eye diameter 16.7–24.7%, and interorbital width 21.9–30.8% HL. Rostral spine present, strong and curving backwards. Supraorbital ridges crenulated in large specimens. Preopercular-mandibular canal not joined to temporal canal. Gill rakers non-dentigerous low knobs.

Colour: In life, pale greyish, belly whitish, with up to 8 cross-bars. Cheek with 2 oblique stripes. Fins and lower parts of body usually blackish in large, mature males. In females and immature males, first dorsal fin blackish, pelvic fins sometimes with dark pigmentation, and other fins pale.

Otoliths

Diagnostic features: The dorsoventrally oval to rectangular shape, the thicker ventral half relative to the dorsal half, the ostio-caudal and heterosulcoid sulcus acusticus, the acutely constricted collum and the clearly separated ostium and cauda, the split V-shaped crista superior, the ventral groove below the crista inferior, the distally rounded rostrum and the presence of a pseudo-excisura ostii.

Fig. 12. Representative otolith of *C. hamatus*; fish length 40 cm SL; scale bar 1 mm

Distribution: Circum-Antarctic on the continental shelf. Depth range 4–600 m.

Remarks: DeWitt & Hureau (1979) showed that *C. kathleenae*, a frequently used name prior to their work (Waite 1916; Norman 1937b; DeWitt 1971), is in fact a junior synonym of *C. hamatus*. It appears that the first dorsal fin and body colour are sexually dimorphic (DeWitt & Hureau 1979). In contrast to its other 2 congeners, *C. hamatus* is not as abundant in east and

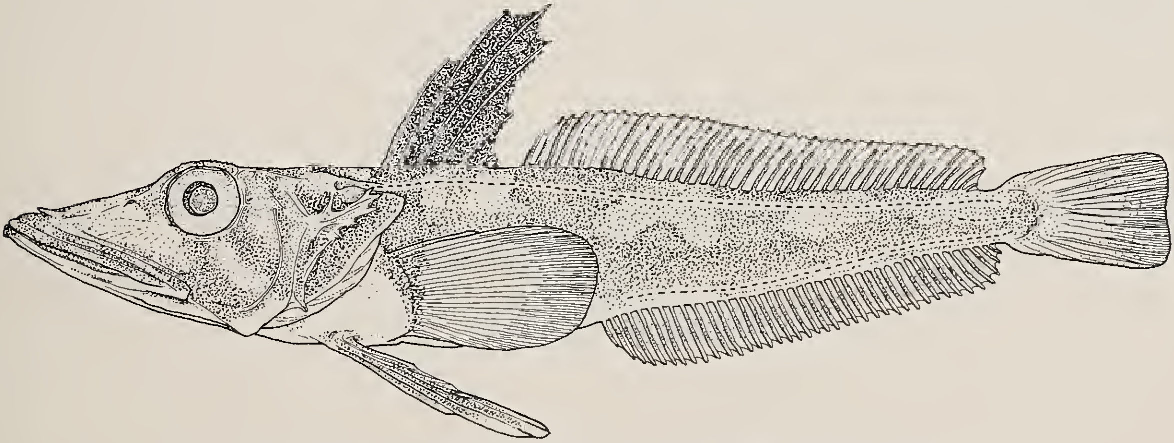
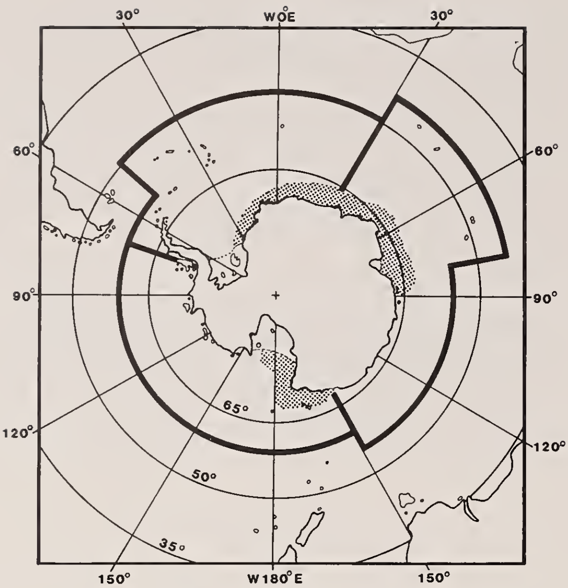


Fig. 11. *Chionodraco hamatus* A19101, 31 cm SL, Ross Sea (76°11.9′S, 168°55′E)



Distribution of *C. hamatus*

west Antarctica. Little is known of the biology of this species. Permitin (1973) described the reproductive biology of "*Chionodraco hamatus*", but judging from his collection localities these specimens were probably *C. rastrospinosus*. The gonadosomatic index of specimens caught in spring in the Weddell Sea indicated spawning in summer. Absolute fecundity was 2,900–4,200 oocytes in fishes of an unspecified size range (Ekau in press).

Attains 49 cm TL.

Chionodraco myersi DeWitt & Tyler, 1960

Fig. 13

Chionodraco myersi DeWitt & Tyler, 1960: 185, figs. 5–6, south-western Ross Sea, off Terra Nova Bay. Holotype: SU 53515.

Chionodraco markhami Miller & Reseck, 1961: 50, fig. 1, north of Franklin Island, Ross Sea (75°38′S, 168°32′E).

Diagnosis: D V–VIII+36–40; A 34–37; P 20–22; V I+5; branched C rays 5+7; lower GR 3–7; vertebrae (21–26)+(32–35)=56–61. Head length 34.6–40.1%, snout length 12.4–18.7%, eye diameter 7.9–8.7% and interorbital width 7.8–10.3% SL. Rostral spine reduced to a low knob. No developed supraorbital ridges or crenulation. Preopercular-mandibular canal joined to temporal canal. Gill rakers non-dentigerous, reduced to small knobs.

Colour: In life, pale greyish, belly whitish, with 5–6 dark cross-bars. Sides of body usually blackish in large males. Cheek with 2 dark stripes. Second dorsal and anal fins black of mature males dusky or blackish, with a broad pale margin; other fins pale.

Otoliths

Diagnostic features: The dorsoventrally oval shape, the homomorph and well developed colliculi, the separated ostium and cauda, and the presence of the pseudo-rostrum and pseudo-antirostrum.

Fig. 14. Representative otolith of *C. myersi*; fish length 28 cm TL; scale bar 1 mm

Distribution: Circum-Antarctic on the continental shelf. Depth range 200–800 m; postlarvae and pelagic juveniles probably also in the upper 100 m. The postlarvae reported by Gon (1988) from the Prydz Bay area were re-identified as *Chionobathyscus dewitti* (Gon pers. comm.)

Remarks: *Chionodraco myersi* is one of the most abundant channichthyid species in the western Ross Sea (Takahashi & Nemoto 1984) and in the Weddell Sea (Ekau 1988). The height of the first dorsal fin of males is 22.5–30.0% SL and that of females is 9.4–16.3% SL. Sexual dimorphism also exists in body colour; males larger than 25 cm SL tend to be dark on the side of the body. The dark blotches described by Iwami & Abe (1981b) resulted from preservation.

Apart from 2 females in prespawning condition, the gonads of all the other specimens captured in the Weddell Sea in February were in resting stage, indicating that spawning is unlikely to occur in summer. The absolute

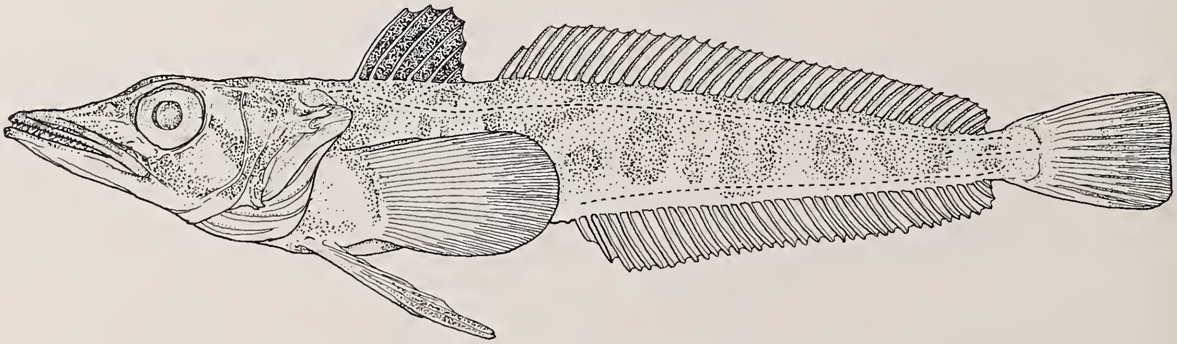
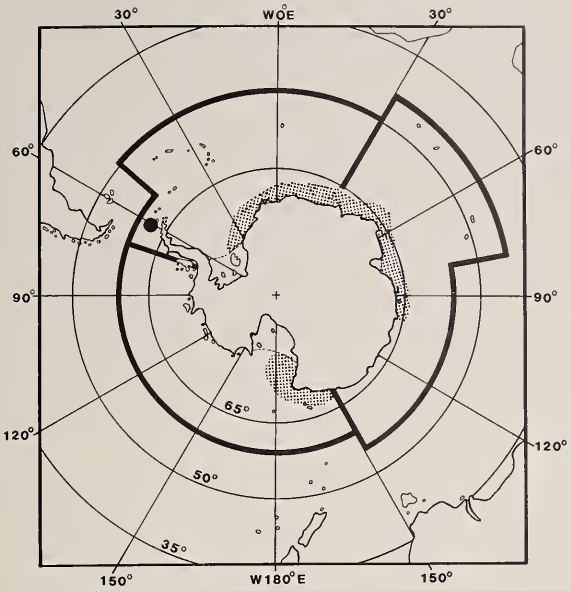


Fig. 13. *Chionodraco myersi* A19076, 31 cm SL, Ross Sea (72°30.47′S, 172°56.6′E)



Distribution of *C. myersi*

fecundity of 1 specimen of unspecified length was 6,200 oocytes (Ekau in press).

In the Ross Sea, *C. myersi* fed on the nototheniid *Pleuragramma antarcticum* and the euphausiid *Euphausia crystallorophias* (Takahashi & Nemoto 1984).

Attains 38 cm TL.

Chionodraco rastrospinosus DeWitt & Hureau, 1979

Ocellated icefish

Fig. 15; Pl. 11, Fig. 1

Chionodraco kathleenae (*non* Regan): Lopez & Bellisio, 1967: 33.

Chionodraco rastrospinosus DeWitt & Hureau, 1979: 805, off Argentine Island, Palmer Archipelago (65°13.6'S, 64°11'W). Holotype: USNM 217422.

Diagnosis: D IV–VII+36–42; A 34–37; P21–23; V I,5; branched C rays 5+6; lower GR 8–14; vertebrae (22–25)+(35–36)=59–62. Head length 32.9–38.8% and pelvic-fin length 19.5–32.4% SL. Snout length 44.1–44.9%, eye diameter 17.4–21.7%, and interorbital width 22.8–33.0% HL. Rostral spine well developed, curved backwards. Dorsal side of head slightly concave; supraorbital ridges with crenulate ridges. Preopercular-mandibular canal not joined to the temporal canal. Gill rakers dentigerous, forming a tooth patch.

Colour: In life, pale greyish, belly whitish, with 4–5 dark cross-bars on sides of body. Dark blotches, 1 between each pair of bars, forming centres of 4 large pale circles in juveniles. Two oblique dark bars on cheek. First dorsal fin dark; other fins pale in juveniles, but dusky (except pelvic fins) in adults.

Otoliths

Diagnostic features: The greater height than length of the otolith and the resultant near rectangular shape, the fusiform crista inferior, the split crista superior, and the well developed colliculi.

Ontogeny: The size of the dorsal half of the otolith, above the sulcus acusticus, increases with increasing fish size and becomes squared off.

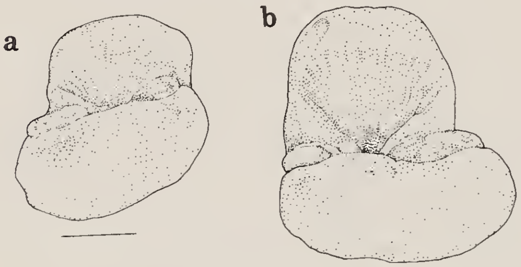


Fig. 16. Representative otoliths of *C. rastrospinosus*; fish lengths: (a) 31 cm, (b) 39 cm TL; scale bar 1 mm

Distribution: South Orkney Islands, South Shetland Islands and the Antarctic Peninsula. Depth range, from close to the surface (pelagic juveniles) to 1,000 m (Hureau 1985c); most frequently collected at 200–400 m (Kock 1986).

Remarks: *C. rastrospinosus* was often confused with *C. kathleenae* or *C. hamatus*. DeWitt & Hureau (1979) stated that nearly all specimens of *Chionodraco* from West Antarctica belong to this species. However, recent

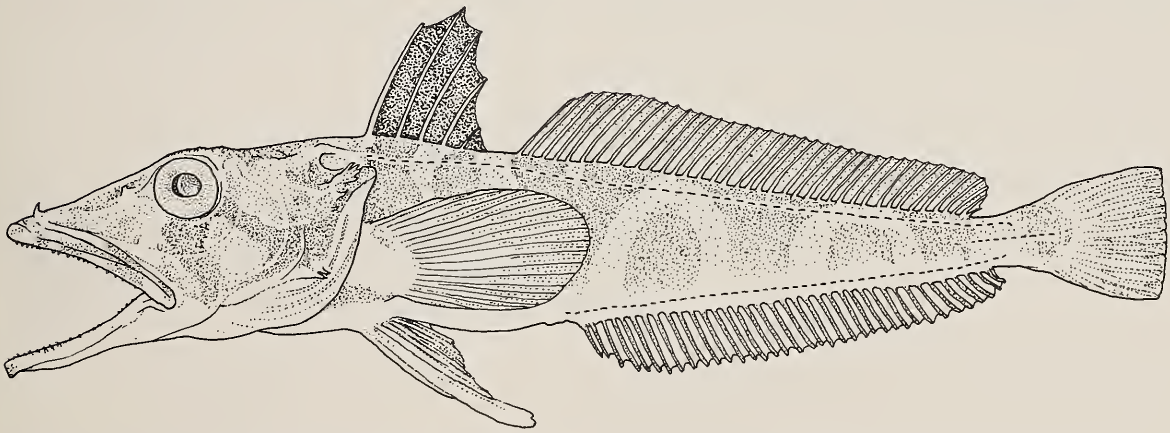
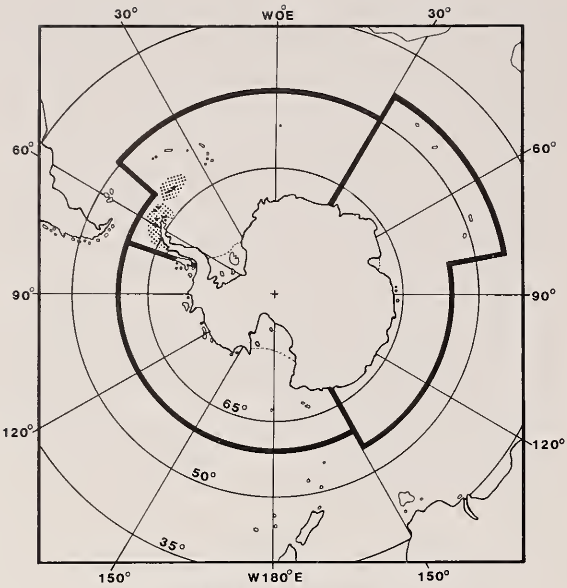


Fig. 15. *Chionodraco rastrospinosus* IBUT 81–0199, 35 cm SL, off South Shetland Islands (62°10'S, 60°47'W)



Distribution of *C. rastrospinosus*

bottom trawl surveys showed that *C. myersi* is also present around the South Shetland Islands (Iwami & Abe 1982; M. Takahashi pers. comm.) Judging from collection localities, Permitin's (1973, 1977) specimens of *C. hamatus* are probably *C. rastrospinosus*. In view of the difficulty in separating these species more work is needed to confirm their taxonomic status.

Length at first spawning off Elephant Island was 36.7 cm in females and 33.3 cm in males. Spawning takes place in March and April. Egg diameter was 4.8–5.0 mm (Kock 1989). In the South Shetlands area, absolute fecundity was 1,461–5,136 oocytes in specimens of 33–47 cm in length (Kock 1989). The eggs are apparently demersal (Permitin 1973). Larvae were observed from September/October onwards, forming one of the most abundunt components of the ichthyoplankton in the region of the Antarctic Peninsula (Kellermann 1989), and frequently encountered in krill swarms (Slosarczyk & Rembiszewski 1982). Postlarvae were 22–36 mm SL in November, 25–49 mm SL in January-February, and 40–66 mm SL in March (Kellermann 1986).

In the vicinity of the South Shetland Islands, stomachs of *C. rastrospinosus* contained mainly krill (*E. superba*), but the frequency of occurrence of fish was higher in larger specimens (Takahashi 1983). Other reports (Permitin & Tarverdiyeva 1978; Tarverdiyeva & Pinskaya 1980) also showed that adult fishes feed mostly on krill and fish. Postlarvae feed mostly on euphausiids (*E. superba* and *Thysanoessa macrura)* and ichthyoplankton (*L. larseni, P. antarcticum, G. gibberifrons)* (Kellermann 1986). Patterns of parasitic infestation in fishes from different localities indicate that the fishes off the South Orkney and South Georgia islands comprise a single stock (Siegel 1980).

Catches of *C. rastrospinosus* over 2 fishing seasons (in FAO subareas 48.1+48.2) were reported by the Polish fishery. In 1978–79 the catch was 1,949 tonnes and in 1979–80 it was 581 tonnes. *C. rastrospinosus* is probably a common by-catch around the South Orkney Islands and in the South Shetland Islands and Antarctic Peninsula region.

Attains 52 cm TL.

Genus *Cryodraco* Dollo, 1900

Rostral spine reduced to a small knob. Gill rakers vestigial. Branchiostegal rays 2 (on epihyal) + 4 (on ceratohyal) = 6; dorsal hypohyal cartilaginous. Opercle with 4–5 spines; subopercle and interopercle without spines. Three lateral lines without bony plates. Pelvic fins long, their distal tip encased in thick skin; second pelvic-fin ray longest. First dorsal fin small, separated from second dorsal fin by a large space. Caudal fin truncate to slightly emarginate.

One or two circum-Antarctic species.

Cryodraco antarcticus Dollo, 1900
Fig. 17

?*Pagetodes* Richardson, 1844b: 15, pl. 8, fig. 3, Ross Sea (without species name).

Cryodraco antarcticus Dollo, 1900a: 129, Bellingshausen Sea (71°18′S, 88°02′W). Holotype: IRSNB 1.

Pagetodes antarcticus Pappenheim, 1912: 175, in part.

Cryodraco atkinsoni Regan, 1914a: 13, Ross Sea (74°25′S, 179°03′E).

Diagnosis: D II–VI+41–46; A 42–46; P 24–25; branched C rays 11; vertebrae (25–28)+(40–44) = 67–70. Depth of body 11.1%, head length 36.2–36.5%, and pelvic-fin length 22.3–63.3% SL. Snout length 43.4–44.9%, eye diameter 19.5–21.4%, and interorbital width 22.2–23.0% HL. Maxilla extending to below middle of eye. Teeth of both jaws small, conical, recurved, in 2–3 rows tapering to a single row posteriorly. Preopercular-

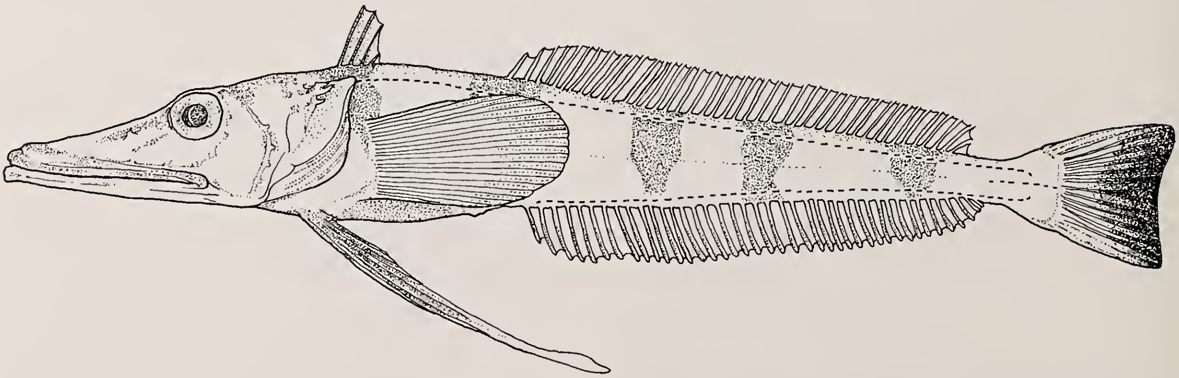


Fig. 17. *Cryodraco antarcticus* IBUT 81–384, 33 cm SL, off South Shetland Islands (62°02′S, 62°21′W)

mandibular canal not joined to temporal canal. Upper lateral line extending beyond last dorsal-fin ray; origin of lower lateral line not anterior to 10th anal-fin ray. Anal-fin origin slightly behind second dorsal-fin origin.

Colour: In life, body pale greyish-brown with 5–6 dark cross-bars. Pelvic fins in pelagic juveniles dusky or blackish; paler in larger juveniles and adults, but with a dusky tip.

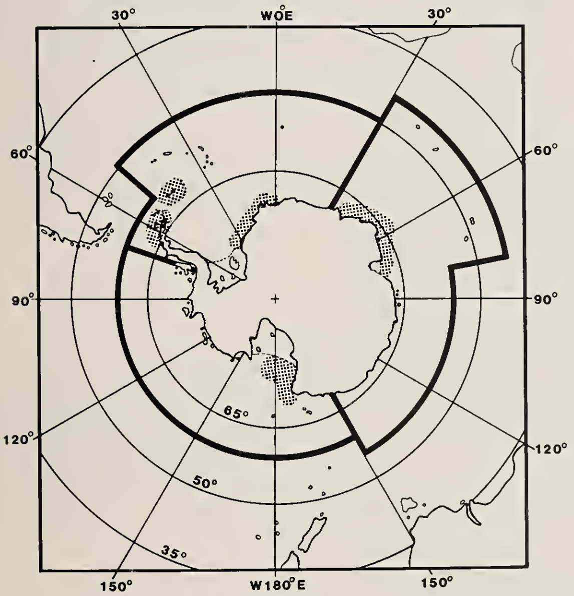
Otoliths

Diagnostic features: The slightly dorsoventral rectangular shape, the extremely constricted collum resulting in a pit-like central portion of the sulcus acusticus, the split crista superior and the ventral groove below the crista inferior, and the well developed colliculi.

Intraspecific variation: Negligible with regard to the geometric shape, but sculpture of margin variable, as well as the anterior colliculum which sometimes projects beyond the anterior margin.

Fig. 18. Representative otolith of *C. antarcticus*; fish length 28 cm SL; scale bar 1 mm

Distribution: Circum-Antarctic on the continental shelf. Northernmost records from the South Orkney and South Shetland Islands. Depth range usually 250–800 m, but postlarvae and pelagic juveniles also in the upper 200 m.



Distribution of *C. antarcticus*

Remarks: Pappenheim (1912) reported 3 channichthyid fishes measuring 168, 69, and 30 mm in length under the name *Pagetodes antarcticus*. Judging from meristic counts, the second of these (69 mm) was referred by Norman (1938) and DeWitt & Hureau (1979) to *Dacodraco hunteri* Waite, 1916. Regan (1913) redescribed the largest specimen (168 mm) as a new species, *Cryodraco pappenheimi,* based only on the description of Pappenheim (1912). Unfortunately, the holotype, the only known specimen of this species, deposited at the Museum für Naturkunde der Humboldt Universität, Berlin, was lost.

Pappenheim (1912) and Regan (1913) described the number of second dorsal- and anal-fin rays of *C. pappenheimi* as 45 and 39 respectively. The difference of 6 rays between the 2 fins is larger than in *C. antarcticus* (usually less than 3). The number of pectoral fin rays of *C. pappenheimi* (22) is smaller than that of *C. antarcticus* (24–25). The height of the first dorsal fin is 6.2–11.3% in *C. antarcticus* and about 15% SL in *C. pappenheimi*. The first dorsal fin is thought to become higher with growth, therefore the relatively high fin of this small specimen (168 mm SL) is significant. In view of this evidence, *C. pappenheimi* is not accepted here as a junior synonym of *C. antarcticus*. Pappenheim (1912) and Regan (1913) erroneously used the elongate pelvic fin as a diagnostic feature of *C. pappenheimi*. Long pelvic fins are also present in the genera of *Chaenocephalus, Chionobathyscus, Chionodraco,* and *Chaenodraco*. Regan (1914b) and Waite (1916) suggested that some characters of *C. pappenheimi* are similar to those of *Chaenocephalus*. However, no species of *Chaenocephalus* is known outside the Scotia Sea and it is rather unlikely that *C. pappenheimi* is a member of this genus. Comparing the descriptions of *C. pappenheimi* with morphological data of other channichthyid fishes, it seems more closely related to the genus *Chionodraco* rather than *Cryodraco*.

