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DEEP–SEA CARTILAGINOUS FISHES OF THE INDIAN OCEAN

Volume 1. Sharks

FAO FISH FINDER

DEEP–SEA CARTILAGINOUS FISHES OF THE INDIAN OCEAN

Volume 1

Sharks

by

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Support to the implementation of the International Guidelines on the Management of Deep-Sea Fisheries in the High Seas (GCP/GLO/323/NOR)
and
Fisheries management and marine conservation within a changing ecosystem context (GCP/INT/253/JPN)

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PREPARATION OF THIS DOCUMENT

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Its production follows the recommendations made during a workshop on “Deep-sea Species Identification” held in Rome in 2009 organized in response to the need for a strategy for the development of appropriate deep-sea species identification tools for fishery purposes, in particular, to address the broadened requirements for reporting on not only target species, but also associated species following recent international developments with respect to fisheries management guidance and biodiversity conservation. The workshop recommended that a series of identification guides be developed for certain vulnerable groups of species affected by bottom gear, with an initial focus on three of the most impacted groups: cartilaginous fishes, corals and sponges. As a starting point, in consideration of the extensive information available on cartilaginous fishes from other FAO guides and publications, it was decided to develop deep-sea identification guides for this group at a regional level.

The present publication is the first of a two–volume set dedicated to the identification of deep–sea cartilaginous fishes known to occur in the Indian Ocean, encompassing FAO Fishing Areas 51 and 57, and that portion of Area 47 off South Africa from about 18°42’E to 30°00’E. It focuses on shark–like species, providing accounts for all orders, families, and genera and for one representative species of each genus. Moreover, fully illustrated keys to all taxa are included.

It is aimed at facilitating the species specific identification of deep–sea shark fishes occurring in the Indian Ocean by fishery observers, crew members, scientists, fishery officers and the interested public.

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D.A. Ebert. 2013
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ABSTRACT

This volume is a comprehensive, fully illustrated Catalogue of the Deep–sea Sharks of the Indian Ocean, encompassing FAO Fishing Areas 51 and 57, and that portion of Area 47 off South Africa from about 18°42’E to 30°00’E. The present volume includes 8 orders, 23 families, 46 genera, and 117 species of shark–like fishes occurring in the Indian Ocean deep–sea. It provides accounts for all orders, families, and genera and all keys to taxa are fully illustrated. A species representative account of each genus is also provided and includes: valid modern names and original citation of the species; synonyms; the English, French, and Spanish FAO names for the species; a lateral view and often other useful illustrations; field marks; diagnostic features; distribution, including a GIS map; habitat; biology; size; interest to fisheries and human impact; local names when available; a remarks sections; and literature. The volume is fully indexed and also includes sections on terminology and measurements for sharks including an extensive glossary, and a dedicated bibliography.

ACKNOWLEDGEMENTS

A volume of this magnitude and scope could not be accomplished without the generous help of others and the author wishes to thank all of those who have been extremely helpful and generous with their time in responding to numerous questions, providing data and information from their own research (some of it unpublished), and providing much needed literature. The generic and species accounts were improved immensely from the contribution of colleagues and friends. Apologies beforehand if somebody was forgotten, which will inevitably happen with a work of this magnitude, but all are thanked for their help and assistance.

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1. INTRODUCTION

The genesis of this Catalogue stems from a workshop on Deep–sea Species Identification held in Rome, Italy, from 2 to 4 December 2009 (FAO, 2011). The workshop objectives were to identify and review key issues for vulnerable deep–sea species, e.g. corals, sponges, and chondrichthyans, that could be addressed when developing identification tools to assist in implementing the FAO Guidelines for the management of deep–sea fisheries and enhance fisheries management tools in general. A global checklist of deep–sea chondrichthyans, that occur in the deep–sea from about 200 m to over 2000 m deep, was compiled in relation to the 19 FAO major fishing areas. Among the recommendations from the workshop was the production of comprehensive regional identification guides to the deep–sea chondrichthyan fauna. The present catalogue covers the deep–sea Indian Ocean, primarily FAO Fishing Areas 51 and 57, and that part of Area 47 that extends from Cape Point, South Africa to the east, e.g. the extreme southwestern Indian Ocean. The catalogue has been divided into two volumes, the first on the sharks (presented below) and a second volume on the batoids and chimaeras. The catalogue includes species of major, moderate, minor, and minimal importance to fisheries as well as those of doubtful or potential use to fisheries. It also covers those little known species that may be of research, educational, and ecological importance. The catalogue is intended to be a comprehensive review of the shark–like fishes of the deep–sea Indian Ocean in a form accessible to fisheries workers as well as researchers on shark systematics, biodiversity, distribution, and general biology. It also caters to other researchers that need comparative information on sharks, and their relatives, and to people who encounter sharks in the sea, and the general public.

Biogeography of Region. The Indian Ocean region includes two major FAO Fishing Areas, the western Indian Ocean (Area 51) and the eastern Indian Ocean (Area 57). The western Indian Ocean extends from the southeast coast of India at 77°00'E longitude where the states of Kerala and Tamil Nadu meet at the sea, and extends southward to the equator, then east to 80°00'E longitude and south to 45°00'S latitude where it runs parallel westward to 30°00'E longitude and north to the coast of Africa. Also, included in this region is the extreme southeastern portion of Area 47, extending from Cape Point at about 18°42'E longitude eastwards to the boundary of Area 51 at 30°00'E longitude. The eastern Indian Ocean region extends essentially from the boundary with Area 51 on its western edge, although it extends further south to 55°00'S latitude, where it runs parallel to 150°00'E longitude and then north to about 37°31'S latitude to the southeast coast of Australia. The eastern boundary of Area 57 runs along the coast of southern Australia and around to the boundary of the states of Western Australia and the Northern Territory at 129°00'E longitude. At that boundary it extends northwards to 08°00'S latitude and then west along 113°28'E longitude where it meets the south coast of Java at 08°23'S latitude and extends westwards along the coasts of Java and Sumatra running south in the Strait of Malacca, where it crosses the Strait at 02°30'N latitude to meet the coast of the Malay Peninsula, where it goes in a northerly and westerly direction along the coasts facing the Bay of Bengal to the point of departure. The Indian Ocean encompasses 10 Large Marine Ecosystems, five in the western Indian Ocean and six in the eastern Indian Ocean; one of the large marine ecosystems crosses the boundary of both areas off India. This includes the Agulhas Current, Somali Coastal Current, Arabian Sea, Red Sea, and a portion of the Bay of Bengal large marine ecosystems in the western Indian Ocean (Area 51), and in the eastern Indian Ocean (Area 57) this includes most of the Bay of Bengal, North Australia, Northwest Australia, West–Central Australia, Southwest Australia, and Southeast Australia large marine ecosystems (Figure 1 – Map of the Indian Ocean FAO Areas 51 and 57).

The Indian Ocean is the warmest ocean with a minimum surface temperature north of 20°S of 22 °C, but often exceeding 28 °C. Two major circular ocean currents, a clockwise flowing current in the northern hemisphere and a counterclockwise flowing current south of the equator, dominate the flow patterns. However, during the winter monsoon season, which heavily influences these currents, the northern current reverses flow. The continental shelves surrounding the Indian Ocean are generally narrow, averaging 200 km in width, except off the western coast of Australia where the shelf exceeds 1,000 km. The average depth is 3,890 m with a maximum depth of 8,047 m in the Diamantia Trench. The Indian Ocean topography is quite dynamic as three crustal plates, African, Indian and Antarctic, converge with their junctures forming an inverted "Y" with the stem originating from the edge of the continental shelf off Mumbai, India and extending to the southern Indian Ocean where all three plates meet at a geologic feature called Rodrigues Triple Point, named after the island of Rodrigues that is located nearby. This geologic feature subdivides the Indian Ocean into three basins, eastern, western and southern. Geologically the region, as the youngest of the major oceans, has active spreading ridges with several distinct subsurface features including the Ninety East Ridge that runs north–south at the 90°E meridian, which bisects the Indian Ocean into its eastern and western halves.

Classification and systematic arrangement used here. The higher classification of these fishes includes the class Chondrichthyes that is divided into two major groups, each with a long and separate pre–Devonian history, the chimaeroids, Holocephali (with a single living order Chimaeriformes), and the sharks and batoids proper, with the surviving group Neoselachii divided into two cohorts, the Selachii (sharks) and the Batoidea (rays and skates) and includes all of the modern living species. The Selachii is further divided into two superorders, the Squalomorphii and Galeomorphii. The superorder Squalomorphii includes the orders Hexanchiformes, Squaliformes, Squatiniformes, and Pristiophoriformes, while the superorder Galeomorphii includes the Heterodontiformes, Orectolobiformes, Lamniformes, and Carcharhiniformes. The cohort Batoidea recognizes four orders, Torpediniformes, Pristiformes, Rajiformes, and Myliobatiformes. The ordinal classification of the shark–like fishes largely follows the arrangement of Compagno (2001, 2005), Ebert and Compagno (In press), and Ebert (In preparation) with some modifications in recognizing eight orders and 34 families. The higher classification and the taxonomic arrangement of the batoid fishes and the chimaeras will be discussed in volume 2 of this catalogue.

The following classification to order is based on the above discussion on higher ordinal classifications (* starred orders are covered in this volume):

Class Chondrichthyes (cartilaginous fishes)
  Subclass Holocephali (chimaeras and fossil relatives)
    Order Chimaeriformes (chimaeras or silver sharks)
  Subclass Neoselachii (modern sharks and batoids)
   Cohort Selachii (modern sharks)
    Superorder Squalomorphii (squalomorph sharks)
     Order Hexanchiformes (cow and frilled sharks)*
     Order Squaliformes (dogfish sharks)*
     Order Squatiniformes (angel sharks)*
     Order Pristiophoriformes (sawsharks)*
    Superorder Galeomorphii (galeomorph sharks)
     Order Heterodontiformes (bullhead sharks)*
     Order Lamniformes (mackerel sharks)*
     Order Orectolobiformes (carpet sharks)*
     Order Carcharhiniformes (ground sharks)*
   Cohort Batoidea (batoids)
     Order Torpediniformes (electric rays)
     Order Pristiformes (sawfishes)
     Order Rajiformes (skates and guitarfishes)
     Order Myliobatiformes (stingrays)

Indian Ocean Deep–sea Biodiversity. Sharks are among one the most successful groups of fishes having penetrated most marine ecosystems, including continental and insular shelf waters from the intertidal out to, and into, the deep–sea as well as occupying oceanic and pelagic habitats; some species have even penetrated into and occupy estuarine and freshwater river ecosystems. Recent reviews on the biodiversity and distribution of sharks in various ecosystems has shown that tropical marine ecosystems have the highest diversity, followed by deep–sea and temperate ecosystems, and with the epipelagic and freshwater ecosystems having a lower diversity of species (Ebert and Winton, 2010; Kyne and Simpfendorfer, 2010; Rosa, Charvet-Almeida and Quijada, 2010; Stevens, 2010; White and Sommerville, 2010). Worldwide there are more than 500 known living and valid species of sharks comprising 8 orders, 34 families, and 107 genera, with additional species requiring description (Nelson, 2006; Ebert and Winton, 2010; D.A. Ebert, pers. database, 1 March 2013). Globally, of these totals, all eight orders, 23 families, 58 genera, and 265 sharks species are considered to primarily inhabit the deep–sea (FAO, 2011; D.A. Ebert, pers. database, 1 March 2013).

The deep–sea Indian Ocean has a very diverse shark fauna with 8 orders, 23 families, 46 genera, and at least 117 species being represented (Table 1); while this catalogue was in preparation a new genus and species of deep–sea Pseudotriakidae from the northern Indian Ocean was described, ***Planonasus parini*** Weigmann, Stehmann, and Thiel, 2013, and is included here. The most specious group of sharks in the deep–sea Indian Ocean are the Squaliformes that have at least 58 species represented, most of which are in the families Etmopteridae (n = 15) and the Centrophoridae and Squalidae with 13 species in each family. The Carcharhiniformes have 41 species representatives, with the vast majority in the family Scyliorhinidae (n = 32). All of the other shark orders only have six of fewer species representatives. Of these totals, the diversity is remarkably similar in terms of numbers of families, genera, and species between the eastern and western Indian Ocean deep–sea (Table 1). The only families not represented in the eastern Indian Ocean are the Pristiophoridae and Heterodontidae, while in the western Indian Ocean only the Parascylliidae is not represented. The number of genera occurring in the western Indian Ocean (n = 42) is slightly higher than in the eastern Indian Ocean (n = 38), as well as the number of species (n = 78 and 77, respectively). A total of 38 species occurs in both regions, with the remaining numbers of species being unique to each region.

Indian Ocean (Tot.)	Sharks	Batoids	Chimaeras	Tot.
Orders	8	3	1	12
Families	23	8	2	33
Genera	46	23	5	74
Species	117	61	17	195
Indian Ocean (Area 51)				
Orders	7	3	1	11
Families	22	5	2	29
Genera	42	14	5	61
Species	78	30	9	117
Indian Ocean (Area 57)				
Orders	6	3	1	10
Families	21	8	2	31
Genera	38	17	4	59
Species	77	34	11	122

Table 1 – The families, genera, and species represented within the Deep–sea Indian Ocean (total for Areas 51 and 57), western Indian Ocean (Area 51), and eastern Indian Ocean (Area 57).

1.1 Plan of the Catalogue

The format for this catalogue follows that of the FAO Catalogue of Sharks of the World (Compagno, 2001; Ebert and Compagno, In press; Ebert, In preparation), with orders as the highest taxonomic group dealt with here, followed by family, genus, and species accounts. A key to the families and genera, where appropriate is also included. A difference in the present catalogue is that not all species accounts are dealt with in the same comprehensive detail. A list of all deep–sea species known to occur in the Indian Ocean is presented for each family, with a representative species of each genus presented in detail and indicated by the presence of a shark icon beside its scientific name. For those genera where more than a single member of the genus has species that are possibly subjected to intense fishing pressures or are considered especially vulnerable (e.g. ***Centrophorus***, ***Squalus***), more than one species is presented in detail. In total, 51 of 117 shark species are presented in detail here.

The species specific information on the biology, conservation status, distribution, habitat, fisheries, and systematics of Indian Ocean sharks was compiled from primary literature sources including, but not limited to, Compagno (2001), Compagno, Ebert and Smale (1989), Last, White and Pogonosky (2007), Last, Motomura and White (2008), Last Séret and White (2008), Last and Stevens (2009), Ebert and

Winton (2010), Kyne and Simpfendorfer (2010), FAO (2011), and Ebert and Compagno (In press). Electronic sources were also of invaluable help, these included, but were not limited to, the California Academy of Sciences Catalogue of Fishes (http://www.calacademy.org/research/ichthyology/catalog/fishcatsearch.html) and IUCN Shark Specialist Group (http://www.iucnredlist.org). A comprehensive bibliography of the literature, including primary, grey, and electronic sources is provided at the end of this volume.

Order accounts include the valid modern form of the order name with author and year; the original citation of the order name with its author, year, reference and pagination; the number of recognized families in the Indian Ocean deep–sea; common order Synonyms mainly from the Indian Ocean deep–sea region with the name, author, year, and pagination; the FAO order Vernacular Names in English, French and Spanish; Field Marks and Diagnostic Features of members of the order; an account of the natural history of the order under separate sections covering Distribution, Habitat and Biology; a section on Interest to Fisheries and Human Impact, a synopsis of the human issues affecting shark families; Local Names when available; a Remarks section mostly with systematic comments; and a Key to Deep–sea Indian Ocean Families, when orders have more than one family.

Family accounts include the valid modern form of the family name with author and year; the original citation of the family name with its author, year, reference and pagination; the valid type genus with author and date; the number of recognized deep–sea Indian Ocean genera in the family; family Synonyms with names mostly associated with the Indian Ocean region and with the name, author, year, and pagination; the FAO family Vernacular Names in English, French and Spanish; Field Marks and Diagnostic Features of members of the family; an account of the natural history of the family under separate sections covering Distribution, Habitat and Biology; a section on Interest to Fisheries and Human Impact, a synopsis of the human issues affecting shark families; Local Names when available; a Remarks section mostly with systematic comments; a Literature section covering references to the entire family; and a Key to Deep–sea Indian Ocean Genera, when families have more than one genus.

Generic accounts include the valid modern form of the genus name with author and year; the original citation of the genus (or subgenus), with its author, year, reference and pagination, and, if a subgenus, the original genus name with author and year that the subgenus was originally placed in; the type species and means of designating it (for example, by original designation, monotypy, absolute tautonymy, or subsequent designation); the number of recognized Indian Ocean species in the genus; the Synonyms of genera, with their rank (genus, subgenus, or other genus–group ranking), author, year, pagination, and genus they were described in, if originally ranked as subgenera or equivalents; FAO Names if they exist; Field Marks if genera are large and distinctive; Diagnostic Features of the genus; Local Names where available; a Key to Deep–sea Indian Ocean Species if the genus has more than one species (is not monotypic); and a Remarks section.

Species accounts include the valid modern names of the species, with author and date; the original citation of the species, with its author, year, reference pagination; the holotype, syntypes, lectotype or neotype of each species (paratypes are not listed in the present account), including the total length and sex of the specimen, its institutional deposition, and its catalogue number; the type locality including the location, coordinates and depth if available, where the holotype, syntypes, lectotype or neotype were caught; Synonyms of the species, including their names, authors and dates; a section listing other scientific names recently in use; the English, French, and Spanish FAO Names for the species; a lateral view illustration, and often other useful illustrations (lateral view drawings are given of each shark species, usually ventral views of heads, and often teeth and denticles of the shark in question); Field Marks; Diagnostic Features (except in monotypic genera); Distribution, including a map; Habitat; Biology; Size; Interest to Fisheries and Human Impact; Local Names when available; a Remarks section when necessary; and Literature.

Synonyms commonly seen in the Indian Ocean literature are listed, where appropriate, and include only true taxonomic synonyms of the valid family, genus and species given. For species, another category, Other Combinations, is provided for common misidentifications of a given species with another, valid species, as well as commonly used combinations that place a valid species in different genera.

FAO Family and Species Names. English, French and Spanish names for each family and species, primarily for use within FAO, were selected by the following criteria: (a) each name applies to a single family or species worldwide; (b) the name conforms with FAO spelling nomenclature; (c) the name conforms to prior usage when possible. FAO names are not intended to replace local species names, but are necessary to overcome the confusion caused by the use of a single name for more than one species or several names for one species. The FAO names used here conform to prior FAO usage. The common French and Spanish names of species from other FAO Catalogues, including the Sharks of World (Compagno, 1984a, b, 2001; Ebert and Compagno, In press, Ebert, In preparation), and regional FAO Catalogues on the Sharks of the Western Indian Ocean (Compagno, 1984c), Namibia (Bianchi *et al.,* 1999), Western Central Pacific (Compagno, 1998), Red Sea and Gulf of Aden (Bonfil and Abdallah, 2004), and North Atlantic (Ebert and Stehmann, 2013), were used when appropriate.

Keys, Field Marks, and Diagnostic Features. These sections include identification data in different forms. Keys to families, genera and species are standard dichotomous biological keys that are followed in steps of alternate choices to single out the taxa covered. It should be noted that the Keys include only those families, genera, and species that occur in FAO Areas 51 and 57, or within the scope of the present Catalogue and does not include those groups not occurring with the area. Field Marks generally include a few obvious characters of use in field identification, extracted from Diagnostic Features at various levels, but included in a separate section. Field Marks are listed at the ordinal, familial and species levels, and occasionally the generic level in cases of large genera with many species. The arrangement of Field Mark characters is semihierarchical and pragmatic and may include characters from a higher level such as an order in lower level taxonomic accounts such as those of species. Field Marks include characters that are obvious in live or fresh–caught individuals but may be obscure in frozen or preserved material. Diagnostic Features are lists of characters at the ordinal, familial, generic, and species level, with the character choice generally limited to external characters, particularly at the species level, because of their primary purpose of identification rather than indication of relationships. The Diagnostic Features sections are hierarchical, with characters at the ordinal level generally not duplicated at the family, genus and species levels. Monotypic orders with one family (such as Squatiniformes), monotypic families with one genus (Mitsukurinidae) or monotypic genera with one species (***Pseudotriakis***) all have the Diagnostic Features section present only in the highest taxon covered.

Distribution. Geographic distributions for nearly all species of sharks are given by listing the countries or oceanographic features, e.g. seamounts and troughs, off the coasts of which the sharks occur, and, in some instances with large countries (Australia), more detailed data are given when available. In compiling distributional data and preparing maps it was noted that the distributions of many wide–ranging coastal and deep–sea species are very patchily known as present. In many cases gaps in distribution may not indicate absence of a given species but absence of knowledge. Continental slope shark faunas are poorly known for much of the world, and a number of deepwater species probably have wider ranges than are currently known. Much effort was made to screen out distribution errors, based on misidentifications of species, at a cost of presenting distributional lists and maps that are patchy, but possibly more accurate.

Habitat. Habitat covers information on physical conditions where various sharks are found. The known depth range of the species (in metres), position in the water column, type of substrate occupied, and preferences relative to coasts are noted when available. In most cases data on salinity, oxygen content, and specific temperature of the water in which they occur was not available or was not in an easily usable form and has not been regularly compiled here.

Biology. Includes data on reproduction, age and growth, diet, and behaviour and movement patterns. Compilation of these data suggests that very few deep–sea species are biologically well known, and several are known only a very few specimens that have ever been observed.

Size. All size data are given as total lengths; this is the measurement most often used as an independent variable and standard measurement in the shark literature, although particularly in fisheries papers precaudal lengths, fork lengths, and other measurements have been used from choice or necessity. Unfortunately shark workers have not agreed on a standard method of measuring total length, so total lengths from different sources in the literature may not be strictly comparable. I prefer and advocate as a standard method a direct measurement, in which the shark is held belly down with its dorsal caudal–fin lobe depressed into line with its body axis and total length measured as a point to point distance (not over the curve of the body) from the snout tip to the tip of the dorsal caudal–fin lobe. This method lends itself readily to quick use of a fishboard with a perpendicular front bar or plate to index the fish's snout against, a one metre or two metre ruler or folding ruler slipped under the shark, batoid, or chimaera or even a steel or cloth tape, and avoids the trouble of computation and possible errors and loss of data.

Total length data presented includes maximum size, size at maturity (in some cases, a size range at maturity, when abundant data were available) and maximum size for both sexes, and size at birth or hatching. Sometimes size at sexual maturity for either or both sexes is not known, in which cases reported minimum and maximum sizes of adult individuals are given. In some cases maximum size exceeds that recorded for either sex, in which case the sex of the outsized individual or individuals representing the maximum size measurements was not indicated. In some poorly known species only immature individuals are known, in which case the hypothetical maximum adult size is almost certainly larger than the known immature maximum.

Interest to Fisheries and Human Impact. This section includes Fisheries information, including whether the species is taken in targeted or non–targeted (bycatch) fisheries and if taken as bycatch whether it is retained or discarded. Data on localities of fisheries, gear used, and uses of the particular species are noted when available. National fisheries data for deep–sea sharks is often sketchy and combined for a number of species. Thus, catch statistics are generally unavailable except for relatively few species of sharks but are noted when available, with particular emphasis on data from those species reported to FAO. Additional data are increasingly available from national and regional fisheries bodies are presented when available. Other aspects of human interaction is presented if available or known, although the average person rarely encounters most of these deep–sea sharks. The current conservation Red List status of each species as evaluated by the IUCN Species Survival Commission's Shark Specialist Group (http://www.iucnredlist.org) is provided. At the end of the Bibliography section an electronic reference section has been added with a link to the Red List Assessment for each species included in the Catalogue.

Local Names. Many deep–sea species have no vernacular names whatsoever or are lumped under catchall names, while some species such as the basking sharks have dozens of names. Wherever possible common local names are presented, especially for important wide–ranging sharks. The broadening interest in sharks and urgent need to acquire species–specific data for their management and conservation should encourage fisheries biologists and other researchers to compile local names for their own countries or regions, and add to the sketchy knowledge of local names.

Remarks. Important information, especially on systematics and nomenclature, are given in the remarks section. Also, the relative number of families per order, genera per family, and species per genus worldwide is given when appropriate for comparison to the groups occurring within FAO Areas 51 and 57.

Literature. References cited here include specific works with important information for each species and family as well as comprehensive accounts, but are not intended as a comprehensive bibliography.

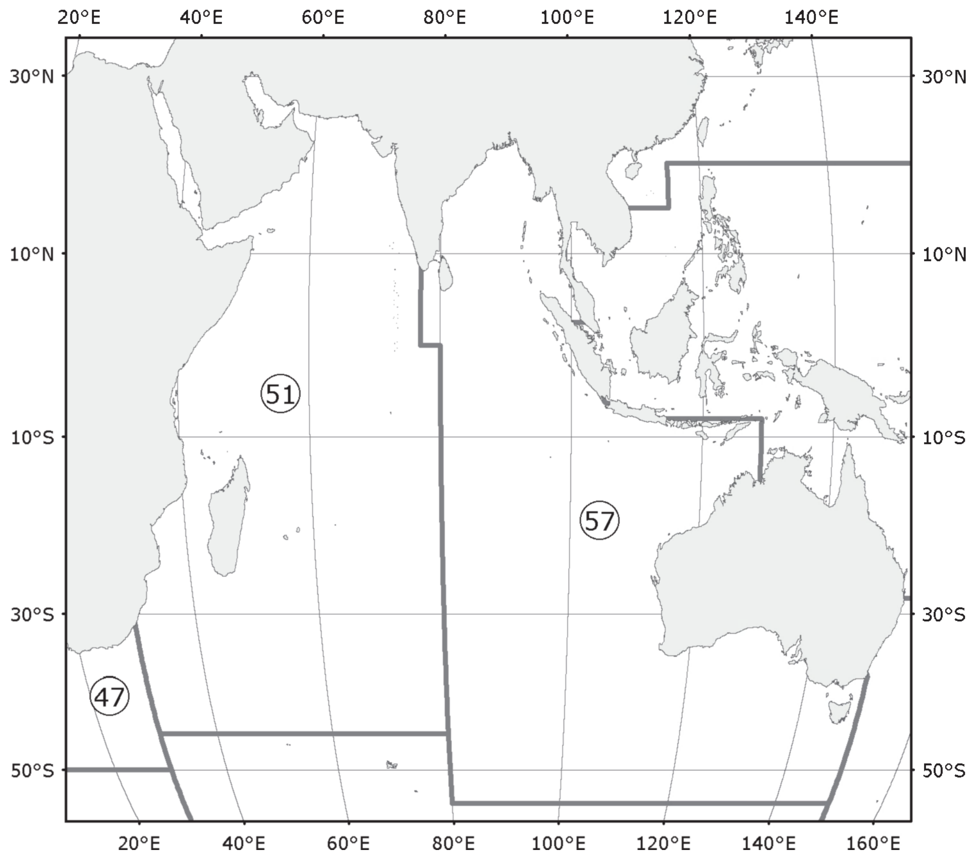


Fig. 1 Map of FAO Area 51 (Western Indian Ocean), Area 57 (Eastern Indian Ocean) and the southeastern portion of Area 47 (Southeastern Atlantic Ocean)

1.2 Technical Terms and Measurements

1.2.1 Picture Guide to External Terminology of Sharks

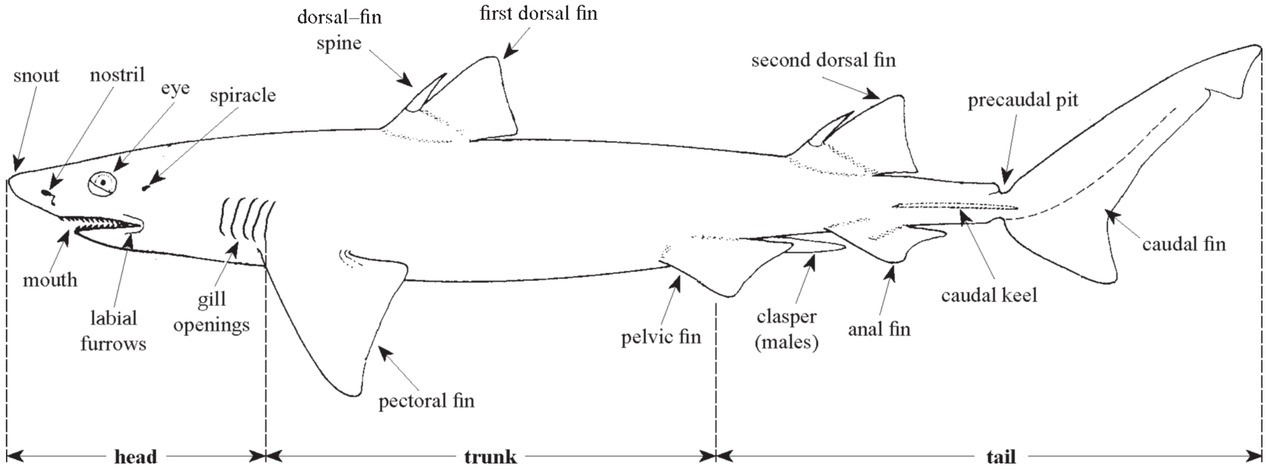


Fig. 2 Lateral view

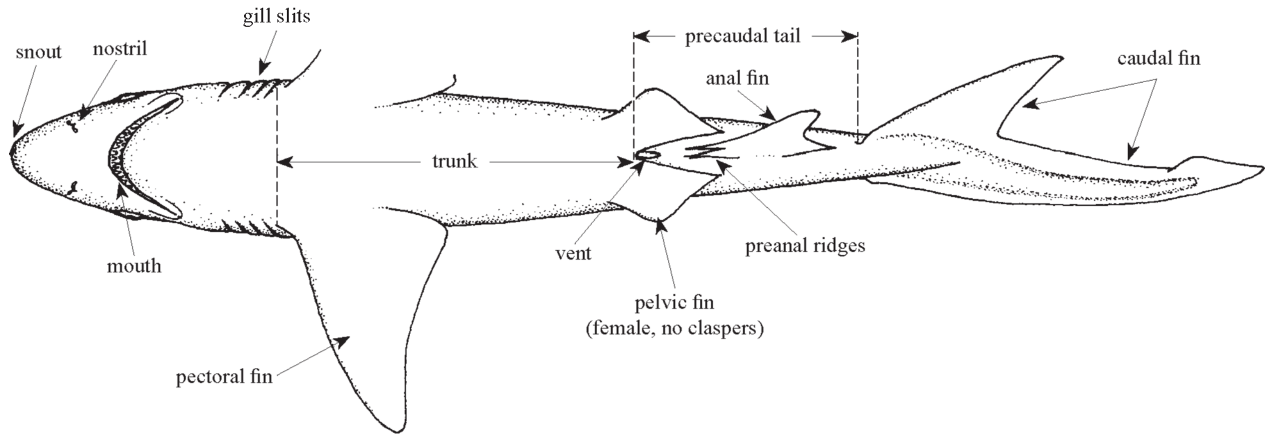


Fig. 3 Ventral view

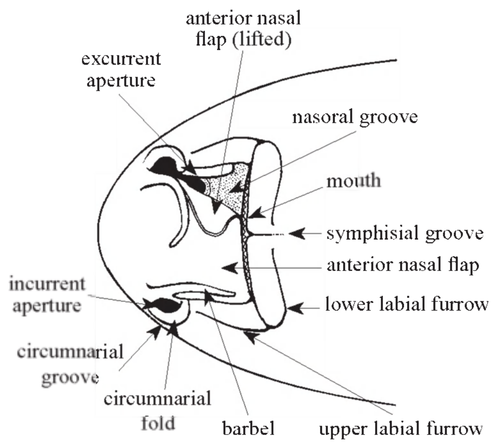


Fig. 4 Head of an orectoloboid shark (ventral view)

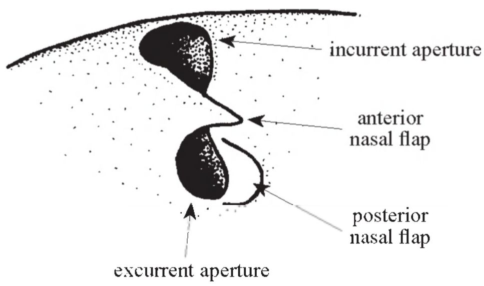


Fig. 5 Nostril

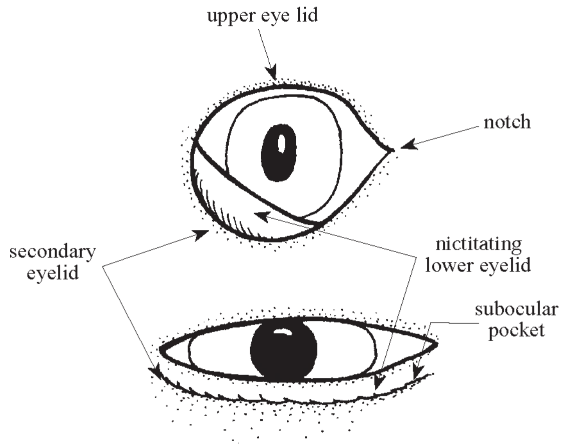


Fig. 6 Eyes

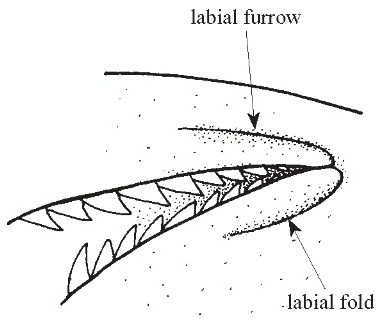


Fig. 7 Mouth corner

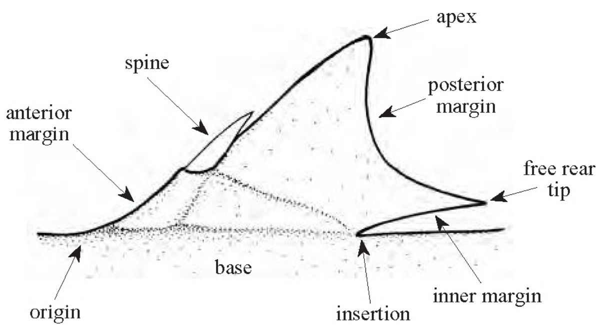


Fig. 8 Dorsal fin

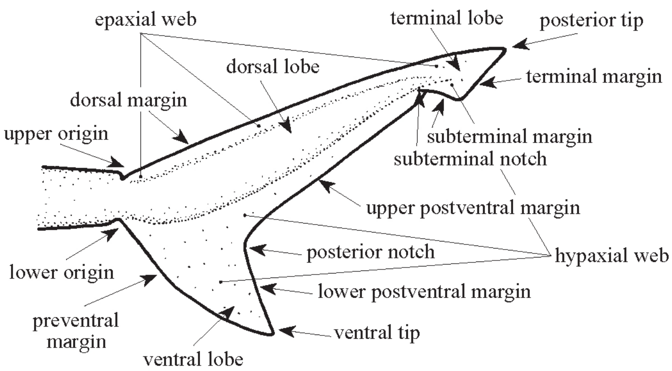


Fig. 9 Caudal fin

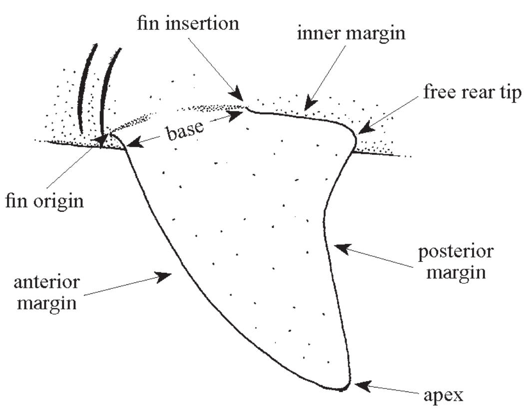


Fig. 10 Pectoral fin

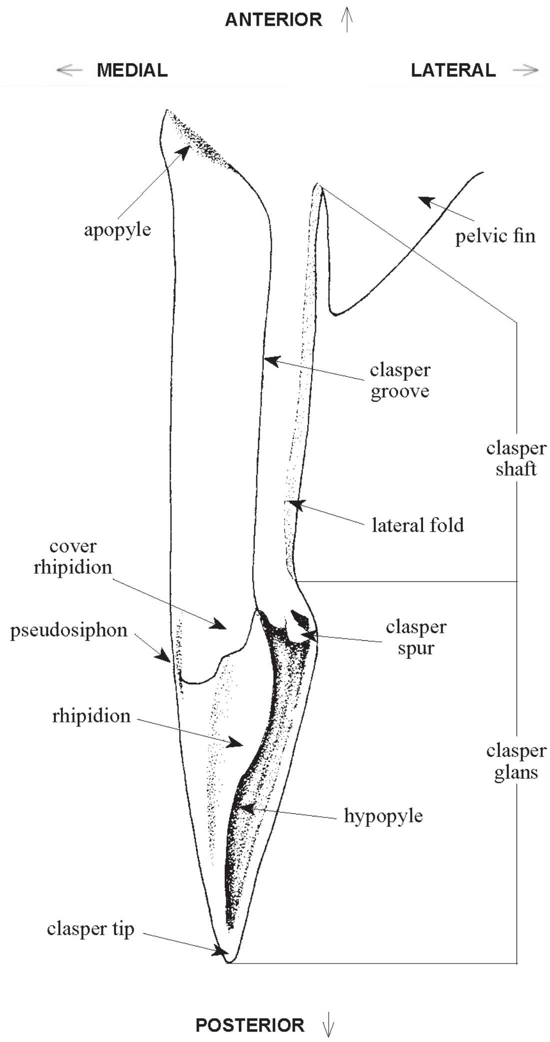


Fig. 11 Dorsal view of clasper (lamnid shark)

1.2.2 Picture Guide to Skeletal Terminology of Sharks

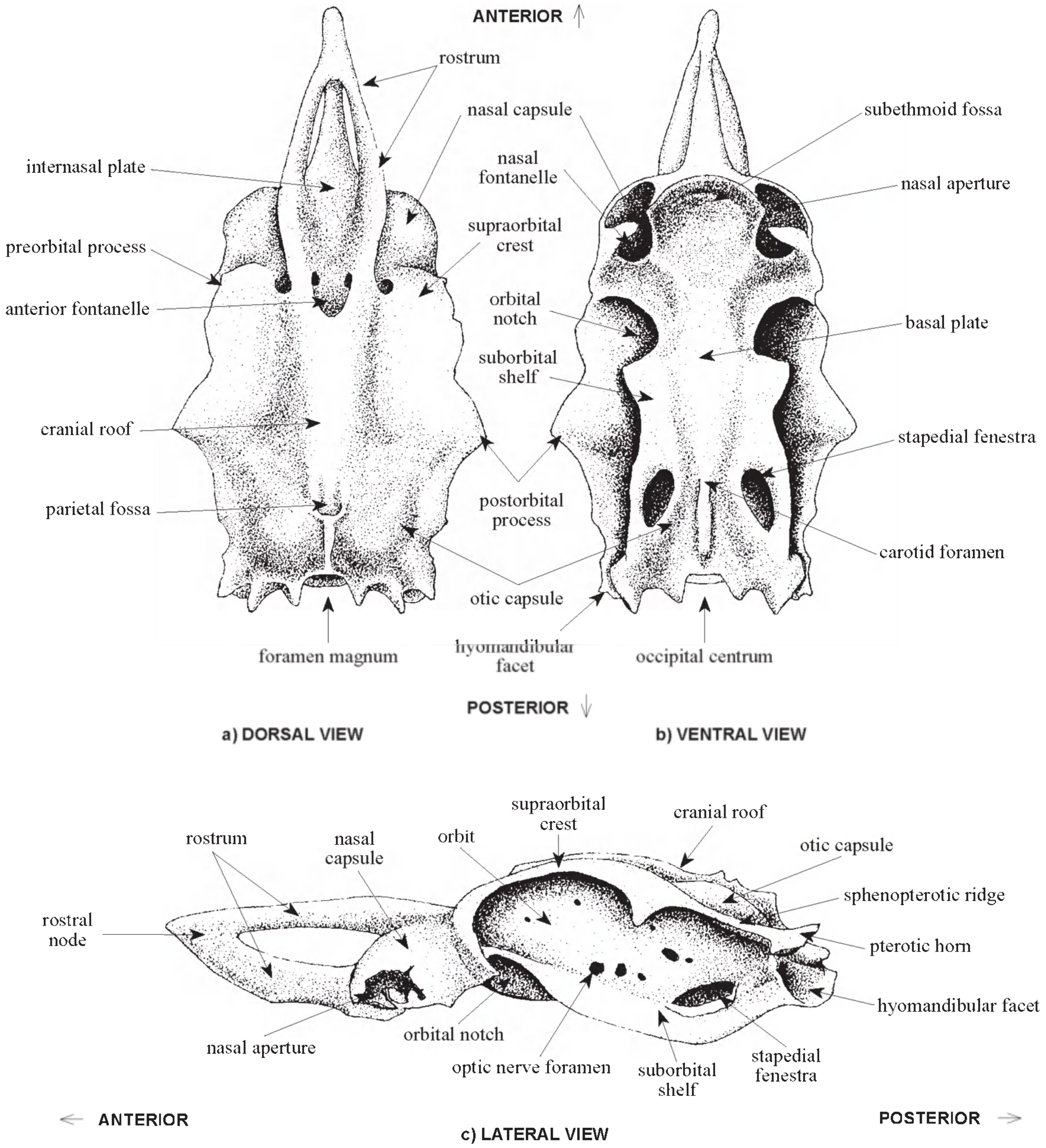


Fig. 12 Chondrocranium

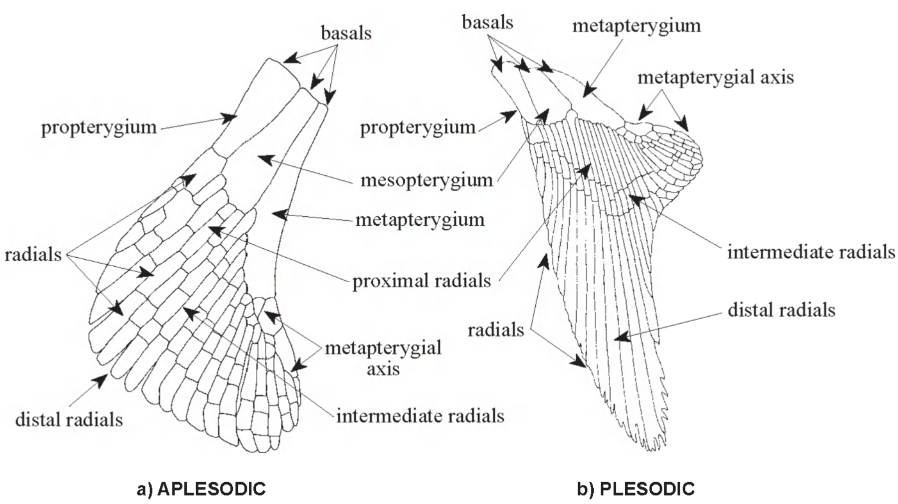


Fig. 13 Aplesodic and plesodic pectoral fins

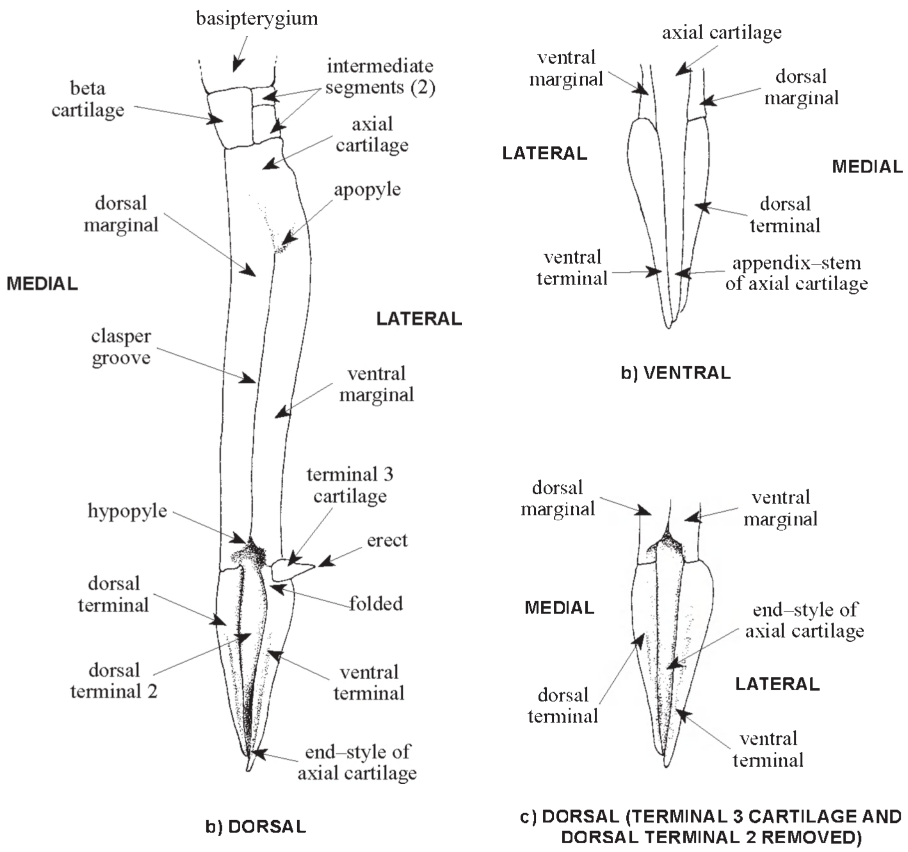


Fig. 14 Clasper skeleton of lamnid shark (right side)

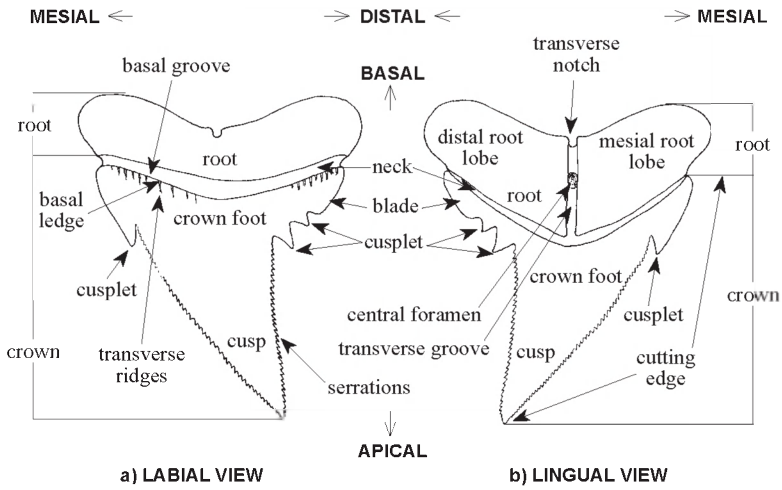


Fig. 15 Tooth terminology (left upper anterolateral tooth)