Since the study of Waite (1916), followed by Norman (1937b, 1938), *Cryodraco atkinsoni* has been regarded as a junior synonym of *C. antarcticus*. Two specimens of *Cryodraco* in which morphological features agreed more with the *atkinsoni* form than with the *antarcticus* form, led Iwami & Abe (1981a) to propose that *C. atkinsoni* is probably a different species. Detailed studies of many specimens of *Cryodraco,* including the type of *C. atkinsoni,* show the presence of 2 distinctive groups that can be separated using the following criteria: (1) The number and shape of cross-bars on the body; (2) the presence or absence of a black blotch on the posterior part of the caudal fin; (3) the position of second dorsal-fin origin; (4) the position of lower lateral-line origin; and (5) relationship between the number of second dorsal-fin rays to anal-fin rays. Each one of the groups included males as well as females and a similar range of fish lengths. These findings evidently call for a re-evaluation of the taxonomic status of *Cryodraco atkinsoni*.

The reproductive biology of *C. antarcticus* is virtually unknown. Unlike other channichthyid fishes, it has not been studied extensively due to its little commercial importance. In the Weddell Sea, spawning probably takes place during the summer. Absolute fecundity was 10,700 oocytes in a specimen of an unspecified length, and the ripe egg size was 4.4 mm (Ekau in press). Hatching probably occurs in winter/spring. Postlarvae caught in the Bransfield Strait in November-December were 32–44 mm SL (Kellermann 1986). Off the South Orkney Islands, postlarvae were collected between November and March (Efremenko 1983). Postlarvae and juveniles are easily recognized by their extremely long pelvic fins (Pl. 11, Fig. 2), which sometimes extend beyond the posterior end of the caudal fin. In fishes 75.2–85.6 mm SL, the pelvic fins were 59.0–63.3% SL.

Analysis of stomach contents of fishes from the South

Shetland Islands and the Ross Sea revealed mainly fishes and Antarctic krill (Gubsch 1982; Takahashi 1983; Takahashi & Nemoto 1984). Postlarvae in the Bransfield Strait fed mostly on furcilia of euphausiids (*E. superba*; *T. macrura)* (Kellermann 1986).

Attains 57 cm TL.

Genus *Dacodraco* Waite, 1916

Rostral spine present, but reduced to a small knob or a blunt spine. Gill rakers vestigial. Branchiostegal rays usually 2 (on epihyal) + 4 (on ceratohyal) = 6. Opercle with prominent ridge ending posteriorly in flattened blade with 1–3 points; subopercle and interopercle without spine. Two lateral lines without bony plates, middle line absent. Upper and lower jaws curved towards each other, forming a gap along the length of the mouth. Pelvic fins with developed fin membrane; second ray longest. First and second dorsal fins separated by large interdorsal space. Monotypic.

Dacodraco hunteri Waite, 1916

Fig. 19

Pagetodes antarcticus: Pappenheim, 1912: 175, Ross Sea (in part).

Dacodraco hunteri Waite, 1916: 36, pl. 2, fig. 2, off Shackleton Ice Shelf (65°06′S, 96°13′E). Holotype: SAMA F374.

Diagnosis: D II–III+32–33; A 29–32; P 24–26; branched C rays 11; vertebrae (20–22)+(31–34)=52–55. Body depth 12.2–19.7%, head length 36.2–39.2%, and pelvic-fin length 19.75–25.5% SL. Snout length 48.7–55.2%, eye diameter 18.6–23.4% and interorbital width 14.1–17.3% HL. Infraorbital ridges not crenulated. Maxilla extending almost to below middle of eye. Teeth on both jaws biserial; inner teeth larger, canine-like and spaced; outer teeth conical; lower jaw greatly projecting, with fleshy lobe at symphysis. Preopercular-mandibular canal not joined to temporal canal. Upper lateral line extending beyond last second dorsal-fin ray; lower lateral line originating above 9–13th anal-fin ray.

COLOUR: In life, reddish-grey with brown tinge; 4 dark cross-bars on body and a fifth dark bar at base of caudal fin; indistinct dark blotch between the third and fourth, and the fourth and fifth bars. First dorsal fin and pelvic fins dark; other fins dusky. Juveniles generally pale with 5 distinct dark cross-bars.

Otoliths

DIAGNOSTIC FEATURES: The dorsoventral oval to rectangular shape, the ostio-caudal and heterosulcoid sulcus acusticus, the ostium and cauda with well developed homomorph colliculi, the broad crista inferior with an associated broad ventral groove.

Ontogeny: The shape of the otolith changes from near discoid to dorsoventrally oval to rectangular with an increase in fish size.

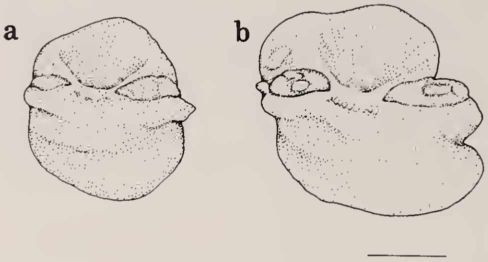


Fig. 20. Representative otoliths of *D. hunteri*; fish lengths: (a) 22 cm, (b) 24 cm TL; scale bar 1 mm

Distribution: Probably circum-Antarctic on the continental shelf. Depth range 300–800 m, but pelagic juveniles also in the upper 50 m.

Remarks: The rarity of this species makes its distribution pattern obscure. The presence of *D. hunteri* in the Ross Sea has not yet been confirmed; however, based on past distribution records it seems reasonable that *D. hunteri* is a circum-Antarctic species.

Of the 3 specimens identified by Pappenheim (1912) as *Pagetodes antarcticus,* the 69 mm fish with 4 dorsal spines, 30 dorsal-fin rays and 33 anal-fin rays, is *D. hunteri* (DeWitt & Hureau 1979). Norman (1938) described the shape of the ventral fins of this species as "pelvics of moderate length, with the rays normally branched, the middle ones the longest". However, in all 7 specimens examined for this study (including 1 paratype), the second pelvic-fin ray was the longest. DeWitt & Hureau (1979) also found that in the holotype and one other specimen the second ray was the longest. One of the most characteristic features of this species is the shape of the upper and lower jaws. The distinct gap along most of the mouth's length, not found in any other

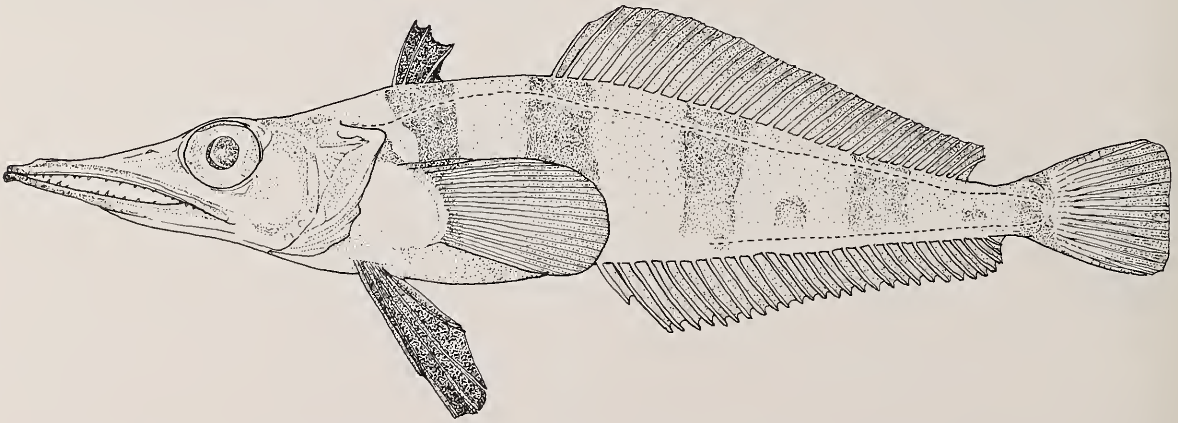
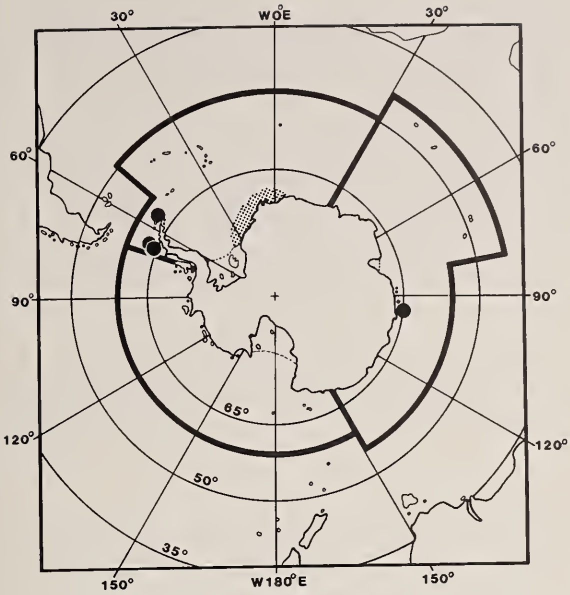


Fig. 19. *Dacodraco hunteri* ADH S870977–080, 20 cm SL, Prydz Bay (68°30.8′S, 73°49.8′E)



Distribution of *D. hunteri*

channichthyids, seems to be compensated for by the presence of large oral valves (DeWitt & Hureau 1979).

Biology unknown. Attains 29 cm TL.

Genus *Neopagetopsis* Nybelin, 1947

Rostral spine present and curved anteriorly. Gill rakers vestigial. Second infraorbital bone with posteroventral expansion. Branchiostegal rays 2 (on epihyal) + 5–7 (on ceratohyal) = 7–9; dorsal hypohyal cartilaginous. Opercle with radiating ridges terminating in 3 or 4 spinous points; subopercle and interopercle spines absent. Three lateral lines without bony plates. Fan-shaped pelvic fins with developed fin membrane; third pelvic-fin ray longest. First dorsal fin well developed and contiguous with second dorsal fin. Monotypic.

Neopagetopsis ionah Nybelin, 1947

Fig. 21

Neopagetopsis ionah Nybelin, 1947: 46, text fig. 2, pl. 5, figs. 3–4, Balleny Islands (from stomach of a whalebone whale). Holotype: ZMUL 287.

Diagnosis: D XIV–XV+32–35; A 29–32; P 24–25; branched C rays 12; vertebrae 60–61. Body depth 12.5–22.4%, head length 32.0–38.9%, pelvic-fin length 27.7–42.0% SL. Snout length 43.7–48.3%, eye diameter 12.3–16.9%, and interorbital width 26.9–32.5% HL. Infraorbital region without prominent ridges, flat and relatively smooth. Maxilla extending to just below anterior border of eye. Preopercular-mandibular canal not joined to temporal canal. Teeth on both jaws biserial.

Colour: In life, dark blackish-green or black. Body of smaller juveniles sometimes with irregular darker markings; belly whitish. First dorsal and pelvic fins blackish; other fins dusky or blackish.

Otoliths

Diagnostic features: The geometric shape is very distinct with the broad and robust ventral half and the thin and narrower dorsal half. The anterior and posterior colliculi project beyond the anterior and posterior margins.

Fig. 22. Representative otolith of *N. ionah*; fish length 46 cm SL; scale bar 1 mm

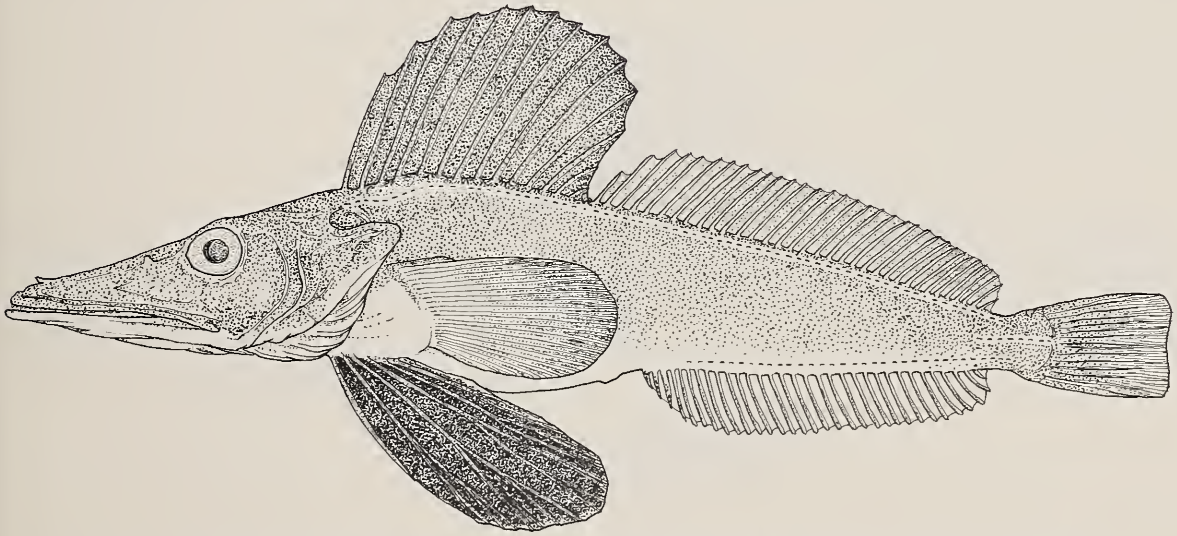
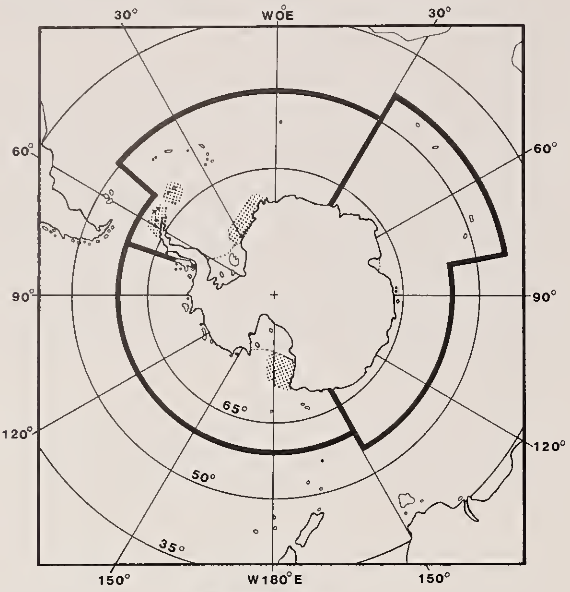


Fig. 21. *Neopagetopsis ionah* IBUT 82–515, 37 cm SL, off South Shetland Islands (62°59′S, 62°09′W)

Distribution: Circum-Antarctic on continental shelf and slope; northernmost records from the South Orkney and South Shetland Islands (Permitin 1969; Takahashi 1983). Depth range 20–900 m.



Distribution of *N. ionah*

Remarks: Young fishes of this species (ca. 100–150 mm SL) are frequently caught along with the Antarctic krill (Abe & Suzuki 1978, 1981). Stomachs of these young specimens contained only krill, *E. superba*. Adult specimens (331–460 mm in SL) collected from the vicinity of the South Shetland Islands fed mainly on *E. superba*. However, three of the 19 specimens examined consumed also fishes (*Dacodraco hunteri, Chaenodraco wilsoni, Pleuragramma antarcticum* and *Chionodraco* sp.) (M. Takahashi pers. comm.)

Attains 56 cm TL.

Genus ***Pagetopsis*** Regan, 1913

Rostral spine present and curved anteriorly. Lower jaw slightly projecting. Gill rakers vestigial. Second infraorbital bone expanded posteroventrally. Branchiostegal rays usually 2 (on epihyal) + 5 (on ceratohyal) = 7; dorsal hypohyal cartilaginous. Opercle with radiating ridges terminating in 3 or 4 spinous points; subopercle and interopercle without spines. Two lateral lines without bony plates; middle lateral line short and restricted to caudal peduncle. Fan-shaped pelvic fins with well developed fin membrane; third pelvic-fin ray longest. First dorsal fin well developed and contiguous with second dorsal fin.

Two species. A taxonomic revision of the genus *Pagetopsis* was done by Barsukov & Permitin (1958).

KEY TO SPECIES

1a Many dark, narrow cross-bars on body; membrane of pelvic fins blackish .... *P. macropterus*
1b Irregular dark blotches on body; membrane of pelvic fins with about 5 dark cross-bars .... *P. maculatus*

Pagetopsis macropterus (Boulenger, 1907)
Fig. 23; Pl. 12, Fig. 1

Champsocephalus macropterus Boulenger, 1907: 3, pl. 1 (mistaken plate number "Plate 2" in the text), Ross Island, Ross Sea (obtained from the stomach of a Weddell seal). Syntypes: BMNH 1906.6.9.50–56.

Pagetopsis macropterus Regan, 1913: 286.

Diagnosis: D XII–XV+27–32; A 24–27; P 22–24; branched C rays 12; lower GR 2–8; vertebrae 25–27+29–31=54–55. Body depth 14.9–20.7%, head length 36.0–41.8%, and pelvic-fin length 24.0–33.0% SL. Snout length 43.4–47.4%, eye diameter 16.4–22.2%, and interorbital width 20.7–25.1% HL. Supraorbital ridges not crenulated. Maxilla extending to below anterior third of eye. Preopercular-mandibular canal not joined to temporal canal. Two series of small conical teeth on both jaws. Pelvic fins longer than pectoral fins. Caudal fin subtruncate to somewhat rounded.

Colour: In life, body greyish-green, but whitish ventrally. About 15 narrow dark cross-bars on side of body, with a lighter area in their centres; cheek also with dark stripes. First dorsal and pelvic fins uniformly blackish, the latter without oblique stripes; other fins pale.

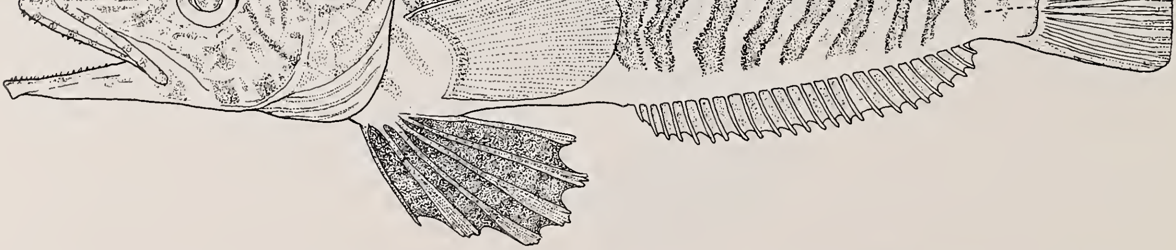


Fig. 23. *Pagetopsis macropterus* IBUT 82–0190, 21 cm SL, off South Shetland Islands (63°08′S, 59°08′W)

Otoliths

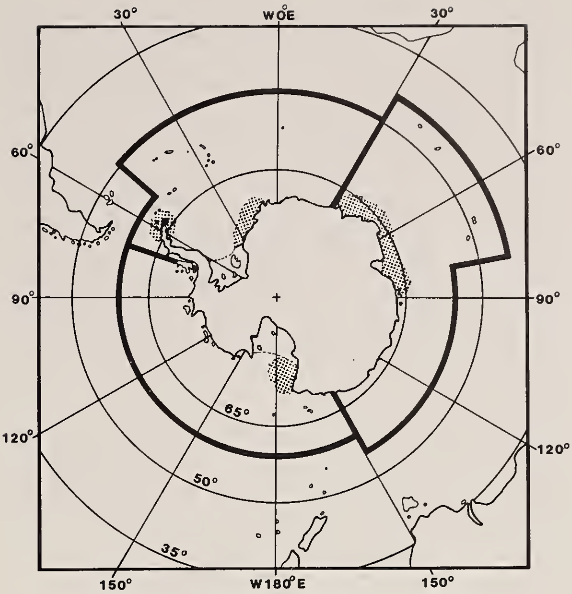
Diagnostic features: The vaguely rounded triangular shape, the entire margin, the homomorph colliculi, and the absence of relief on the dorsal half of the otolith.

Fig. 24. Representative otolith of *P. macropterus*; fish length 33 cm SL; scale bar 1 mm

Distribution: Circum-Antarctic on the continental shelf and South Shetland Islands. *P. macropterus* is often found at relatively shallow depths of 5–40 m (Robilliard & Dayton 1969; DeWitt 1971; Daniels & Lipps 1982). Depth range 5–655 m.

Remarks: Postlarvae and juveniles are sometimes caught along with krill. In the Prydz Bay area, postlarvae and juveniles (33–47 mm in SL) fed on *E. crystallorophias* and larvae of *Chionodraco* (Williams 1985a, b) A female, about 29 cm TL, collected in mid-January, had eggs of 4.0 mm in diameter (Pappenheim 1912)

Robilliard & Dayton (1969) observed the behaviour of this species in its natural environment and described its defense posture as: "The mouth was opened wide, the corners of the mouth and the opercula were expanded laterally, the dorsal fin was erected, the pectoral fins were flared and held at right angles to the body, and the body was bent in a semicircle." They suggested that this behaviour has developed as a defense mechanism against other fishes and seals, particularly the Weddell seal. Barsukov & Permitin (1958) also noted that *P. macropterus* was often found in the stomachs of the Weddell seal as in the case of the syntypes.



Distribution of *P. macropterus*

In the Antarctic Peninsula, krill, *E. superba,* was the most important component in the diet of *P. macropterus* of 10–15 cm SL. Other than krill, fishes (e.g. *Pleuragramma antarcticum* and *Notothenia nudifrons*), were also consumed (Daniels 1982). One specimen 13.2 cm SL collected from the vicinity of the South Shetland Islands also fed only on krill.

Attains 33 cm TL.

Pagetopsis maculatus Barsukov & Permitin, 1958

Fig. 25

Pagetopsis macropterus (*non* Boulenger): Waite, 1916: 37 (in part).

Pagetopsis maculatus Barsukov & Permitin, 1958: 1410, fig. 2, Prydz Bay (67°09′S, 77°03.5′E) Holotype: ZIN 37200.

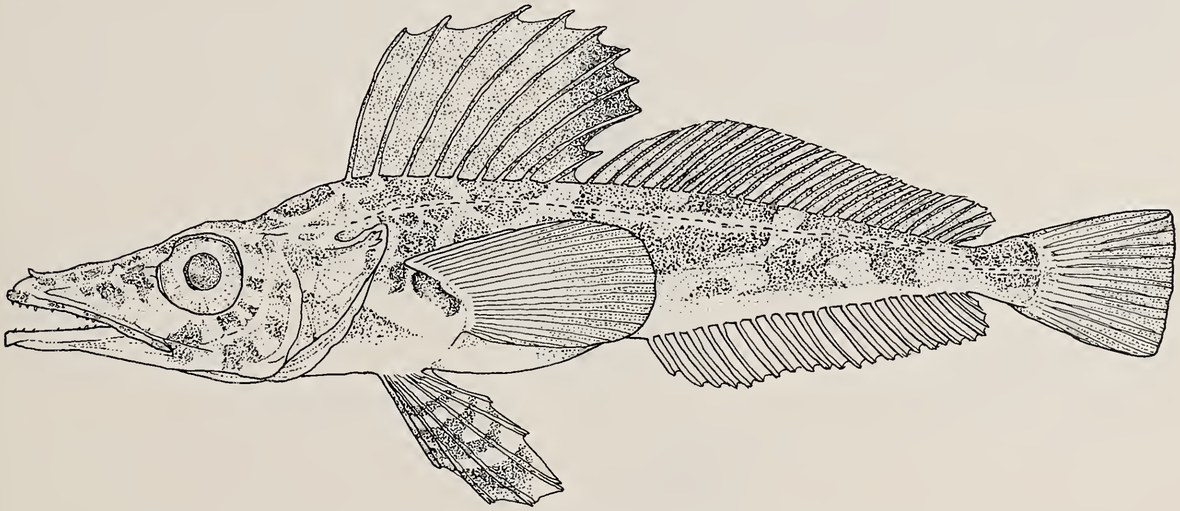


Fig. 25. *Pagetopsis maculatus* A19049, 155 mm SL, Ross Sea (75°33′S, 169°50.5′E)

Diagnosis: D IX–XII+25–27; A 22–24; P 23–24; branched C rays 12; lower GR 3–10; vertebrae (22–25)+(25–27)=49–50. Body depth 16.8–20.6%, head length 35.3–38.0%, and pelvic-fin length 19.2–23.1% SL. Snout length 42.9–46.2%, eye diameter 20.7–24.4%, and interorbital width 22.4–23.6% HL. Supraorbital ridges not crenulated. Maxilla extending to just below or slightly behind anterior margin of eye. Preopercular-mandibular canal not joined to temporal canal. Caudal fin subtruncate to somewhat rounded.