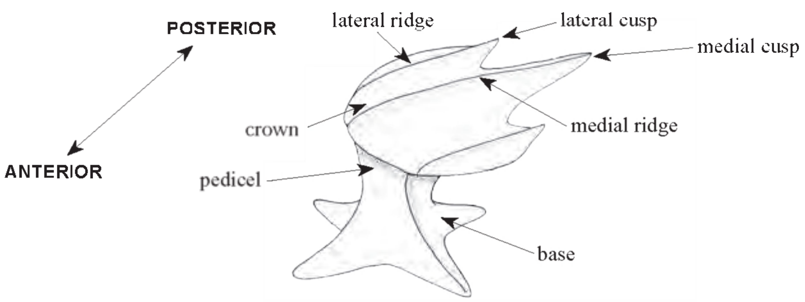


Fig. 16 Oblique anterolateral view of lateral trunk dermal denticle

1.2.3 Measurements Used for Sharks

TL = TOTAL LENGTH
FL = FORK LENGTH
PCL = PRECAUDAL–FIN LENGTH
PD2 = PRE–SECOND DORSAL–FIN LENGTH
PD1 = PRE–FIRST DORSAL–FIN LENGTH
HDL = HEAD LENGTH
PG1 = PREBRANCHIAL LENGTH
PSP = PRESPIRACULAR LENGTH
POB = PREORBITAL LENGTH
PP1 = PREPECTORAL–FIN LENGTH
PP2 = PREPELVIC–FIN LENGTH
SVL = SNOUT–VENT LENGTH
PAL = PREANAL–FIN LENGTH
IDS = INTERDORSAL SPACE
DCS = DORSAL CAUDAL–FIN SPACE
PPS = PECTORAL–FIN PELVIC–FIN SPACE
PAS = PELVIC–FIN ANAL–FIN SPACE
ACS = ANAL–FIN CAUDAL–FIN SPACE
PCA = PELVIC–FIN CAUDAL–FIN SPACE
VCL = VENT CAUDAL–FIN LENGTH

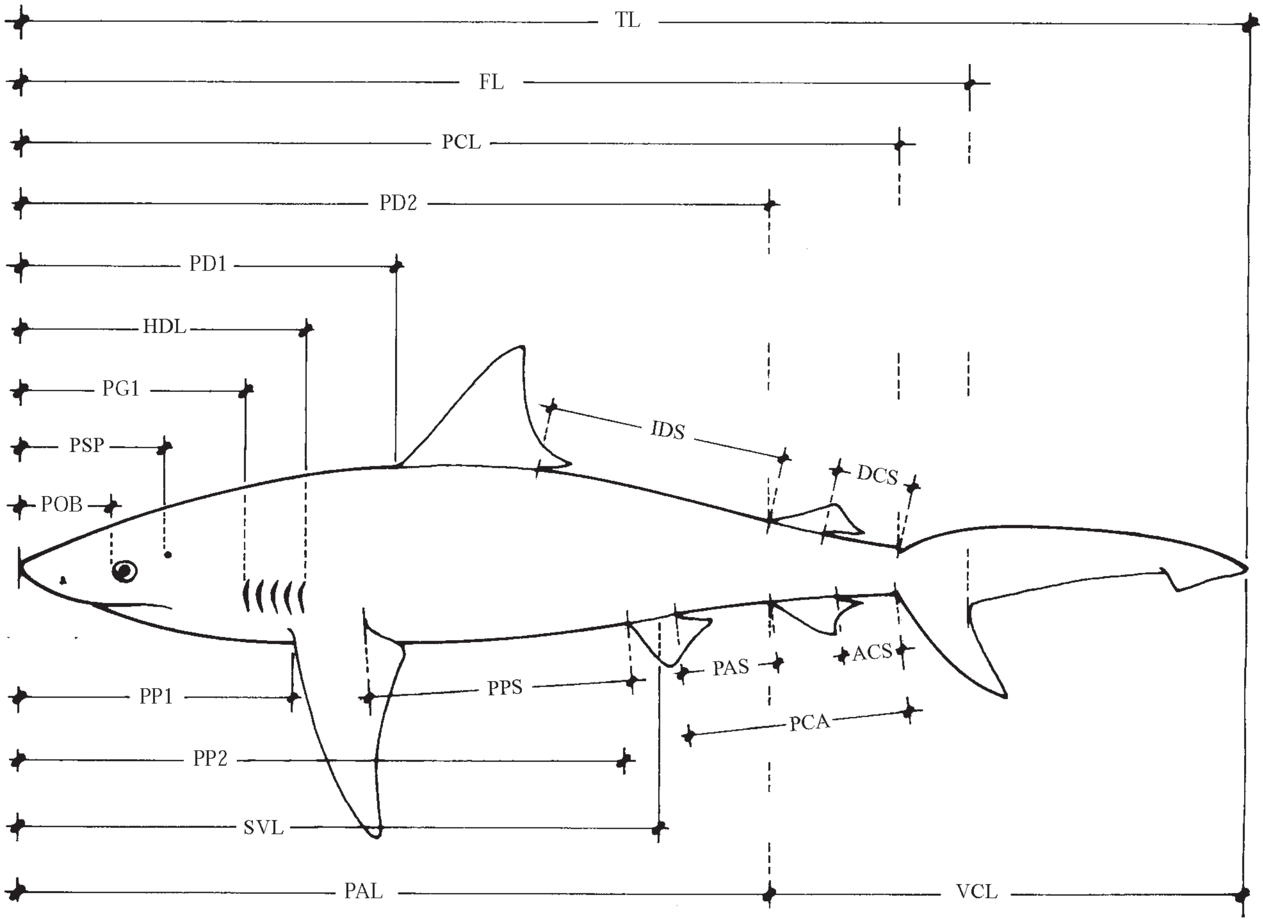


Fig. 17 Main longitudinal measures

PRN = PRENARIAL LENGTH
POR = PREORAL LENGTH
EYL = EYE LENGTH
EYH = EYE HEIGHT
ING = INTERGILL LENGTH
GS1 = FIRST GILL SLIT HEIGHT
GS2 = SECOND GILL SLIT HEIGHT
GS3 = THIRD GILL SLIT HEIGHT
GS4 = FOURTH GILL SLIT HEIGHT
GS5 = FIFTH GILL SLIT HEIGHT
GS6 = SIXTH GILL SLIT HEIGHT
GS7 = SEVENTH GILL SLIT HEIGHT
P1A = PECTORAL–FIN ANTERIOR MARGIN
P1R = PECTORAL–FIN RADIAL LENGTH
P1B = PECTORAL–FIN BASE
P1I = PECTORAL–FIN INNER MARGIN
P1P = PECTORAL–FIN POSTERIOR MARGIN
P1H = PECTORAL–FIN HEIGHT
P1L = PECTORAL–FIN LENGTH
SOD = SUBOCULAR POCKET DEPTH

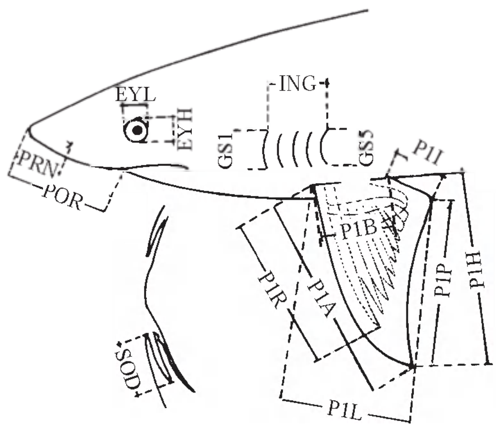


Fig. 18 Measurements of pectoral fin, gill slits, eye and snout

CDM = DORSAL CAUDAL–FIN MARGIN
CPV = PREVENTRAL CAUDAL–FIN MARGIN
CPU = UPPER POSTVENTRAL CAUDAL–FIN MARGIN
CPL = LOWER POSTVENTRAL CAUDAL–FIN MARGIN
CFW = CAUDAL–FIN FORK WIDTH
CFL = CAUDAL–FIN FORK LENGTH
CST = SUBTERMINAL CAUDAL–FIN MARGIN
CSW = SUBTERMINAL CAUDAL–FIN WIDTH
CTR = TERMINAL CAUDAL–FIN MARGIN
CTL = TERMINAL CAUDAL–FIN LOBE

D1L = FIRST DORSAL–FIN LENGTH
D1A = FIRST DORSAL–FIN ANTERIOR MARGIN
D1B = FIRST DORSAL–FIN BASE
D1H = FIRST DORSAL–FIN HEIGHT
D1I = FIRST DORSAL–FIN INNER MARGIN
D1P = FIRST DORSAL–FIN POSTERIOR MARGIN

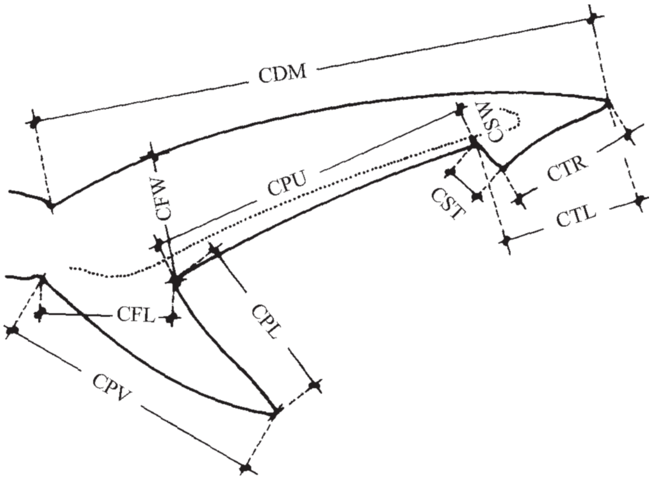


Fig. 19 Measurements of caudal fin

D2L = SECOND DORSAL–FIN LENGTH
D2A = SECOND DORSAL–FIN ANTERIOR MARGIN
D2B = SECOND DORSAL–FIN BASE
D2H = SECOND DORSAL–FIN HEIGHT
D2I = SECOND DORSAL–FIN INNER MARGIN
D2P = SECOND DORSAL–FIN POSTERIOR MARGIN

P2L = PELVIC–FIN LENGTH
P2A = PELVIC–FIN ANTERIOR MARGIN
P2B = PELVIC–FIN BASE
P2H = PELVIC–FIN HEIGHT
P2I = PELVIC–FIN INNER MARGIN [LENGTH]
P2P = PELVIC–FIN POSTERIOR MARGIN [LENGTH]

ANL = ANAL–FIN LENGTH
ANA = ANAL–FIN ANTERIOR MARGIN
ANB = ANAL–FIN BASE
ANH = ANAL–FIN HEIGHT
ANI = ANAL–FIN INNER MARGIN
ANP = ANAL–FIN POSTERIOR MARGIN

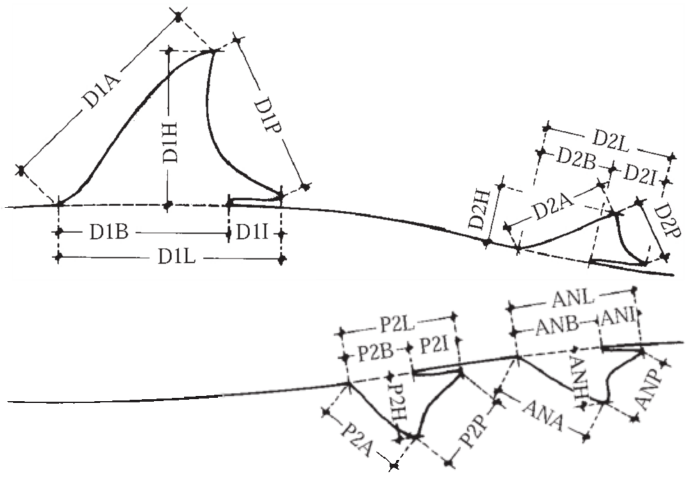


Fig. 20 Measurements of dorsal, pelvic and anal fins

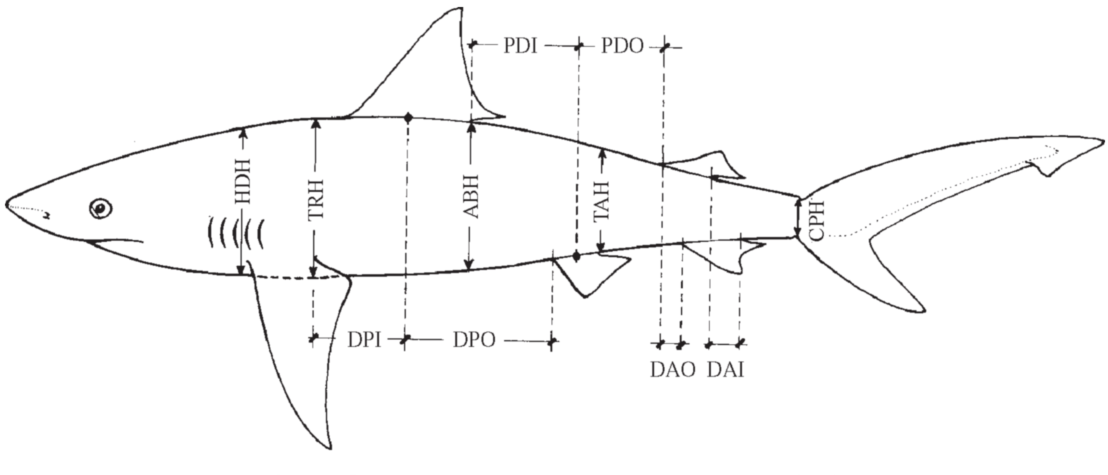


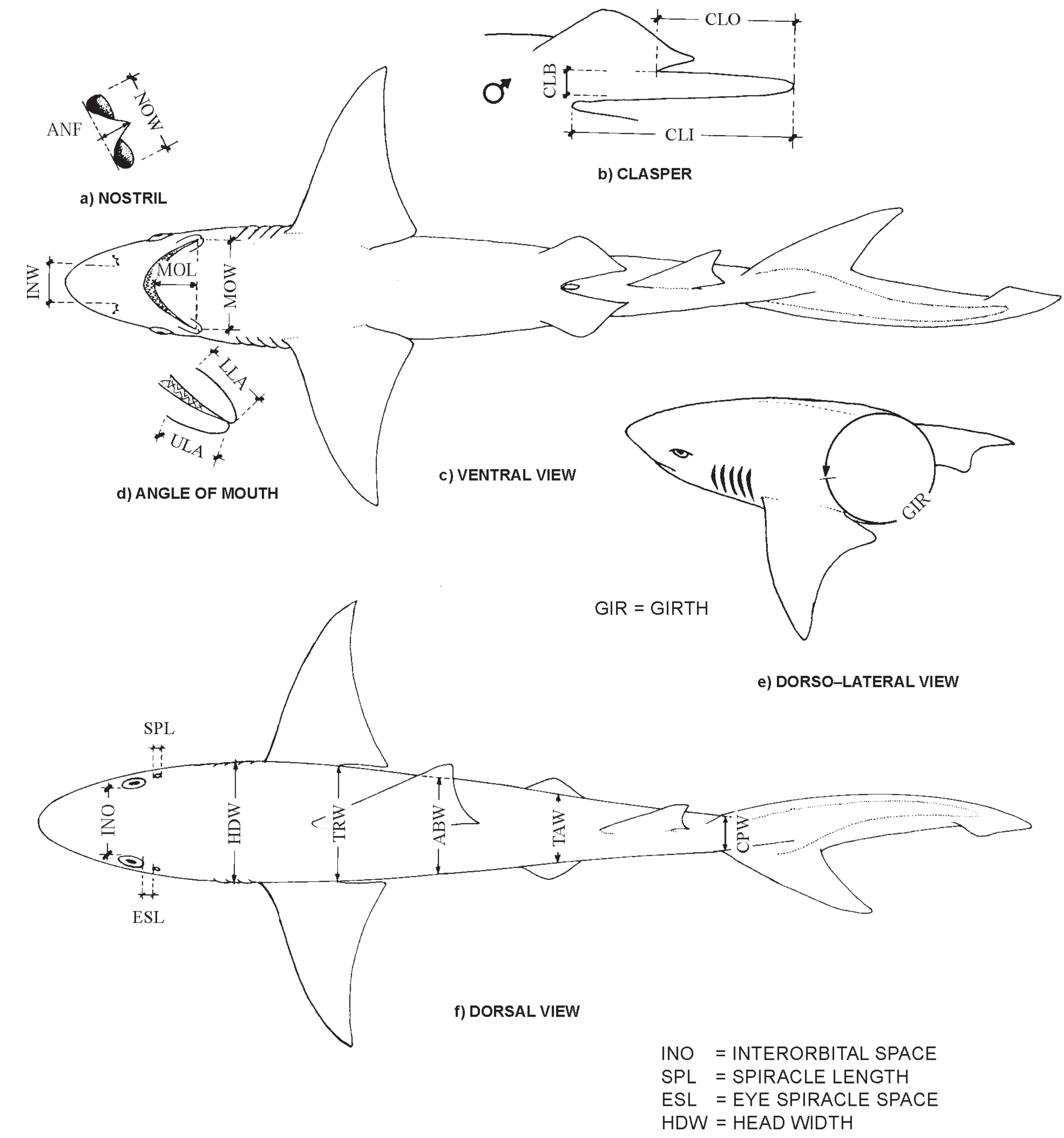
Fig. 21 Other common measurements (lateral view)

HDH = HEAD HEIGHT
TRH = TRUNK HEIGHT
ABH = ABDOMEN HEIGHT
TAH = TAIL HEIGHT
CPH = CAUDAL–FIN PEDUNCLE HEIGHT
DAI = SECOND DORSAL–FIN INSERTION ANAL–FIN INSERTION
DAO = SECOND DORSAL–FIN ORIGIN ANAL–FIN ORIGIN

DPI = FIRST DORSAL–FIN MIDPOINT PECTORAL–FIN INSERTION
DPO = FIRST DORSAL–FIN MIDPOINT PELVIC–FIN ORIGIN
PDI = PELVIC–FIN MIDPOINT FIRST DORSAL–FIN INSERTION
PDO = PELVIC–FIN MIDPOINT SECOND DORSAL–FIN ORIGIN

MOL = MOUTH LENGTH
MOW = MOUTH WIDTH
ULA = UPPER LABIAL–FURROW LENGTH
LLA = LOWER LABIAL–FURROW LENGTH
NOW = NOSTRIL WIDTH
INW = INTERNARIAL SPACE
ANF = ANTERIOR NASAL–FLAP LENGTH

CLO = CLASPER OUTER LENGTH
CLI = CLASPER INNER LENGTH
CLB = CLASPER BASE WIDTH



INO = INTERORBITAL SPACE
SPL = SPIRACLE LENGTH
ESL = EYE SPIRACLE SPACE
HDW = HEAD WIDTH
TRW = TRUNK WIDTH
ABW = ABDOMEN WIDTH
TAW = TAIL WIDTH
CPW = CAUDAL–FIN PEDUNCLE WIDTH

Fig. 22 Other common measurements (ventral and dorsal view)

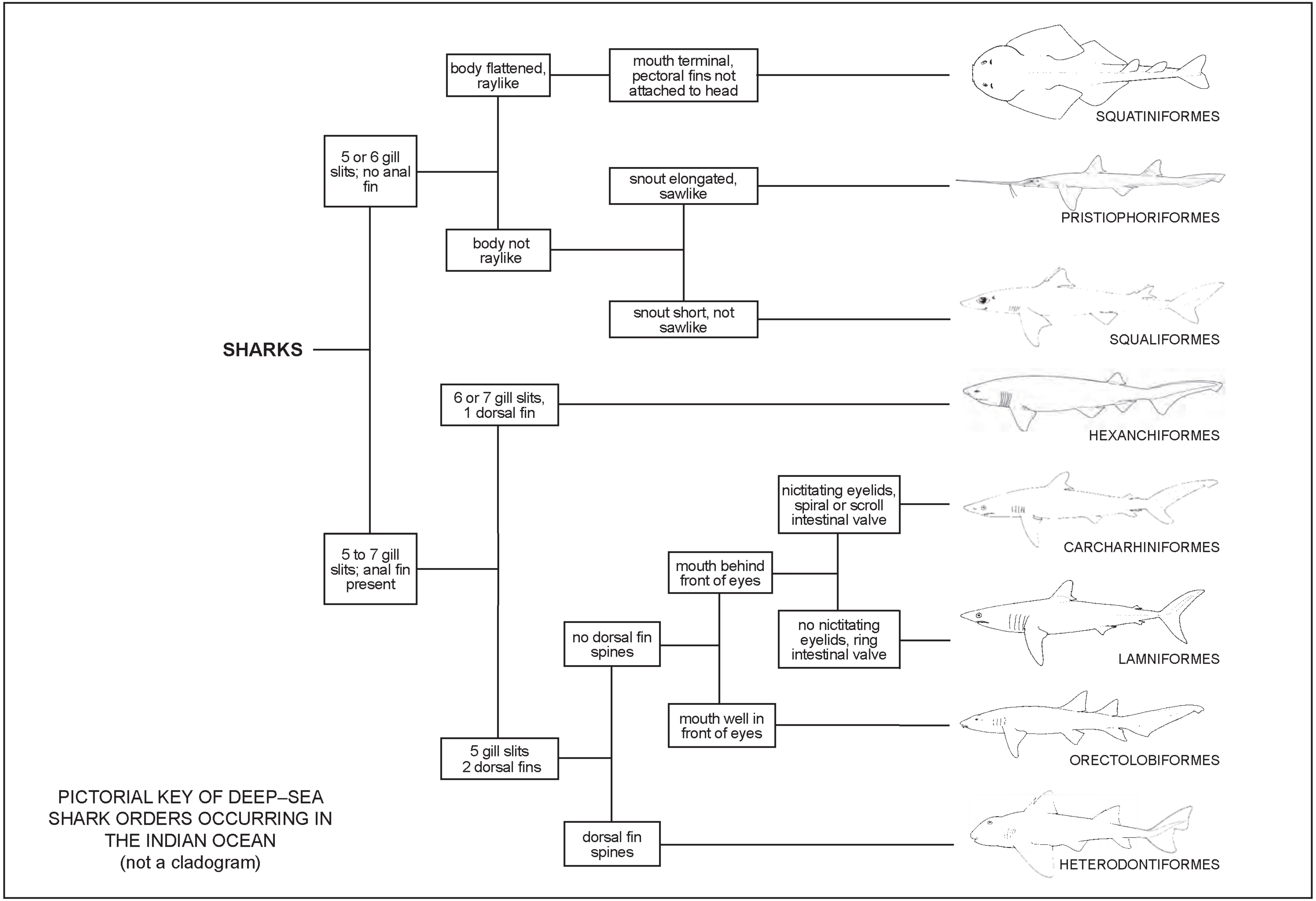


Fig. 23 Higher classification of Sharks (Orders)

1.2.4 Glossary of Technical Terms

The following glossary of terms used for the anatomy and biology of shark–like fishes is modified from terms in Compagno (1984, 1988, 1999) and a short glossary in Compagno, Ebert and Smale (1989). The main glossary duplicates that in volume 2 of the revised shark catalogue (Compagno, 2001), except that additional terms for habitat and distribution used in the text are reinstated in the glossary. Terms for photophore patterns (including photomarks) that pertain only to the family Etmopteridae and primarily to the genus ***Etmopterus*** are discussed under that family.

Abdominal ridges or **keels:** In some sharks, paired longitudinal dermal ridges that extend from the bases of the pectoral fins to the pelvic–fin bases.

Abyss: The deep sea bottom, ocean basins or abyssal plain descending from 4000 m to about 6000 m.

Accessory dorsal marginal: In the clasper skeleton, a flat cartilage on the posterior end of the dorsal marginal cartilage that supports the cover rhipidion.

Adductor mandibulae muscles: Paired head muscles originating on the lateral faces of the quadrate process of the palatoquadrates and inserting on the lateral surface of the Meckel's cartilages; the primary jaw–closing muscles of sharks.