COLOUR: In life, body pale greyish-green, whitish ventrally, and with irregular dark blotches on the sides. Cheek with dark cross bars. First dorsal fin relatively pale with 3–4 dark bands, darker along its outer edge. Pelvic fins with 4–5 oblique stripes across; other fins pale.

Otoliths

DIAGNOSTIC FEATURES: The top hat shape with an ostiocaudal and heterosulcoid sulcus acusticus, the separated ostium and cauda, the absence of a crista superior, the broad and prominent crista inferior, and the distinct ventral groove below the crista inferior.

Ontogeny: The dorsal half of the otolith becomes higher and more slender with increasing fish size.

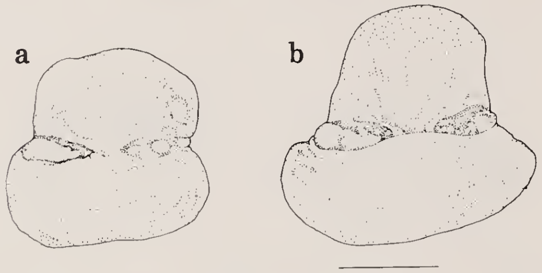
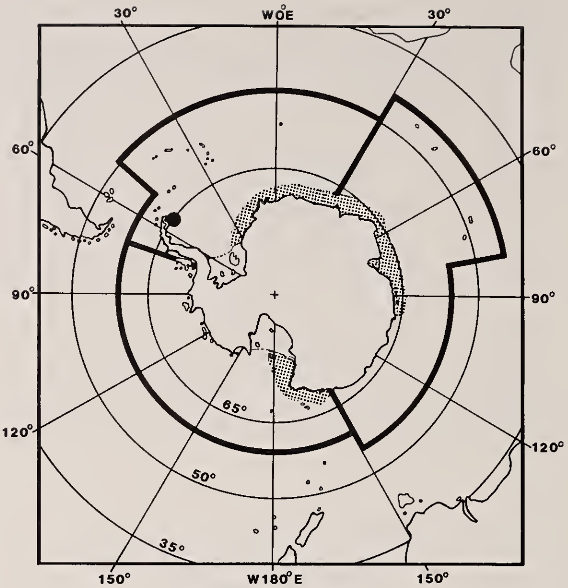


Fig. 26. Representative otoliths of *P. maculatus*; fish lengths: (a) 171 mm, (b) 176 mm TL; scale bar 1 mm

Distribution: Circum-Antarctic on continental shelf. Depth range 200–800 m.



Distribution of *P. maculatus*

Remarks: Despite extensive surveys carried out in the Scotia Sea, a positive record of *P. maculatus* has yet to be confirmed. The 2 specimens of *Pagetopsis* (142 and 144 mm in SL) described by Waite (1916) appear to be *P. maculatus,* as suggested by Barsukov & Permitin (1958) Judging from reported depths of capture, the much larger size of the eye, and the colour pattern, *P. maculatus* seems to inhabit deeper water than *P. macropterus* (Barsukov & Permitin 1958)

Attains about 25 cm TL.

Genus *Pseudochaenichthys* Norman, 1937

Antrorse rostral spine present. Gill rakers dentigerous. Branchiostegal rays 2 (on epihyal) + 5 (on ceratohyal) = 7; dorsal hypohyal ossified. Lower jaw projecting. Opercle with 4–5 spines; subopercle and interopercle without spines. Three lateral lines without bony plates. Pelvic fins broad, fan shaped, the middle ray longest. Dorsal fins separated by an interspace. Second infraorbital bone expanded posteroventrally. Caudal fin slightly rounded. Monotypic.

Pseudochaenichthys georgianus Norman, 1937
South Georgia icefish
Fig. 27; Pl. 12, Fig. 2

Pseudochaenichtys georgianus Norman, 1937c: 476, South Georgia Island. Holotype: BMNH 1937.7.12.769.

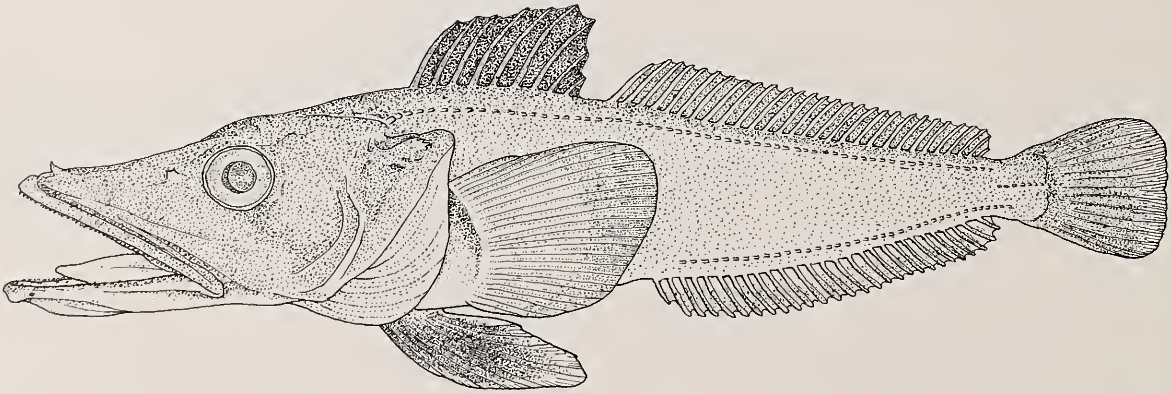


Fig. 27. *Pseudochaenichthys georgianus* IBUT 81–050, 45 cm SL, off South Shetland Islands (62°29′S, 61°52′W)

Diagnosis: D VIII–XI+28–32; A 27–31; P 22–25; branched C rays 12; lower GR 18–23; vertebrae (25–27)+(27–31) = 52–55. Depth of body 15.6–20.7%, head length 35.5–43.0%, and pelvic-fin length 22.6–35.3% SL. Snout length 42.9–61.0%, eye diameter 13.6–23.1%, and interorbital width 20.9–28.1% HL. Maxilla extending to below middle of eye. Preopercualr-mandibular canal joined to temporal canal. Supraorbital ridges crenulated in large specimens. Upper and lower lateral lines extending beyond last second dorsal-fin ray; middle lateral line restricted to caudal peduncle.

COLOUR: In life, dark greyish-green; darker markings present in small specimens. First dorsal and pelvic fins blackish; pelvic fins with a pale band along their outer border; other fins pale to dusky.

Otoliths

DIAGNOSTIC FEATURES: The dorsoventrally oval to rectangular shape and the anterior and superior projections of the colliculum beyond the margin.

Intraspecific variation: Anterior and posterior projections of the colliculum sometimes absent.

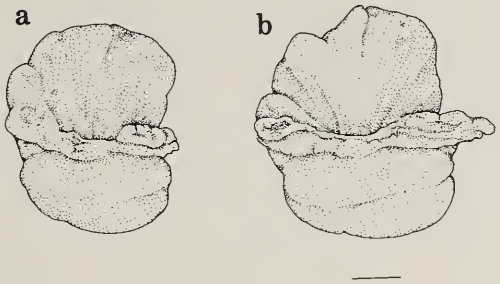
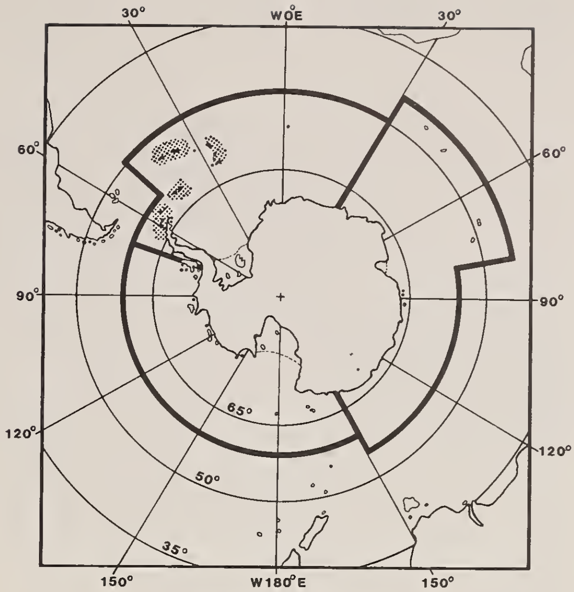


Fig. 28. Representative otoliths of *P. georgianus*; fish lengths: (a) 31 cm, (b) 44 cm TL; scale bar 1 mm

Distribution: Known only from the Islands of the Scotia Sea and the northern part of the Antarctic Peninsula. Depth range, from the surface to 475 m.

Remarks: Sexual maturity is reached at 41–43 cm length, or 4–5 years, for both sexes (Kock 1981). In the vicinity of South Georgia, *P. georgianus* spawns in the autumn (Olsen 1955; Permitin 1973; Kock 1981). Hatching of the larvae takes place from August to October (Efremenko 1979b). Juvenile *P. georgianus* 50–96 mm in length were collected in February and March, often with krill, *E. superba* (Permitin 1973; Linkowski & Rembiszewski 1978; Kock 1981). Absolute fecundity in the South Georgia area ranged from 5,152 to 10,914 in fishes 44–60 cm length (Permitin 1973; Kock 1981). The eggs are probably demersal, yellowish in colour and up to 4.8 mm in diameter (Olsen 1955; Permitin 1973; Kock 1981). Mucha (1980) observed a dominance of females in catches from January to September in South Georgia.



Distribution of *P. georgianus*

Adults feed mainly on Antarctic krill and fish (Permitin & Tarverdiyeva 1972; Linkowski & Rembiszevski 1978; Kock 1981; Targett 1981; Takahashi 1983). Off the South Shetland Islands, the fishes consumed by *P. georgianus* included mostly channichthyids and nototheniids, with a small number of myctophids (Kock 1981; Takahashi 1983). In South Georgia the diet was similar, but bathydraconid and artedidraconid species replaced the myctophids (Kock 1981).

Based on a study of parasite infestation, Siegel (1980) suggested that there is no exchange of individuals between the South Orkneys and South Georgia populations of *P. georgianus*.

This species is a regular by-catch in the trawl fishery, with annual catches in the order of several hundred to 2,000 tonnes. In 1977–78, *P. georgianus* was a target species of the trawl fishery and 13,015 tonnes were reportedly taken by Polish and East German vessels in South Georgia. As in the case of *C. aceratus,* catches may in fact be higher as the Soviet Union does not record catches of this species separately.

Attains 60 cm TL.

TRIPTERYGIIDAE

Triplefins

by O. GON

Body elongate and compressed. Three distinct dorsal fins, first 2 spinous, with the following range of fin rays: II-IX+X-XXV+7–17. Rays of third dorsal fin segmented, last ray usually split to base. Anal-fin rays 0-II,14–32. Pectoral-fin rays 10–19, lower- and uppermost rays unbranched. Pelvic-fin rays I, 2–3, spine short and covered by skin. First gill arch attached to opercle. Scales mostly ctenoid, but some species with only cycloid scales (e.g. *Notoclinops*). Lateral line either complete, with tubular scales, or interrupted with anterior section of tubular scales and posterior (lower) section of notched scales. Mouth small, usually with a band of small, conical teeth on each jaw. Nasal and orbital tentacles sometimes present, simple or branched.

Small, cryptically coloured benthic fishes inhabiting rocky habitats from the intertidal zone to about 200 m. Sexual dimorphism and dichromatism shown by many species. Males larger and more colourful than females. Found in shallow tropical and temperate waters of all oceans, a single species recorded from inshore waters of the Antarctic Peninsula. Böhlke & Chaplin (1968) and Holleman (1986) estimated 16 genera and 100 to over 130 species respectively. Matarese *et al.* (1984) counted 18–19 genera and 75–95 species. Unpublished family revision by Rosenblatt (1959). Recent regional revisions by Böhlke & Chaplin (1968), Clark (1979), Wirtz (1980), Holleman (1986), and Hardy (1986, 1987a-c).

Helcogrammoides Rosenblatt, new genus

Type species *Tripterygium cunninghami* Smitt, 1898.

Diagnosis: Lateral line continuous and complete, composed of pored scales only. Lateral line originates at top of shoulder girdle and curves downward to midline of body. Supraorbital tentacle multifid and nasal tentacle bifid. Scales ctenoid, moderate in size, about 35 longitudinal rows on back. Pelvic-fin rays 2, united by a membrane. No anal-fin spines. Membrane between spinous dorsal fins deeply incised. Jaws subequal, the lower included. Teeth in both jaws fixed, conical and recurved, and set in bands. Outer teeth in each jaw longer than inner teeth. Palatine teeth present. Tongue free marginally and distally only, adnate to floor of mouth for almost its entire length, ending in a bluntly round point. First gill slit slightly restricted by membrane binding gill arch to opercle. Five brown bars on the sides. Ventral surface of head of male not dark.

Etymology: *Helcogramma,* a related genus; -oides, from the Greek eidos, resemblance; in reference to the similarity of *H. cunninghami* to certain species of *Helcogramma*. Gender masculine.

Remarks: The Diagnosis above was taken almost verbatim from the unpublished thesis of R. H. Rosenblatt (1959).

Helcogrammoides differs from all other tripterygiid genera in having the character combination of multifid supraorbital and nasal tentacles with a continuous and complete lateral line.

Lateral line characters were regarded by Rosenblatt (1959) as important in higher level classification within the Tripterygiidae. Hardy (1984) proposed that the role of the lateral line in the evolution of tripterygiid genera should be investigated, but also warned (Hardy 1986) that the lateral line alone cannot be used in the establishment of higher categories in this family. *Helcogrammoides* shares a continuous and complete lateral line of pored scales with 5 other genera. A comparison of these genera based on selected morphological characters is present in Table 1. The unbranched condition of the last dorsal- and anal-fin rays in *Helcogrammoides* is provisional and based on the illustration of *H. cunninghami* in Smitt (1898: pl. 3, fig. 26), in which these rays were depicted as unbranched. This character was not discussed by Rosenblatt (1959).

Helcogrammoides occurs in southern South America and the Antarctic Peninsula, and includes 2 species.

Helcogrammoides antarcticus (Tomo, 1981)

Fig. 1

Tripterygium antarcticum Tomo, 1981: 88, figs. 66–69, Antarctic Peninsula, Paradise Bay (64°S, 62°W). Holotype: IAA 4.

Diagnosis: Based on original description and illustrations of holotype (male) by Tomo (1981). DIII+XV+10; A ca 20; P 14/16; V I,2; LL 40; branchiostegal rays 6. Snout length 3.5, eye diameter 2.8, interorbital space 7.0, and upper jaw length 2.0 in HL. Pectoral-fin length 3.3 and pelvic-fin length 4.1 in SL. Distances from snout to origin of first dorsal fin 4.1, to second dorsal fin 3.1, to third dorsal fin 1.4, to pelvic-fin insertion 4.4, and to anal-fin origin 2.0 in SL. Body scales ctenoid, but cycloid on abdomen. No scales on pectoral fin base. First dorsal-fin spine elongate, with spinules on its anterior edge. Head with small spines on interorbital space, occiput and upper part of preopercle and opercle. Supraorbital tentacle trifid and nasal tentacle bifid. Rear edge of branchiostegal membrane free from isthmus. Mouth small and somewhat protractile. Jaws with a band of small teeth, those of outer row enlarged. Vomer with a patch of teeth and palatines with 2 rows of teeth. A large, conical genital papilla behind anus.

Table 1. A comparison of tripterygiid genera with continuous and complete lateral line.

	D_1	A spines	V rays	Palatine teeth	Supraorbital tentacle	Suborbital flange	Last D+A ray
Helcogrammoides	3	0	2	present	trifid	large	unbranched?
Cryptichthys	4	0	3	present	absent	small	?
Blennodon	4	0	2	absent	absent	large	unbranched
Helcogramma	3	1	2	present	simple/absent	small	branched
Karalepis	4	2	2	present	simple	small	branched
Lepidoblennius	3	0–2	3	absent	absent	large	branched

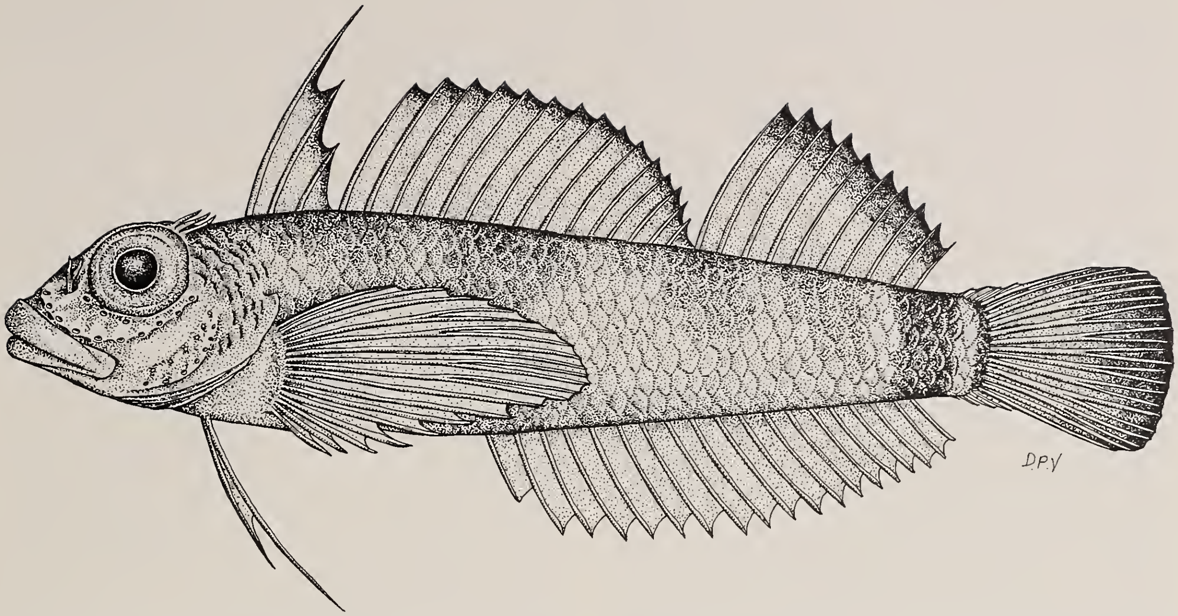
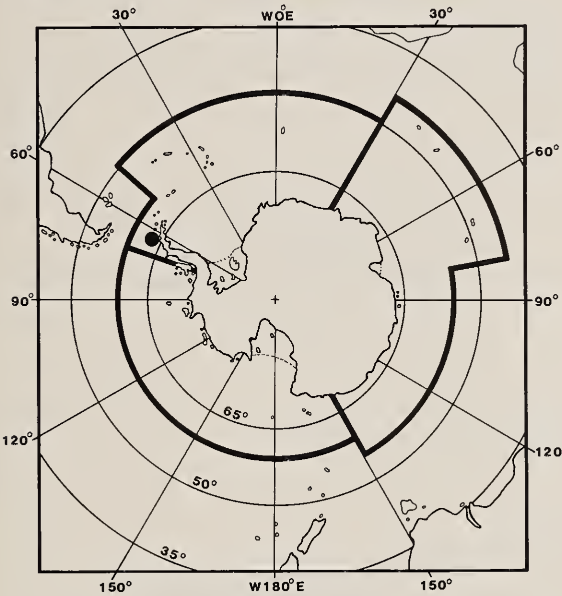


Fig. 1. *Helcogrammoides antarcticus* IAA 4, 59 mm TL, holotype (reconstructed from Tomo 1981: 88, figs. 67–69)

Colour: In life, reddish-yellow, with dark markings on head and dorsal part of body. Caudal peduncle with a wide vertical dark bar placed between 2 pale ones. Dorsal fins pale, with black margin. Other fins with dark stripes. Caudal fin with black margin.

Distribution: Known only from the type locality.



Distribution of *H. antarcticus*

Remarks: The illustrations of the heads of a male and a female *H. antarcticus* in Tomo (1981: figs. 69 and 70 respectively) suggest that the first dorsal-fin spines of the male are relatively longer and that small spines are absent from the female's opercle, thus indicating likely sexual dimorphism. A sex-related difference in the length of the first dorsal-fin spine was also observed by Rosenblatt (1959) in *H. cunninghami* and is common in the family. In addition, Tomo (1981) described and illustrated morphological differences of the anus and the genital opening between males and females.

Tomo's (1981) placement of his species in the genus *Tripterygium* is incorrect. In contrast to his description, *Tripterygium* has simple supraorbital and nasal tentacles, a discontinuous lateral line with only about 20 tubular scales, and no small spines on the interorbital space, occiput, and the upper part of opercle and preopercle. Although Tomo (1981) overlooked important generic characters, his description and illustrations of *T. antarcticum,* agree better with the diagnosis of *Helcogrammoides* and description of *H. cunninghami* of Rosenblatt (1959) than with the current concept of *Triptrygium.*

Rosenblatt (1959) found no sexual dichromatism in *H. cunninghami* and made its absence a generic trait. *H. antarcticus,* however, appears to display sexual dichromatism. Tomo (1981) described the male (holotype) as having plain dorsal and caudal fins with dark distal margin. His photograph of a female shows striped dorsal and caudal fins; the dark margin is clearly absent from the third dorsal fin, where it is widest in the male. Whether these are permanent differences or merely a seasonal phenomenon remains to be confirmed. Another point in need of confirmation refers to squamation. In his diagnosis, Rosenblatt (1959) described *Helcogrammoides* as having a naked belly. In contrast, Tomo (1981) maintained that the belly of *H. antarcticus* has cycloid scales.

H. antarcticus is known only from the disintegrating, poorly-preserved types. Of these, I have seen, but did not dare to examine, 2 paratypes. The 59.0 mm TL holotype is the largest known specimen.

GEMPYLIDAE

Snake mackerels

by I. NAKAMURA

Body elongate and compressed or semifusiform; mouth large and nonprotractile with strong teeth in both jaws; several pairs of teeth on anterior part of upper jaw and a pair of teeth on tip of lower jaw often fang-like. Gill openings wide, left and right gill membranes not united with each other, free from isthmus; gill rakers small and spinescent with the raker at angle largest, few in number mostly 0–15, up to about 40; branchiostegal rays 7. Nostrils double. Two continuous dorsal fins, base of first longer than that of second (excluding finlets, if present), VIII–XLIV, 0–II, 8–41+2–8 finlets; anal fin similar to and slightly smaller than second dorsal fin, I–II, 8–35+2–7 finlets; pectoral fin rather short midlateral or somewhat low in position, rays 12–19; pelvic fins thoracic, completely absent or present, sometimes rudimentary, I, 0–5; caudal fin forked, various in size; no keels on caudal peduncle (except in *Lepidocybium* which has a median caudal keel with 2 small supplementary keels). Lateral line single (straight or undulated) or double; scales thin and small or rudimentary, sometimes modified (in *Lepidocybium* and *Ruvettus*).

Sixteen genera and about 20 species of medium to large size predatory fishes. Typical meso- and bathypelagic fishes with world-wide or fairly wide geographical distribution. Some species perform nocturnal vertical migration. Taxonomic revisions by Parin & Bekker (1972) and Russo (1983). One species occurs in the Southern Ocean.

Genus ***Paradiplospinus*** Andriashev, 1960

Anus closer to tip of caudal fin than to tip of snout and situated in front of first anal fin by distance nearly equal to snout length. Anterior part of anal fin fairly high with well developed fin membrane. Lateral line single, continuous, tough, remaining intact in even rather damaged specimens when caught. Monotypic.

Paradiplospinus gracilis (Brauer, 1906)

Fig. 1

Lepidopus gracilis Brauer, 1906: 291, pl. 12, fig. 1, off South Africa (21°53′S, 7°00′E). Holotype: ZMB 17679.

Paradiplospinus antarcticus Andriashev, 1960a: 245, figs. 1–2, Antarctic Sea (64°22′S, 128°08′W).

Diagnosis: D XXXVI–XXXIX, 28–33; A II, 25–31; P 12–14; V I (in postlarvae and juveniles), absent (in adults); C 17; GR 34–41; branchiostegal rays 7; vertebrae (32–34)+(32–34)=65–67. Body depth at pectoral-fin origin 7.0–9.1%, body depth at anal-fin origin 5.1–6.3%, head length 17.5–19.2%, snout length 7.9–8.6%, upper jaw length 8.5–8.9%, orbit diameter 2.8–3.5%, eye diameter 2.8–3.4%, predorsal length 15.1–16.5%, prepectoral length 17.3–19.0%, preanal length 71.6–74.6%, preanus length 62.6–67.4%, length of spiny section of dorsal-fin base 51.4–59.3%, length of soft-rayed section of dorsal-fin base 23.5–28.2% SL. Mouth curved and large. All jaw teeth strongly compressed, pointed and irregularly spaced, with several gently curved fangs on anterior part of upper jaw and a pair on tip of lower jaw; elongate uniserial minute teeth on palatines and no teeth on vomer. Prominent interorbital slits on both left and right distal margins. Small juveniles with long pelvic fins (about 13% of SL) consisting of a feather-shaped spine, V-shaped in transverse section, with serrate edge; larger specimens without pelvic fins; 2 stout anal-fin spines (second longer), heavy based, pointed distally and V-shaped in transverse section with thin serrate edges; dorsal-fin spines serrate (Bussing 1965). Caudal fin small and weakly forked. Six simple, elongate pyloric caeca. Stomach elongate, U-shaped; intestine straight, without folds. Spleen visible from ventral side. Gall-bladder elongate. Liver with 3 lobes, the middle part very small.