Adelphophagy: Foetus–eating, a mode of live–bearing reproduction employing uterine cannibalism; early foetuses deplete their yolk sacs early and subsist by first eating their smaller siblings and then eating nutritive eggs produced by the mother. At present only known for certain in the sand tiger shark (***Carcharias taurus***), but suspected in a few other lamnoids.

Alternate teeth: Small oral teeth with asymmetrical crowns that form two interdigitated rows on the symphysis, with the cusps of each row hooked mesially towards the opposite row. Additional paired rows of alternates may be present distal to the symphysial rows.

Amphitemperate: Referring to a species that occurs in temperate water in the northern and southern hemispheres, but is absent from the tropics.

Anal fin: A single fin on the ventral surface of the tail between the pelvic fins and caudal fin of some sharks, absent in batoids, dogfish, sawsharks, angel sharks, and some chimaeras.

Annular rings or **annuli:** In a vertebral centrum in cross section, rings of calcified cartilage separated by uncalcified cartilage that occupy the intermedialia only, or concentric rings that cross both the intermedialia and basalia.

Anterior: Forward, in the longitudinal direction of the snout tip. Also, **cranial**.

Anterior fontanelle: On the elasmobranch neurocranium, an aperture on the anterodorsomedial surface, usually at the rear of the ethmoid region and forming a passage into the internal cranial cavity. It is closed by a tough membrane, varies tremendously in shape, and may be pinched off by the medially expanded orbits in a few sharks.

Anterior margin: In precaudal fins, the margin from the fin origin to its apex.

Anterior nasal flap: A flap on the front edges of the nostrils, that serves to partially divide the nostril into incurrent and excurrent apertures or openings.

Anterior teeth: Enlarged, tall, narrow–rooted oral teeth near the symphysis, often with lingually curved cusps.

Anterodorsal palpebral depressor muscle: In the orectoloboid family Parascylliidae, paired head muscles that originate at the insertions of the preorbitalis muscles on the anterolateroventral face of the Meckel's cartilage, and insert on the skin of the upper eyelid anterior to the eye. These are possibly for depressing the upper eyelids and closing the eyes, and are not found in any other sharks.

Antorbital cartilages: On the neurocranium of sawsharks and batoids, separate cartilages attached to the sides of the nasal capsules that support the sides or front of the head.

Apex: In precaudal fins, the distal tip, which can be acutely pointed to broadly rounded.

Apical: In oral teeth, towards the tip of the crown or cusp. Can also be used as indicating direction towards the apex or tip of a fin, fin–spine, etc.

Aplacental viviparity: Live–bearing in which the young do not have a yolk–sac placenta. Found in all groups of live–bearing sharks.

Aplesodic fin: A pectoral, pelvic, dorsal, or anal fin in which the fin radial cartilages do not extend into the distal fin web and between the supporting ceratotrichia of the fin web. Modern sharks always have aplesodic caudal fins, in which the haemal arches of the caudal vertebrae do not support the ventral caudal lobe.

Apopyle: The anterior opening of the clasper, on the anteromesial surface of the clasper and close to the vent. The apopyle receives sperm from the cloaca and fluid from the siphons, which enter the clasper groove and are discharged through the hypopyle. Apopyle is also used for clasper skeletons for the anterior opening of the tubular shafts formed by enlarged marginal and axial cartilages.

Axial cartilage: In the clasper skeleton, the elongated ventral rod or plate–shaped cartilage that forms the main support of the clasper. Also termed **appendix–stem**.

Barbels: Long conical paired dermal lobes on the snouts of sharks, that may serve to locate prey. Sawsharks have barbels on the underside of the snout in front of the nostrils as in sturgeon, but most barbeled sharks have them associated with the nostrils, either as an extension of the anterior nasal flaps or as separate structures medial to the nasal apertures.

Basal: In oral teeth, a proximal direction towards the crown foot and roots.

Basal cartilages or **basals:** In precaudal fins the large cartilages of the fin bases, immediately distal to the pectoral and pelvic fin girdles or the vertebral column (dorsal and anal fins), on which the radials articulate distally. The paired pectoral fins of living sharks primitively have a tribasal pectoral fin, with a **propterygium**, **mesopterygium**, and **metapterygium** as basals, although these may be fused; in batoids, additional **neopterygial basals** may be added between the **mesopterygium** and **metapterygium** and the **propterygium** is variably expanded anterior with a **propterygial basal** and axis. The pelvic fins have a **basipterygium** that supports the pelvic radials and, in males, the claspers. The caudal fin has no basals, but these are functionally replaced by expanded neural and haemal arches of the vertebral column.

Basal communicating canals: See **subnasal fenestrae**.

Basal groove: In oral teeth, a deep groove proximal to the basal ledge on the labial surface of the crown neck and apical root margin.

Basal ledge: In oral teeth, a shelf–like projection on the labial surface of the crown foot.

Basal plate: The floor of the cranial cavity of the neurocranium, a ventral, medial plate extending from the ethmoid region between the orbits and otic capsules and below the cranial cavity to the occipital condyles, occipital centrum and foramen magnum.

Basals or **basalia:** In a vertebral centrum, the diagonal spaces below the attachment surfaces of the basidorsal cartilages, above the basiventral cartilages, and between the two halves of the double cone. Basalia may be filled with uncalcified cartilage, may have diagonal calcifications penetrating the uncalcified cartilage, or may have calcified annuli or solid calcified cartilage that are continuous with calcification of the intermedialia. See **diagonal calcifications** and **intermedialia**.

Base: In precaudal fins, the proximal part of the fin between the origin and insertion, extending distally, and supported by the cartilaginous fin skeleton. In the caudal fin, that thickened longitudinal part of the fin enclosing the vertebral column and between the epaxial and hypaxial lobes or webs of the fin. In oral teeth, the proximal root and crown foot, in apposition to the distal cusp. In denticles, the proximal anchoring structures, often with four or more lobes, holding the denticles in the skin.

Basidorsal cartilages: A pair of wedge–shaped arched, thin cartilages articulating with the dorsolateral surfaces of a vertebral centrum and forming a continuous neural arch with the interdorsal cartilages to protect the spinal cord.

Basipterygium: The large elongate longitudinal cartilage at the fin base of the pelvic fin, attached to the posterolateral ends of the pelvic girdle or puboischiadic bar. The basipterygium has pelvic radials attached along its distal edge and has the clasper skeleton attached posteriorly in males.

Basiventral cartilages: A pair of rounded or wedge–shaped cartilages on the ventrolateral surfaces of a vertebral centrum that form the bases for attachment of ribs in monospondylous precaudal vertebrae. In diplospondylous precaudal and caudal vertebrae the basiventrals form haemal arches along with the interventral cartilages for protecting the caudal artery and vein.

Bathypelagic zone: That part of the oceans beyond the continental and insular shelves, from about 1000 m to 4000 m and above the middle and lower continental rises and the abyssal plain, the sunless zone. Some oceanic sharks may transit the epipelagic, mesopelagic and bathypelagic zones to the bottom while migrating vertically.

Batoid: A ray or flat or winged shark, a neoselachian of the cohort Batoidea, a sawfish, sharkray, wedgefish, guitarfish, thornray, panray, electric ray, skate, stingray, butterfly ray, eagle ray, cownose ray, devil ray or *Manta*. Rays are closely allied to the sawsharks (Pristiophoriformes) and angel sharks (Squatiniformes), but differ from them in having the pectoral fins fused to the sides of the head over the gill openings, which are ventral rather than laterally or ventrolaterally placed.

Benthic or **Demersal:** referring to organisms that are bottom–dwelling.

Beta cartilage: In the clasper skeleton, a single, dorsolateral flattened, wedge–shaped or cylindrical cartilage connecting the pelvic basipterygium and axial cartilage and reinforcing the intermediate segments, possibly derived from a pelvic radial.

Blade: In oral teeth, an arcuate, convex–edged section of the cutting edge of the crown foot, without cusplets.

Body ridges: Elongated longitudinal dermal ridges on the sides of the trunk and precaudal tail in certain carpet sharks (Orectolobiformes), in the whale, zebra and some bamboo sharks.

Body: Can refer to an entire shark, sometimes restricted to the trunk and precaudal tail.

Branchial arches: The paired visceral arches behind the hyoid arch and just in front of the **scapulocoracoid** that support the gills. In elasmobranchs the five to seven branchial arches primitively consist of a pair of dorsomedial and wedge–shaped cartilages, the **pharyngobranchials**, closely situated against the roof of the pharynx, a pair of dorsolateral and more cylindrical **epibranchials** that are connected dorsomedially to the **pharyngobranchials**, a pair of ventrolateral cylindrical **ceratobranchials** that are connected ventrolaterally to the epibranchials, a pair of ventromedial hypobranchials that are connected ventrolaterally to the ceratobranchials, and unpaired ventromedial **basibranchials** that are connected ventrolaterally to the hypobranchials. The hypobranchials and basibranchials along with the expanded ventral ends of the ceratobranchials form the **basibranchial skeleton** of the floor of the branchial pharynx. The branchial skeleton is variably modified in elasmobranchs, with basibranchials and sometimes hypobranchials often lost, the last two pharyngobranchials and the last epibranchial often fused together, and the last basibranchial often expanded into a long, broad **copula** with which the anterior hypobranchials and posterior ceratobranchials articulate.

Calcified cartilage: Shark skeletons are formed of hyaline cartilage or gristle, but this is often reinforced with layers of calcified cartilage, cartilage impregnated with a mineral, hydroxyapatite, similar to that of bone but organized differently, in a hard, tile–like pavement of tiny **tesserae**, or more compactly as in the calcified structures of vertebral centra.

Calcified double cones: In vertebrae, the primary calcifications of the notochordal sheath, in lateral view resembling two hollow, horizontal cones with their apices merged, or an hourglass.

Cannibal viviparity: See **uterine cannibalism**.

Carcharhinoid: A ground shark, a member of the order Carcharhiniformes, and including the catsharks, false catsharks, finbacked catsharks, barbeled houndsharks, houndsharks, weasel sharks, requiem sharks and hammerheads.

Carina: On the crowns of oral teeth, a low blunt mesodistal ridge replacing the cusp and cutting edge, in sharks that eat hard–shelled invertebrate prey.

Carotid foramen: A single foramen or one of a pair of foramina that penetrate the basal plate usually near its midlength and allow passage of the internal carotid arteries into the cranial cavity. In some advanced elasmobranchs the carotid foramina shift through the stapedial foramina and onto the medial wall of the orbit.

Cartilaginous fishes: Members of the class Chondrichthyes.

Caudal crest: A prominent saw–like row of enlarged pointed denticles along the dorsal caudal margin and sometimes along the ventral caudal margin of the caudal fin. Found in certain sharks including hexanchoids and some carcharhinoids.

Caudal fin: The fin on the end of the tail in shark–like fishes, lost in some batoids.

Caudal keels: A dermal keel on each side of the caudal peduncle that may extend onto the base of the caudal fin, and may, in a few sharks, extend forward as a body keel to the side of the trunk.

Caudal peduncle: That part of the precaudal tail extending from the insertions of the dorsal and anal fins to the front of the caudal fin.

Central foramen: In oral teeth, a nutrient foramen on the midline of the lingual surface of the root, in the transverse groove.

Centrum (plural, Centra): A spool–shaped, partially or usually fully calcified structure that forms as a segmental constriction in the notochordal sheath of neoselachians, and which as an articulated string forms the principal structural units of the vertebral column. Centra are primarily formed by the calcified double cones in the notochordal sheath, which may be their only calcification, but additional secondary calcification may occur in the centrum between the outer surfaces of the calcified double cones, including calcified intermedialia, radii, annuli, and diagonal calcifications.

Ceratotrichia: Slender soft or stiff filaments of an elastic protein, superficially resembling keratin or horn, from the Greek *keratos*, horn, and *trichos*, hair. Ceratotrichia run in parallel and radial to the fin base and support the fin webs. The prime ingredient of shark–fin soup.

Chimaera: A member of the order Chimaeriformes, subclass Holocephali, see also **Chimaeroid**, **Holocephali**.

Chimaeroid: A chimaera, ratfish, silver shark, ghost shark, spookfish or elephant fish, a member of the order Chimaeriformes.

Chondrichthyan: Referring to the class Chondrichthyes.

Chondrichthyes: The class Chondrichthyes, from Greek *chondros*, cartilage, and *ichthos*, fish, a major taxonomic group of aquatic, gill–breathing, jawed, finned vertebrates with primarily cartilaginous skeletons, 1 to 7 external gill openings, oral teeth in transverse rows on their jaws, and mostly small, tooth–like scales or dermal denticles. Chondrichthyes include the living elasmobranchs and holocephalans and their numerous fossil relatives, and also can be termed shark–like fishes or simply sharks.

Chondrocranium: See **neurocranium**.

Circumglobal: Occurring around the world.

Circumnarial fold: A raised semicircular, lateral flap of skin around the incurrent aperture of a nostril, in heterodontoids, orectoloboids, and a few batoids, defined by a circumnarial groove.

Circumnarial groove: A shallow groove defining the lateral bases of the circumnarial folds.

Circumtropical: Occurring around the tropical regions of the world.

Clasper claws: In parascylliid orectoloboids, a longitudinal row of large anterolaterally directed claw–like denticles on the dorsolateral surface of the clasper glans, supported by the terminal ventral.

Clasper dactyl: In parascylliid orectoloboids, a large finger–like process on the medial face of the clasper, supported by the dorsal terminal and having a **mesospur**, an analogue to the lateral spur or spine of the terminal 3 cartilage of other orectoloboids and other sharks.

Clasper gaff or **hook:** In the external clasper glans, a posterior hook–like structure, like a clasper spur but formed from the dorsal terminal cartilage, found in squaloids of the family Squalidae.

Clasper glans: The distal and dorsal part of the external clasper from the hypopyle to its tip, and including various movable terminal structures; also, the same area of the clasper skeleton.

Clasper groove: The longitudinal groove through the clasper, surrounded by the axial and marginal cartilages, and connecting the apopyle and hypopyle.

Clasper hooks: In the clasper glans of some carcharhinoid sharks, small claw–like dermal denticles arranged in a row along the ventral surface of the free edge of the exorhipidion.

Clasper sacs: Dermal sacs with longitudinally ribbed walls on the ventral and medial surfaces of the claspers of hexanchoids.

Clasper shaft: That part of the clasper skeleton from its origin on the pelvic fin basipterygium to the hypopyle; also, that part of the external clasper from its base to the hypopyle.

Clasper spine: In the external clasper, a projection of the terminal 3 cartilage on the lateral surface of the clasper glans, which forms a short to long, acutely pointed, spine that is covered with shiny hard tissue, possibly enameloid, dentine or both. In some squaloids other terminal cartilages may have spines.

Clasper spur: In the external clasper, a projection of the terminal 3 cartilage on the lateral surface of the clasper glans, which may be pointed but is not covered with shiny hard tissue.

Clasper tip: The posterior end of a clasper.

Claspers: The paired copulatory organs present on the pelvic fins of male cartilaginous fishes, for internal fertilization of eggs, also termed **mixopterygia**.

Classification: The ordering of organisms into groups on the basis of their relationships, which may be by similarity or common ancestry.

Cloaca: The common chamber at the rear of the body cavity of elasmobranchs through which body wastes and reproductive products including sperm, eggs, and young pass, to be expelled to the outside through a common opening or **vent**.

Cover rhipidion: On the external clasper glans, an elongated, longitudinal blade or flap on its dorsomedial external edge, often supported by an accessory dorsal marginal cartilage.

Cranial cavity: The central cavity of the neurocranium, containing the brain, pituitary gland, and roots of the cranial nerves. It extends posteriorly between the orbits and otic capsules to the foramen magnum.

Cranial roof: The anterior roof of the cranial cavity of the neurocranium, a dorsomedial, arched or flattened plate extending from the anterior fontanelle and between the orbits to the parietal fossa of the otic capsule. Sometimes perforated by a frontal or parietal foramen or fenestra, which may be continuous with the anterior fontanelle and can occupy most of the cranial roof.

Craniomandibular muscles: Paired head muscles in heterodontoid sharks that originate from long tendons on the medial walls of the orbits that extend below and transverse to the levator palatoquadrati and spiracular constrictor muscles and behind the spiracles to insert on the posterodorsolateral face of the Meckel's cartilages. They are found in no other sharks and may serve to retract or elevate the jaws.

Crown: The distal part of the oral tooth, almost entirely covered with shiny enameloid except for the neck. In denticles, a flat dorsal plate–like or thorn–like structure, elevated above the denticle base on a stalk or pedicle or confluent with the base.

Crown foot: The expanded, proximal, basal part of the crown, often bearing cusplets or blades.

Cusp: A usually pointed large distal projection of the crown. A **primary cusp** is situated on the midline of the crown foot. **Multicuspid** refers to oral teeth or denticles with more than one cusp. In lateral trunk denticles, the posterior ends of the crown may have **medial** and **lateral cusps**, sharp or blunt projections associated with the medial and lateral ridges.

Cusplet: As with a cusp, but a small projection in association with a cusp, and usually mesial and distal but not medial on the crown foot.

Cutting edge: In oral teeth, the compressed sharp longitudinal ridge on the mesodistal edges of the crown.

Dentine: The primary material of shark oral teeth, a hard tissue with numerous vascular and nonvascular canals.

Dermal denticle or **placoid scale:** A small tooth–like scale found in cartilaginous fishes, covered with enameloid, with a core and base of dentine and usually small and often close–set to one another and covering the body. A few non–batoid sharks, many batoids, and chimaeroids generally have them enlarged and sparse or reduced in numbers.

Dermal lobes: In wobbegongs, family Orectolobidae, narrow or broad–based, simple or branched projections of skin along the horizontal head rim and on the chin.

Diagonal calcifications: In a vertebral centrum in cross–section, plate–like (**diagonal calcified lamellae**) or knob–like (**diagonal calcified lobes**) structures of calcified cartilage that partially fills the uncalcified basalia. These have a radial orientation from the centre of the centrum.

Diphycercal: A caudal fin with the vertebral axis running horizontally into the fin base, which is not elevated.

Diplospondylous vertebrae: Vertebrae of the tail with two centra and two basidorsal and basiventral elements per segment, and mostly with a haemal arch formed by the basiventral and interventral elements. These include diplospondylous precaudal vertebrae between the monospondylous vertebrae and the base of the caudal fin, and diplospondylous caudal vertebrae in the caudal fin.

Distal: In any direction, at the far end of a structure. In oral teeth, used in a special sense for structures on the teeth towards the posterolateral mouth corners or rictuses. See **apical** and **basal**.

Dorsal: Upwards, in the vertical direction of the back. See **ventral**.

Dorsal fin: A fin located on the trunk or precaudal tail or both, and between the head and caudal fin. Most sharks have two dorsal fins, some batoids one or none.

Dorsal–fin spine: A small to large enameloid–covered, dentine–cored spine located on the anterior margins of one or both of the dorsal fins, found on bullhead sharks (Heterodontiformes), many dogfish sharks, fossil (but not living) batoids, chimaeroids, but lost entirely or buried in the fin bases of other shark–like fishes.

Dorsal lobe: In the caudal fin, the entire fin including its base, epaxial and hypaxial webs but excepting the ventral lobe.

Dorsal margin: In the caudal fin, the margin from the upper origin to its posterior tip. Usually continuous, but in angel sharks (Squatiniformes) with their hypocercal, superficially inverted caudal fins, it is subdivided. See **squatinoid caudal fin**.

Dorsal marginal: In the clasper skeleton, a flat semicylindrical cartilage that is partially fused to the medial edge of the axial cartilage, and forms the medial wall of the clasper groove.

Dorsal terminal: On the skeleton of the clasper glans, an often triangular, elongated, curved, plate–like cartilage that articulates or is attached to the medial or dorsomedial edge of the end–style and anteriorly to the dorsal marginal.

Dorsal terminal 2: A flat elongated cartilage with its mesial edge attached to the floor of the glans, and supporting the rhipidion.

Ectethmoid chambers: On the neurocranium, cavities in the nasal capsule that drain the nasal sinuses through the orbitonasal canals into the orbital sinuses.

Ectethmoid processes: On the neurocranium of hexanchoid and some squaloid sharks, posteroventrolateral angular or lobular projections of the nasal capsules and the preorbital walls.

Egg case: A stiff–walled elongate–oval, rounded rectangular, conical, or dart–shaped capsule that surrounds the eggs of oviparous sharks, and is deposited by the female shark on the substrate. It is analogous to the shell of a bird's egg and is made of protein, which is a type of collagen that superficially resembles horn or keratin. Egg cases often have pairs of tendrils or horn–like structures on their ends, or flat flanges on their sides or spiral flanges around their lengths, which anchor the cases to the bottom. As the egg travels from the ovaries into the oviducts and through the nidamental glands, the egg case is secreted around it and the egg is fertilized. Live–bearing sharks may retain egg cases, and these vary from being rigid and similar to those of oviparous sharks to soft, bag–like, degenerate and membranous. Soft egg cases may disintegrate during the birth cycle.

Elasmobranch: Referring to the subclass Elasmobranchii.

Elasmobranchii: The subclass Elasmobranchii, (from Greek *elasmos*, plate, and *branchos*, gills, in allusion to their plate–like gill septa), the shark–like fishes other than the Holocephali or chimaeras, and including the living non–batoid sharks, batoids, and a host of fossil species. They differ from holocephalans in having 5 to 7 pairs of gill openings open to the exterior and not covered by a soft gill cover, oral teeth separate and not formed as tooth plates, a fixed first dorsal fin with or without a fin spine, and a short spined or spineless second dorsal.

Embryo: An earlier development stage of the young of a live–bearing shark, ranging from nearly microscopic to moderate–sized but not like a miniature adult. See **foetus**.

Enameloid: The shiny hard external coating of the crowns of shark oral teeth, superficially similar to enamel in land vertebrates.

End–style: In the clasper skeleton, the posterior end of the axial cartilage, between the dorsal and ventral terminal cartilages.

Endemic: A species or higher taxonomic group of organisms that is only found in a given area. It can include national endemics found in a river system or along part or all of the coast of a given country, but also regional endemics, found off or in adjacent countries with similar habitat, but not elsewhere.

Epaxial lobe or **web:** In the caudal fin, that part of the caudal fin between the base and dorsal margin, supported by ceratotrichia.

Epaxial web: The entire fin web above the vertebral column and caudal base.

Epipelagic zone: That part of the oceans beyond the continental and insular shelves, in oceanic waters, from the surface to the limits of where most sunlight penetrates, about 200 meters. Also known as the sunlit sea or `blue water'. Most epipelagic sharks are found in the epipelagic zone, but may penetrate the mesopelagic zone.

Epiphysial foramen or **notch:** On the neurocranium, a foramen or notch in the cranial roof at the dorsomedial edge of the anterior fontanelle, that houses the pineal body.

Ethmoid region: That anteriormost sector of the neurocranium including the nasal capsules, internasal plate between them, and the rostrum.

Ethmonuchal muscles: In the orectoloboid family Parascylliidae, paired head muscles that originate on the dorsal myomeres of the nape, and insert via long tendons on the nasal capsules. These are possibly for elevating the snout. Not found in any other sharks, though analogous muscles exist in batoids.

Euselachian: Referring to the Euselachii.

Euselachii: The cohort Euselachii (Greek *Eu*, true, good or original, and *selachos*, shark or cartilaginous fish), the spined or 'phalacanthous' sharks, including the modern sharks or Neoselachii, and fossil shark groups including the hybodonts, the ctenacanths, and the xenacanths, all primitively with anal fins and having two dorsal fins with fin spines.

Excurrent apertures: The posterior and ventrally facing openings of the nostrils, which direct water out of the nasal cavities and which are often partially covered by the anterior nasal flaps. These are usually medial on the nostrils and posteromedial to the incurrent apertures, but may be posterior to the incurrent apertures only.