Colour: silvery-white without any conspicuous markings. Buccal, branchial and abdominal cavities, and anus blackish; dorsal-fin base, opercular region, and tail dark-brownish. About 40–50 longitudinal lines constituting of pale melanophores on body.

Otoliths

Diagnostic features: The fusiform shape, the pseudo-ostial and homosulcoid sulcus acusticus, the single colliculum, and the presence of only the crista superior.

Fig. 2. Representative otolith of *P. gracilis*; fish length 39 cm TL; scale bar 1 mm

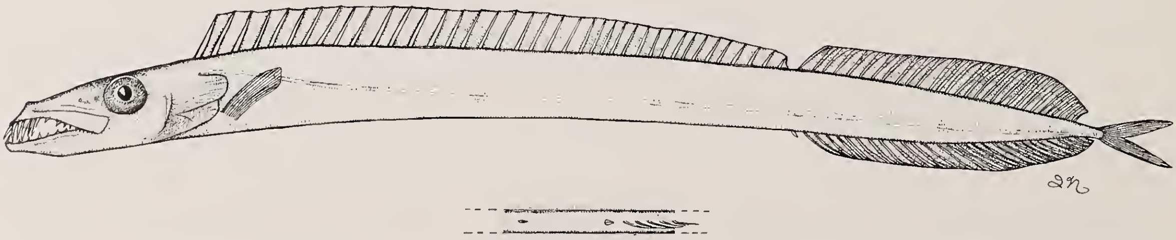
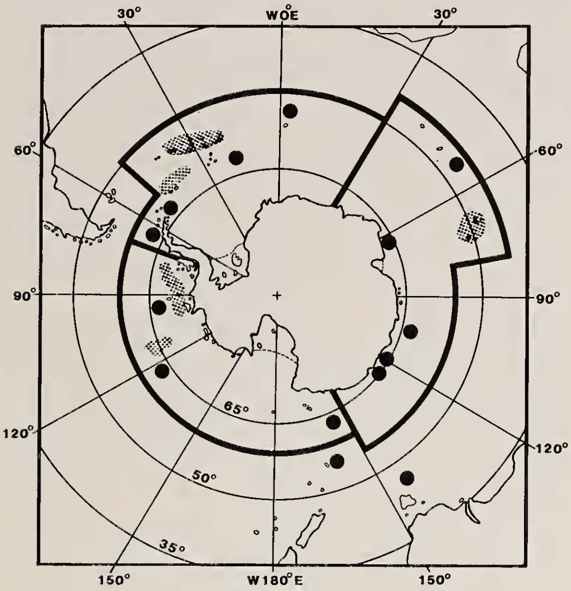


Fig. 1. *Paradiplospinus gracilis* ZMUB uncatalogued, 27 cm SL (60°S, 19°W), with a ventral view of area between anus and anal fin

Distribution: Large specimens of *P. gracilis* seem to be restricted to Antarctic waters, where they have been taken to at least 69°18′S, just west of Peter I Island (Bussing 1965); larval, juvenile and young specimens have been mostly obtained from north of the Antarctic Convergence (Brauer 1906; Bussing 1965; Nishikawa 1984). Probably circumpolar distribution.



Distribution of *P. gracilis*

Remarks: This species was originally described by Brauer (1906) as *Lepidopus gracilis* based on a single juvenile specimen (69 mm SL) obtained off the west coast of South Africa, which was thought to be the juvenile of *Diplospinus multistriatus* by Tucker (1956). *Lepidopus gracilis* Brauer, 1906 (=*Paradiplospinus gracilis)* is, however, a valid species and easily separated from *D. multistriatus* in proportional measurements and fin formulae (Karrer 1975). *Paradiplospinus antarcticus* was described by Andriashev (1960a) as a new species and a new genus based on 8 adult specimens obtained from the Antarctic Sea. Although Karrer (1975) recognised *P. antarcticus* as a valid species, it has been synonymised with *P. gracilis* by many authors (Bussing 1965; Parin & Andriashev 1972; Parin & Bekker 1972; Nakamura 1982; Nishikawa 1984). *Paradiplospinus gracilis* is most closely related to *Diplospinus multistriatus* within the family Gempylidae.

The greater part of the lateral line of this species is situated nearer the ventral contour than the dorsal contour as in fishes of family Trichiuridae. This indicates that, like trichiurid fishes, *P. gracilis* is better adapted to the sea bottom than to the upper layer. Adults of this species seem to inhabit relatively shallower water (188–2,830 m deep), while juveniles and young individuals seem to inhabit deeper (1,400–2,890 m deep) waters (Bussing 1965). Nishikawa (1984) showed that the postlarvae are near the surface as they were collected in a sub-surface larval-net tow (about 20–50 m deep). Little is known of the biology of *P. gracilis*; the stomach of one fish, caught in the Indian Ocean sector, was filled with Antarctic krill, *E. superba* (Solyanik 1964).

Attains about 50 cm SL.

SCOMBRIDAE

Tunas

by I. NAKAMURA

Body elongate and fusiform, moderately compressed in lower scombrids. Mouth rather large and nonprotractile with strong but rather small teeth in both jaws (no fangs and no true canines). Snout pointed and stout, forming beak-like structure; nostrils double. Gill openings wide; left and right gill membranes not united with each other, free from isthmus; gill rakers absent (in *Acanthocybium)* to numerous (in *Allothunnus*), 0–80; branchiostegal rays 7. Two dorsal fins and several finlets present; first dorsal fin usually low and short, continuous with or separated by a short interspace from second dorsal fin, depressible into a groove, IX–XXVII, 10–25 + 5–11 finlets; anal fin similar to and slightly smaller than second dorsal fin, 0-I, 10–25 + 5–12 finlets; pectoral fin midlateral, the rays 18–38; pelvic fins thoracic and well developed. Two small caudal keels in lower scombrids on each side of caudal peduncle. Lateral line single (nearly straight or fairly undulated) or double (in *Grammatorcynus*). Scales rather small and thin; corselet and postorbital thick scaly area developed in higher scombrids.

Fifteen genera and 49 species of medium size to enormous predatory fishes. Typical epi- and mesopelagic fishes with world-wide or fairly wide geographical distribution. Some species perform transoceanic migration. Taxonomic revisions of the Scombridae were done by Fraser-Brunner (1950), Gibbs & Collette (1967), Collette (1979, 1986) and Collette & Nauen (1983). One species occurs in the Southern Ocean.

Genus ***Thunnus*** South, 1845

Body fusiform. Gill rakers on first arch well developed, 19–43. Interpelvic process bifid and rather small. Pectoral-fin rays numerous, 30–38. Small scales on body; corselet and postorbital area with larger and thicker scales. Caudal peduncle with a large lateral keel supported by well-developed bony processes on caudal peduncle vertebrae, and 2 small accessory keels. Total vertebrae 39 (18+21 or 19+20). Seven species world-wide, one species in our area.

Thunnus maccoyii (Castelnau, 1872)

Southern bluefin tuna

Fig. 1

Thynnus maccoyii Castelnau, 1872: 104, Melbourne, Australia. Types were not designated by the author.

Thunnus phillipsi Jordan & Evermann, 1926: 13, pl. 2, fig. 4, Bay of Islands, New Zealand. Holotype: A photograph, CAS 596.

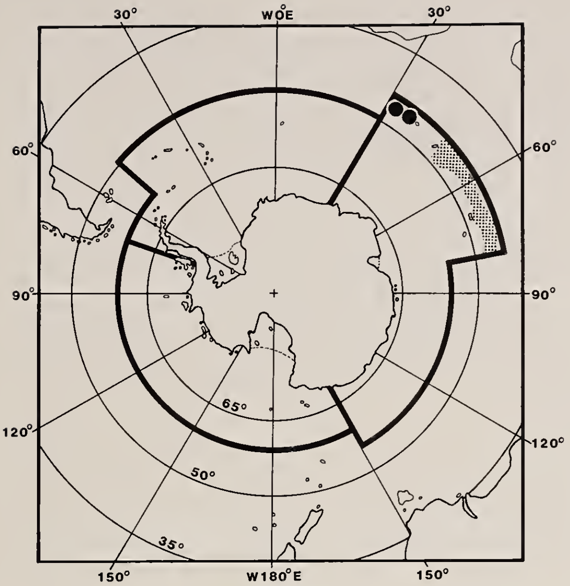
Diagnosis: D XIII-XIV,14–15 + 8–9 finlets; A 13–14 + 7–9 finlets; P 30–34; V I,5; GR 31–37; LL about 220; vertebrae 18+21=39. Body depth 27.5–22.7%, head length 30.7–31.6%, pectoral fin length 20.0–22.2% FL. Snout length 34.9–40.1%, interorbital width 36.3–42.2%, least depth of caudal peduncle 8.5–8.9% HL. Pectoral fin less than 75% HL, never reaching origin of second dorsal fin. Air-bladder present. Liver with 3 lobes (median lobe largest) and striated surface. Muscles of dorsal wall of body cavity projecting remarkably into body cavity. Olfactory rosette without marginal fleshy ridge, nasal laminae (about 45) well developed with few small serrations on distal margins.

Colour: In life, blue black dorsally, silvery-white ventrally; white transverse lines alternated with rows of white dots visible in fresh specimens. First dorsal fin yellow; second dorsal and anal fins dusky yellow; dorsal and anal finlets dusky yellow margined by black. Median caudal keel yellow (most conspicuous specific character, if visible).

Distribution: Distributed throughout temperate and cold seas of the Southern Hemisphere, mainly between 30° and 50°S. Southern limit of distribution is nearly 60°S. In spawning season, large fish migrate to tropical seas, off the west coast of Australia, up to 10°S.

Remarks: Calculated maximum fork length is about 220 cm (Yukinawa 1970); a large specimen of *T. maccoyii* estimated at 260 kg body weight (227 kg without gills and gut) and 245 cm FL was captured by a Japanese

Fig. 1. *Thunnus maccoyii* FAKU 39313, 117 cm FL (37°19′S, 8°54′E), with dorsal view of tail



Distribution of *T. maccoyii*

longliner around New Zealand waters in 1986 (Y. Nishikawa, Far Seas Fisheries Research Laboratory, pers. comm.) This species occurs in epi- and mesopelagic oceanic waters, swimming from the surface to about 300 m depth, and generally performing northward migration to warmer waters for spawning, and southward migration to colder waters for feeding. Preferred surface temperature and salinity for spawning adult fish in the eastern Indian Ocean are 17–25 °C, 35–36°/$_{oo}$ (20–35 °S, 80–120 °E), 24–30 °C, 34–35°/$_{oo}$ (10–20 °S, 100–130 °E), for adult and immature fish migrating north around Tasmania and New Zealand 14–20 °C, 35–37°/$_{oo}$, for young fish off Australia 15–20 °C, 35–36°/$_{oo}$, and for adult and immature fish migrating south in the west wind drift area 5–15 °C, 34–35°/$_{oo}$ (Shingu 1970). According to Shingu (1970), the estimated fork length (cm) and body weight (kg) at the beginning of each year class are (age indicated in brackets): 29, 0.6 (1); 54, 3.4 (2); 76, 9.2 (3); 95, 17.7 (4); 112, 28.3 (5); 127, 40.3 (6); 150, 79.1 (8); 168, 91.5 (10); 181, 114.5 (12); 196, 143 (15); 223, 208.6 (L-infinity and its equivalent weight derived from von Bertalanfy growth equations). Robins (1963) and Yukinawa (1970) obtained almost the same result, but Murphy (1976) was somewhat lower. *T. maccoyii* is an opportunistic feeder, preying on a wide variety of fishes, crustaceans, cephalopods, salps and other groups of marine animals.

CENTROLOPHIDAE

Driftfishes

by P.C. HEEMSTRA

Body oblong/elongate, compressed. Dorsal fin long, the spines hard or soft and flexible, the spinous and soft-rayed parts more or less continuous; median fins mostly covered with skin and scales, the rays difficult to count; pelvic fins present. Scales small, usually cycloid and often deciduous. Head with numerous small pores. Opercle with 1 or 2 weak spines. Minute teeth in jaws, none on vomer, palatines, endopterygoids or tongue. Branchiostegals usually 7, the membranes separate.

This family comprises 7 genera and about 30 species; represented in all oceans, from polar to tropical waters. Pelagic fishes of the open ocean, but some species are found near shore and are often taken in bottom trawls. Only 1 genus is represented in the Southern Ocean.

Genus *Icichthys* Jordan & Gilbert, 1880

Body elongate, compressed and flexible. Dorsal fin continuous, with short, flexible spines grading into longer segmented rays, the fin origin well behind the pectoral fins. Scales present on cheeks. Vertebrae 50–61; predorsal bones 7–11.

Remarks: The type-species, *Icichthys lockingtoni* Jordan & Gilbert (1880), is known only from the North Pacific. A new genus, *Pseudoicichthys*, was proposed by Parin & Permitin (1969) for the species originally described by Haedrich (1966) as *Icichthys australis*. Parin & Permitin (1969) explicitly and implicitly (by the name *Pseudoicichthys)* recognized that *I. australis* is most closely related to *I. lockingtoni,* and neither Krefft (1969) nor McDowall (1982) have accepted *Pseudoicichthys* as a valid genus. The supposed difference in the number of epurals for these 2 species (2 in *lockingtoni* and 3 in *australis)* reported by Parin & Permitin (1969) is vitiated by the observation of "occasionally three" epurals in *I. lockingtoni* (Ahlstrom *et al.* 1976). Although these 2 species are readily separable on the basis of vertebral number (56–60 in *lockingtoni*), number of pyloric caeca (ca. 10 in *lockingtoni)* and the tubular cephalic lateralis pores (absent in *lockingtoni*), it serves no useful purpose to put *australis* in a separate monotypic genus.

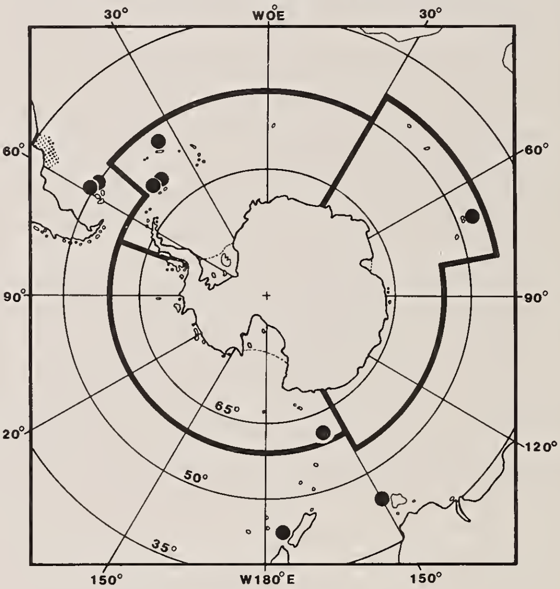
Icichthys australis Haedrich, 1966
Southern driftfish
Fig. 1

Icichthys australis Haedrich, 1966: 210, fig. 1, east of New Zealand (44°40′S, 173°39′E). Holotype: ZMUC P69870

Diagnosis: D (spines + rays) 38–44; A 25–29; P 16–18; GR (4–6)+(11–13); vertebrae 48–52. Body depth 2.5–3.9 and head length 3.2–5.3 in SL. Dorsal pores of the cephalic lateralis system open via short tubes. Pectoral fins of adults distinctly less than head length and the pelvic fins are much shorter. Ventral midline of belly with a low fleshy keel. Pyloric caeca numerous, dendritic.

Colour: In alcohol, dull brown; fins distinctly darker.

Distribution: Juveniles are known both north and south of the Antarctic Convergence and are probably circumpolar betwen 50° and 60°S. The species has been reported from South Georgia (White & North 1980),



Distribution of *I. australis*

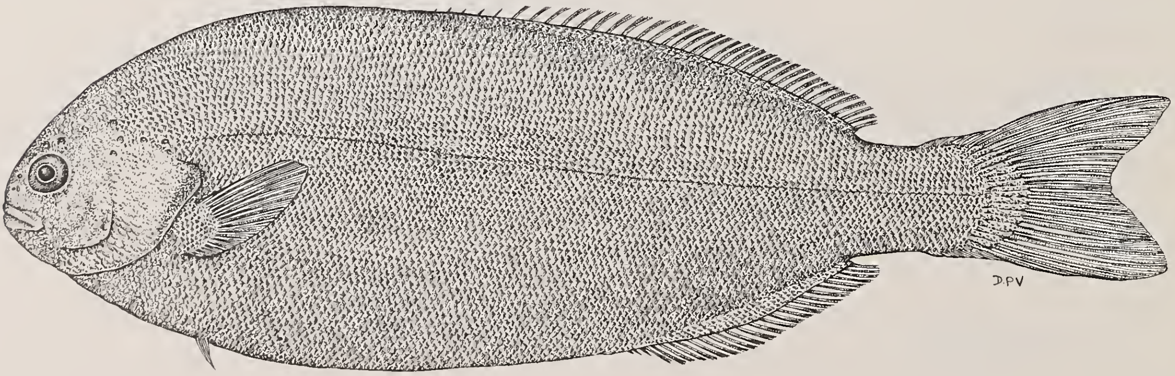


Fig. 1. *Icichthys australis* MNHN 1985–268, 34 cm SL, Kerguelen Islands (snout reconstructed)

South Orkneys and the Falkland Islands (Haedrich 1986), Argentina (Krefft 1969), Chile (Nakamura 1986), New Zealand and Tasmania (McDowall 1982). I have examined a specimen from the Kerguelen Islands (MNHN 1985–268). Juveniles exhibit a wide depth range (0 to 2,000 m).

Remarks: The diagnosis above is compiled from McDowall (1982), White & North (1980), Parin & Permitin (1969) and Krefft (1969). *Icichthys australis* attains at least 81 cm (McDowall 1982). Adults close to spawning have been found on the continental slope off Argentina (Krefft 1969).

This species is rare and appears to be of no commercial importance.

ACHIROPSETTIDAE

Southern flounders

by P.C. HEEMSTRA

Body greatly compressed; both eyes on left side of head. Dorsal and anal fins separate from caudal fin; no fin spines; pectoral fins rudimentary (in juveniles) or absent; left pelvic fin with 4–8, right with 4–7 rays; base of left pelvic fin distinctly longer than right one, its anterior part on ventral midline of isthmus, and rear part of fin curving slightly onto eyed side; fin rays of all fins unbranched (except median caudal rays). Preopercle edge more or less covered by skin and scales. Lateral line straight (no distinct arch anteriorly), well developed on both sides of body. Branchiostegal membranes separate. No teeth on vomer. Neural spine of first vertebra absent; no transverse apophyses on vertebrae; epipleural and pleural ribs present. Caudal fin skeleton with 5 separate hypurals, none fused to the ural centra; epural not fused to 5th hypural. Egg with multiple oil globules.

Three genera and 4 species of small to medium-size benthic fish of Antarctic and sub-Antarctic waters.

Remarks: The family Achiropsettidae was proposed by Evseenko (1984) for his new genus *Pseudomancopsetta*. In a discussion of the relationships of his new genus, Evseenko suggested that "Most probably, the remaining genera of lefteye ('armless') flounders, *Mancopsetta, Achiropsetta* and *Neoachiropsetta,* will also be included under this family". But, of course, if a new family named Achiropsettidae is erected, it will necessarily include the type-genus, *Achiropsetta*. Hensley (1986) mentioned that the genus *Mancopsetta* (with *Achiropsetta* Norman, 1930, *Apterygopectus* Ojeda, 1978 and *Neoachiropsetta* Kotlyar, 1978a, as synonyms) did not belong in the family Bothidae. Several important characters in which *Mancopsetta* differs from bothids were listed by Hensley & Ahlstrom (1984); most of these characters are incorporated in the diagnosis above. The 22 mm SL metamorphosing larva of *M. maculata,* as described by Evseenko & Efremenko (1986), exhibits only 1 (large size at metamorphosis) of the 5 synapomorphies of bothid larvae listed by Hensley & Ahlstrom (1984: 686).

The taxonomy of this family is poorly known. Several undescribed species are represented in Russian collections (Sergei Evseenko, pers. comm.), and the intraspecific variation in characters used to differentiate species cannot be assessed without examination of large series of specimens from throughout the range of each species. The material and time required for a thorough revision of the Achiropsettidae are not available in the present circumstances. Consequently, the account presented here is simply a review of the family compiled from the literature and examination of a few specimens.

KEY TO GENERA

1a Anus on blind side of body; D 83–93; A 69–75 ....*Pseudomancopsetta*
1b Anus on ventral midline of body; D 104–141; A 89–123 2
2a Scales all over body with 1–4 spinules projecting vertically (away from body); head length contained 4–5 times in SL ....*Achiropsetta*
2b Scales on main part of body with ctenii directed posteriorly (lying flat against body); head length 3–4 times in SL ....*Mancopsetta*

Genus *Achiropsetta* Norman, 1930

Head small, its length 19–23% SL. Body scales with 1–4 long spinules projecting upward from plane of scale. Anal-fin origin posterior to left pelvic-fin base. Anus on ventral midline of body. No caudal peduncle, rear end of the dorsal and anal fins attached to base of caudal fin. No interorbital crest.

One species. Hensley (1986) regarded *Achiropsetta* as a synonym of *Mancopsetta,* but the peculiar scale morphology of *A. tricholepis* sets it off from the other members of the *Achiropsettidae*. And there are no apparent derived characters shared exclusively with *Mancopsetta* or *Pseudomancopsetta*. If generic taxa are to have some meaning in this family, it seems necessary to recognise *Achiropsetta* as a monotypic genus.

Achiropsetta tricholepis Norman, 1930
Prickly flounder
Fig. 1

Achiropsetta tricholepis Norman, 1930: 362, fig. 47, off

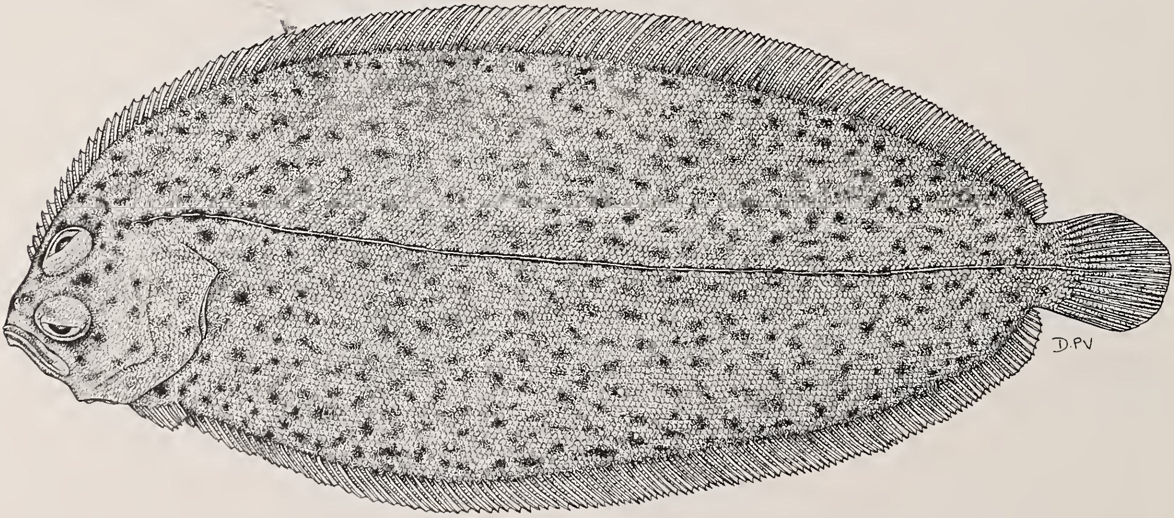


Fig. 1. *Achiropsetta tricholepis* MNHN 1986–428, 30 cm SL, Crozet Islands (45°44′S, 49°20′E)

Tierra del Fuego (53°01'S, 68°06'W). Holotype: BMNH 1930.5.6.42.