Exorhipidion: In claspers, a longitudinally elongated, external blade or flap with its base attached to the dorsolateral edge of the clasper glans, and with its free edge directed medially. It is supported by the **ventral terminal 2 cartilage**.

Eye notch: A sharp anterior or posterior indentation in the eyelid, where present cleanly dividing the upper and lower eyelids.

Filter screens: In the whale shark (Rhincodontidae) and devil rays (Mobulidae), transverse bars with lateral dermal lobes on the internal gill openings that form devices for screening out plankton.

Fin skeletons: In unpaired precaudal fins, the basal plates and radials; in the caudal fin, the vertebral column including expanded neural and haemal arches; and in the paired fins, the fin girdles, basals, and radials.

Fin web: The usually thin, compressed part of the fin, distal to the base, that is supported by ceratotrichia alone (in aplesodic fins) or by ceratotrichia surrounding expanded fin radials or by radials only (plesodic fin).

First dorsal constrictor muscles: Paired head muscles that are confluent and functionally part of the levator palatoquadrati muscles in most non–batoid sharks, except in orectoloboids where they are discrete muscles with separate origins and insertions similar to but more lateral than the levators.

First dorsal fin: The anteriormost dorsal fin of two, ranging in position from over the pectoral fin bases to far posterior on the precaudal tail.

Foetus: A later development stage of the unborn young of a live–bearing shark, that essentially resembles a small adult. **Term foetuses** are ready to be born, and generally have oral teeth and denticles erupting, have a colour pattern (often more striking than adults), and, in ovoviviparous sharks, have their yolk sacs reabsorbed.

Foramen magnum: On the neurocranium, the ‘great hole’ or posteromedial aperture through the occiput into the cranial cavity, above the occipital centrum and medial and usually dorsal to the occipital condyles. The spinal cord passes from the brain through the foramen magnum into the neural canal of the vertebral column.

Free rear tips: The pectoral, pelvic, dorsal, and anal fins all have a movable rear corner or flap, the free rear tip, that is separated from the trunk or tail by a notch and an inner margin. In some sharks the rear tips of some fins are very elongated.

Frontal and **parietal fenestrae:** On the neurocranium, medial apertures in the cranial roof between the anterior fontanelle and the parietal fossa, the frontal fenestra being closer to the anterior fontanelle and the parietal fenestra to the parietal fossa. Sometimes the two merge and become a **frontoparietal fenestra**, while in many batoids and in some orectoloboid sharks there is a merging of the anterior fontanelle with the frontoparietal fenestra so that it extends nearly to the parietal fossa. All of these fenestrae are closed by tough membranes.

Functional series: A series of oral teeth that are in functional position on the jaw.

Galeomorph: Referring to the Galeomorphii.

Galeomorphii: The neoselachian superorder Galeomorphii, including the heterodontoid, lamnoid, orectoloboid, and carcharhinoid sharks.

Gill openings or **slits:** In elasmobranchs, the paired rows of five to seven transverse openings on the sides or underside of the head for the discharge of water through the gills. Chimaeras have their four gill openings hidden by a soft gill cover and discharge water through a single external gill opening.

Gill–raker denticles: In the basking shark (Cetorhinidae), elongated denticles with hair–like cusps arranged in rows on the internal gill openings, which filter out planktonic organisms.

Gill–raker papillae: Sparse to dense dermal papillae on the gill arches of some sharks that serve as filters to collect small food organisms.

Girdle: A bar of cartilage buried in the body wall that supports the basals of the paired fins: the pectoral girdle (scapulocoracoid) and pelvic girdle (puboischiadic bar).

Hadal: The benthic zone of the deep trenches, 6000 to about 11000 m, from which no cartilaginous fishes have been observed or recorded to date.

Hadopelagic zone: The pelagic zone inside the deep trenches, 6000 to about 11000 m, from which no chondrichthyans have been observed or recorded.

Haemal arch: The arch ventral to the notochord or vertebral centra on tail vertebrae that is formed by the basiventrals and interventrals and which houses the caudal artery and caudal vein in a **haemal canal**.

Haemal spines: On the haemal arches of the diplospondylous precaudal and caudal vertebrae, elongated ventral surfaces forming vertical plates, particularly well–developed on the caudal fin.

Head: That part of a cartilaginous fish from its snout tip to the last or (in chimaeras) only gill slits.

Heterocercal: A caudal fin with the vertebral axis slanted dorsally into the fin base, which is also dorsally elevated.

Heterodontoid: A bullhead shark, horn shark, or Port Jackson shark, a member of the order Heterodontiformes, family Heterodontidae.

Heterodonty: In oral teeth, structural differences between teeth in various positions on the jaws, between teeth in the same position during different life stages, or between teeth in the same positions in the two sexes.

Hexanchoid: A cowshark or frilled shark, members of the order Hexanchiformes, and including the sixgill sharks, sevengill sharks, and frilled sharks.

Holocephalan: Referring to the Holocephali.

Holocephali: The subclass Holocephali (from Greek *holos*, entire, and *kephalos*, head), the living chimaeras and their numerous fossil relatives, a major subdivision of the class Chondrichthyes. The name is in reference to the fusion of the upper jaws or palatoquadrates to the skull in all living species and in many but not all fossils. The living holocephalans include three families in the order Chimaeriformes. The living species differ from elasmobranchs in having four pairs of gill openings covered by a soft gill cover and with a single pair of external gill openings, oral teeth fused and reduced to three pairs of ever–growing tooth plates, an erectile first dorsal fin with a spine and a long, low spineless second dorsal.

Holotype: Either the only specimen used and mentioned in an original description of a species, with or without a designation of such, or one of two or more specimens used and mentioned in an original description of a species and designated as such. This becomes the 'name–bearer' of the species, and is used to validate the species or scientific name by anchoring it to a single specimen.

Homodonty: In oral teeth, structural similarity between teeth in various positions on the jaws, between teeth in the same position during different life stages, or between teeth in the same positions in the two sexes.

Hyoid arch: The visceral arch that supports the tongue and, in elasmobranchs, the rear of the upper jaws. The hyoid arch is between the mandibular arch and the first branchial arch, and has the spiracular pocket between it and the mandibular arch. The hyoid arch in elasmobranchs includes a medial **basihyoid** in the floor of the mouth and inside the tongue, a pair of elongated **ceratohyals** articulating with the basihyoid and the hyomandibulae, and a pair of **hyomandibulae** articulating with the ceratohyals and the hyomandibular facets of the neurocranium. Chimaeroids have a nonsuspensory hyoid arch similar to the gill arches, with a pair of **epihyals** and **pharyngohyals** equivalent to the hyomandibulae. Batoids have the ceratohyals reduced and separated from the hyomandibulars or absent, and functionally replaced by paired dorsal and ventral **pseudohyoids**.

Hyomandibular facet: On the neurocranium of elasmobranchs, a joint surface, socket or cotyle that is usually on the ventrolateral surfaces of each otic capsule but may be extended posteriorly or arched dorsally. The heads of the hyomandibulae articulate with these facets. Chimaeras lack hyomandibular facets and differentiated hyomandibulae.

Hyomandibular nerve foramina: Foramina for the roots of the hyomandibular nerves, behind the orbital fissures. These foramina are confluent with the orbital fissure in many sharks.

Hypaxial web: The entire fin web below the vertebral column (vertebral axis) and the caudal base.

Hypercalcified structures: Parts of the skeleton that have developed extremely dense calcified cartilage, primarily during growth and maturation, which sometimes swell to knobs that distort and engulf existing cartilaginous structures. The rostrum of the salmon shark (***Lamna ditropis***) is a particularly impressive hypercalcified structure.

Hypocercal: A caudal fin with the vertebral axis slanted ventrally into the fin base, which is also ventrally depressed. Found only in angel sharks (Squatiniformes) among living sharks.

Hypopyle: On the external clasper and clasper skeleton, the posterior opening of the clasper groove onto the clasper glans.

Incurrent apertures: The anterior and ventrally facing openings of the nostrils, which direct water into the nasal cavities. These are usually lateral on the nostrils and anterolateral to the excurrent apertures, but may be anterior to the excurrent apertures only.

Independent dentition: Teeth along a mesodistal series in which the roots do not overlap and are separated by a space. See **overlapping dentition**.

Inner margin: In precaudal fins including the pectoral, pelvic, dorsal and anal fins, the margin from the fin insertion to the rear tip.

Insertion: The posterior or rear end of the fin base in precaudal fins. The caudal fin lacks insertions except with many batoids and some chimaeroids that have a caudal filament that extends posterior to the fin. See **origin**.

Interdorsal cartilages: A pair of wedge–shaped arched thin cartilages fitting between the basidorsal cartilages of each vertebra to complete the neural arch.

Interdorsal ridge: A ridge of skin on the midback of sharks, in a line between the first and second dorsal fins; particularly important in identifying grey sharks (genus ***Carcharhinus***, family Carcharhinidae).

Intermedialia: In a vertebral centrum, dorsal, ventral and lateral spaces between the attachment surfaces of the basidorsal and basiventral cartilages and between the two halves of the double cone. These can be filled with uncalcified cartilage, with solid or hollow wedges of calcified cartilage, or with plate–like, branched calcified radii within uncalcified cartilage. See **basalia**.

Intermediate segments: In the clasper skeleton, one or more short cylindrical cartilages connecting the pelvic basipterygium to the axial cartilage of the clasper. Also termed **stem–joints**.

Intermediate teeth: Small oral teeth between the laterals and anteriors of the upper jaw, found in most lamnoids.

Internasal plate or **septum:** On the neurocranium, a plate or partition between the two nasal capsules. It ranges from a vertical plate to a broad horizontal plate.

Interventral cartilages: A pair of rounded or wedge–shaped cartilages fitting between the basiventral cartilages of each vertebra, that in diplospondylous precaudal and caudal vertebrae form the haemal arches with the basiventral cartilages.

Intestinal valve: A dermal flap inside the intestine, protruding into its cavity or lumen, and of various forms in different cartilaginous fishes. Often formed like a corkscrew or augur. See **spiral**, **ring** and **scroll valves**.

Jaws: See **mandibular arch**.

Labial cartilages: Paired cartilages that are internal and support the labial folds at the lateral angles of the mouth. Living neoselachians typically have two pairs of upper labial cartilages, the **anterodorsal** and **posterodorsal** labial cartilages, and one pair of **ventral labial cartilages**, but these are variably reduced and sometimes absent in many sharks. Chimaeras have more elaborate labial cartilages than living elasmobranchs.

Labial flange: On tooth crowns of many squaloids and some orectoloboids, a narrow, vertically elongated labial basal ledge.

Labial folds: Lobes of skin at the lateral angles of the mouth, usually with labial cartilages inside them, separated from the sides of the jaws by pockets of skin (labial grooves or furrows).

Labial furrows or **labial grooves:** Grooves around the mouth angles on the outer surface of the jaws of many cartilaginous fishes, isolating the labial folds. Primitively there is a distinct **upper labial furrow** above the mouth corner and a **lower labial furrow** below it.

Labial: In oral teeth, the outer face of the tooth that is directed outside the mouth and towards the lips. See **lingual**.

Lamnoid: A mackerel shark, a member of the order Lamniformes, and including the sand tiger sharks, goblin sharks, crocodile sharks, megamouth shark, thresher sharks, basking shark, and the makos, porbeagle, salmon shark and white shark.

Lateral clasper fold: In mackerel sharks (family Lamnidae), a unique longitudinal flap of skin along the lateral edge of the external clasper shaft.

Lateral commissures: On the neurocranium, tube–like or ring–like enclosed passages for the lateral head veins, which drain the orbital sinuses, through the postorbital walls of the orbits and below the sphenopterotic ridges and above the hyomandibular facets in neoselachians. The lateral commissures are reduced or absent in many living neoselachians.

Lateral or **laterad:** Outwards, in the transverse direction towards the periphery of the body. See **medial**.

Lateral orolabial grooves: Shallow longitudinal grooves on the lower jaw that connect the edge of the lip on each side with the medial ends of the lower labial furrows. Found in more advanced orectoloboids.

Lateral teeth: Large broad–rooted, compressed, high crowned oral teeth on the sides of the jaws between the anteriors and posteriors.

Lateral trunk denticle: A dermal denticle from the dorsolateral surface of the back below the first dorsal fin base.

Lectotype: One of two or more specimens that were syntypes in an original description, designated as a lectotype by a subsequent writer. It then becomes equivalent to a holotype, and anchors the name of the species to a specimen unless invalidated by a ruling of the International Commission on Zoological Nomenclature or a previous designation of a lectotype.

Levator palatoquadrati muscles: Paired head muscles that primitively originate on the underside of the postorbital processes and sphenopterotic ridges, extend vertically, and insert on the posteromedial surfaces of the quadrate processes of the palatoquadrates. In advanced carcharhinoids the origins of the levator palatoquadrati muscles are expanded far forwards and diagonally into the orbits. Primitively these muscles lift or retract the jaws upwards, but in advanced carcharhinoids may help rotate the jaws forwards and downwards in opposition to the levator hyomandibularis muscles, which retract the jaws.

Lingual: In oral teeth, the inner face of the tooth that is directed inside the mouth and towards the tongue. See **labial**.

Littoral zone: That part of the oceans over the continental and insular shelves, from the intertidal to 200 m.

Live–bearing: A mode of reproduction in which female sharks give birth to young sharks, which are miniatures of the adults. See **viviparity**.

Longitudinal ridges: In lateral trunk denticles, parallel ridges that extend anteroposteriorly on the distal surface of the crown. These may be in the form of a single **medial ridge** (sometimes paired), and paired **lateral ridges**, and may terminate in medial and lateral cusps.

Lower eyelid: The ventral half of the eyelid, separated by a deep pocket (conjunctival fornix) from the eyeball. In some derived batoids the pocket also fuses with the eyeball.

Lower origin: In the caudal fin, the anteroventral beginning of the hypaxial or lower web of the caudal fin, at the posterior end of the anal–caudal or pelvic–caudal space (see measurement illustrations).

Lower postventral margin: In the caudal fin, the lower part of the postventral margin of the hypaxial web, from the ventral tip to the posterior notch.

Mandibular arch: The paired primary jaw cartilages of sharks, including the dorsal palatoquadrates and the ventral Meckel's cartilages.

Mandibulocutaneous muscles: Paired head muscles in squaloid and hexanchoid sharks, that originate on the inside of the skin of the head behind the eyes and near the spiracles, and insert on the dorsoposterolateral face of the quadrate processes of the palatoquadrates.

Meckel's cartilages: The paired lower jaw cartilages, articulating mesially with each other at the midline or symphysis of the lower jaw, and articulating laterally with the distal ends of the palatoquadrates. The Meckel's cartilages are fused together at the symphysis in some shark–like fishes or are articulated to a symphysial cartilage in others.

Medial teeth: Small oral teeth, generally symmetrical and with narrow roots, in one row at the symphysis and often in additional paired rows on either side of the symphysial one.

Medial: Inwards, in the transverse direction towards the middle of the body. See **lateral**.

Mesial: In oral teeth, mesial structures are towards the midlines of the jaws, the symphyses. See **distal**.

Mesopelagic zone: That part of the oceans beyond the continental and insular shelves, in oceanic waters, from about 200 to 1000 m, the twilight zone where little light penetrates.

Mesopterygium: In the pectoral fin skeleton of living neoselachians, the middle basal cartilage, between the propterygium and metapterygium. The mesopterygium is sometimes fused to the propterygium or metapterygium, or to both.

Mesorhipidion: A knife–like or blade–like structure on the lateral clasper glans of some carcharhinoid sharks, formed from the terminal 3 cartilage, and over and partially lateral to the ventral terminal and mesial to the pseudopera.

Metapterygial axis: In the pectoral fin skeleton of living neoselachians, the posterior extension of the mesopterygium as a flattened, elongated segmented series of cartilages that supports the distal bases and free rear tips of the pectoral fins; the axis has radials along its distal edge continuous with the radials on the metapterygial basal.

Metapterygial basal: In the pectoral fin skeleton of living neoselachians, the anteriormost, expanded cartilage of the metapterygium.

Metapterygial proximal segment: In the hexanchoid pectoral fin skeleton, a short jointed segment on the proximal end of the metapterygial basal, not found in other sharks.

Metapterygium: In the pectoral fin skeleton of living neoselachians, the rearmost basal cartilage, adjacent to the posterior edge of the mesopterygium and with several radials attached to its distal edge. It includes the **metapterygial basal** and the **metapterygial axis**.

Molariform: In oral teeth, referring to a tooth with a broad flat crown with low cusps or none, for crushing hard–shelled invertebrate prey.

Monospondylous precaudal vertebrae: Vertebrae with one centrum and one pair of basidorsals, basiventrals, and ribs per body segment (myotome), and generally extending from the occiput to the end of the body cavity and to over the pelvic girdle. However there is much variation in the position of the monospondylous–diplospondylous transition, which can range well in front or behind the pelvic girdle.

Monospondylous–diplospondylous transition: The position on the vertebral column where monospondylous centra end and diplospondylous centra begin. In lateral view the transition often appears as an abrupt decrease in length of the diplospondylous centrum compared to the last monospondylous centrum, but this can be obscure in various sharks with very numerous, very short centra. Often a centrum of intermediate length appears between a long monospondylous centrum and a short diplospondylous centrum. In a few sharks there is a **stutter zone** of alternating long and short centra that marks the transition. Also, the basidorsals and basiventrals have foramina for the spinal nerves on every other vertebra, rather than on each vertebra as in monospondylous vertebrae. The transition from long to short centra is generally coordinated with the transition of vertebrae with free ribs and no haemal arches to those without ribs and with haemal arches. However, in some sharks the two transitions can be anterior or posterior to each other.

Multiple oviparity: A mode of egg–laying or oviparity in which female sharks retain several pairs of cased eggs in the oviducts, in which embryos grow to advanced developmental stages. When deposited on the bottom (in captivity) the eggs may take less than a month to hatch. Found only in the scyliorhinid genus ***Halaelurus***, with some uncertainty as to whether the eggs are normally retained in the oviducts until hatching. Eggs laid by these sharks may be abnormal, unusual, or an alternate to ovoviviparity. The whale shark (***Rhincodon typus***) may have multiple retention of egg cases; near–term foetuses have been found in their uteri and egg–cases with developing foetuses have been collected on the bottom.

Nasal aperture: On the neurocranium, an aperture in the anteroventral surface or floor of each nasal capsule, through which the nostril directs water into and out of the nasal organ.

Nasal capsules: On the neurocranium, a pair of spherical, oval or trumpet–shaped, thin–walled structures behind the rostrum (when present) and in front of the orbits, cranial roof and basal plate. They serve as containers for the nasal organs or organs of smell, and have passages into the cranial cavity to connect the nasal organs with the brain.

Nasal curtain: Anterior nasal flaps that are expanded medially and posteriorly and have fused with each other. Nasal curtains are found in some carcharhinoid sharks and in many batoids.

Nasal flap: One of a set of dermal flaps associated with the nostrils, and serving to direct water into and out of them, including the anterior, posterior, and mesonarial flaps.

Nasal fontanelle: On the neurocranium, an aperture in the posteroventral surface or floor of each nasal capsule, behind the nasal apertures and closed by a dermal membrane.

Nasoral grooves: Many bottom–dwelling, relatively inactive sharks have nasoral grooves, shallow or deep grooves on the ventral surface of the snout between the excurrent apertures and the mouth. The nasoral grooves are covered by expanded anterior nasal flaps that reach the mouth, and form water channels that allow the respiratory current to pull water by partial pressure into and out of the nostrils and into the mouth. This allows the shark to actively irrigate its nasal cavities while sitting still or when slowly moving. Nasoral grooves occur in heterodontoids, orectoloboids, chimaeroids, some carcharhinoids, and most batoids. Also termed **oronasal grooves**.

Neck: A narrow band of finely porous dull tissue (possibly orthodentine) encircling the proximal end of the crown of a tooth, and apparently covered with dental membrane.

Neoselachian: Referring to the Neoselachii.

Neoselachii: From Greek *neos*, new, and *selachos*, shark. The modern sharks, the subcohort Neoselachii, consisting of the living elasmobranchs and their immediate fossil relatives. See **Euselachii**.

Neotype: A specimen, not part of the original type series for a species, which is designated by a subsequent author, particularly if the holotype or other types have been destroyed, were never designated in the original description, or are presently useless.

Neural arch: In shark vertebrae, a dorsal arch formed by basidorsal and interdorsal cartilages above the centrum and forming a neural canal containing the spinal cord.

Neural spines: On the neural arches of shark vertebrae, elevated dorsal plate–like surfaces, particularly well–developed in many squalomorph sharks.

Neurocranium: In sharks, a box–shaped complex cartilaginous structure at the anterior end of the vertebral column, containing the brain, housing and supporting the nasal organs, eyes, ears, and other sense organs, and supporting the visceral arches or splanchnocranium. Also termed **chondrocranium**, **chondroneurocranium**, or **endocranium**.

Nictitating lower eyelid: In the ground sharks (order Carcharhiniformes), a movable lower eyelid that has special posterior eyelid muscles that lift it and, in some species, completely close the eye opening (or palpebral aperture). Often incorrectly termed **nictitating membrane**, a different, nonhomologous structure in terrestrial vertebrates.

Nictitating upper eyelid: In parascylliid orectoloboids, the upper eyelid has anterior eyelid muscles that pull it down and close the eye opening, analogous to the nictitating lower eyelids of carcharhinoids.

Nomenclature: In biology, the application of distinctive names to groups of organisms.

Nostrils: The external openings of the cavities of the nasal organs, or organs of smell.

Notochord: In embryonic sharks (and other chordates) the notochord is a fluid–filled tube below the spinal cord that has a connective–tissue notochordal sheath surrounding it. The notochord forms the primitive developmental base of the chondrichthyan vertebral column. Chimaeroids retain the notochord and its sheath without constriction (although some have ring–like centra in the sheath), but in neoselachians it is constricted by the development of double–cone calcifications of the centra within the sheath into biconical chambers between each centrum. The addition of centra to the notochordal sheath strengthens the vertebral column. Some deepwater squaloid, hexanchoid, and lamnoid sharks have the sheath constriction and calcified double cones variably reduced, sometimes to connective tissue septa only. Some of these taxa with a 'notochordal' vertebral column have been considered primitive but are apparently derived from ancestors with well–calcified, constricted vertebral centra.

Occipital centrum: On the occiput of the neurocranium, the posterior half of a calcified double cone of the vertebral column, imbedded in the basal plate and articulating with the anteriormost centrum of the vertebral column. Also termed **occipital hemicentrum**.

Occiput: The posteriormost sector of the neurocranium, behind and partially between the otic capsules, with its dorsal surface from the parietal fossa rearwards to the foramen magnum, and its posterior surface including the occipital condyles, the occipital centrum, the paired vagus nerve foramina, the paired glossopharyngial nerve foramina, and the rear surface of the hyomandibular facets.

Oceanic: Referring to organisms inhabiting those parts of the oceans beyond the continental and insular shelves, over the continental slopes, ocean floor, sea mounts and abyssal trenches. The open ocean.

Ocelli or **eyespots:** Large eye–like pigment spots located on the dorsal surface of the pectoral fins or bodies of some sharks including rays, angel sharks, and some bamboo sharks, possibly serving to frighten potential enemies.

Oophagy: From Greek *oön*, egg, and *phagos*, to eat. Egg–eating, a mode of live–bearing reproduction employing uterine cannibalism; early foetuses deplete their yolk sacs early and subsist by eating nutritive eggs produced by the mother. Known in several lamnoid sharks, the carcharhinoid family Pseudotriakidae, and in the orectoloboid family Ginglymostomatidae (***Nebrius ferrugineus***).

Optic nerve foramen: A large foramen usually in the middle of the orbital wall, passing the optic nerve from the brain to the eye.

Optic pedicel: On the neurocranium, a slender cartilage that projects from the medial orbital wall and articulates with the eyeball; it serves as a pivot point for the eyeball and a spacer between the eyeball and the orbital wall.

Orbital fissures: The main foramina or fenestrae that pass the trigeminal and facial nerves from the brain to the orbits, located on the posteroventral ends of the medial walls of the orbits.

Orbital notches: On the neurocranium, the paired anterior notches in the suborbital shelves that articulate with the orbital processes of the palatoquadrates. In many squalomorph sharks these are enlarged, deepened, socket–like, and posteriorly situated in the orbits, with telescoping of the suborbital shelves, and are lost in batoids.

Orbits: Large, paired cavities on the sides of the neurocranium, behind the nasal capsules, mostly in front of the otic capsules, and separated medially by the cranial cavity. They are bounded anteriorly by the preorbital walls and processes, dorsally by the supraorbital crests, ventrally by the suborbital shelves (reduced or lost in various squalomorph sharks), and posteriorly by the postorbital processes and walls. The orbits contain the eyeballs and their muscles, venous sinuses, several arteries that connect to the cranial cavity, and most of the cranial nerves.

Orectoloboid: A carpet shark, a member of the order Orectolobiformes, including barbelthroat carpet sharks, blind sharks, wobbegong sharks, bamboo sharks, epaulette sharks, nurse sharks, zebra sharks, and whale sharks.

Origin: The anterior or front end of the fin base in all fins. The caudal fin has **upper** and **lower** origins but no insertion. See **insertion**.

Orthodentine: A primary hard tissue comprising the crown of oral teeth in sharks, with numerous fine mostly parallel nonvascular tubules.

Orthodont: An oral tooth with its crown filled with orthodentine, and with a prominent central pulp cavity.

Osteodentine: A primary hard tissue comprising the roots and sometimes the inside of the crown in the oral tooth, with bone–like large reticulating, thick–walled tubules.

Osteodont: An oral tooth with its crown filled with osteodentine, continuous with the root, and without a pulp cavity.

Otic capsules: On the neurocranium, a pair of complex thick–walled capsules containing the inner ears, and located between the orbits and the occiput, and partially separated medially by the cranial cavity.

Overlapping dentition: Teeth along a mesodistal series in which the roots overlap and are not separated by a space. Two types of overlap patterns occur, **alternate overlap**, in which teeth in a series alternate from more labial to more lingual, and **imbricate overlap**, in which the distal end of each tooth lingually or labially overlaps the mesial end of the succeeding tooth, repeating to the distal ends of the dental band. **Alternate–imbricate dentitions** combine both alternate and imbricate overlap. See **independent dentition**.

Oviparity: A mode of reproduction in which female sharks deposit eggs enclosed in oblong or conical egg–cases on the bottom, which hatch in less than a month to more than a year, producing young sharks which are miniatures of the adults.

Ovoviviparity: Generally equivalent to **yolk–sac viviparity**, live–bearing in which the young are nourished primarily by the yolk in the yolk sac, which is gradually depleted and the yolk sac reabsorbed until the young are ready to be born. Sometimes used to cover all forms of **aplacental viviparity**, including **cannibal viviparity**.

Paired fins: The pectoral and pelvic fins.

Palatoquadrates: The paired upper jaw cartilages, articulating mesially with each other at the midline or symphysis of the upper jaw, and articulating laterally with the distal ends of the Meckel's cartilages. The palatoquadrates are fused to the neurocranium in all living holocephalans. The palatoquadrates of neoselachians are divided into cylindrical anteromedial sectors or **palatine processes**, which articulate or are otherwise attached to each other at the symphysis; variably modified conical to flattened articular structures or **orbital processes** on the middle of the palatoquadrates for attachment to the neurocranium at the orbital notches; and often elevated posterodistal **quadrate processes** that articulate with the distal ends of the Meckel's cartilages and are loosely or firmly attached to the distal ends of the hyomandibulae. In a few living neoselachians, and many fossil elasmobranchs, the quadrate processes have **postorbital articulations** with the rear surfaces of the postorbital processes of the neurocranium.

Palpebral aperture: The eye opening, defined by the upper and lower eyelids.

Papillae: Elongated finger–like processes of skin, located around the spiracles of torpedo rays, and in the mouths and on the gill arches of other sharks.

Papillose gill rakers: See **gill raker papillae**.

Paralectotype: One of two or more specimens that were syntypes in an original description, but which became a paralectotype or paralectotypes when a subsequent author designated one of the syntypes as a lectotype. Paralectotypes are equivalent to paratypes.

Paratype: Each specimen of a type series other than the holotype. Specimens other than the holotype automatically become paratypes unless the author designates them as referred specimens that are not part of the type series.

Parietal fossa: On the neurocranium, a shallow or deep depression between the otic capsules and at the rear of the cranial roof, that houses foramina for paired ducts leading to the inner ears and for the spaces around them.

Pectoral fins: A symmetrical pair of fins on each side of the trunk just behind the head and in front of the abdomen. These are present in all cartilaginous fishes and correspond to the forelimbs of a land vertebrate (a tetrapod or four–footed vertebrate).

Pectoral or **shoulder girdle:** See **scapulocoracoid**.

Pedicel: In lateral trunk denticles, a narrow stalk separating the crown from the base.

Pelagic: Referring to organisms that are free–swimming, not bottom–dwelling.

Pelvic fin: Asymmetrical pair of fins on the sides of the body between the abdomen and precaudal tail which correspond to the hindlimbs of land vertebrate (a tetrapod or four–footed vertebrate). Also, **ventral fins**.

Pelvic girdle: See **puboischiadic bar**.

Photophores: Conspicuously pigmented small spots on the bodies of most lantern sharks (family Etmopteridae) and some kitefin sharks (family Dalatiidae). These are tiny round organs that are covered with a conspicuous dark pigment (melanin) and produce light by a low–temperature chemical reaction.

Placenta: See **yolk–sac placenta**.

Placental viviparity: Live–bearing in which the young develop a yolk–sac placenta, which is apparently confined to the carcharhinoid sharks.

Placoid scale: See **dermal denticle**.

Plesodic fin: A pectoral, pelvic, dorsal, or anal fin in which the radial cartilages of the fin skeleton extend far into the distal fin web, often near its edges, and between the supporting ceratotrichia of the fin web. Some fossil sharks also have plesodic caudal fins, in which the expanded haemal arches of the caudal vertebrae extend far into the fin web. In more advanced batoids the radials of the plesodic paired fins become highly branched and segmented, very narrow and slender, and essentially replace the ceratotrichia as supports for the fin webs.

Pores, pigmented: In a few sharks and skates, the pores for the lateral line and ampullae of Lorenzini are conspicuously black–pigmented, and look like little black specks.

Posterior: Rearwards, in the longitudinal direction of the caudal–fin tip or tail filament. Also **caudal**.

Posterior margin: In precaudal fins, the margin from the fin apex to either the free rear tip (in sharks with distinct inner margins) or the fin insertion (for those without inner margins).

Posterior nasal flaps: Low flaps or ridges arising on the posterior edges of the excurrent apertures of the nostrils.

Posterior notch: In the caudal fin, the notch in the postventral margin dividing it into upper and lower parts.

Posterior teeth: Small or sometimes enlarged irregular oral teeth near and at the distal ends of the dental bands, with low crowns and sometimes missing cusps.

Posterior tip: The posteriormost corner or end of the terminal lobe of the caudal fin.

Postocular eyelid muscles: A complex of paired head muscles unique to carcharhinoid sharks that originate around the spiracles and insert on the posterior ends of the upper eyelids and nictitating lower eyelids. Primitively they depress the upper eyelid and elevate the nictitating lower eyelid to close the eye, but in more derived carcharhinoids the eye is closed only by elevation of the nictitating lower eyelid.

Postorbital processes: On the neurocranium, posterolateral projections of the supraorbital crests, below which the postorbital walls originate.

Postorbital walls: On the neurocranium, the posterior boundaries of the orbits, variously reduced vertical plates of cartilage that close the orbits between the postorbital processes and the suborbital shelves, more or less reduced in living neoselachians.

Postventral margin: In the caudal fin, the margin from the ventral tip to the subterminal notch of the caudal fin. See **lower** and **upper** postventral margins.

Preanal ridges: A pair of low, short to long, narrow ridges on the midline of the caudal peduncle extending anteriorly from the anal fin base.

Precaudal fins: All fins in front of the caudal fin.

Precaudal pit: A depression at the upper and sometimes lower origin of the caudal fin where it joins the caudal peduncle.

Precaudal tail: That part of the tail from its base at the vent to the origins of the caudal fin.

Precaudal vertebrae: Vertebrae from the occiput to the dorsal origin of the caudal fin.

Predorsal ridge: A low narrow ridge of skin on the midline of the back anterior to the first dorsal fin base.

Preorbital canals: On the neurocranium, anterior passages for the superficial opthalmic nerves out of the orbits and onto the nasal capsules and rostrum, situated at the anteromesial edges of the supraorbital crests at the rear bases of the preorbital processes; sometimes greatly expanded posteriorly.

Preorbital processes: On the neurocranium, anterolateral projections of the supraorbital crests, below which the preorbital walls originate.

Preorbital walls: On the neurocranium, the anterior boundaries of the orbits, curved vertical plates of cartilage that vary from complete to absent in neoselachians.

Preorbitalis muscles: Paired head muscles that primitively originate on the rear of the nasal capsules or on the preorbital walls, run diagonally rearwards, and insert on the adductor mandibulae at the mouth angles. Orectoloboids and heterodontoids have the preorbitalis vertical, with cross–biased fibres in the latter, and the insertions are along the ventral edge of Meckel's cartilage. In derived orectoloboids the origins of the preorbitalis are expanded onto the cranial roof and the muscles greatly expanded. Primitively the preorbitalis may primarily serve to protrude the jaws, but they may primarily serve to increase the power of the bite in orectoloboids and heterodontoids. Also termed **levator labii superioris muscles**.

Preventral margin: In the caudal fin, the margin from the lower origin to the ventral tip of the caudal fin.

Pristiophoroid: A saw shark, order Pristiophoriformes, family Pristiophoridae.

Propterygium: In the pectoral fin skeleton of living neoselachians, the anteriormost basal cartilage, adjacent to the anterior edge of the mesopterygium and with one or more radials attached to its distal end. In batoids with expanded anterior pectoral fin lobes it becomes expanded and segmented into a **propterygial basal** and **propterygial axis**, similar to the metapterygial basal and axis.

Proximal: In any direction, at the near end of a structure.

Pseudopera: On the external clasper glans, a dorsally opening blind pocket along the lateral edge of the clasper, and about opposite the anterior edge of the glans.

Pseudosiphon: On the external clasper glans, a dorsally opening blind pocket along the medial edge of the clasper, and about opposite the cover rhipidion.

Pterotic horn or **process:** On the neurocranium, elongated posterior projections of the sphenopterotic ridges of the otic capsules.

Puboischiadic bar: A transverse flattened or cylindrical plate in the posterior body wall opposite the anterior ends of the pelvic fins, in front of the vent and at the posterior end of the body cavity, that supports a few anterior pelvic radials and a basal cartilage, the basipterygium. The **pelvic girdle**.

Radial cartilages or **radials:** The small, segmented, more distal cartilages of the precaudal fins, attached proximally to the distal edges of the basal cartilages. In the pectoral fin skeleton of living neoselachians, the radials mostly have three segments but range from no segments to 30 or more. The radial segments adjacent to the pectoral basals are the **proximal radials**, the radial segments furthest from the basals are the **distal radials**, and any segments between them are **intermediate radials**.

Radii: In a vertebral centrum in cross–section, branching plates of calcified cartilage in the intermedialia. These have a radial orientation from the centre of the centrum.

Ray: See **batoid**.

Replacement series: A series of oral teeth that are lingual to the functional series, and not in a functional position on the jaw.

Rhipidion: In non–batoid sharks, a longitudinal, elongated flap attached to the floor of the glans along its base and with its free edge directed laterally. In skates (Rajoidei) rhipidion is used for a soft mass of erectile tissue in the glans, not necessarily homologous to the rhipidion of non–batoid sharks.

Rhomboidal: In the form of a rhombus or diamond.

Ribs: On the shark vertebral column, short to elongated paired and typically pointed cartilages attached to the basiventral cartilages and extending into the horizontal septum of the segmented trunk musculature or myomeres. Chondrichthyan ribs are therefore dorsal ribs rather than ventral ribs as in bony fishes (which support the body cavity).

Ring valve: A type of spiral intestinal valve in which the valve turns are very numerous and short and resemble a stack of washers.

Rise: The transitional and less steep bottom zone from the lower slope to the abyss or ocean floor, between 2250 m and 4500 m. The rise can be divided into upper (2250 to 3000 m), middle (3000 to 3750 m) and lower (3750 to 4500 m) rises. Few sharks are known from the rise, and those mostly from the upper rise. See **Abyss**, **Hadal**, **Shelf** and **Slope**.

Root lobe: Sharks often have the roots of their oral teeth divided into separate lobes at their midlengths, which are termed **mesial** and **distal root lobes**.

Root: The proximal part of the oral tooth, made of porous osteodentine and anchoring the tooth in the dental membrane of the jaw.

Rostral keel: In the neurocranium of squaloids, a large vertical plate on the underside of the rostrum and internasal septum, sometimes reduced, and with the cavities of the subnasal fenestrae on either side of the keel.

Rostral node: On the neurocranium, the anterior end of the rostrum of cartilaginous fishes, and the plate formed by the fused anterior ends of the tripodal rostra in many galeomorph sharks.

Rostromandibular muscle: In the orectoloboid family Parascylliidae, paired head muscles that originate on the sides of the adductor mandibulae muscles and insert via long tendons on the medial rostral cartilage. These are possibly for depressing the snout. Not found in any other sharks, though analogous muscles exist in batoids.

Rostronuchal muscles: In the orectoloboid family Parascylliidae, paired head muscles that originate on the dorsal myomeres of the nape, and insert via long tendons on the medial rostral cartilage. These are possibly for elevating the snout. Not found in any other sharks, though analogous muscles exist in batoids.

Rostrum: On the neurocranium, the cartilaginous anteriormost structure which supports the prenasal snout including lateral line canals and masses of ampullae, and is located in front of the nasal capsules and anterior fontanelle. The rostrum is very variable, and in squalomorph sharks is primitively trough or basin–shaped, while it may be primitively rod–shaped or tripodal in galeomorph sharks. It is absent in a few non–batoid sharks and in many batoids. See **rostrum**, **tripodal**.

Rostrum, tripodal: The rostrum of the neurocranium in lamnoids and carcharhinoids is primitively tripodal, with a pair of dorsolateral **lateral rostral cartilages** that arise from the posterolaterodorsal surfaces of the nasal capsules or from the preorbital wall, and a **medial rostral cartilage** that arises from the anteromedial surface of the internasal septum. The medial and lateral rostral cartilages extend anteriorly and articulate or fuse at the rostral node. Living orectoloboids have only the medial rostral cartilage although a tripodal rostrum may be present in some fossil orectoloboids, while heterodontoid sharks lack a rostrum as adults but apparently lose it as embryos.

Row: In oral teeth, a single replicating line of teeth, approximately transverse to the longitudinal jaw axis, which includes functional teeth and their replacements, derived from one tooth–producing area on the jaw.

Saw or **saw–snout:** The elongated snout in sawfish and sawsharks, with side and (in sawsharks) ventral teeth formed from enlarged denticles, used to kill, ensnare or dig for prey. Also termed rostral saw.

Scapulocoracoid: The primitively U–shaped cartilage in the body wall just behind the gills and at the anterior end of the pectoral bases, that supports the pectoral fins and articulates with the pectoral basals. The scapulocoracoid consists of a ventral **coracoid bar** connecting its paired **lateral faces** with articular condyles or ridges for the pectoral basals, and a pair of dorsal **scapular processes** dorsal to the lateral faces. The scapular processes sometimes have separate **suprascapulae** above them, but they are sometimes fused with the scapular processes. The coracoid bar has a medial joint or even a separate medial cartilage (sternal cartilage) in a few living sharks, as with many fossil cartilaginous fishes. The **pectoral** or **shoulder girdle**.

Scroll valve: A type of spiral intestinal valve in requiem and hammerhead sharks in which the valve has uncoiled and resembles a rolled–up bib or scroll.

Second dorsal fin: The posteriormost dorsal fin of two in cartilaginous fishes, ranging in position from over the pelvic–fin bases to far posterior on the precaudal tail.

Secondary caudal keels: Low horizontal dermal keels on the ventral base of the caudal fin in mackerel sharks (Lamnidae) and sometimes somniosids.

Secondary lower eyelid: The eyelid below or lateral to the nictitating lower eyelid, separated from it by a subocular groove or pocket, and, in many carcharhinoids with internal nictitating lower eyelids, functionally replacing them as lower eyelids. Some orectoloboids have shallow subocular grooves separating their non–nictitating lower eyelids from weakly developed secondary lower eyelids. They may, however, be able to close their eye openings by retracting the eyeballs.

Semiplesodic fin: In some sharks, a pectoral or dorsal fin with the fin radial cartilages extending partway into the fin web but not to its distal edges, essentially intermediate between plesodic and aplesodic fins.

Series: In oral teeth, a line of teeth along the jaws which is parallel to the jaw axis and includes teeth from all rows present.

Serrations: In oral teeth, minute teeth formed by the cutting edge of the crown that enhance the slicing abilities of the teeth.

Shark: Generally used for cylindrical or flattened cartilaginous fishes with 5 to 7 external gill openings on the sides of their heads, pectoral fins that are not attached to the head above the gill openings, and a large, stout tail with a large caudal fin; that is, all living elasmobranchs except the rays or batoids. Living sharks in this sense are all members of the Neoselachii, the modern sharks and rays. Shark is also used loosely for fossil chondrichthyans that are not neoselachians but have a shark–like form, and even for ‘spiny sharks’ (acanthodians) and for certain teleosts. Rays are essentially flattened sharks with the pectoral fins attached to their heads and are cladistically nested within the squalomorph sharks, while living chimaeras are the immediate sister group of living neoselachians and are called ghost sharks or silver sharks. Hence shark is used here in an alternate and broader sense to include the rays and chimaeras.

Shelf, continental and insular: The sloping plateau–like area along the continents and islands between the shoreline and approximately 200 m depth. It is roughly divided into inshore (intertidal to 100 m), and offshore (100 to 200 m) zones. The shelves have the greatest diversity of cartilaginous fishes. See **Abyss**, **Rise** and **Slope**.

Shoulder: In oral teeth, an arcuate or straight, convex–edged section of the crown foot, without cusplets and similar to a blade but without a cutting edge.

Single oviparity: A mode of egg–laying or oviparity in which female sharks produce encased eggs in pairs, which are not retained in the oviducts and are deposited on the bottom. Embryos in the egg–cases are at an early developmental stage, and take a few months to over a year to hatch. Found in almost all oviparous cartilaginous fishes.

Siphons: A pair of dermal sacs in the ventral abdominal wall of male sharks, connecting posteriorly with the apopyles of the claspers, and extending anteriorly a variable distance from about opposite the pelvic–fin origins to opposite the pectoral–fin bases.

Skull or **cranium:** The skull or head skeleton of sharks includes the **neurocranium** and the **splanchnocranium** or visceral arches. The visceral arches articulate with and are associated with the neurocranium, but, except for the upper jaws of many holocephalans, are not fused to it. Also termed **syncranium**.

Slope, continental and insular: The precipitous bottom zone from the edge of the outer shelf down to the submarine rise, between 200 m to 2250 m. The slope can be divided into upper (200 to 750 m), middle (750 to 1500 m) and lower (1500 to 2250 m) slopes, of which the upper and middle slope has the highest diversity of deepwater benthic sharks. See **Abyss**, **Rise** and **Shelf**.

Snout: That part of a cartilaginous fish in front of its eyes and mouth, and including the nostrils.

Sphenopterotic ridge: On the neurocranium, a horizontal ridge along the dorsolateral edge of each otic capsule that either ends at the occiput or terminates in an expanded pterotic process.

Spiracle: A small to large opening between the eye and first gill opening of most sharks and rays, representing the modified gill opening between the jaws and hyoid (tongue) arch. This is secondarily lost in chimaeras and some sharks.

Spiral or **conicospiral valve:** An intestinal valve shaped like a corkscrew or augur, with the valve angled anteriorly and medially in the intestine.

Splanchnocranium: That part of the shark skull including the visceral arches. These include the jaws or mandibular arch, the tongue or hyoid arch, and the five to seven gill or branchial arches. Also, **viscerocranium**.

Squalene: Along–chain oily hydrocarbon present in the liver oil of deepwater cartilaginous fishes. It is highly valued for industrial and medicinal use.

Squaloid: A dogfish shark, a member of the order Squaliformes, including bramble sharks, picked dogfish, gulper sharks, lantern sharks, viper sharks, rough sharks, sleeper sharks, kitefin sharks, and cookiecutter sharks.

Squalomorph: Referring to the Squalomorphii.

Squalomorphii: The neoselachian superorder Squalomorphii, including the hexanchoid, squaloid, squatinoid,and pristiophoroid sharks.

Squatinoid: An angel shark, order Squatiniformes, family Squatinidae.

Squatinoid caudal fin: Angel sharks (Squatiniformes) are unique among living sharks in having hypocercal caudal fins that resemble inverted caudal fins of ordinary sharks. The dorsal margin is subdivided into a **predorsal** margin from the upper origin to its **dorsal tip** (analogous to the preventral margin and ventral tips in ordinary sharks), a **postdorsal** margin (like the postventral margin) from the dorsal tip to its supraterminal notch (similar to the subterminal notch), and a short **supraterminal margin** and large **ventral terminal margin** (similar to the subterminal and terminal margins) between the supraterminal notch and the ventral tip of the caudal. The ventral margin has a preventral margin forming a ventral lobe with the ventral tip and the ventral terminal margin.

Stapedial foramen or **fenestra:** On the neurocranium, a foramen through the posteroventromedial surface of each suborbital shelf into the orbit, for the stapedial or orbital arteries. It may be greatly expanded into a stapedial fenestra in sharks with greatly coiled stapedial arteries or lost in sharks with the suborbital shelves greatly reduced or absent.

Stapediocarotid foramen: On the neurocranium of certain sharks, fusion of the stapedial and carotid foramina on either side produces a single pair of stapediocarotid foramina.

Subcaudal keel: In a few dogfish sharks (family Centrophoridae), a single longitudinal dermal keel on the underside of the caudal peduncle.

Subethmoid fossa: On the neurocranium, a deep cavity on the ventral surfaces of the nasal capsules and the internasal plate, into which fit the palatine processes of the upper jaws.

Subnasal fenestrae: On the neurocranium of squaloids, a pair of apertures in the internasal plate between the nasal capsules that connect the cerebral cavity with two ventral fluid–filled cavities between the nasal capsules and the rostral keel. The fenestrae themselves are covered by tough membranes as with the anterior fontanelle. Subnasal fenestrae are present in most squaloids but reduced in a few derived species, and are not found in other sharks. Their function is obscure but may be sensory. Also termed **basal communicating canals**.

Suborbital shelf: On the neurocranium, a horizontal plate arising on the ventral junction of the orbital wall and basal plate on each side which extends from the nasal capsule to the otic capsule; it forms the floor of the orbit. A well–developed suborbital shelf is apparently primitive for shark–like fishes but is variably telescoped, reduced or lost in many squalomorph sharks and a few galeomorphs.

Subterminal margin: In the caudal fin, the margin from the subterminal notch to the ventral beginning of the terminal margin.