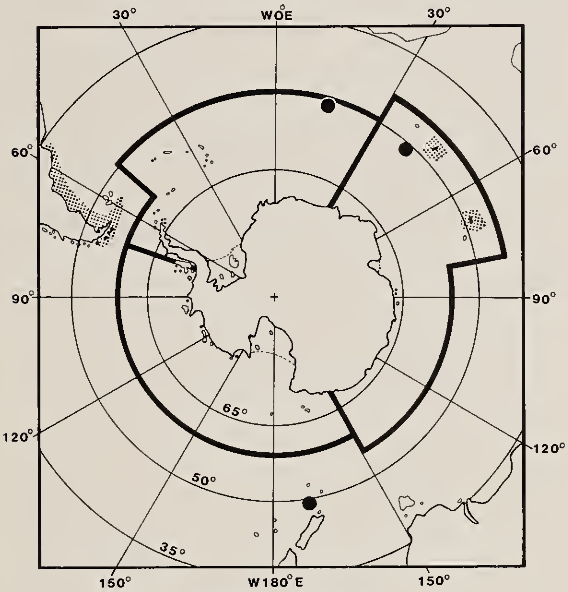
?*Mancopsetta argentina* Lahille, 1939: 195, text fig. 7, pl. 4, fig. 2, mouth of Rio de la Plata, Argentina.

?*Achiropsetta heterolepis* Evseenko, 1987: 780, fig. 4, off Crozet Islands (45°05'S, 50°36'E).

Diagnosis: D 123–145; A 106–123; V 7 (left), 6–7 (right); LL 152–195; GR (0–5)+(8–10); vertebrae (15–17)+(48–50) = 64–66; holotype of *A. tricholepis* with 16+46 vertebrae. Body depth 2.3–2.8 and head length 4.3–5.2 in SL. Eye diameter longer than snout, but much shorter than upper jaw, 23–27% HL; upper jaw length of eyed side 25–42% and interorbital width 9–14% HL. Gill rakers short, the tips rounded. Most scales with 1–4 long spinules directed upward at an acute angle, giving the surface of the body a bristly or villose aspect. Jaws with small, slender, conical teeth, uniserial except at front of jaws and equally developed on both sides of both jaws.

COLOUR: In alcohol, dark uniform greyish-brown (photograph published by Nakamura 1986). Specimens from the Kerguelen Islands were described with "taches brunes sur toute sa surface" (Duhamel & Hureau 1982).

Distribution: Known from the upper slope region (100–1,020 m) off Patagonia, the Falklands and the Burdwood Bank; also reported from the Ob Bank, Kerguelen Islands, Crozet Islands, and the Campbell Plateau.



Distribution of *A. tricholepis*

Remarks: The diagnosis above was compiled from Kotlyar (1978), Duhamel & Hureau (1982), Menni *et al.* (1984), Duhamel (1986), Nakamura (1986) and Evseenko (1987).

According to Evseenko (1987), *A. heterolepis* differs from *A. tricholepis* in "that only some of the scales carry vertically protruding spinules and one or a few gill rakers on the ceratobranchial of the 1st gill arch on the inner side carry one terminal denticle". He also mentions that the paratypes of *A. heterolepis* differ from the holotype in having "vertically protruding spinules in a large number of scales covering the head and trunk sections of the body, as well as on the rays of all fins". If the number of scales bearing vertically projecting spinules varies from "some" to "a large number", it would seem that it might also vary from "a large number of scales" to "most scales on the body"; and the fact that the presence of vertically projecting spinules on the scales (and their angle) varies from one part of the body to another would argue against using the proportion of scales with vertically projecting spinules to differentiate species. The presence or absence of a single denticle on a single gill raker also seems to be of little value in distinguishing species.

The fin-ray counts given by Lahille (1939) for his new species (D 117; A 105) are somewhat low for *Achiropsetta tricholepis*; unfortunately the holotype of Lahille's species was not available for examination.

Attains at least 39 cm (Kotlyar 1978).

Genus *Mancopsetta* Gill, 1881

Head large, its length 23–31% SL. Anal fin origin posterior to left pelvic-fin base. Anus on ventral midline of abdomen. Ctenii of scales on main part of body directed posteriorly (as usual in fishes).

Two species are here assigned to this genus. Kotlyar's (1978a) proposal of a new genus (*Neoachiropsetta)* for *M. milfordi* was based on the difference in number of vertebrae (63–67 versus 52–56 for the other species of *Mancopsetta)* and the supposed difference in position of gill rakers on the epibranchial of the first gill arch. *M. milfordi* was said to have the gill rakers "located on actual bend of arch", whereas *M. maculata* had gill rakers "along the entire length of the upper part of the 1st gill arch". This supposed difference in positioning of epibranchial gill rakers seems more to be a function of the number of gill rakers on the upper limb, which varies from 0–5 in *M. milfordi,* rather than any substantive anatomical disparity in these species. A specimen of *M. milfordi* with five gill rakers on the upper limb would have them located along most (if not all) of the length of the epibranchial, and the position of these 5 gill rakers is not likely to be noticeably different from those of *M. maculata* with 5 upper-limb gill rakers. In fact, D. Hensley (pers. comm.) has examined specimens of *M. milfordi* with gill rakers all along the epibranchial. And the supposed generic difference in number of vertebrae (7) is hardly more than the range of vertebral number within *M. milfordi* (4).

Evseenko (pers. comm.) recommends keeping *Neoachiropsetta* as a valid genus because it lacks a postcleithrum, which is present in *Mancopsetta,* and "Besides that the gill rakers of the species of *Mancopsetta* have no spines. Most of the gill rakers of *Neoachiropsetta* species (*N. milfordi* plus several undescribed species) have several strong spines which are situated on the inner side of the gill rakers". But the similarities between the species of *Mancopsetta* (including *M. milfordi*), as listed in the diagnosis above, indicate a closer relationship of species within this genus than with any species of *Achiropsetta* or *Pseudomancopsetta.* The most convenient way to represent this close relationship is to include *maculata* and *milfordi* in a single genus.

KEY TO SPECIES

1a A 89–109; body, head and fins covered with brownish-red spots and blotches; vertebrae 52–56 2
1b A 104–124; body, head and fins uniform dark brown; vertebrae 63–67 .... *M. milfordi*
2a LL scales 100–126; GR club-shaped, expanded at their tips; teeth uniserial .... *M. maculata maculata*
2b LL scales 128–159; GR pointed; teeth biserial .... *M. maculata antarctica*

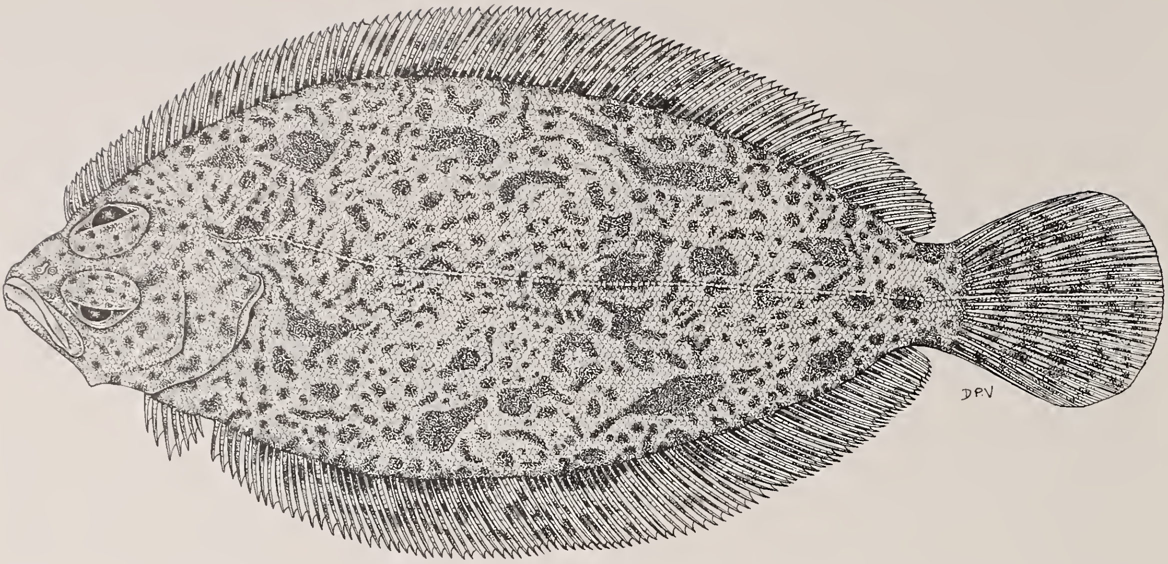


Fig. 2. *Mancopsetta maculata antarctica* BMNH 1938.7.12.824, 22 cm SL, South Georgia (53°48′30″S, 35°09′W)

Mancopsetta maculata antarctica Kotlyar, 1978
Variegated flounder
Fig. 2

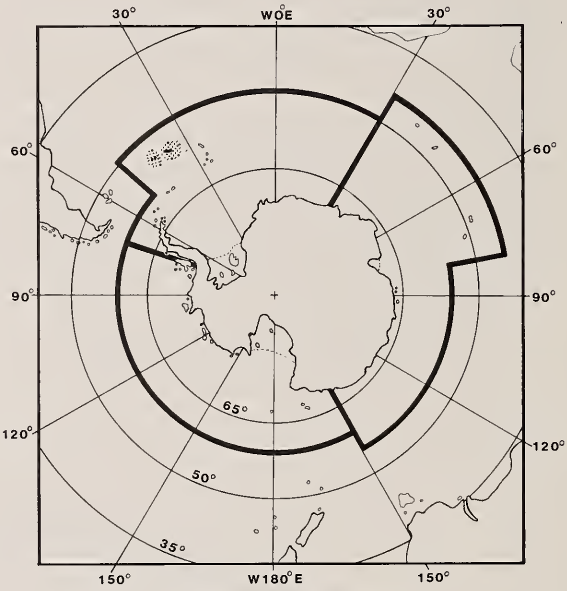
Mancopsetta maculata antarctica Kotlyar, 1978a: 801, fig. 3, type-locality not specified, either Shag Rocks or South Georgia. Holotype: ZMMGU P 14183.

Diagnosis: D 104–124; A 89–109; V 6–8 (left), 4–6 (right); LL 128–159; GR (5–7)+(10–16)=15–22; vertebrae (13–16)+(38–42)=53–56. Body depth 2.2–2.8 and head length 3.0–4.4 in SL. Greatest eye diameter longer than snout, 27–37% HL; upper jaw length equal to or greater than eye diameter, 33–43% HL; interorbital width 3.2–6.7% HL. Gill rakers on lower limb of first arch short, slender, with pointed tips. Most body scales with ctenii directed posteriorly (lying flat against body).

COLOUR: In alcohol, ocular side variegated brownish-grey to yellowish-green, occasionally almost black; head, body and fins covered with irregular-shaped, large and small, brown spots; body sometimes with pale spots. Blind side white to pale grey.

Distribution: Known only from the Shag Rocks and South Georgia. Depth range 140–320 m.

Remarks: The diagnosis above was compiled from Kotlyar (1978a). The type series comprises 52 specimens of 14–30 cm TL. *Mancopsetta maculata antarctica* was originally described as a subspecies of *M. maculata* and compared with specimens identified as *M. maculata maculata* that were collected at the Burwood Bank south of the Falkland Islands (Kotlyar 1978a). Although he did not examine specimens of *M. maculata* from the type locality (Prince Edward Islands), it appears that Kotlyar's specimens from Burdwood Bank are members of the same subspecies. The distributions of these 2 subspecies are not well known, but it appears that *M. m. maculata* crosses the Antarctic Polar Front and is widely distributed in the Southern Ocean. Consequently, Kotlyar's (1978a) subspecies *M. m. antarctica* is here tentatively recognised as a valid subspecies endemic to the Shag Rocks and South Georgia area. Hureau (1985b) has confused *M. m. maculata* with *M. m. antarctica*. His description applies to *M. m. antarctica*, but the distribution he gives is a combination of both taxa.



Distribution of *M. m. antarctica*

M. m. antarctica attains 30 cm SL.

Mancopsetta maculata maculata (Günther, 1880)
Spotted flounder

Lepidopsetta maculata Günther, 1880: 18, pl. 30, fig. C, off Prince Edward Island. Holotype: BMNH 1879. 5.14.90.

Achiropsetta slavae Andriashev, 1960c: 1056, figs. 1–2, off Wilkes Land (64°22′S, 121°08′E).

Diagnosis: D 105–128; A 89–105; V 6–7 (left), 4–6 (right); LL 100–126 (Nakamura (1986g) records a count of 131 LL scales); GR (5–8)+(9–15)=14–20; vertebrae (13–15)+

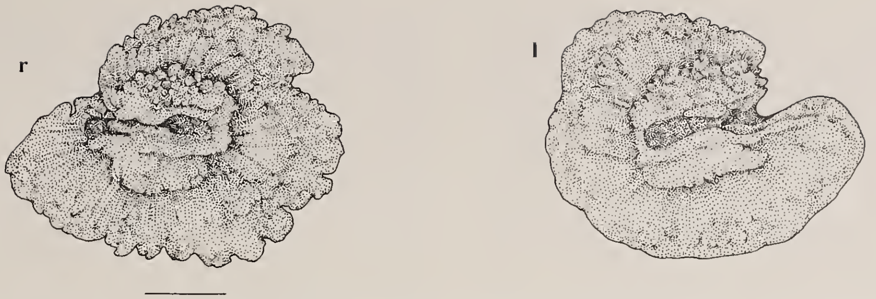


Fig. 3. Right (r) and left (l) otoliths from *M. maculata maculata*, 36 cm TL; scale bar 1 mm

(38–41)= 52–55. (Morphometric data are from 9 specimens 10–30 cm SL.) Body depth 1.8–2.6 and head length 3.1–3.8 in SL. Greatest eye diameter longer than snout, 31–42% HL; upper jaw length subequal to eye diameter, 31–43% HL; interorbital width 8–13% HL. Gill rakers on lower limb of first arch short, stout, expanded at their tips. Most body scales of adults and benthic juveniles (greater than 10 cm SL) with ctenii directed posteriorly (lying flat against body); body scales of post-larvae and pelagic juveniles (45–95 mm SL) with 1–3 spinules (ctenii) that project more or less vertically from the surface of the scale.

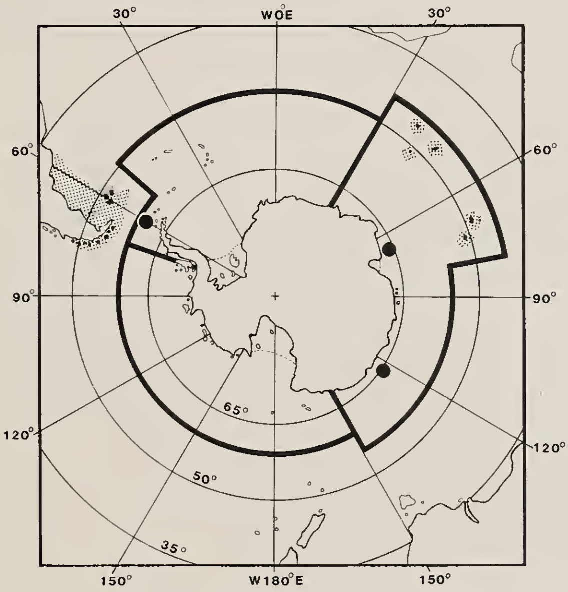
COLOUR: In alcohol, brownish, covered with numerous irregular dark spots. A colour photograph of a specimen from Patagonia (Far Seas Research Laboratory, 1976) shows the head, body and fins covered with reddish brown spots, the "eyelids" and abdominal region a pale greenish-blue.

Otoliths

DIAGNOSTIC FEATURES: The discoid shape of the otolith, the continuous crescent-like cristae around the sulcus acusticus, and the depressed area around the continuous cristae.

Ontogeny: The margin of the otoliths of fish larger than 325 mm TL becomes acutely dentate. The margin of smaller otoliths is entire.

Distribution: Known from the Argentine shelf/slope from 37°S to the Falklands and Burdwood Bank in depths of 132–1,115 m (Menni *et al.* 1984; Kotlyar 1978a); reported from 180–1,055 m at the Crozet Islands (Duhamel 1986); the holoype was captured at 550 m near Prince Edward Island. Postlarvae from off Wilkes Land were described as a new species, *Achiropsetta slavae*, by Andriashev (1960c), and a pelagic juvenile taken at the South Shetlands was also identified as *A. slavae* by Kotlyar & Svetlov (1985). Gon (1988) reported on a pelagic juvenile from off Prydz Bay (66°20.38′S, 62°03.96′E).



Distribution of *M. m. maculata*

Remarks: Gon and Klages (1988) provide additional information on the holotype of *Lepidopsetta maculata*.

The original description of *A. slavae* was based on 4 post-larvae of 48–63 mm TL (Andriashev 1960c). Although the meristic data for his new species agreed with counts for *Mancopsetta maculata*, Andriashev (1960c: 1060) discounted the possibility that *A. slavae* might be the post-larval stage of *M. maculata*: "However, our young cannot be assigned to this form because in the genus *Mancopsetta*, according to Norman, the body is not transparent and the scales, although ctenoid, lack the characteristic vertically projecting spinules. To explain these differences in terms of developmental change is hardly possible, since the difference between the specimens closest in length of *M. maculata* and *A. tricholepis* is (only) 29 mm, so that there is absolutely no basis for doubting the correctness of generic differentiation of both species, as shown by such an authority of flatfishes as Norman." (Footnote: "It is very probable that the peculiar prickliness of the body of *Achiropsetta* (that is, the strongly developed, vertically projecting spinules) can be considered as a larval character of a caenogenetic nature that is retained and repeatedly reinforced since there are similar spines in the majority of bothid larvae on various parts of the body (on the head, along the unpaired fins, on the belly, and elsewhere); on completion of metamorphosis, in correlation with settling, they disappear (Kyle 1913: 41–44), but in *Achiropsetta* they are retained, evidently in connection with the prolongation of pelagic life.") (Translated from the Russian by Laurence Penny.)

Despite Andriashev's protestations of incompatibility between his small, young *A. slavae* and the older and larger *M. maculata*, Penrith (1965) was not entirely convinced that *A. slavae* was not the post-larval stage of *M. maculata*. He also raised the possibility that his new species (*M. milfordi)* might be the adult form of *A. tricholepis*. The latter possibility is disproved by the observations of Menni *et al.* (1984), who compared specimens of nearly the same size (24 and 32 cm SL) of both species. But the hypothesis that *A. slavae* is the post-larval form of *M. maculata* has been confirmed by the discovery of a larger (112 mm TL) transitional specimen identified as *A. slavae* by Kotlyar & Svetlov (1985). This specimen, caught in 190–210 m (over a depth of 4,860 m) is a pelagic pre-juvenile in the process of transforming from a semi-transparent post-larva to the typical benthic, darkly-pigmented form: "Colour of fish (after fixation in formalin) dark brown on eyed side, covered with whitish and numerous dark brown spots. Fins yellowish-brown, (with) brownish spots on dorsal and anal fins. Blind side brownish." (Translated from Russian). In the configuration of their spinules, the scales of Kotlyar's prejuvenile are intermediate between the scales of *A. slavae* (with 1 or 2 vertical spinules) and those of *M. maculata* (with several posteriorly-directed spinules that lie flat against the body): "Each scale armed (with) 3–5 slender spinules, directed posteriorly and somewhat upward, giving the surface of the body a fleecy aspect."

In view of Kotlyar & Svetlov's (1985) intermediate specimen, it seems reasonable to conclude that the semi-transparent type-specimens of *A. slavae* do represent the post-larval stage of *M. maculata*; and that, with growth, the vertical spinules on the scales of the post-larvae bend posteriorly (eventually lying flat against the body) and increase in number.

A 22 mm SL post-larva collected near the Falkland Islands was described and illustrated by Evseenko & Efremenko (1986). The meristic data for this specimen agree with its assignment to *M. m. maculata*. This specimen is especially important because it was caught in metamorphosis, with the eye from the blind side situated on the dorsal edge of the head just in front of the dorsal fin origin, thus providing further evidence for the non-bothid affinities of *Mancopsetta*. (According to Hensley & Ahlstrom (1984), eye migration in bothids is effected by the right eye passing under, rather than in front of, the dorsal fin.)

M. m. maculata attains about 35 cm SL.

Mancopsetta milfordi Penrith, 1965
Largemouth flounder
Fig. 4

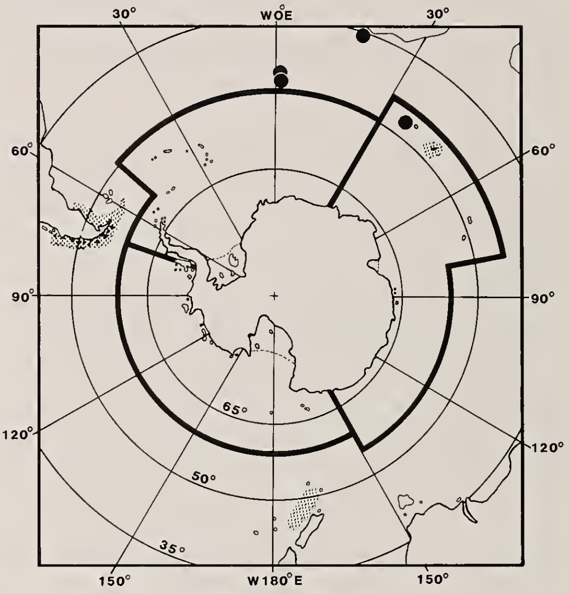
Mancopsetta milfordi Penrith, 1965: 181, fig. 1, pl. 3, off Cape Town. Holotype: SAM 24041.

Apterygopectus avilesi Ojeda, 1978: 3, fig. 103, off southern Chile (44°57′S, 75°16′W).

Diagnosis: D 117–145; A 104–124; V 4–7 (both sides); LL 142–212; GR (0–6)+(6–11); vertebrae (16–17)+(47–49)=63–67. Body depth 2.5–3.3 and head length 3.2–4.3 in SL. Eye diameter longer than snout but much shorter than upper jaw, 23–30% HL; mouth large, the upper jaw length of eyed side 40–50% HL; interorbital width 6–10% HL. Midbody region thick and muscular, the dorsal and ventral margins of body thin and semi-transparent (except in large adults). Dorsal head profile distinctly concave. Gill rakers small and pointed. Minute teeth on both sides of jaws. Scales on the main part of body with 8–12 recumbent ctenii; the scales near and on the fins have ctenii projecting at an angle away from the plane of the scale.

Colour: In alcohol, uniform dark brown.

Distribution: Known from the outer continental shelf and upper slope region (depths 165–840 m) off southern Chile, Argentina and the Burdwood Bank (Nakamura 1986g), Discovery Seamount (Golovan & Pakhorukov 1983), off Cape Town (Penrith 1965), Prince Edward Islands (underwater photograph, Gon & Klages 1988), the Crozet Islands (Duhamel 1986), and southern New Zealand (Hensley 1986).



Distribution of *M. milfordi*

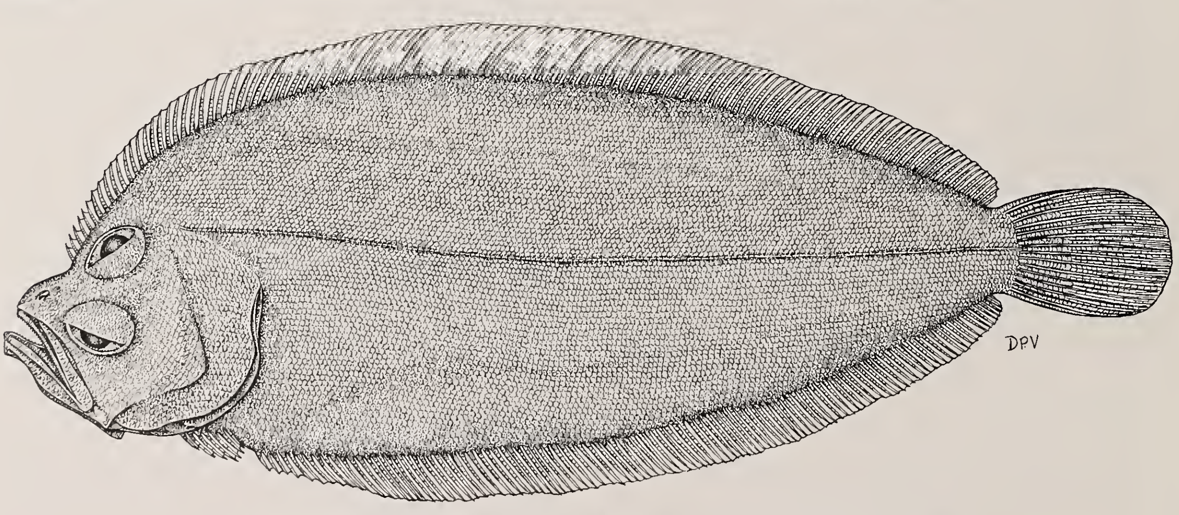


Fig. 4. *Mancopsetta milfordi,* holotype, 36 cm SL (scalation approximate)

Remarks: Nakamura (1986g) mentioned that *Apterygopectus avilesi* Ojeda, 1978, "seems to be a junior synonym" of *M. milfordi*. Ojeda was apparently unaware of the description of *M. milfordi* when he described *A. avilesi*.

Menni *et al.* (1984) demonstrated that *M. milfordi* is easily distinguished from *Achiropsetta tricholepis* on the basis of several morphometric characters, as well as by the distinctive structure of the scales.

Attains at least 57 cm (Kotlyar 1978a).

Genus *Pseudomancopsetta* Evseenko, 1984

Anus on blind side of body. Anal-fin origin under fifth ray of left pelvic fin. Vertebrae 41–44.

One species. The caudal skeleton of *P. andriashevi* that was illustrated by Evseenko (1984) is obviously abnormal, with the antepenultimate vertebra bearing an extra neural and heamal spine.

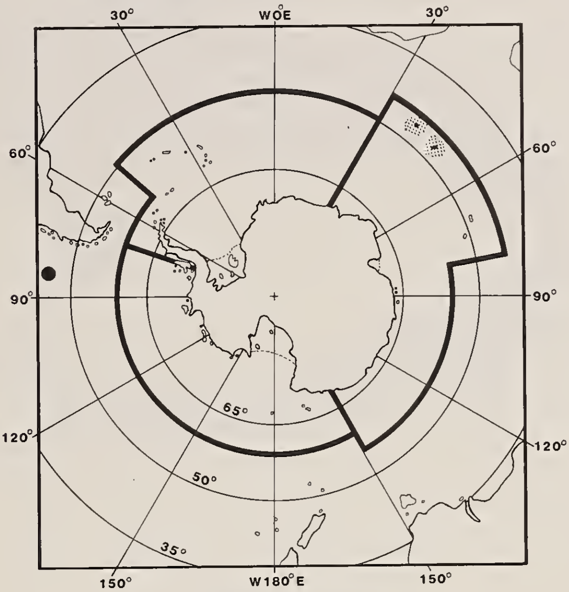
Pseudomancopsetta andriashevi Evseenko, 1984
Fig. 5

Pseudomancopsetta andriashevi Evseenko, 1984: 711, fig. 1, about 400 miles off south coast of Chile (45°49'S, 84°18'W). Holotype: MMSU 16262.

Diagnosis: D 83–89; A 69–75; V 6 (left), 4 (right); LL 79–92; GR (9–12)+(18–22); about 12 abdominal vertebrae. Body depth 1.9–2.1 and head length 3.2–3.9 in SL. Eye diameter greater than snout length and slightly less than length of upper jaw, 28.5–32.0% HL; upper jaw of eyed side 32–33% and interorbital 3.6–4.0% HL. Gill rakers well developed, pointed, those on inner (medial) side of arch fewer and smaller than the outer rakers. Scales of the usual ctenoid configuration: about 7–12 ctenii in a row on the rear edge of the scale directed slightly upward from the plane of the scale. Teeth not visible on left premaxilla; jaws of blind side with a row of minute teeth along most of the jaw and a second, inner row on front half of both jaws; lower jaw of left side with two irregular rows of minute teeth.

Colour: In alcohol, variegated; ground colour yellowish to dark brown, covered with minute and medium-sized dark brown spots of irregular shape. In life, eyelids and pelvic region pale blue and blind side white.

Distribution: The holotype was collected in 240 m off the south coast of Chile. Reported from 200–365 m at the Crozet Islands by Duhamel (1986). Gon & Klages (1988) reported 2 juveniles collected with a dredge in 243 and 376 m at the Prince Edward Islands.



Distribution of *P. andriashevi*

Remarks: The diagnosis above is taken from Evseenko (1984) and Duhamel (1986). The lower number of gill rakers (8–10 + 17) in the 2 juveniles (47 and 70 mm SL) reported by Gon & Klages (1988) may be due to the small size of these specimens.

Attains 110 mm SL.

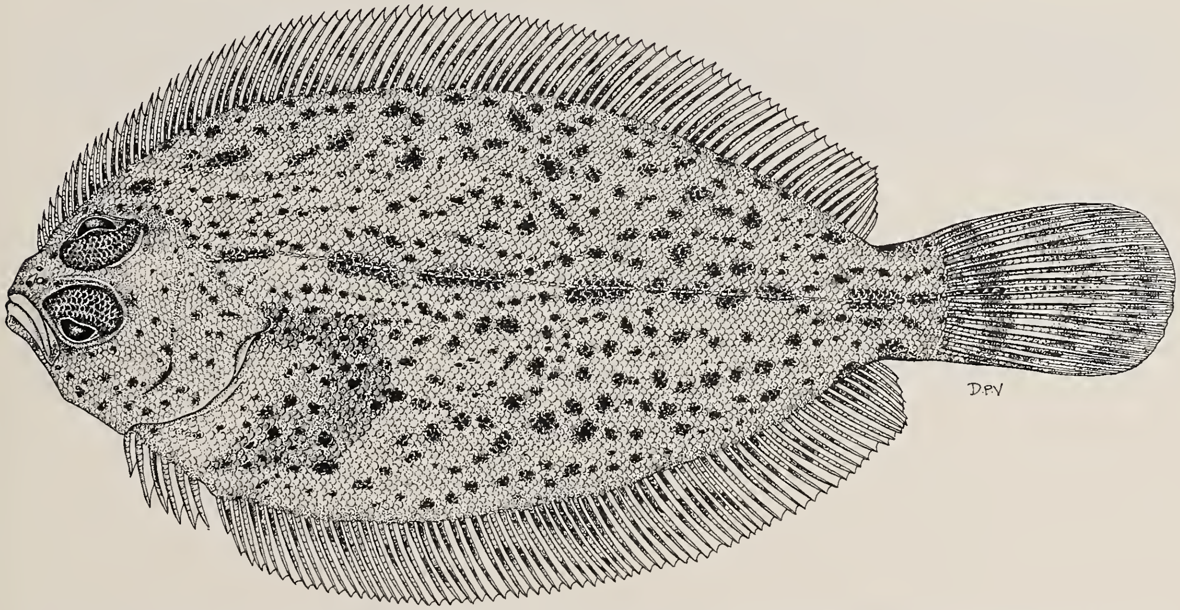


Fig. 5. *Pseudomancopsetta andriashevi* RUSI 27495, 69.6 mm SL, Prince Edward Island (46°59.75'S, 38°00.65'E)

PLATE 1

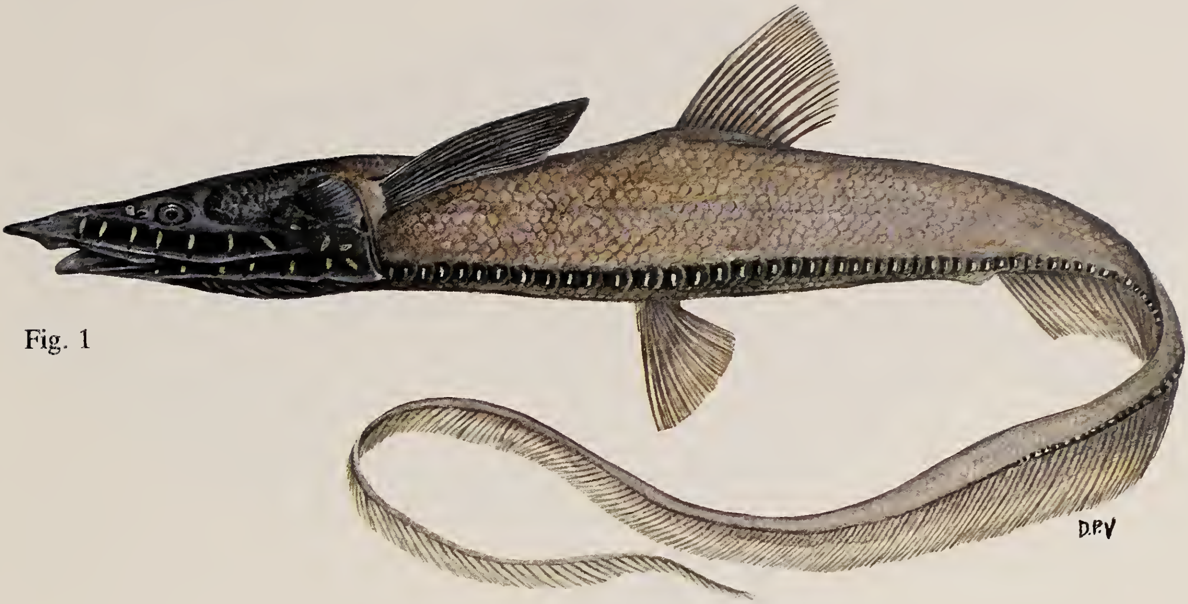


Fig. 1

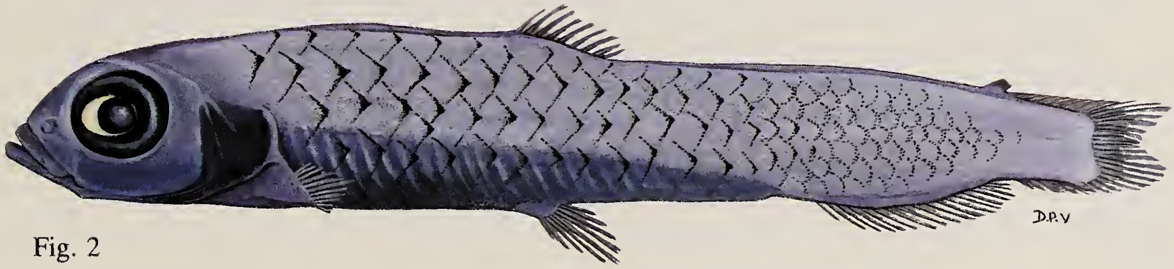


Fig. 2

Fig. 1. *Halosauropsis macrochir*, 48 cm TL, near Marion Island (colour based on Machida *et al*. 1988)
Fig. 2. *Bathylagus antarcticus*, 10.7 cm SL, off Mawson Station (from a photograph by O. Gon)

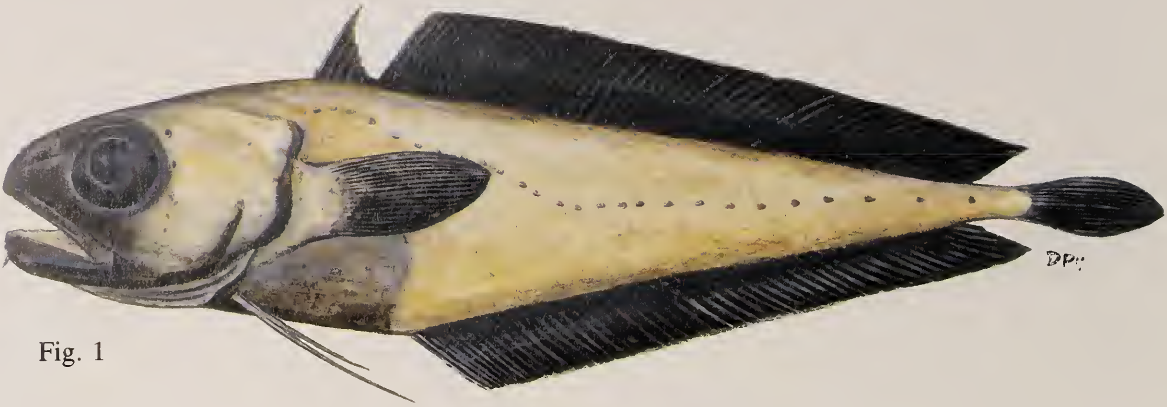


Fig. 1

Fig. 2

Fig. 1. *Laemonema kongi*, 8.7 cm SL, juvenile, Prince Edward Islands
Fig. 2. *Lampris guttatus*, 95 cm SL, off Cape Town (from *Smith's Sea Fishes*)

Fig. 1

Fig. 2

Fig. 1. *Lampris immaculatus*, 82 cm SL, Kerguelen (from a photograph by G. Duhamel).
Fig. 2. *Zanclorhynchus spinifer*, 6.4 cm SL, Macquarie Island (from a photograph by R. Williams)

PLATE 4

Fig. 1

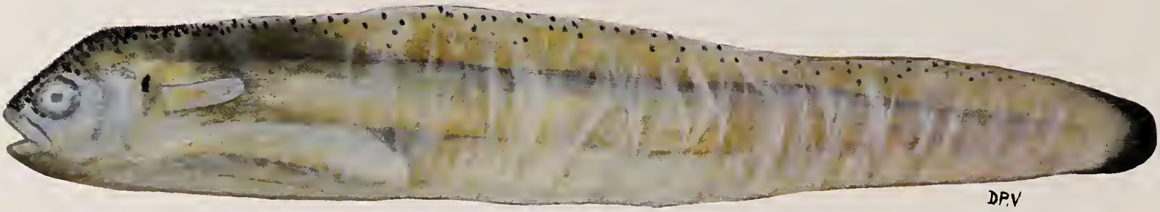


Fig. 2

Fig. 1. *Lycodichthys antarcticus*, 18.6 mm TL, McMurdo Sound
Fig. 2. *Melanostigma gelatinosum*, 12 cm TL (colour based on Nakamura 1986)

PLATE 5

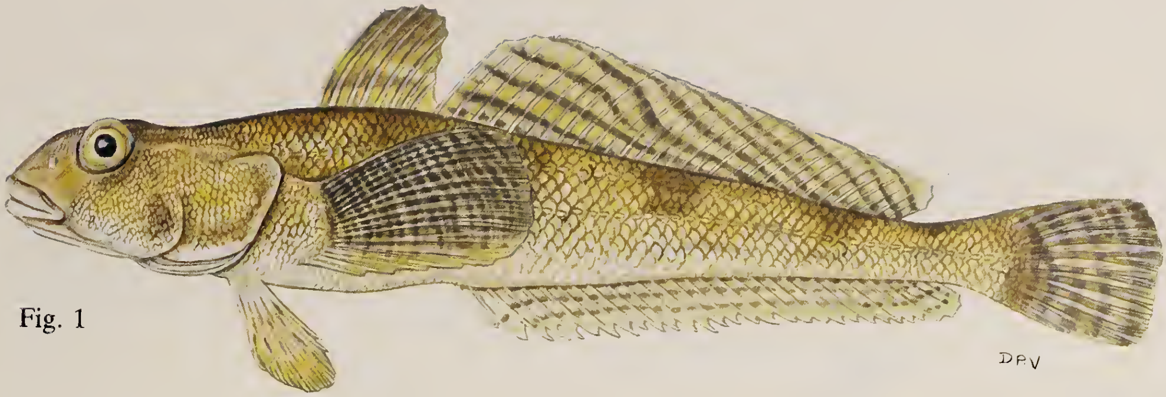


Fig. 1

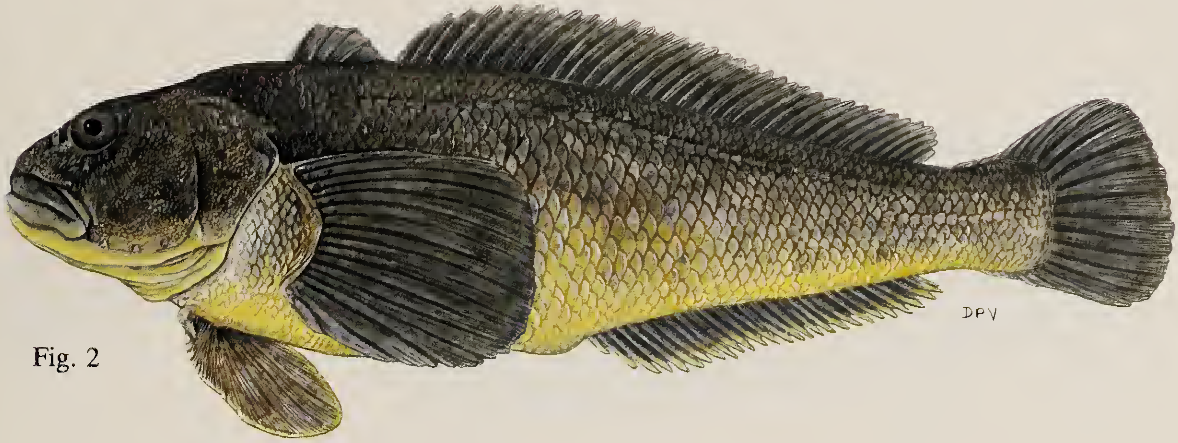


Fig. 2

Fig. 1. *Gobionotothen gibberifrons*, 40.5 cm SL, Atlantic Ocean sector (from a photograph by W. Slosarczyk)
Fig. 2. *Notothenia coriiceps*, 37 cm SL, Marion Island (from a photograph by O. Gon)

Fig. 1

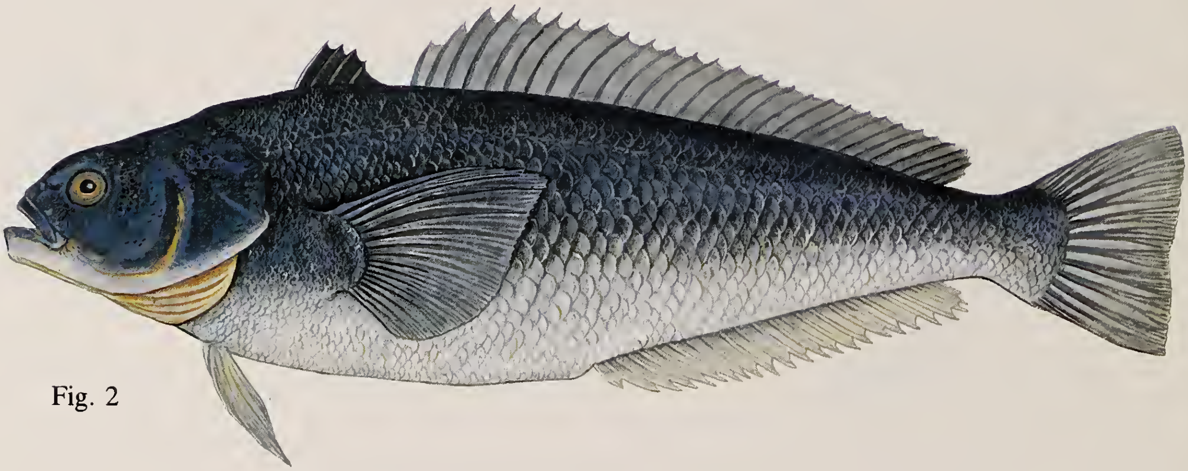


Fig. 2

Fig. 1. *Notothenia rossii*, 50.2 cm SL, Atlantic Ocean sector (photograph by W. Slosarczyk)
Fig. 2. *Paranotothenia magellanica*, 36.5 cm SL, Marion Island (from a photograph by L. Laurenson)

PLATE 7

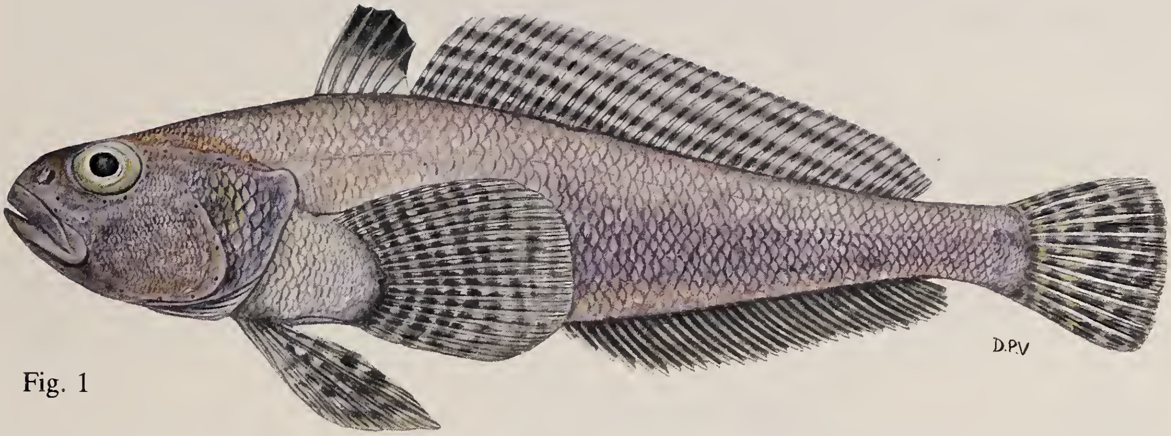


Fig. 1

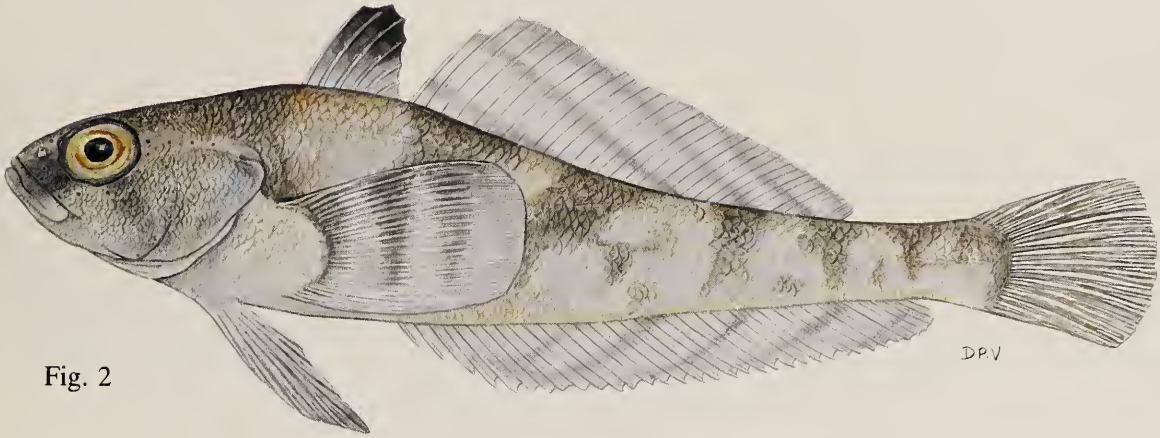


Fig. 2

Fig. 1. *Trematomus hansoni*, 27.7 cm SL, Atlantic Ocean sector (from a photograph by W. Slosarczyk)
Fig. 2. *Trematomus lepidorhinus*, 21.4 cm SL, Prydz Bay (from a photograph by R. Williams)

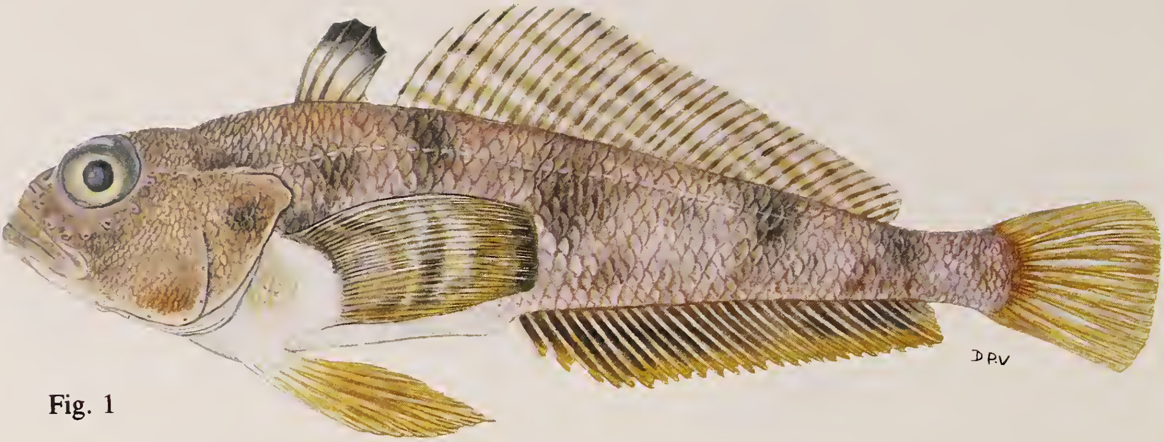


Fig. 1

Fig. 2

Fig. 1. *Trematomus pennellii*, 22.7 cm SL, Prydz Bay (from a photograph by R. Williams)
Fig. 2. *Cygnodraco mawsoni*, 23.6 cm SL, Prydz Bay (from a photograph by R. Williams)