Subterminal mouth or **ventral mouth:** Mouth located on the underside of the head, behind the snout. Also termed an **inferior mouth**, in reference to its ventral position but not its function. A **superior mouth** (not found in living cartilaginous fishes) is on the dorsal surface of the head.

Subterminal notch: On the caudal fin of most non–batoid sharks and at least one batoid, the notch in the lower distal end of the caudal fin, between the postventral and subterminal margins, and defining the anterior end of the terminal lobe.

Superficial ophthalmic nerve foramina: Foramina for the roots of the superficial ophthalmic nerves in the medial wall of the orbits, separate from the orbital fissure. These foramina are confluent with the orbital fissure in many sharks.

Supraorbital crest: On the neurocranium, an arched horizontal plate of cartilage forming the dorsal edge of the orbit on each side; it arises from the medial orbital wall and the cranial roof and extends horizontally from the preorbital process to the postorbital process. It is apparently primitive for shark–like fishes but is variably reduced or absent in some living elasmobranchs.

Supraorbital or **brow ridge:** A dermal ridge above each eye, particularly well–developed in heterodontoids and some orectoloboids.

Symphyseal or **symphysial groove:** A longitudinal groove on the ventral surface of the lower jaw of some orectoloboid sharks, extending posteriorly from the lower symphysis.

Symphysial teeth: Larger oral teeth in one row on either side of the symphysis, distal to medials or alternates where present. Symphysials are broader than medials and usually have asymmetrical roots.

Symphysis: The midline of the upper and lower jaws, where the paired jaw cartilages articulate with each other.

Syntype: Two or more specimens used and mentioned in an original description of a species, where there was no designation of a holotype or a holotype and paratype(s) by the describer of the species.

Systematics: Scientific study of the kinds and diversity of organisms, including relationships between them.

Tail: That part of a cartilaginous fish from the cloacal opening or vent (anus in chimaeroids, which lack a cloaca) to the tip of the caudal fin or caudal filament, and including the anal fin, usually the second dorsal fin when present, and caudal fin.

Taxon, plural taxa: A taxonomic group at any level in a classification. Thus the taxon Chondrichthyes is a class with two taxa as subclasses, Elasmobranchii and Holocephali, and the taxon ***Galeorhinus***, a genus, has one taxon as a species, ***G. galeus***.

Taxonomy: Often used as a synonym of systematics or classification, but narrowed by some researchers to the theoretical study of the principles of classification.

Temperate: Two circumglobal bands of moderate ocean temperatures usually ranging between 10° and 22 °C at the surface, but highly variable due to currents and upwelling: including the north temperate zone between the Tropic of Cancer, 23°27'N latitude, to the Arctic Circle, 66°30'N; and the south temperate zone between the Tropic of Capricorn, 23°27'S latitude, to the Antarctic Circle, 66°30'N.

Term foetus: See **foetus**.

Terminal 3 cartilage: A wedge–shaped or elongated cartilage articulating with the posterior edge of the ventral marginal cartilage and over the ventral terminal cartilages. It supports a variety of structures, including clasper spines and spurs, the shields of many skates (Rajoidei), and the mesorhipidion of some carcharhinoid sharks.

Terminal lobe: In the caudal fin of most non–batoid sharks and at least one batoid, the free rear wedge–shaped lobe at the tip of the caudal fin, extending from the subterminal notch to the posterior tip.

Terminal margin: In the caudal fin, the margin from the ventral end of the subterminal margin to the posterior tip.

Terminal mouth: Mouth located at the very front of the animal. Most cartilaginous fishes have subterminal mouths, but some species (viper sharks, wobbegongs, angel sharks, frilled sharks, whale sharks, megamouth sharks, and ***Manta***) have it terminal or nearly so.

Thorn: In many batoids, most angel sharks and the bramble shark (***Echinorhinus brucus***), enlarged, flat conical denticles with a sharp, erect crown and a flattened base (which may grow as the shark grows).

Tongue arch: See **hyoid arch**.

Transverse groove: In oral teeth, a deep groove transverse on the lingual root surface, transecting it into mesial and distal root lobes.

Transverse notch: In oral teeth, a distinct notch in the proximal labial edge of the root at about its midlength.

Transverse ridges: Small narrow ridges on the labial and lingual surfaces of the crown, apicobasally oriented and sometimes extending to the cusp edges.

Tribasal pectoral fin: A pectoral fin skeleton with three basal cartilages, the propterygium, mesopterygium, and metapterygium, primitively found in most euselachians including living neoselachians.

Trilobate lower lip: In advanced orectoloboids, shallow orolabial grooves divide the lower lips into a medial section and a pair of lateral sections.

Tropeic folds: Longitudinal paired ridges on the ventral midline of the abdomen in frilled sharks (Chlamydoselachidae).

Tropical: Circumglobal band of warm coastal and oceanic water, usually above 22°C at the surface (but varying because of currents and upwelling), between the latitudes of 23°27'North (Tropic of Cancer) and 23°27' South (Tropic of Capricorn) and including the Equator.

Truncate: Blunt, abbreviated.

Trunk: That part of a cartilaginous fish between its head and tail, from the last gill openings to the vent, including the abdomen, back, pectoral and pelvic fins, and often the first dorsal fin.

Umbilical cord: A modified yolk stalk in placental viviparous sharks, carrying nutrients from the placenta to the foetus.

Unpaired fins: The dorsal, anal, and caudal fins.

Upper eyelid: The dorsal half of the eyelid, separated by a deep pocket (conjunctival fornix) from the eyeball. The upper eyelid fuses with the eyeball and the pocket is lost in all batoids.

Upper origin: In the caudal fin, the anterodorsal beginning of the epaxial or upper web of the caudal fin, at the posterior end of the dorso–caudal space (see measurement illustrations).

Upper postventral margin: In the caudal fin, the upper part of the postventral margin of the hypaxial web, from the posterior notch to the subterminal notch.

Uterine cannibalism or **cannibal viviparity:** A mode of reproduction in which foetuses deplete their yolk–sacs early and subsist by eating nutritive eggs produced by the mother (see **oophagy**) or first eat smaller siblings and then nutritive eggs (see **adelphophagy**).

Vent: The opening of the cloaca on the ventral surface of the body between the inner margins and at the level of the pelvic–fin insertions.

Ventral: Downward, in the vertical direction of the abdomen. See **dorsal**.

Ventral fin: See **pelvic fin**.

Ventral lobe: In the caudal fin, the expanded distal end of the preventral and lower postventral margins, defined by the posterior notch of the caudal fin.

Ventral margin: In the caudal fin, the entire ventral margin from lower origin to posterior tip, either a continuous margin or variably subdivided into preventral, postventral, subterminal and terminal margins.

Ventral marginal: In the clasper skeleton, a flat semicylindrical cartilage that is partially fused to the lateral edge of the axial cartilage, and forms the lateral wall of the clasper groove.

Ventral terminal: On the skeleton of the clasper glans, an often triangular, elongated, curved, plate–like cartilage that articulates or is attached to the lateral or ventrolateral edge of the end–style and to the posterior end of the ventral marginal cartilage.

Ventral tip: In the caudal fin, the ventral apex of the caudal fin where the preventral and postventral margins merge.

Vertebra, plural **vertebrae:** A single unit of the vertebral column, including a vertebral centrum and associated cartilages that form neural arches and ribs or haemal arches.

Vertebral axis: That part of the vertebral column inside the base of the caudal fin.

Vertebral column: The entire set or string of vertebrae or 'backbone' of a shark, from the rear of the chondrocranium to the end of the caudal base. Living elasmobranchs range from having as few as 35 vertebrae (some squaloids of the family Somniosidae) to as many as 477 vertebrae (thresher sharks).

Visceral arches: See **splanchnocranium**.

Viviparity: Used in two ways in recent literature, as being equivalent to **placental viviparity** only, that is for carcharhinoid sharks with a yolk–sac placenta; or for all forms of live–bearing or **aplacental viviparity**.

Web, fin: See **fin web**.

Yolk sac or **yolk sack:** Almost all sharks start embryonic development somewhat like a chicken, as a large spherical yolky egg inside an elongated shell, the egg case. A small disk of dividing cells represents the pre–embryo or blastula atop the huge yolk mass. The blastula expands around the sides and ventral surface of the yolk mass, and differentiates into an increasingly shark–like embryo, the yolk sac or bag–like structure containing the yolk, and a narrow tubular yolk stalk, between the abdomen of the embryo and the yolk sac.

Yolk stalk: The connecting passage between embryo or foetus and yolk sac, which allows yolk to pass from the sac into the embryonic gut.

Yolk–sac placenta: An organ in the uterus of some ground sharks (order Carcharhiniformes), formed from the embryonic yolk sac of the embryo and maternal uterine lining, through which maternal nutriment is passed to the embryo. It is analogous to the placenta of live–bearing mammals. There are several forms of yolk–sac placentas in carcharhinoid sharks, including entire, discoidal, globular, and columnar placentas (see Compagno, 1988).

Yolk–sac viviparity: Live–bearing in which the young are nourished primarily by the yolk in the yolk sacs, which is gradually depleted and the yolk sacs reabsorbed until the young are ready to be born.

2. SYSTEMATIC CATALOGUE – Subclass NEOSELACHII – Cohort SELACHII

2.1 Order HEXANCHIFORMES – Frilled and cow sharks

Order: Hexanchiformes Garman, 1913, *Mem. Mus. Comp. Zool. Harvard* 36: 10, 11 (emendation of order Plagiostoma, suborder Antacea, "group" Hexanchoidei Garman, 1913).

Number of Recognized Deep–sea Indian Ocean Families: 2.

Synonyms: Part 1 Squali, Abtheilung 3: Müller and Henle, 1839: 80. Ordo Plagiostomi, Subordo Squalini, Sectio Proktopterides, Tribus Mononotopterini: Bleeker, 1859: xii. Order Squali, suborder Squali: Gill, 1862: 394, 396. Order Squali, suborder Galei: Gill, 1872: 23. Order Plagiostomi diplospondyli, suborder (equivalent rank) Palaeonotidani: Hasse, 1879: 35, tab. 2. Order Selachophichthyoidi: Garman, 1884b: 116; Garman, 1884d: 484; Jordan, 1923: 97; Whitley, 1940: 68. Order Pternodonta: Gill, 1884: 524. Order Opistarthri: Garman, 1884d: 484; Gill, 1893: 129. Group Cladodonti Garman, 1885: 30. Group Notidani Garman, 1885: 30. Order Selachii, suborder Asterospondyli: Woodward, 1889: 157. Order Diplospondyli: Jordan and Evermann, 1896: 15, 16; Fowler, 1941: 4; Smith, 1949: 37, 38. Order Euselachii, suborder Pleurotremata, Division Notidanoidei: Regan, 1906a: 722. Order Selachii, Group 1, suborder Notidani Goodrich, 1909: 139. Order Pleurotremata, suborder Notidanoidei: Engelhardt, 1913: 97. Order Notidani, suborder Opistharthri: Jordan, 1923: 97. Order Plagiostomi, suborder Notidaniformes: Lozano y Rey, 1928: 280. Order Hexanchea, suborder Hexanchida, superfamily Hexanchoidea: White, 1936: 4; White, 1937: 36, tab. 1; Whitley, 1940: 68. Order Euselachii, suborder Notidaniformes: Bertin, 1939: 8. Order Hexanchiformes: Berg, 1940 (1947): 136; Berg and Svetovidov, 1955: 63; Arambourg and Bertin, 1958: 2025; Patterson, 1967: 670; Lindberg, 1971: 8, 256; Rass and Lindberg, 1971: 303; Applegate, 1974: 743; Nelson, 1976: 32; Chu and Meng, 1979: 114, tab. 2; Compagno, 1973a: 26; Nelson, 1984: 49; Compagno, 1984: 13; Pfeil, 1983: 24; Gubanov, Kondyurin and Myagkov, 1986: 3, 44; Cappetta, 1987: 26, 44; Eschmeyer, 1990: 435; Shirai, 1992a: 122; Nelson, 1994: 53; de Carvalho, 1996: 55; Shirai, 1996: 33; Eschmeyer, 2012. Order Selachii, Suborder Notidanoidea: Romer, 1945: 576; Bigelow and Schroeder, 1948: 77. Order Selachii, suborder Chlamydoselachoidea: Bigelow and Schroeder, 1948: 77, 93. Order Hexanchoidei: Schultz and Stern, 1948: 224. Order Hexanchiformes, suborder Chlamydoselachoidei: Berg and Svetovidov, 1955: 63; Patterson, 1967: 670; Compagno, 1973a: 26; Cappetta, 1987: 26, 44; de Carvalho, 1996: 55. Order Hexanchiformes, suborder Hexanchoidei: Berg and Svetovidov, 1955: 64; Patterson, 1967: 670; Compagno, 1973a: 26; Cappetta, 1987: 26, 44; de Carvalho, 1996: 55. Order Lamnida, suborder Hexanchida: Matsubara, 1955: 1–789. Order Lamnida, suborder Chlamydoselachina: Matsubara, 1955: 1–789. Order Pleurotrema, suborder Notidanoidea: Norman, 1966: 6. Order Selachii, suborder Hexanchoidea: Romer, 1966: 350. Order Chlamydoselachida, suborder Chlamydoselachina: Fowler, 1967a: 91. Order Hexanchida, suborder Hexanchina: Fowler, 1967a: 83. Order Chlamydoselachida: Glikman, 1967: 213; Fowler, 1967a: 91. Order Hexanchida: Glikman, 1967: 214; Fowler, 1967a: 82. Order Hexanchida, suborder Hexanchoidei: Glikman, 1967: 214. Order Selachii: Blot, 1969: 702–776. Order Pleurotremata, suborder Hexanchiformes: Budker and Whitehead, 1971: 5, tab. 2. Order Chlamydoselachiformes: Fowler, 1947: 8; Rass and Lindberg, 1971: 303; Applegate, 1974: 743; Pfeil, 1983: 24; Shirai, 1992a: 122; Shirai, 1996: 33. Order Hexanchiformes, suborder Chlamydoselachoidea: Chu and Meng, 1979: 114, tab. 2. Order Hexanchiformes, suborder Hexanchoidea: Chu and Meng, 1979: 114, tab. 2. Order Galeomorpha, suborder Hexanchoidea: Carroll, 1988: 599.

FAO Names: En – Frilled and cow sharks.

Field Marks: Sharks with six or seven pairs of gill openings, one spineless dorsal fin, and an anal fin.

Diagnostic Features: Head conical to slightly depressed, not expanded laterally. Snout very short to moderately long, truncated to conical, not greatly elongated or flattened, and without lateral teeth or rostral barbels. Eyes on sides of head, without nictitating lower eyelids, secondary lower eyelids, or subocular pouches; upper eyelids not fused to eyeball. Nostrils of the ordinary shark type, transverse on snout, without barbels, nasoral grooves or circumnarial grooves, separate from mouth, anterior nasal flaps short and not reaching mouth. Six or seven paired gill openings are present on sides of head, with the last gill opening in front of pectoral fin origins. Spiracles present, very small, and well behind and above level of eyes. Mouth large, arched and elongated, extending well behind eyes. Labial furrows reduced but present on both jaws. Teeth weakly to strongly differentiated along the jaws, without enlarged anterior teeth or enlarged molariform posterior teeth and without a gap or small intermediate teeth between anterior and lateral teeth in the upper jaw. Tooth row counts 19 to 46 upper jaw, 19 to 38 lower jaw. Trunk cylindrical or somewhat compressed, but not flattened and ray–like. Caudal peduncle without lateral dermal ridges or keels. Dermal denticles covering entire body, with no enlarged thorns or spines. Pectoral fins small to moderately large, not expanded and ray–like, without triangular anterior lobes that cover the gill slits. Pelvic fins small to moderately large, with vent continuous with their inner margins. Claspers without siphons in the abdomen but with large clasper sacs. A single spineless dorsal fin present, with origin over or behind pelvic–fin insertions. Anal fin is present. Caudal fin with a long dorsal lobe and the ventral lobe short to absent. Vertebral counts: total vertebral counts 118 to 171, precaudal vertebral counts 54 to 102, monospondylous vertebral counts 18 to 75, diplospondylous vertebral counts 13 to 38, and caudal vertebral counts 50 to 82. Intestinal valve of spiral or ring type, with 14 to 49 turns. Moderate sized to very large sharks with adults 85 to 500 cm or more in length. **Colour:** variable depending on species from a silvery grey to reddish brown, olive grey, dark brown or black above, most species light below, but some (***Chlamydoselachus***) uniformly coloured; most species without prominent spotting (except ***Notorynchus***) or saddle markings; juvenile colour pattern of some species are quite striking with darker or lighter fin edges.

Distribution: Wide–ranging in all seas, but are only found inshore in temperate seas and in deep water in the tropics.

Habitat: These sharks occur in a wide range of marine habitats from shallow bays and estuaries (in some parts of the world), on the continental shelves down to the continental and insular slopes and on seamounts and submarine ridges, from close inshore to at least 2500 m; some deepwater species common down to 1100 m. These sharks do not penetrate into fresh water rivers and lakes but can be found in estuaries that fluctuate seasonally in salinity.

Biology: Reproductive mode is yolk–sac viviparity with litters ranging from 2 to at least 108. These are rare to common sharks where they occur that feed on a wide variety of cephalopods, crustaceans, bony fishes, other sharks, and batoid fishes, and with the largest member of this group ***Hexanchus griseus*** also consuming marine mammals.

Interest to Fisheries and Human Impact: These sharks are relatively unimportant commercially, but are targeted by some shark fisheries and are regular bycatch components of other fisheries. They are incidentally caught in trawls, gillnets, and on long–line gear. Larger species may snap during capture, but are apparently docile when approached underwater. Ecotourism diving operations have sprung up in some areas where the larger species are known to seasonally congregate.

The conservation status of the group varies by region from Data Deficient to Near Threatened depending on the species.

Local Names: Hexanchoid or Hexanchiform sharks, One–dorsaled sharks.

Remarks: The interrelationships of frilled and cow sharks were reassessed by Ebert and Compagno (In press) and built upon newer findings on hexanchoid morphology by Maisey and Wolfram (1984), Ebert (1990), Shirai (1992a, b, 1996), and de Carvalho (1996). These works, along with more recent molecular evidence (Naylor *et al.*, 2005, 2012), tend to support the hexanchids and chlamydoselachids as a monophyletic squalomorph group, united by several derived features of their skeletal and external morphology including details of their chondrocrania, branchial skeleton, pectoral and pelvic fin skeletons, clasper morphology, and external morphology. It also suggests that both hexanchids and chlamydoselachids are highly derived and ecomorphologically divergent, and that some of the 'primitive' features that they supposedly share with various palaeoselachian and protoselachian sharks may be convergent.

The present classification of the Hexanchiformes continues to rank the living taxa in a common order with two families, the Chlamydoselachidae and Hexanchidae, comprised of four genera and six species; both families, three genera and four or five species occur in the Indian Ocean deep–sea.

Key to Deep–sea Indian Ocean Families:

1a. Body elongated and eel–like. Head snakelike, with short snout and terminal mouth (Fig. 24a). Teeth tricuspidate in both jaws (Fig. 24b) . . . . **family Chlamydoselachidae**

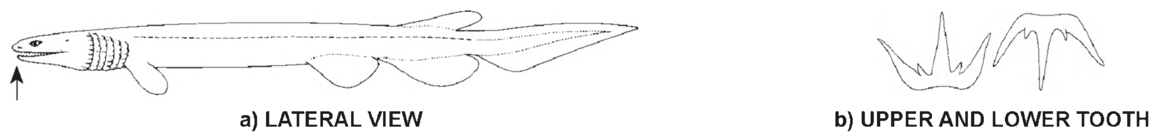


Fig. 24 *Chlamydoselachus*

1b. Body moderately stout and not eel–like. Head not snakelike, with moderate snout and subterminal mouth (Fig. 25a). Teeth cuspidate in upper jaw and compressed and comb–like in lower jaw (Fig. 25b) . . . . **family Hexanchidae**

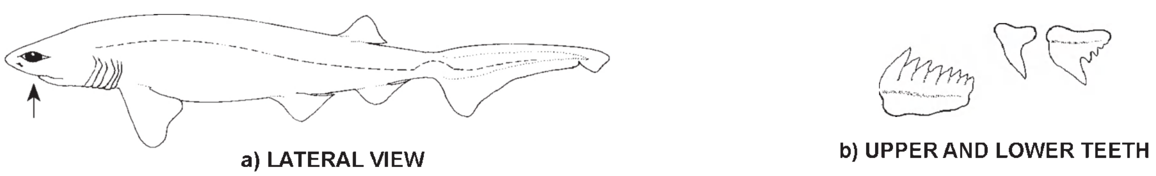


Fig. 25 *Hexanchus*

2.1.1 Family CHLAMYDOSELACHIDAE

Family: Chlamydoselachidae Garman, 1884a, *Bull. Essex Inst.*, 16: 52 (p. 8 in separate).

Type genus: ***Chlamydoselachus*** Garman, 1884a.

Number of Recognized Deep–sea Indian Ocean Genera: 1.

Synonyms: Family Chlamidoselachidae Cervigón, 1960: 40. Erroneous spelling of Chlamydoselachidae Garman, 1884a.

FAO Names: En – Frilled sharks; **Fr** – Requins à collerette; **Sp** – Tiburones anguila.

Field Marks: See genus ***Chlamydoselachus***.

Diagnostic Features: Elongated eel–shaped sharks with the head flattened and subtrapezoidal in dorsoventral outline. A pair of longitudinal keels or tropeic folds is present on the ventral surface of the abdomen. A prominent horizontal subocular groove above the upper lip extends below the nostrils and eyes to the cheek. Snout extremely short, its tip nearly transverse and truncated. Eyes are well behind symphyses of mouth. Interbranchial septa greatly enlarged and frilly, ventral edges of those of first gill openings attached across the throat as a gular flap; gill raker papillae absent from gill arches. Nostrils are about opposite of jaw symphyses. Lateral trunk denticles with spike–like crowns; enlarged and monocuspidate denticles along the mouth edges. Mouth terminal, teeth and mouth edges exposed when mouth is closed. Upper lip not expanded below the level of tooth bases to form a prominent flange and groove; lower lip not expanded anteriorly and laterally to the teeth series; no deep groove between lower lip and teeth. Tongue prominent and with a deep sublingual groove separating it from the dental membrane. Labial cartilages complete (two pairs of uppers and one pair of lowers). Teeth are alike in both jaws, with three cusps and two cusplets on crown, and with flat, low lingually bilobate roots; no small granular posterior teeth. Total tooth counts 19 to 30 upper jaw, 21 to 29 lower jaw. Pectoral fins rounded and smaller than pelvic fins. Pelvic fins with broadly rounded anterior margins and apices, inner margin not forming expanded clasper sheath in males. Dorsal fin very low, rounded, and elongated, insertion just behind upper caudal–fin origin. Anal fin is broad–based and rounded, larger than dorsal fin; anal–fin insertion ending at the lower caudal–fin origin. Caudal peduncle is very short and compressed. Caudal fin with a vestigial subterminal notch; ventral caudal–fin lobe is essentially absent. Vertebral counts: total vertebral counts 147 to 171, precaudal vertebral counts 93 to 102, monospondylous vertebral counts 18 to 75, diplospondylous precaudal vertebral counts 21 to 76, and caudal vertebral counts 52 to 78. Intestinal spiral valve turn counts 26 to 49. These are moderately large sharks, with adults up to 196 cm total length. **Colour:** a uniform dark chocolate brown, brownish grey or brownish black without any dark or light banding or mottled colour patterns.

Distribution: The family Chlamydoselachidae has a patchy, but almost circumglobal range with most records of this family from the western Pacific, southern Africa, and the eastern North Atlantic including the Mid–Atlantic Ridge.