PLATE 9

Fig. 1

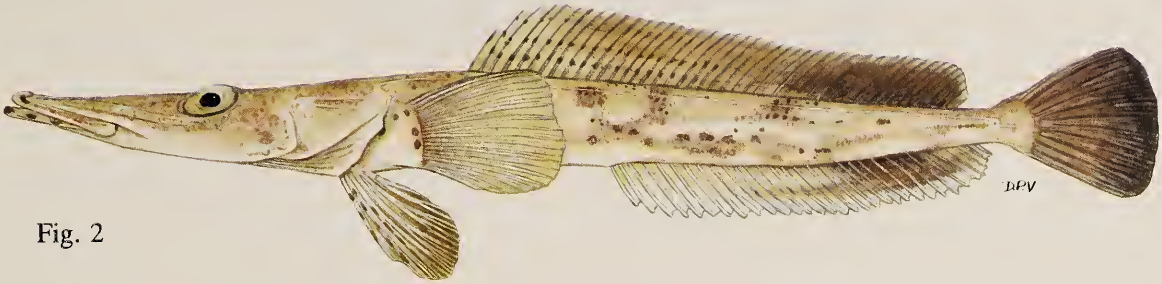


Fig. 2

Fig. 3

Fig. 1. *Cygnodraco mawsoni*, 90.4 mm SL, postlarva, off Mawson Station (photograph by O. Gon)
Fig. 2. *Parachaenichthys georgianus*, 50.2 cm SL, South Georgia (from a photograph by W. Slosarczyk)
Fig. 3. *Chaenocephalus aceratus*, 55.5 cm SL, Atlantic Ocean sector (photograph by W. Slosarczyk)

Fig. 1

Fig. 2

Fig. 1. *Champsocephalus gunneri*, 42.3 cm SL, Atlantic Ocean sector (photograph by W. Slosarczyk)
Fig. 2. *Chionobathyscus dewitti*, 47 mm SL, postlarva, off Mawson Station (photograph by O. Gon)

Fig. 1

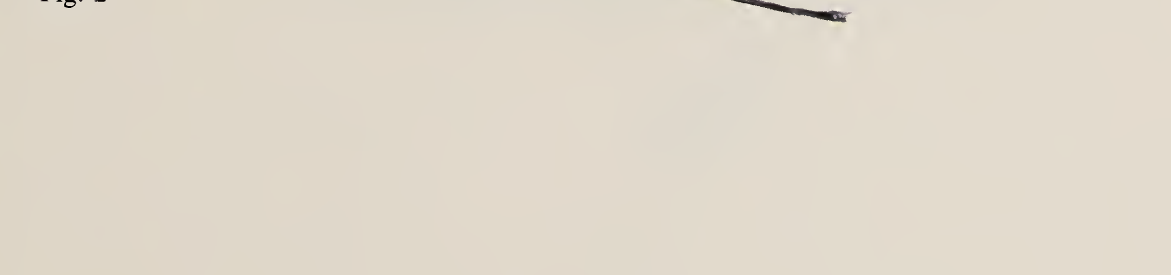


Fig. 2

Fig. 1. *Chionodraco rastrospinosus*, length unknown, Atlantic Ocean sector (photograph by W. Slosarczyk)
Fig. 2. *Cryodraco antarcticus*, length unknown, juvenile, Prydz Bay (photograph by R. Williams)

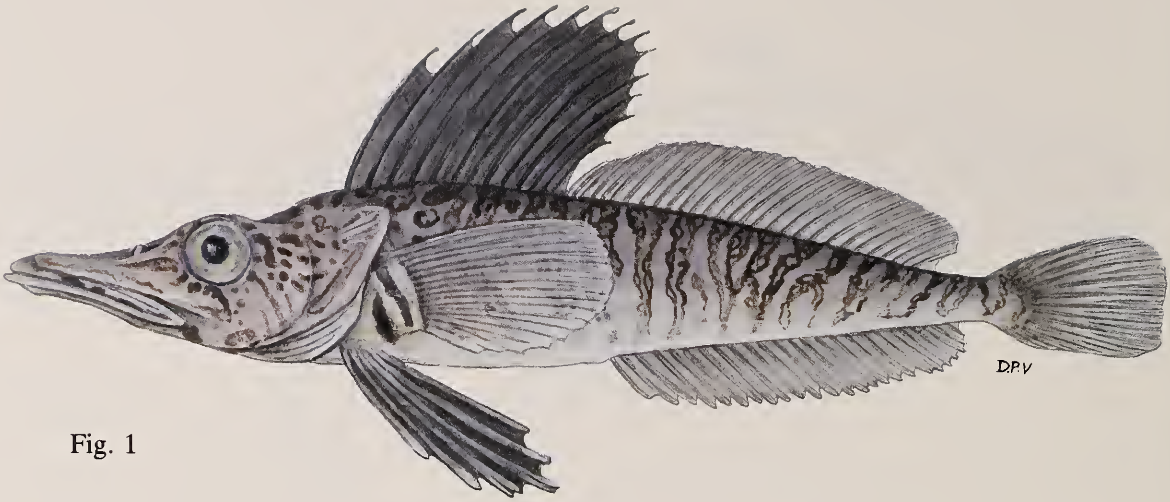


Fig. 1

Fig. 2

Fig. 1. *Pagetopsis macropterus*, 29.8 cm SL, Prydz Bay (from a photograph by R. Williams)
Fig. 2. *Pseudochaenichthys georgianus*, 49.2 cm SL, Atlantic Ocean sector (photograph by W. Slosarczyk)

Glossary of Terms

Absolute fecundity: the total number of ripe eggs in the ovary.

Adductor mandibulae: the major muscle of the cheek area; closes lower jaw.

Adipose: fatty tissue as in the small rayless dorsal fin of most salmoniform fishes.

Adpressed: lying flat against a surface.

Aglomerular: of kidneys without glomeruli.

Alar spines: specialised prehensile spines near the disc edge in all male skates (Rajoidea).

Allelic: referring to forms of a gene arising by mutation and occupying the same relative position on homologous chromosomes.

Allometric growth: differential rate of growth so that the size of one part of the body changes in proportion to another part, or the whole body.

Ammocoetes: larvae of lamprey, filter-feeding in fresh water; living on the bottom.

Amphipods: a group of bilaterally compressed, scavenging crustaceans; mostly marine burrowing organisms but also several terrestrial and a few freshwater representatives.

Anadromous: adjective used of fishes that spend part of their lives at sea but ascend rivers for spawning.

Anal lappet: a small flap of skin supported by internal scale(s) over the base of the anal fin; found in some cetomimid whalefishes.

Anomurans: decapod crustaceans (including hermit and mole crabs).

Antarctic Bottom Water: very cold (0 to −1 °C) and saline (34.65%) water formed on the Antarctic Continental Shelf and covering most of the world ocean bottom (see Figure 7).

Antarctic Circumpolar Current: the major current in a clockwise (eastward) direction around Antarctica between the *Antarctic Divergence* and the *Subtropical Covergence* (see Oceanography chapter, Fig. 7). This flow extends through the whole water column; also known as the Westwind Drift.

Antarctic Convergence: see Antarctic Polar Front.

Antarctic Divergence: an ephemeral front forming the boundary between the *Eastwind Drift* and the *Antarctic Circumpolar Current* (see Oceanography chapter, Fig. 7). It is thought to be associated with upwelling of *Deep Water*.

Antarctic Polar Front: a circumpolar surface front of the Southern Ocean that coincides with the subduction of *Antarctic Surface Water* (see Oceanography chapter, Fig. 7) where the subsurface temperature minimum intersects the 200 m isobath; also termed the *Antarctic Convergence*.

Antarctic Surface Water: oceanic surface water between the *Antarctic Circumpolar Current* and the *Antarctic Divergence*. Its salinity range is 34.0 to 34.5 per mille and its temperature range −1.8 to 1.0 °C.

Anterior: on or toward the front (head) end of the fish.

Anterodorsal: see "anterior" and "dorsal".

Anteroventral: see "anterior" and "ventral".

Anticyclonic circulation: movement in an anticlockwise direction in the Southern Hemisphere.

Antorbital: in front of the orbit.

Apophyses: bony projections from vertebrae, or other bones, usually for muscle attachment.

Appendicularians: pelagic tunicates of the Class Larvacea.

Arciform: bow-shaped.

Articular: of or relating to a joint; the hinge bone at the rear of the lower jaw.

Auditory capsules: bony chambers at the rear of the cranium that contain the sense organs for hearing and balance.

Autapomorphies: unique derived characters.

Autogenous: separate from another bone.

Baroclinicity: a state of water column stratification in which surfaces of constant pressure and constant density intersect.

Barotropicity: a state of water column stratification in which surfaces of constant pressure and constant density coincide.

Basibranchials: a series of 3 or 4 median bones joining the ventral ends of the gill arches.

Basioccipital: bone at rear end of cranium to which the vertebral column attaches.

Basisphenoid: median skull bone at rear end of orbital region connecting pterosphenoid and parasphenoid.

Bathypelagic: living in midwater between about 1 000 and 4 000 m.

Baudelot's ligament: the ligament joining the upper part of the pectoral skeleton to the skull or the vertebral column.

Benthic: living on the ocean floor.

Benthopelagic: living near the ocean floor in deep water.

Beryciform: pertaining to fishes of the order Beryciformes.

Bifurcate (bifid): forked or branched into two parts.

Bioluminescent: producing light.

Bisubtropical: occurring in both the northern and southern subtropical zones of the globe.

Bitemperate: occurring in the northern and southern temperate zones of the globe.

Branchial: of the gills.

Branchial aperture: gill opening on the outside surface of the animal.

Branchiostegals: bony "rays" supporting the branchiostegal membrane on the underside of the head.

Brazil-Falkland confluence: a frontal system east of South America at about 50 °S where the *Falkland (Marlvinas) Current* and the *Brazil Current* converge (See Oceanography chapter, Fig. 6).

Buccal: pertaining to the mouth cavity.

Caecal: pertaining to the pyloric caeca.

Caenogenetic: of recent origin.

Calanoid: copepods of the order Calanoida.

Calyptopis: a larval stage of euphausiids (krill).

Canaliculus: a small branch of a canal or a duct.

Caprellid: amphipods of the suborder Caprellidea.

Caruncles: fleshy growths on the skin.

Cavernous tissue: spongy white tissue embedded in the skin near the anus of most cetomimid whalefishes, and near the fin bases of a few.

Cephalic: of the head region.

Cephalic lateralis system: the head canals and neuromasts of the latero-sensory canal system.

Ceratobranchial: longest bones or cartilages of the branchial arches, situated immediately below the angle of the arch, between the epibranchials and the hypobranchials.

Ceratotrichia: the horny rays that support the fins of sharks and rays.

Chaetognatha: small phylum of torpedo-shaped, translucent, planktonic marine invertebrate organisms; arrow-worms.

Chondrichthyians: cartilaginous fishes (sharks, rays, skates, chimaeras).

Chondroneurocranium: the cartilaginous braincase of chrondrichthyians.

Circumorbital: around the eye.

Circumpolar: around the pole or around the Antarctic Continent.

Cladogram: a diagram of supposed evolutionary relationships.

Clasper: the copulatory organ of male sharks and rays.

Cloaca: common chamber into which the intestinal, urinary, and reproductive canals open.

Commissure: see coronal commissure below.

Confluent: joining or fused to something.

Congeners: of the same genus.

Continental shelf: the sea bottom from the shore out to a depth of 200 m.

Continental slope: the sea bottom from 200 to 2 000 m.

Continental Water Boundary: an oceanic front found at certain locations off Antarctica, usually coinciding with the continental shelf break. It is characterised by a gradient in temperature and salinity.

Copepods: a group of tiny mostly planktonic crustaceans (subclass Copepoda) of major importance in marine food chains; some species are parasitic.

Copular plate: The tooth plate on the basibranchials of cetomimid whalefishes.

Coracoid: the lower bone attached to the rear edge of the cleithrum.

Coronal commissure: the branch of the latero-sensory canals that extends across the top of the head, between the eyes and joins the left and right supraorbital canals.

Corselet: an armoured body covering; a densely scaled area in certain tuna-like fishes usually behind the pectoral fins.

Crumenal organ: bilateral pouches incorporating-fifth ceratobranchial bone and its accessory cartilage.

Cryopelagic: at or near the water surface under the ice shelf or pack ice.

Ctenii: the minute teeth or spines on the rear margin of ctenoid scales which give the fish a rough feel when stroked towards the head.

Cumaceans: mostly benthic, burrowing crustaceans of the order Cumacea.

Cycloid scale: thin, flexible scale with a smooth surface.

Cyclonic circulation: in the Southern Hemisphere, a movement in a clockwise direction.

Decapods: crustaceans of the order Decapoda, including shrimps, prawns, crabs etc.

Deciduous: easily shed or rubbed off.

Deep Water: see *North Atlantic Deep Water*.

Demersal: sinking to or lying on the bottom.

Dendritic: tree-like in shape or markings; with many branches.

Dentary: the anterior and largest of the bones making up the lower jaw.

Denticle: the tooth-like scale of elasmobranchs; a tooth-like projection.

Denticular bones: ossified, usually toothed elements found only in adolescent and adult ceratioid males, located at the tip of the jaws.

Denticular teeth: teeth associated with the denticular bones.

Dentigerous: with teeth.

Dermal: pertaining to the skin.

Diel: during a 24 hour period.

Diphycercal: a caudal fin in which the vertebrae run straight to the tip of the tail, dividing the fin into equal dorsal and ventral halves.

Distal: remote from the point of attachment.

Dorsolateral: pertaining to the dorsal and lateral surfaces.

Dorsoventral: pertaining to the dorsal and ventral surfaces.

Dorsum: the upper (dorsal) surface of the head or body.

Eastwind Drift: flow of water in a westerly direction found in a narrow strip between the Antarctic Continent and the *Antarctic Divergence* (see Oceanography chapter, Fig. 7). This current is driven by the prevailing polar easterly winds.

Echiurans: marine worms.

Ectopterygoid: the posterolateral bone of the palatine arch; bears teeth in some species.

Eddy field: a circulation system that consists of a collection of closed circulation cells that may have a range of physical dimensions.

Edentate: without teeth.

Efferent branchial duct: duct leading to the exterior from gill pouch.

Emarginate: with a slightly concave margin.

Endemic: a group of organisms that is geographically restricted in its distribution to a particular ocean, bay or part of the sea.

Endopterygoid: the middle of the three pterygoid bones found below the cheek muscles, and forming the walls of the mouth cavity.

Engibenthic: living close to the bottom, but not actually on it.

Epaxial: muscle segments, or region of the body, above the vertebrae.

Epibenthic: see engibenthic.

Epipelagic: at or near the surface, usually in the open ocean to a depth of 200 m.

Epipleural ribs: small, accessory ribs attached to the vertebrae or to the main (pleural) ribs.

Epurals: dorsal bones that form part of the caudal fin skeleton of most fishes.

Errant polychaetes: free swimming worms of the annelid class Polychaeta.

Esca: the terminal lure or "bait" on the specialized angling device or illicium of angler fishes (Lophiiformes), usually on the dorsal surface of the head.

Esters: a chemical compound formed by combining molecules of acid and alcohol with the loss of a molecule of water.

Ethmoid: the anterior bones or cartilage of the skull (in the snout).

Euphasiid: small marine, pelagic, shrimp-like crustaceans of the order Euphausiacea, (krill).

Euphotic zone: upper layer of the ocean in which sufficient sunlight penetrates to allow photosynthesis by aquatic algae.

Eurytropical: occurring throughout the tropics.

Extrascapula: tube-like, superficial bones through which the latero-sensory canal branches to the preopercle and posttemporal canals.

Falcate: long, narrow and curved; sickle-shaped.

Fasciculi: refers to bundles of muscle fibers.

Fast ice: ice forming part of the ice shelves or glaciers of the continent. This ice is not seasonal.

Fecund: producing large numbers of eggs or young.

Fecundity: the potential reproductive capacity of an organism.

Foraminifers: microscopic, planktonic or benthic protozoans; most species have a calcareous shell.

Fossa: a groove or pit.

Frontal system: an oceanic transition area where the distinctly different salinities, temperatures or nutrient contents of two adjoining water masses produce high gradients in these variables across the area.

Frontal zone: an oceanic strip of variable geographic extent in which a front (see frontal system) plays a dominant role.

Furcilia: a larval stage of euphausiids (krill).

Fusiform: spindle-shaped; tapering towards both ends.

Gammaridean: amphipod crustaceans of the suborder Gammaridea.

Gas-bladder: see swim-bladder.

Gastropods: molluscs with a ventral muscular disc adapted for creeping.

Glans: the terminal end of the intromittent organs of skates and other chondrichthyan fishes.

Glycopeptides: organic compounds that lower the freezing point of body fluids in which they are dissolved.

Gular: the median, dermal bone of the lower jaw of some primitive fishes (e.g. *Elops*).

Gyre: semi-closed circulation on the scale of an ocean basin, such as the *South Atlantic Ocean gyre*.

Haemal spine: the spine on the haemal arch on the ventral surface of caudal vertebrae.

Hastate: in the shape of a spearhead.

Hermaphrodite: individual having both male and female reproductive organs.

Heterocercal: a caudal fin in which the vertebral column extends to the tip of the upper lobe, which is usually larger than the lower one.

Holo-eurytropical: species distributed in tropical and subtropical waters (Hulley 1981).

Holoepipelagic: permanent inhabitants of the epipelagic zone.

Holosubantarctic: species that are distributed and spawn between the subtropical convergence and the Antarctic convergence (Hulley 1981).

Holothuroids: echinoderms of the class Holothuroidea (sea cucumbers).

Holotype: a specimen on which the author bases the description of a new species.

Homoplasious: similar characters in two species that have been developed independently.

Hyoid: pertaining to the skeletal support for the lower jaw.

Hyomandibular: a cartilage or bone forming the dorsal end of the hyoid arch, and serving to connect the lower jaw with the skull.

Hyperiidae: a family of the amphipod crustacean suborder Hyperiidea.

Hypobranchials: bones or cartilages of the branchial arches below the ceratobranchials, and between them and the basibranchials.

Hypocercal: a caudal fin in which the vertebral column extends into the lower lobe of the fin.

Hypural bones: the fan-shaped series of bones (sometimes fused to one or two plate-like bones) to which the caudal fin rays are attached.

Ichthyofauna: fish fauna.

Illicium: the "fishing pole" of anglerfishes, developed as a greatly modified dorsal fin ray and located on top of the head.

Imbricate: overlapping.

Infaunal: living within the bottom sediments.

Infracaudal: below the posterior part of the vertebral column.

Infraorbital bones: a series of bones forming the lower and rear border of the orbit and containing the infraorbital sensory canal; the bones are numbered with the anteriormost as first.

Internarial: within (or between) the nostrils.

Interneurals: bones located between or above the neural spines of the anterior vertebrae, but not supporting fin rays.

Interorbital: between (or above) the eyes.

Interpelvic: between the pelvic fins.

Isobath: a line of equal depth.

Isohaline: a zone of equal salinity.

Isometrically: of equal measure or dimensions.

Isopods: dorsoventrally flattened crustaceans of the order Isopoda.

Isthmus: the ventral extension of the body that separates the two gill chambers.

Iteroparous: animals that breed more than once during their life span.

Jugular: in the throat area, usually used with reference to the location of the pelvic fins on the isthmus.

Katabatic wind: air movement caused by a large density difference between adjacent air masses. Air cooled over the ice of Antarctica forms such winds that blow offshore.

Krill: planktonic euphausiid crustaceans of the genus *Euphausia*.

Lacrimal: the first and largest bone of the infraorbital series on the side of the snout; preorbital bone.

Lamella: thin, plate-like structure.

Lenticular: pertaining to a lens (of the eye); having the form of a lens, double convex.

Leptocephalus: the ribbon-like, transparent larva of eels, tarpon and some other primitive fishes.

Littoral: the intertidal zone of the marine environment delimited by the high and low water marks.

Luminescent gland: light organ or gland that produces a luminescent substance.

Macroinvertebrates: large invertebrate animals.

Malar: of the cheek or side of the head.

Mandible (mandibular): the lower jaw.

Maxillary (maxilla, plural: **maxillae):** one of the two bones that comprise each half of the upper jaw.

Melanophore: a black pigment cell.

Mental barbel: a fleshy cirrus or flap of skin on the chin.

Meridional movement: movement in a north-south direction.

Meristics: countable features (e.g. fin rays, gill rakers).

Mesocoracoid: a bone in the pectoral fin skeleton.

Mesopelagic: pertaining to the region of the oceanic zone from 200 to 1 000 m.

Mesopterygoid (metapterygoid): the posterior pterygoid bone of the cheek region.

Molluscs: marine invertebrates including cephalopods (squid, octopus), pelecypods (bivalves, e.g., clams, mussels), scaphopods (tooth shells) and gastropods (snails, abalone, conch).

Monotypic: containing only one species.

Morphometric: pertaining to measurements of some part of the fish.

Myosepta: the connective tissue membrane between adjacent muscle segments.

Mysids: small, shrimp-like crustaceans of the order Mysidacea.

Myxopterygia: claspers of sharks and rays.

Naris (plural **nares):** nostrils.

Nasal: in the region of the nostrils; also, a bone surrounding one of the lateralis canals in the snout.

Nasal lamellae: folds of the sensory epithelium of the olfactory organ.

Necrophagy: feeding on dead animals.

Nekton: the animals that can swim in the ocean.

Neurocranial: pertaining to the cranium or brain case.

Neuromast: one of many small, budlike sensory organs in the lateral line system; a general term for a sensory papilla of the lateralis system.

Nictitating eyelid: the movable inner eyelid of sharks.

Non-imbricate scales: scales arranged alongside each other, as opposed to overlapping scales.

(North Atlantic) Deep Water: water lying between 1 000 m and 4 000 m in the Southern Ocean associated with a temperature and salinity maximum and a oxygen minimum (see Oceanography chapter, Fig. 7). This water mass has its origin in the North Atlantic.

Notal: dorsal, pertaining to the back.

Notochordal canal: the canal in the centre of the vertebral centra through which the notochord passes.

Nyctoepipelagic: inhabiting the epipelagic region of the ocean only during the night (at dawn, the nyctoepipelagic fishes retreat to deeper water).

Occiput: the posterior region of the head.

Oceanic rim: the section of ocean that borders the continents consisting of the continental shelf and the continental slope.

Octopods: molluscs with 8 arms or tentacles.

Olfactory rosette: radial arrangement of the nasal lamellae that make up the olfactory organs.

Opercle: the large, posterior bone of the gill-cover, the largest bone of the operculum.

Opercular: pertaining to the operculum or opercle.

Opercular flap: refers to the gill cover of liparidid fishes, in which the opercular bone is reduced to a curved blade supporting the posterior fleshy lobe of the gill cover.

Operculum: gill cover; comprising the opercle, subopercle, preopercle and interopercle.

Orbitosphenoid: a median bone in the dorsal part of the interorbital region of most beryciform fishes.

Orobranchial: refers to the mouth cavity and gill cavity.

Oronasal: mouth to nostril connection; referring to the groove between the nostril and the corner of the mouth in skates.

Osmolality: the sum of the concentrations of solutes per kg of water.

Osteology: study and description of the bones (skeleton).

Ostracods: small mainly benthic crustaceans, living in a bivalve shell resembling a clam.

Otophysic: a connection between the ears and swimbladder.

Ovarian tunic: the membrane covering the ovary.

Oviparous: producing eggs that develop and hatch outside and free of the mother's body.

Ovoviviparous: reproduction in which the eggs are fertilised internally and the embryos develop within the body of the mother until birth at a relatively large size, but there is no placental connection to the oviduct or uterus.

Pack ice: ice caused by the freezing of surface sea water in winter. This ice melts again in summer; also called *sea ice*.

Paedomorphosis: embryonic or primitive characters appearing in adult animals.

Palatine: occurring in the region of the palate; also, a bone in the roof of the mouth on each side of the vomer.

Palate: the roof of the mouth.

Palmate: shaped like a hand.

Papilla: a small, fleshy projection.

Parabolic: in the shape of a parabola (mouth of shark).

Parapatric: having contiguous, but not overlapping, geographical distribution.

Parapophyses: the lateral projections from the vertebrae to which the ribs are attached.

Parasphenoid: long, median, ventral bone of the cranium.

Paratype: a specimen, other than the holotype, that is part of the type series on which the description of a new species is based.

Parhypural: the anteriormost of the lower caudal fin bones.

Pauciglomerular: with few glomeruli.

Peri-Antarctic Islands: the islands of the greater Southern Ocean area around Antarctica, including (from 00° meridian eastward): Bouvet, Prince Edward, Crozet, Kerguelen, Heard, McDonald, Amsterdam, Saint-Paul, Macquarie, Balleny, Auckland, Campbell, Scott, Peter I, South Shetland, South Orkney, Shag Rocks, South Georgia, South Sandwich and Gough.

Parietals: a pair of bones in the posterodorsal part of the cranium.

Pectoral: pertaining to the pectoral fins.

Pectoral axil: the inner side of the pectoral-fin base.

Pectoral foramen: a hole in the scapular and/or coracoid bones of the pectoral skeleton.

Pelagic: swimming or floating in the open ocean.

Peritoneum: membrane lining the body cavity.

Pharyngeal: associated with the anterior part of the alimentary canal; the throat region.

Pharyngobranchials: the uppermost elements of the branchial arch serving to attach the arches to the skull, and usually bearing teeth.

Pharyngocutaneous duct: a canal from inside of pharynx to the exterior of the animal.

Photophores: light emitting organs.

Phyletic (phylogenetic): pertaining to the evolutionary branching sequence of life.

Physoclistous (physoclistic): with a closed swimbladder i.e. without any connection to the oesophagus (gullet).

Piscivorous: feeding on fish.

Placoid scales: enamel-like scales of sharks and other elasmobranchs.

Plankton: small floating organisms that drift more or less passively with the ocean currents.

Plesiomorphic: primitive characters.

Pleural ribs: the main ribs supporting the body cavity.

Polychaete: a segmented marine worm with bristles.

Polynya: extensive and permanent area of ice-clear ocean in an otherwise *pack ice* covered area.

Polyphag: eating several different kinds of food.

Polyphyletic: a taxonomic group consisting of species derived from two or more ancestral groups.

Postcleithrum: the lath-like bone running posteriorly from the cleithrum.

Posterior: on or towards the rear end (tail) of the fish.

Postlacrimal: the second bone of the infraorbital series (immediately posterior to the lacrimal bone).

Postorbital: behind the eye.

Posttemporal: a Y-shaped bone attaching the pectoral fin skeleton to the skull.

Predorsals: the free, median bones between the head and the first dorsal fin; supraneurals.

Preopercle (preopercular): L-shaped bone along the front edge of the operculum.

Preopercular-mandibular: canal of the lateralis system running from the preopercle to the lower jaw; preopercular and mandibular segments are sometimes disconnected.

Preorbital: the part of the head in front of the eye; also used as a synonym for the first infraorbital (lacrimal) bone.

Priapulids: sausage-shaped benthic invertebrates of the phylum Priapulida.

Procellariiform birds: an order of small to large seabirds including albatrosses, diving petrels, petrels, sheerwaters and stork petrels.

Procurrent rays: small rays on the upper and lower edges of the caudal fin base.

Protrusile (protractile): capable of being thrust out or extended forwards; protrusible.

Pseudobranch: a small, gill-like organ on the inner surface of the operculum.

Pseudoceanic: members of a basically oceanic group that are distributed over continental shelf and slope regions and in the neighbourhood of oceanic islands and which are associated with land-orientated food chains.

Pterosphenoids: bones of the cranium on each side of the orbital entrance to the brain cavity.

Pterotic: lateral bones of the posterior part of the cranium.

Pterygoids: bones of the roof and walls of the mouth in fishes, behind the palatines.

Pterygiophores: bones or cartilages with which the base of the rays of the median fins articulate.

Pungent: sharp like a thorn.

Pyloric caecum: a variously shaped diverticulum from the junction of the stomach and intestine; the pyloric caeca may be long and numerous, or short and few, or profusely branched, or even absent.

Quadrate: a triangular bone that connects the lower jaw to the palatine and hyoid arches.

Quincunx: arranged in staggered rows.

Ramus: a projecting limb or branch.

Relative fecundity: the number of eggs per gram of total weight.

Reniform: shaped like a kidney.

Retia mirabilia: an anastomosing network of blood vessels that reunites into a single vessel, as in the counter current system associated with the swimbladder.

Retrorse: pointing or curved backwards.

Rictus: corner of the mouth.

Rostral: pertaining to the snout or rostrum.

Salps: pelagic tunicates of the class Thaliacea.

Scapular: relating to the scapula bone of the pectoral fin girdle.

Scapular foramen: a hole in the scapula bone.

Sea ice: oceanic ice formed by freezing of surface sea water in winter; also called *pack ice*.

Seisomosensory: lateral-line sense organs and nerves.

Semelparous: animals that breed only once during their life span.

Sipunculids: benthic worm-like invertebrates of the phylum Sipunculida.

Spatulate: having an end that is broad and flattened.

Sphenotic: cranial bone at rear edge of orbit, to which the circum-orbital bones are connected.

Spicules: minute, hard, needle-like or sharp-pointed, processes or projections; splinter-like bits of silica or carbonate that support the tissue of sponges and echinoderms.

Spinescent: tending towards the form of a spine.

Spinulose: covered with small spines or prickles.

Spiracle: a dorsolateral opening on the head of elasmobranchs and a few fishes for the passage of respiratory water, into the gill chamber.

Spiral valve: spiral shaped internal partition in the intestine of some sharks.

Squamation: arrangement of scales on a fish.

Stegural complex: dorsal bone at the base of the caudal fin skeleton.

Striate: marked by lines or grooves.

Stylophthalmid larva: a larva of the genus *Idiacanthus* (Stomiidae) with the eyes at the end of long stalks.

Sub-Antarctic: that part of the Southern Ocean that lies between the *Subtropical Convergence* and the *Antarctic Polar Front*.

Sub-Antarctic Front: an oceanic surface front of the Southern Ocean lying between the *Subtropical Convergence* and the *Antarctic Polar Front*, characterised by a sharp drop in temperature and salinity (see Oceanography chapter, Fig. 7).

Sub-Antarctic Mode Water: the water mass in the sub-surface part of the upper water column of the *sub-Antarctic* region that exhibits a markedly lower thermal gradient with depth.

Subopercle: the elongate bone ventral to the opercle and attached anteriorly to the interopercle.

Subterminal mouth: a mouth positioned below an overhanging snout.

Subtropical Convergence: the oceanic front at about 40 °S that forms the northern border to the Southern Ocean as usually defined (see Oceanography chapter, Fig. 7). It is characterised by a sharp drop in temperature and salinity at the sea surface.

Supracaudal: above the caudal region of the tail.

Supramaxilla: a small bone along the upper rear edge of the maxilla.

Supraorbital: above the eye; also, a small bone found above the eye.

Supratemporal: the region of the upper surface of the head posterior to the eyes.

Surface drifter: a scientific instrument, usually in the form of an instrumented buoy, that is placed in the ocean to move with the water. In most cases these drifters report data via a satellite link-up.

Surface mixed layer: the upper part of the water column that is uniform in temperature and salinity with depth, showing the complete mixing induced by the action of winds and waves.

Swim-bladder: gas-filled sac dorsal to the digestive tract; its chief function is to regulate the buoyancy of the fish; also called air-bladder or gas-bladder. In some species, the swim-bladder is filled with fat instead of gas.

Sympatric: occurring in the same geographical area.

Symphysis: the median point or junction of the two halves of the jaws.

Synapomorphies: shared derived characters inherited from a common ancestor.

Synonymy: list of scientific names that have been applied, correctly or incorrectly, to a given taxon.

Syntype: specimens on which a species description is based but from which no holotype was designated.

Syphonal: pertaining to a syphon (siphon).

Temporal: the region on the side of the head behind the eyes.

Terminal: at the end (pertaining to a mouth at the anteriormost part of the head).

Thalassobathyal: a category of vertical zonation coined by Andriashev (1977) for the slopes of oceanic submarine geomorphological features (seamounts, banks, guyots, mid-ocean ridges, etc.) separated from continental shelves and slopes by the oceanic abyssal plains; usually referring to 200 m or deeper.

Thermohaline: water movement or characteristics caused by differences in density of water masses due to differences in temperature and salinity.

Thoracic: in the region of the chest.

Triacylglycerol: organic compounds used as lipid stores in nototheniid fishes.

Truncate: having a square-cut or even margin.

Tubercle: a small rounded knob or swelling.

Uniserial: arranged in one row.

Ural: pertaining to the vertebrae posterior to the bifurcation of the caudal artery.

Uroneurals: the slender pair of bones at the upper edge of the dorsalmost hypural bone; the first uroneurals are usually fused with the stegural and the second uroneurals are often lost.

Urostyle: a hollow, median, ossifed sheath of the posterior end of the notochord as seen in *Gasterosteus, Elops* and some clupeomorphs.

Ventral: on or towards the lower surface (underside) of the fish.

Vexillifer: the unique, pelagic larval stage of carapid fishes, characterised by a long, variously ornamented predorsal filament (vexillum).

Verrucae: wart-like projections of skin or bone.

Villiform: having the appearance of velvet or fine bristles of a brush.

Villose: with villi.

Viviparous: giving birth to living (active, free-swimming) young.

Viscera (visceral): the internal organs of the body cavity.

Vomer: a median bone in the front of the palate; often bears teeth.

Zooplankton: animals (mostly microscopic) that drift freely in the water column.

Abbreviations

A—anal fin
ACC—Antarctic Circumpolar Current
AFGP—antifreeze glycopeptide
APF—Antarctic Polar Front
C—caudal fin
CCAMLR—Convention for the Conservation of Antarctic Marine Living Resources
D—dorsal fin
DSL—deep scattering layer
FL—fork length
FRG—Federal Republic of Germany
GDR—German Democratic Republic
GPL—gnathoproctal length
GR—gill-rakers
H_1–H_5—hypural bones in the caudal skeleton, counting the ventral most bone as H_1
HL—head length
LL—lateral line
LLL—lower lateral line
LSS—lateral scale series
MLL—middle lateral line
P—pectoral fin
SD—standard deviation
SEM—standard error of mean
SL—standard length
STC—Subtropical Convergence
TAC—total allowable catch
TL—total length
UK—United Kingdom
ULL—upper lateral line
USA—United States of America
USSR—Union of Soviet Socialist Republics
V—pelvic fin
WH—*Walther Herwig*, research vessel of ISH

Codes and Addresses of Institutional Collections

A—Dr T. Iwami, personal collection (Channichthyidae only)
ADH—Antarctic Division, Department of Science, Channel Highway, Kingston, Tasmania 7150, Australia
AMNH—American Museum of Natural History 79th St & Central Park West, New York, New York 10024, USA.
AMS—Australian Museum, P O Box A285, 6–8 College Street, Sydney South, New South Wales 2000, Australia
ANSP—Academy of Natural Sciences, 19th and the Parkway, Philadelphia, Pennsylvania 19103, USA
BAS—British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET, England
BMNH—British Museum (Natural History), Department of Zoology, Cromwell Road, London SW7 5BD, England
CAS—California Academy of Sciences, Golden Gate Park, San Francisco, California 94118, USA
CMC—Canterbury Museum, Private Bag, Rolleston Ave., Christchurch, New Zealand
FAKU—Department of Fisheries, Faculty of Agriculture, Kyoto University, Okiwake-cho, Sakyo-ku, Kyoto 606, Japan
FSFL—Far Seas Fisheries Research Laboratory, 1000 Orido, Shimizu 424, Shizuoka Perfecture, Japan
GNM—Göteborgs Naturhistoriska Museet, Box 7283, S-402 35 Göteborg, Sweden
IAA—Instituto Antartico Argentino, Cerrito 1248, Buenos Aires, Argentina
IBUT—Institute of Biology, University ot Tsukuba, Ibaraki, Honshu, Japan
IRSNB—Institut Royal des Sciences Naturales de Belgique, Rue Vautier 31, B-1040 Brussels, Belgium
ISH—Institut für Seefischerei, Martin-Luther-King Platz 3, D-2000 Hamburg 13, Germany
LACM—Los Angeles County Museum of Natural History, 900 Exposition Blvd, Los Angeles, California 90007, USA
MACN—Museo Argentino de Ciencias Naturales Bernardino Rivadavia, Ave. Angel Gallardo 470, 1405 Capital Federal, Argentina
MCZ—Harvard University, Museum of Comparative Zoology, Cambridge, Massachusetts 02138, USA
MHNV—Museo de Historia Natural de Valparaiso, Calle Errazuriz 254, Playa Ancha, Valparaiso, Chile
MNHN—Muséum National d'Histoire Naturelle, 43 Rue Cuvier, 75231 Paris Cedex 5, France
MNHNC—Museo Nacional de Historia Natural, Casilla 787, Santiago, Chile
MOM—Musée Océanographique Monaco, Avenue Saint-Martin, Monaco-Ville, Monaco
MTUF—Museum of the Tokyo University of Fisheries, 4–5–7 Konan, Minato-ku, Tokyo 108, Japan
NMNZ—National Museum of New Zealand, Private Bag, Wellington, New Zealand
NMSZ—Royal Scottish Museum, Chambers Street, Edinburgh EH1 1JF, Scotland
NRM—Naturhistoriska Riksmuseet, Box 50007, S-104 05, Stockholm, Sweden
ROM—Royal Ontario Museum, 100 Queen's Park, Toronto, Ontario M5S 2C6, Canada
RUSI—JLB Smith Institute of Ichthyology, Private Bag 1015, Grahamstown 6140, South Africa
SAM—South African Museum, P O Box 61, Cape Town 8000, South Africa
SAMA—South Australian Museum, North Terrace, Adelaide, South Australia 5000, Australia
SIO—Scripps Institution of Oceanography, Marine Vertebrate Collection, University of California, La Jolla, California 92093, USA
SU —Stanford University Collections (now merged with CAS)
USC—University of Southern California (now merged with LACM)
UMO—University of Maine, Department of Zoology, Orono, Maine 04473, USA
USNM—National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560, USA
ZIK—Ukrainian Academy of Sciences, Zoological Institute, Vladimirskaya ul. 55, 252150 Kiev-30, USSR
ZIN—Academy of Sciences, Zoological Institute, Leningrad Centre 199164, Leningrad, USSR
ZMB—Universität Humboldt, Museum für Naturkunde, Invalidenstrasse 43, 104 Berlin, Germany
ZMH—Zoologisches Institut und Museum, Universität Hamburg, Martin-Luther-King Platz 3, D-2000 Hamburg 13, Germany
ZMMGU—Moscow State University, Zoological Museum, Kerzenst. 6, Moscow, USSR
ZMUB—Universitetet i Bergen, Zoologisk Museum, Museplass 3, N-5014 Bergen/Univ., Norway
ZMUC—Zoologisk Museum, København Universitet, Universitetsparken 15, DK-2100 København, Denmark
ZMUL—Lund Universitet, Zoologiska Museet, S-221 01 Lund, Sweden
ZUMT—University of Tokyo, Department of Zoology, University Museum, Tokyo, Japan

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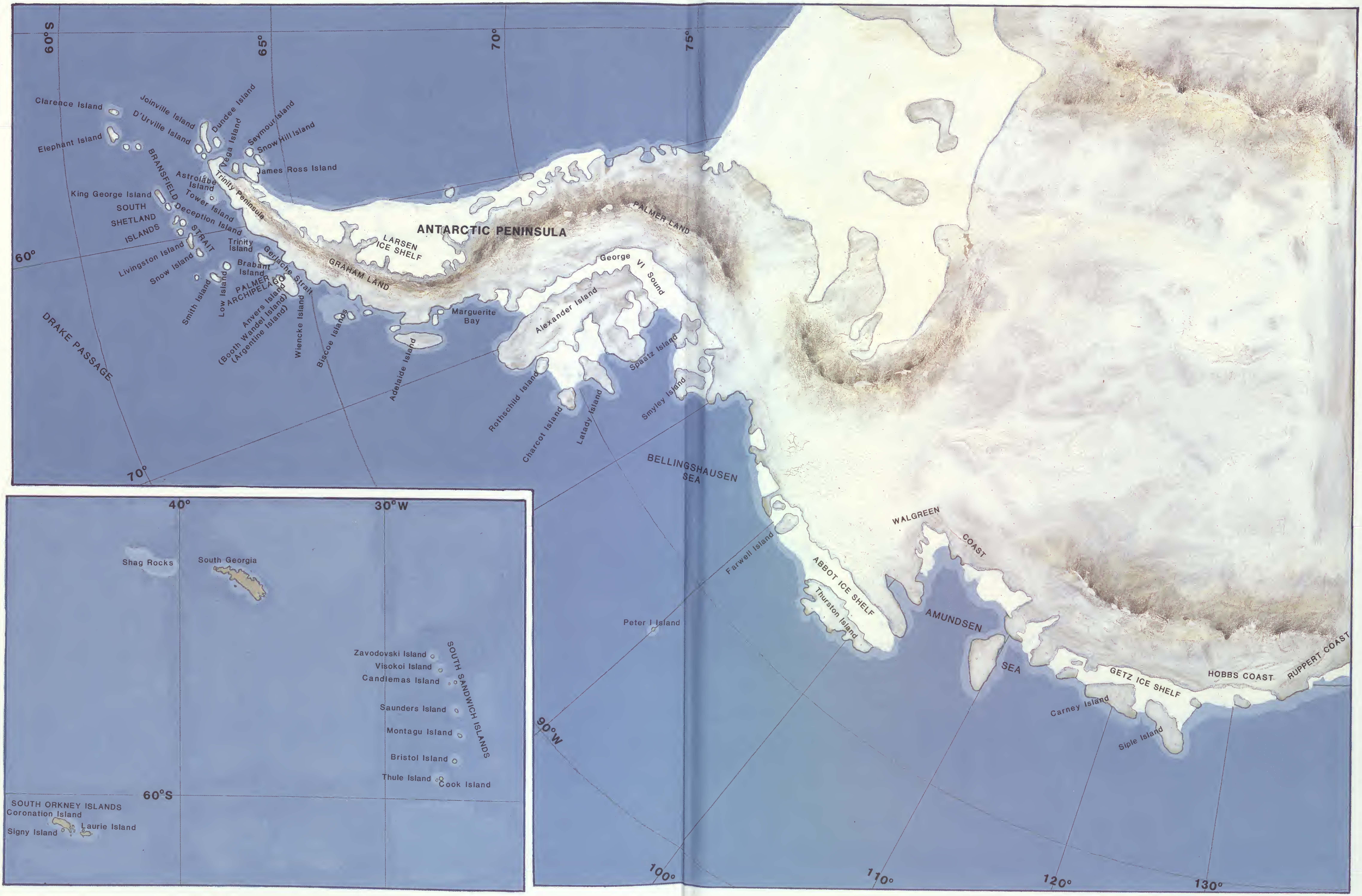
Index of Scientific Names

Names of the Antarctic fish families described in the book are in capital letters. Names of the valid genera and species described in the book are in *italics*. Generic names in parentheses refer to subgenera. Page numbers for the main family, genus and species accounts are in bold face type.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James Ross Island
Astrolabe Island
BRANSFIELD
Trinity Peninsula
Tower Island
King George Island
SOUTH SHETLAND ISLANDS
Deception Island
STRAIT
Trinity Island
Livingston Island
Snow Island
Smith Island
Low Island
Brabant Island
Gerlache Strait
PALMER ARCHIPELAGO
Anvers Island
(Booth Wandel Island)
(Argentine Island)
Wiencke Island
Biscoe Islands
DRAKE PASSAGE
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Alexander Island
Rothschild Island
Charcot Island
Latady Island
Spaatz Island
Smyley Island
BELLINGSHAUSEN SEA
Peter I Island
Farwell Island
ABBOT ICE SHELF
Thurston Island
WALGREEN COAST
AMUNDSEN SEA
GETZ ICE SHELF
Carney Island
Siple Island
HOBBS COAST
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Shag Rocks
South Georgia
Zavodovski Island
Visokoi Island
Candlemas Island
SOUTH SANDWICH ISLANDS
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Cook Island
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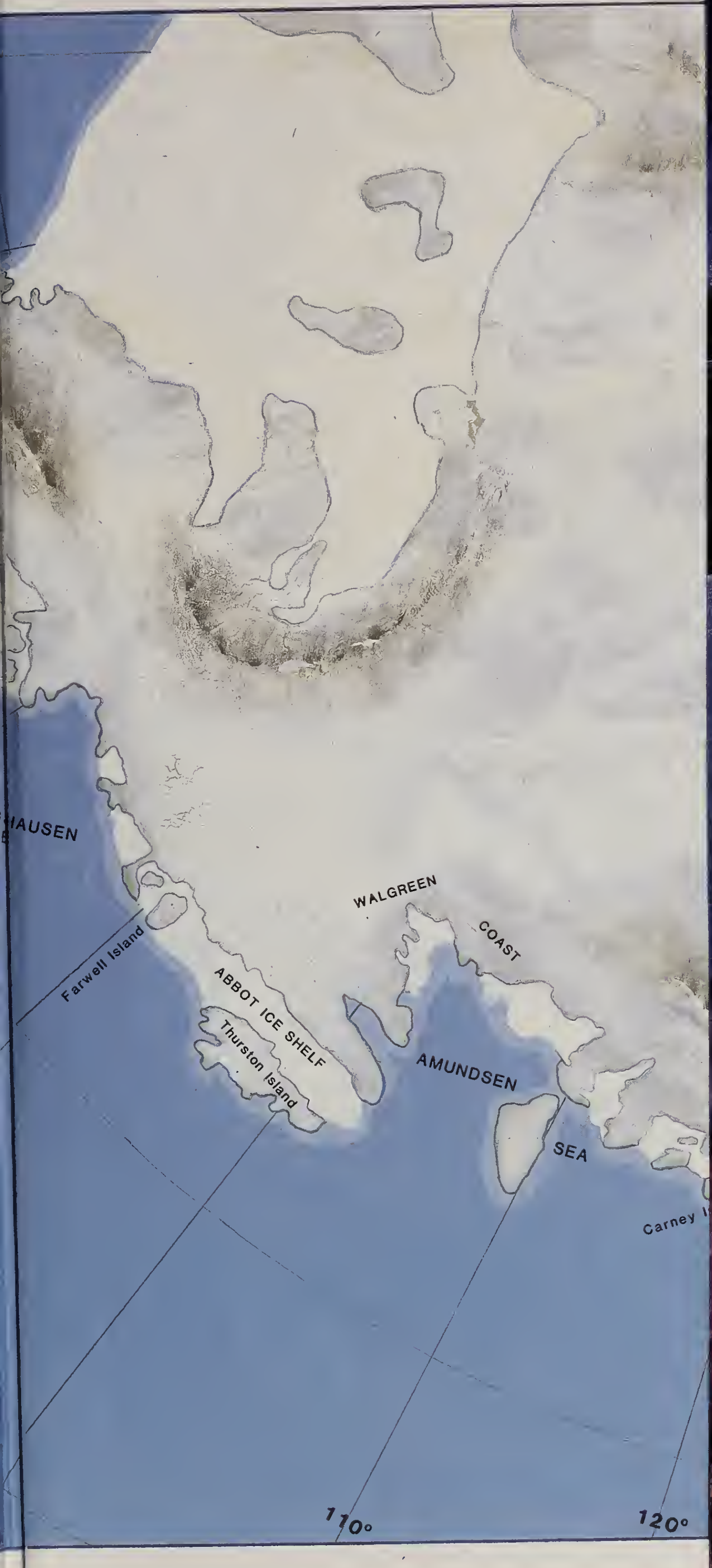

THE EDITORS

Ofer Gon was born in Haifa, Israel in 1949. A childhood in a relatively pristine area rich with wild flowers and frequent visits to the beaches of the Mediterranean Sea made him inclined towards nature. Between 1967 and 1970, while working as a conservation officer on the coast of the Red Sea, he became fascinated with the marine environment.

In 1971, after a short stint as a commercial diver, Ofer enrolled in the Hebrew University, Jerusalem. He did undergraduate studies (B.Sc.) in biology, and postgraduate work (M.Sc.) in oceanography and marine biology under the supervision of A. Ben-Tuvia. During his postgraduate studies he decided to develop his scientific career in the field of marine fish taxonomy.

In 1979, after he completed his studies, he moved to Honolulu, Hawaii, to work at the Bishop Museum on fishes of the Pacific Ocean under J.E. Randall. Professionally, this was a very important period as he acquired first-hand knowledge of many families, genera and species of fishes and published his first taxonomic papers on new species and records of fish from Hawaii.

In 1983 he came to the J.L.B. Smith Institute in Grahamstown, South Africa. During this year he assisted Margaret Smith and Phillip Heemstra with their preparation of the new *Smiths' Sea Fishes* and also contributed to the volume. In 1984 he was awarded a scholarship from the German Government to study fishes of the family Apogonidae which led to a number of papers on the taxonomy of this group. At the same time he also started working on *Fishes of the Southern Ocean*. He participated in several expeditions to the Southern Ocean and has published papers on the fish fauna of this unique ocean.

In addition to his scientific work, he has kept in close contact with nature through his diving and hiking activities, as well as nature photography.

Phillip C. Heemstra received his B.Sc. degree (with a major in Zoology) from the University of Illinois. He then worked for two years as a biologist at the Florida State Board of Conservation Marine Laboratory in St. Petersburg. He developed an interest in ichthyology and enrolled in the Institute of Marine Science at the University of Miami. In graduate school, his research focused on the taxonomy of marine fishes, and for his Ph.D. thesis he completed a world-wide revision of the shark genus *Mustelus*. After graduation he worked at the Academy of Natural Sciences in Philadelphia and then left America to take an appointment in Australia.

He came to the J.L.B. Smith Institute of Ichthyology in 1978, to assist Margaret Smith with the revision of her husband's book, the *Sea Fishes of Southern Africa* and was co-editor and a major contributor to the new book *Smiths' Sea Fishes*. He is now the Senior Curator of Fishes at the J.L.B. Institute of Ichthyology in Grahamstown.

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