Habitat: Frilled sharks are benthic, epibenthic, and occasionally epipelagic, and are often in association with continents, islands, submarine canyons, peaks and ridges. They appear to be most common in boreal, temperate and subtropical seas.

Biology: Reproductive mode is viviparous with a yolk sac, and litters of up to 12. The reproductive cycle may be either two years or possibly up to three and a half years. Nothing is known about the age and growth of these sharks. The diet consists mainly of cephalopods, teleosts, and elasmobranchs, especially members of the families Squalidae and Scyliorhinidae.

Interest to Fisheries and Human Impact: There are not fisheries for these sharks. They are relatively uncommon in most areas where they occur and their flesh is of little value. They are likely caught on occasion as bycatch, but are most likely discarded.

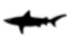
The conservation status of these sharks is poorly known due to a lack of life history data and information on population trends.

Local Names: Frill sharks, Frilled sharks, Frilled–gilled sharks (English).

Remarks: A single genus, ***Chlamydoselachus***.

Literature: Garman (1884a, b, c, d); Ebert (1990); Ebert and Compagno (2009, In press).

List of Deep–sea Species Occurring in the Area:

Chlamydoselachus africana Ebert and Compagno, 2009

Chlamydoselachus anguineus Garman, 1884

Chlamydoselachus Garman, 1884

Genus: ***Chlamydoselachus*** Garman, 1884a, *Bull. Essex Inst.*, 16: 47, 52 (pp. 8, 13 in separate).

Type species: ***Chlamydoselachus anguineus*** Garman, 1884a, by monotypy.

Number of Recognized Deep–sea Indian Ocean Species: 2.

Synonyms: Genus ***Chlamydoselache*** Günther, 1887: 2. Emendation of ***Chlamydoselachus*** Garman, 1884a, and hence taking the same type species, ***Chlamydoselachus anguineus*** Garman, 1884a. Genus ***Chlamydoselachoides*** Fowler, 1947: 8. Type species: ***Chlamydoselachus lawleyi*** Davis, 1887 by original designation; Pliocene of Tuscany, Italy. Synonymized with ***Chlamydoselachus*** by Pfeil (1983) and Cappetta (1987), which is followed here. Genus ***Chlamidoselachus*** Cervigón, 1960: 36, 39–42. Consistent erroneous spelling of ***Chlamydoselachus*** Garman, 1884a (cited six times as such).

Field Marks: Eel–like sharks with 6 gill slits, terminal mouth with tricuspid teeth in both jaws, and one dorsal fin.

Diagnostic Features: See family.

Local Names: Frilled sharks.

Remarks: Living frilled sharks had long been considered a single wide–ranging species, ***Chlamydoselachus anguineus*** Garman, 1884, but Ebert (1990) compared frilled sharks from a wide geographic range and suggested that the morphological variability of this species may represent an additional species within the genus. Further comparisons and examination of frilled sharks taken from off Angola and Namibia with Pacific specimens from Australia, California (U.S.A.), Japan, New Zealand, and Taiwan (Province of China), and from the North Atlantic revealed differences in morphometrics, size at maturity, chondrocranial morphology, vertebral counts, vertebral morphology and calcification patterns, pectoral fin skeletal morphology and radial counts, and intestinal valve counts that lead Ebert and Compagno (2009) to separate the southern African frilled shark (***Chlamydoselachus africana***) into a distinctly different species.

Indian Ocean records of frilled sharks (***Chlamydoselachus*** spp.) are patchy, and as such specimens should be carefully examined to determine the specific species involved. The frilled shark (***Chlamydoselachus anguineus***) is known from Australian waters, but records of this species from the southwestern Indian Ocean should be carefully examined to determine whether it is ***C. anguineus*** or ***C. africana***, the latter known from South African waters. Since both species are very similar morphologically, tissue samples should also be taken when possible.

Key to Deep–sea Indian Ocean Species:

1a. Total vertebral centra 147, monospondylous–diplospondylous transition at 18th vertebral segment just behind the posterior end of the pectoral fins. Spiral intestinal valve counts 26 to 28. Head length 17.3 to 17.9%. . ***Chlamydoselachus africana***

1b. Total vertebral centra 160 to 171, monospondylous–diplospondylous transition between the 72nd and 75th vertebral segment and occurs about over the pelvic fins. Spiral intestinal valve counts 35 to 49. Head length 13.1 to 16.2% of total length . . . . ***Chlamydoselachus anguineus***

Chlamydoselachus anguineus Garman, 1884

Chlamydoselachus anguineus Garman, 1884a, *Bull. Essex Inst.*, 16: 47 (p. 3 in separate), fig. Holotype, Museum of Comparative Zoology, Harvard University, MCZ–800–S, female, probably adult, ca. 151 cm (59.5") TL with caudal tip missing, from "Japanese seas" (probably southeastern Honshu), now in pieces (Ebert, 1990; Hartel and Dingerkus, *in* Garman, 1997, The Plagiostoma: xxxvii).

Synonyms: ***Chlamydoselache anguinea*** Günther, 1887: 2 (emended spelling).

Other Combinations: None.

FAO Names: En – Frilled shark; **Fr** – Requin lézard; **Sp** – Tiburón anguila.

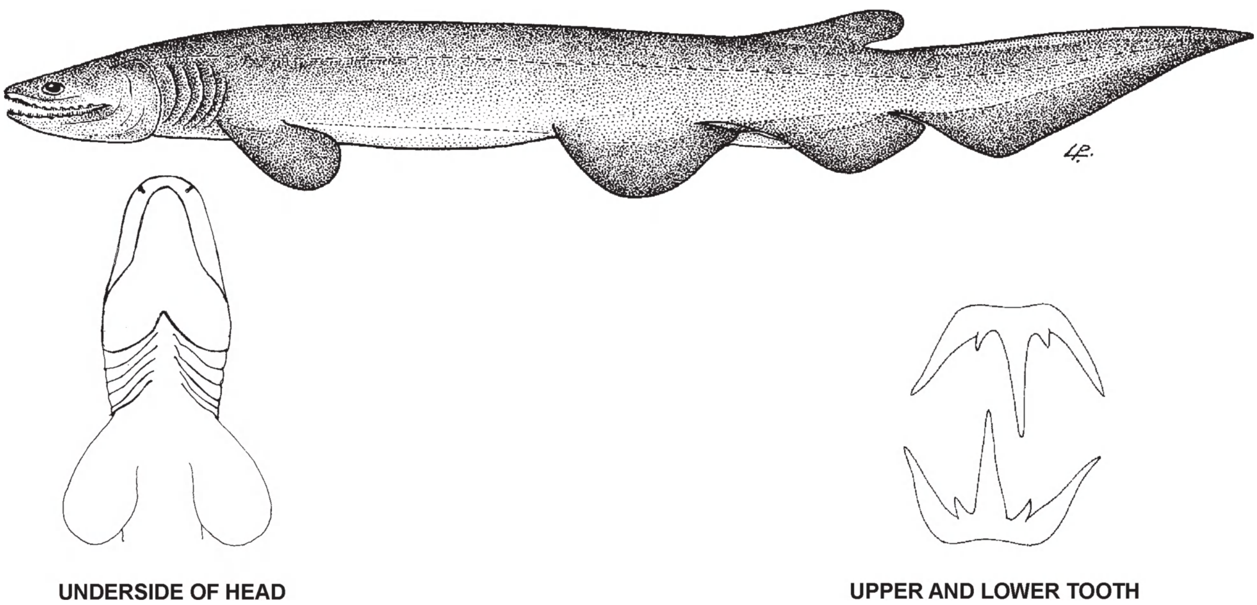


Fig. 26 *Chlamydoselachus anguineus*

Field Marks: Eel–like shark with 6 gill slits, snakelike terminal mouth with tricuspid teeth in both jaws, and one dorsal fin, colour uniform brown with dark brown fins and prominent lighter lateral line.

Diagnostic Features: Body long, slender, eel–like, compressed behind the pelvic fins. Pectoral–pelvic space elongated 26.4 to 31.0% total length. Head broad, flattened, wider than high, slightly convex; head length 13.1 to 16.2% total length. Preoral snout length 0.1 times mouth width. Snout tip broadly rounded. Nostrils lateral, width 6.3 to 7.9 in internarial width. Eyes large, rounded, length approximately 10.1 times in head length. Spiracle present or absent. Height of gill openings descending in length; first gill opening extends across throat. Mouth broadly rounded, large, distensible. Teeth are similar in both upper and lower jaws, each tooth with three long, slender, smooth–edged cusps, and a small pointed cusplet between each cusp; upper medial teeth paired, form similar to anterolateral teeth, but noticeably reduced; lower jaw with a single medial tooth row undifferentiated from anterolaterals; teeth on upper and lower jaws are curved inwards and set on a broad base that projects behind and interlocks with the tooth base posterior to it; tooth count is 19 to 28 upper jaw, 21 to 29 lower jaw. Lateral trunk denticles lanceolate, single cusped, with flattened bases; crown slightly projected above the body with four longitudinal ridges extending from the base to the cusp; denticle crowns widely spaced. Pectoral fins are broad, rounded and low on body; pectoral–fin length 7.6 to 8.6% total length; pectoral fins smaller than pelvic fins; pectoral–fin origin is posterior to sixth gill opening. Pelvic fins large and broadly rounded; anterior and posterior margins convex. Anal fin very large, broadly rounded, its height is 1.5 to 2.0 times dorsal–fin height, base length 1.2 to 1.6 in dorsal–fin base; anterior and posterior fin margins are rounded and convex; an acute angle forms at the tip of the posterior and inner margins. Dorsal fin is set far back, about 54.3 to 65.0% total length from snout tip; anterior margin is rounded and convex with posterior margin. Caudal fin elongated, subtriangular, and without a subterminal lobe; length of dorsal margin 2.5 times in precaudal length. Vertebral counts: total vertebral counts 160 to 171, precaudal vertebral counts 93 to 102, monospondylous vertebral counts 72 to 75, diplospondylous vertebral counts 21 to 27. Spiral valve turns 35 to 49. A large species, adults up to 196 cm total length. **Colour:** dark chocolate brown, brownish grey or brownish black.

Distribution: Wide ranging but patchily distributed. Eastern Indian Ocean: only confirmed records are from off Tasmania (Australia). Western Indian Ocean: South Africa, seamounts off southern Mozambique, and possibly the Maldives, but these specimens should be checked and compared with ***Chlamydoselachus africana***.

Habitat: A rare to locally common benthic, epibenthic, and occasionally pelagic species on offshore continental and insular shelves, upper slopes, seamounts, and along mid–ocean ridges at depths between 20 and 1500 m. Usually caught near the bottom, individuals are known to migrate into the water column, venturing at least 1500 m, or more, off the bottom and into the midwater. In Suruga Bay, Honshu, Japan, these sharks are regularly caught in pelagic trawls and in bottom gillnets at 51 to 300 m. A remote operated vehicle videotaped a frilled shark swimming a couple meters off the bottom off North Carolina, U.S.A.

Biology: Yolk–sac viviparous, with the number of young ranging from 2 to 15 per litter, six being the average. Very little is known about its reproductive cycle or life history. Kukuev and Pavlov (2008), based on the catch of 34 frilled sharks in a single bottom trawl tow, suggested that seamounts along the Mid–Atlantic Ridge were areas where mating activity occurred. In Japanese waters this species appears to reproduce year–round with mating thought to occur from March to June. The gestation period is probably very long, on the order of one to two years, by extrapolating the observed growth rate of early embryos artificially kept alive for up to 3 months. Tanaka *et al.* (1990) suggested that the total gestation period may be up to 3.5 years. Uterine eggs are enormous, about 11 to 12 cm in diameter, and greatly distend the abdomens of gravid females.

The needle–sharp, slender–cusped teeth of this shark suggest feeding on deepwater cephalopods and bottom fishes. The only diet study with a reasonable sample size (n = 139) of frilled sharks was in Japanese waters where squids were found to be the dominant prey item, occurring in about 61% of the stomachs examined compared to 11% with fish remains (Kubota, Shiobara and Kubodera, 1991). Examination of frilled shark diet from the North Atlantic and elsewhere reveals them to have consumed mostly smaller sharks, mainly squaloids and scyliorhinids (Ebert, 1990, 2003; D.A. Ebert, pers. obs.).

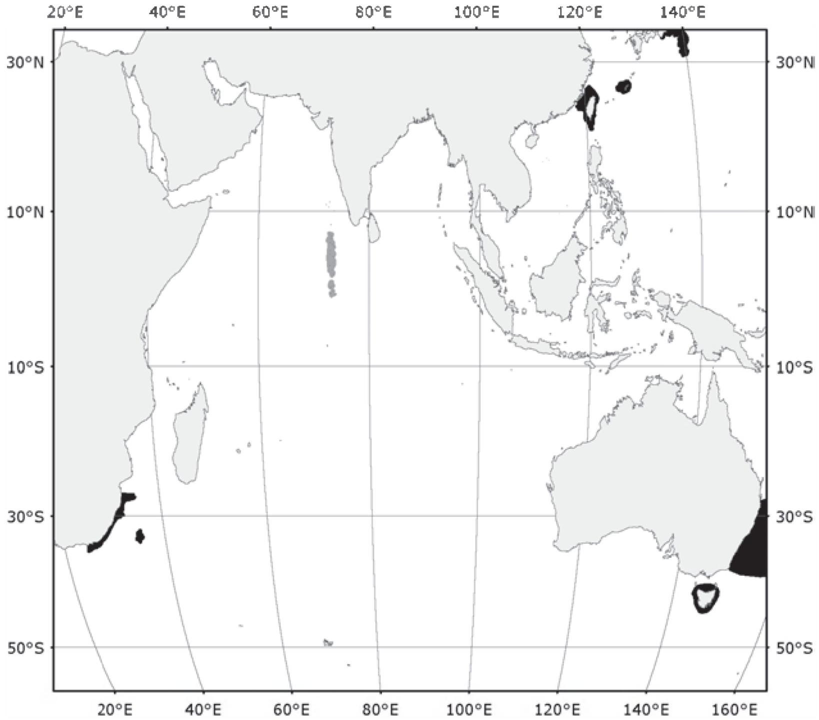


Fig. 27 *Chlamydoselachus anguineus*

Known distribution Possible distribution

The long mouth of the frilled shark can accommodate relatively large prey, and their snakelike head and firm, muscular bodies suggest that they may be able to slowly approach faster swimming epipelagic prey and make a sudden snakelike lunge to snag a potential prey item with their relatively strong, tooth–studded jaws. The mouth of a frilled shark bears a functional resemblance to a squid jig, with many needle–sharp, inward and diagonally–directed curved points on its teeth which is enhanced by the outward rotation of the tooth rows when the jaws are protruded. Even a glancing strike by a shark on a cephalopod or other soft–bodied prey could readily snag it.

Live frilled sharks have been photographed swimming in captivity with mouth agape and with lighter coloured tooth bands highlighted against the darker coloured mouth. Whether this serves to lure prey items such as squids and fishes to within striking distance is speculative at present. Also, a frilled shark caught on video by a remotely operated vehicle (ROV) showed it to take flight quite rapidly as the ROV approached. There are no known predators of these sharks, but one can assume that larger sharks may on occasion consume them.

Size: Maximum total length 196 cm; males adult at approximately 118 cm to 163 cm; females maturing at 130 to 150 cm and reaching 196 cm. Size at birth about 39 to 50 cm.

Interest to Fisheries and Human Impact: Of no importance in Indian Ocean fisheries as it is usually taken as bycatch in other fisheries. There are no reported landings of this species. Elsewhere, this species if taken as bycatch and not discarded is utilized for meat or fishmeal. It has occasionally been kept in aquaria in Japan. A harmless species, the needle–sharp teeth can hook and cut the hands of the unwary scientist examining its mouth.

The conservation status of this species is Near Threatened due to concerns over expansion of deepwater fisheries that may increase bycatch levels.

Local Names: Frilletjieshaai (Afrikaans).

Literature: Garman (1884a, b, c, d, 1885, 1913); Gudger and Smith (1933); Fowler (1936, 1941, 1967a); Gudger (1940); Whitley (1940); Smith (1967a); Trunov (1968); Bass, D'Aubrey and Kistnasamy (1975c); Domanevskij (1975); Golovan (1976); Boeseman *in* Whitehead *et al.* (1984); Compagno (1984); Bass *in* Smith and Heemstra (1986); Lloris (1986); Borets (1986); Shcherbachev (1987); Compagno *et al.* (1989); Ebert (1990, 2003); Tanaka *et al.* (1990); Compagno *et al.* (1991); Kubota, Shiobara and Kubodera (1991); Anderson and Ahmed (1993); Last and Stevens (1994, 2009); Paul and Fowler (2003a); Sedberry, Meister and Loefer (2007); Kukuev and Pavlov (2008); Ebert and Compagno (2009, In press); Barnett *et al.* (2012); D.A. Ebert and L.J.V. Compagno (unpubl. data).

2.1.2 Family HEXANCHIDAE

Family: Tribe Hexanchina Gray, 1851 (family Squalidae), *List Fish British Mus., Pt. 1, Chondropterygii, British Mus. (Nat. Hist.)*: 67, London.

Type genus: ***Hexanchus*** Rafinesque, 1810.

Number of Recognized Deep–sea Indian Ocean Genera: 2.

Synonyms: Subfamily Notidanini Bonaparte, 1838 (family Squalidae): 130. Type subgenus: ***Notidanus*** Cuvier, 1816, a junior synonym of ***Hexanchus*** Rafinesque, 1810. Family Notidanidae Owen, 1846: 51. Type subgenus: ***Notidanus*** Cuvier, 1816, a junior synonym of ***Hexanchus*** Rafinesque, 1810. Family Notidanoidae Gill, 1862: 404. Type subgenus: ***Notidanus*** Cuvier, 1816, a junior synonym of ***Hexanchus*** Rafinesque, 1810. Family Hexanchidae Gill, 1884: 618. Also subfamily Hexanchinae (family Hexanchidae) Fowler, 1947: 8. Type genus: ***Hexanchus*** Rafinesque, 1810. Family Heptranchidae Garman, 1913: 2. Type genus: ***Heptranchias*** Rafinesque, 1810. Family Hexeptranchidae Garman, 1913: 2, 14. Inadmissible since based on a combination of two type genera, ***Hexanchus*** Rafinesque, 1810 and ***Heptranchias*** Rafinesque, 1810. Family Heptranchidae Barnard, 1925: 20. Type genus: ***Heptranchias*** Rafinesque, 1810. Family Heptranchiidae McCulloch, 1929: 3. Subfamily Heptranchiinae (family Hexanchidae) Fowler, 1947: 8. Type genus: ***Heptranchias*** Rafinesque, 1810. Family Notorynchidae Shirai, 1992a: 122. Type genus: ***Notorynchus*** Ayres, 1855.

FAO Names: En – Cow sharks; **Fr** – Requins grises; **Sp** – Cañabotas.

Field Marks: Moderately slender to stocky sharks with a subterminal mouth, large compressed comb–like teeth in the lower jaw, smaller cuspidate teeth in upper jaw, 6 or 7 pairs of gill openings, one spineless dorsal fin, and an anal fin.

Diagnostic Features: Moderately elongated to stout sharks with the head flattened and conical in dorsoventral outline. No subocular groove on head. Snout moderately long; snout tip pointed to broadly round. Eyes about opposite to symphyses of mouth. Interbranchial septa moderately enlarged, without a gular flap connecting the first gill openings; gill raker papillae present on gill arches. Nostrils positioned well anterior to jaw symphyses. Mouth subterminal. Teeth and mouth edges concealed when mouth is closed. Upper lip expanded below the level of tooth bases to form a prominent flange and groove that extends posteriorly to the mouth angle and labial furrows; lower lip expanded anterior and lateral to the teeth series and separated from them by a deep groove. Labial cartilages are incomplete with one pair on the upper jaw only. Teeth dissimilar in upper and lower jaws, with lower anterolateral teeth much larger, compressed, comb–shaped, and with more cusplets than uppers; small granular posterior teeth present. Tooth counts 23 to 46 upper jaw, 15 to 38 lower jaw. No longitudinal keels on the abdomen. Caudal peduncle is moderately long and cylindrical. Enlarged and cuspidate denticles weakly developed or absent from the mouth edges. Pectoral fins angular, larger than pelvic fins. Pelvic fins with nearly straight anterior margins and narrowly rounded apices, inner margins expanded into broad clasper sheaths in males. Dorsal fin relatively high, angular, and short, insertion well anterior to upper caudal–fin origin by dorsal–fin base length or more. Anal fin is narrow–based and angular, insertion ending well anterior to the lower caudal–fin origin. Caudal fin with a well–developed subterminal notch and a ventral caudal–fin lobe weak to moderately developed. Vertebral counts: total vertebral counts 118 to 159, precaudal vertebral counts 72 to 94, monospondylous vertebral counts 41 to 58, diplospondylous vertebral counts 13 to 38, caudal vertebral counts 50 to 82. Spiral valve turns 14 to 39. These sharks range in size from small to very large, with various species between 140 to 500 cm and more in maximum total length. **Colour:** uniform olive to dark grey, black or brown above, lighter to white below; some species with scattered small spots on the dorsal surface, others without any spotting.

Distribution: Worldwide in boreal and cold temperate to tropical seas.

Habitat: Most cow shark species are deepwater inhabitants of the outer continental shelves, upper continental slopes, insular shelves and slopes, and submarine canyons down to at least 2500 m depth, near the bottom or well above it. Some species also occur in shallow bays, close inshore, and near the surface.

Biology: Reproduction is yolk–sac viviparity with some species having relatively large litters of 13 to at least 108. The reproductive cycle, although poorly known, is annual or biannual for those species where some information is available. These are sluggish to active, strong swimming sharks usually occurring near the bottom. They feed on a wide variety of relatively large marine organisms, including crustaceans and cephalopods, bony fishes, other sharks, rays, marine mammals including seals and dolphins, and carrion (including mammalian meat).

Interest to Fisheries and Human Impact: Cow sharks are relatively unimportant commercially but are regular components of shark fisheries and bycatch of other fisheries in temperate and tropical waters, and are usually taken by line gear, bottom and pelagic trawls, and gill nets. These sharks are excellent for human food and are utilized fresh and dried–salted; they are also processed for fishmeal, oil, and leather. Some species are subject to sports fisheries in inshore temperate waters. It is likely that the bigeyed sixgill shark (***Hexanchus nakamurai***) is caught and landed, but reported as bluntnose sixgill shark due to misidentification between these two species.

Cow sharks may snap when captured and can inflict lacerations if carelessly handled; the two larger species (***Hexanchus griseus*** and ***Notorynchus cepedianus***) have been confirmed as biting divers in the sea. These two cow sharks (***H. griseus*** and ***N. cepedianus***) reach large sizes (from 300 to 500 cm) and feed on large prey including marine mammals. Diving with ***N. cepedianus*** and ***H. griseus*** in the sea has become a popular ecotourism attraction in some areas, especially in southern Africa and in the north–eastern Pacific. Although the paucity of confirmed attacks by cow sharks biting people suggests that they are often docile and inquisitive in their reactions to humans, large cow sharks should be treated with respect as with other big macropredatory sharks.

The conservation status of this family is poorly known. The smaller deep–sea species are little–known but potentially vulnerable to demersal trawl and longline fisheries. The larger species have been the subject of localized fisheries from various geographic regions throughout the world. All of these targeted fisheries quickly ended when these species were subsequently overfished.

Local Names: Sixgill and Sevengill sharks, Sixgill and Sevengill cow sharks, Combtooth sharks (English).

Remarks: Three living genera are currently recognized, ***Heptranchias***, ***Hexanchus***, and ***Notorynchus***, of which two (***Heptranchias*** and ***Hexanchus***) occur in the deep–sea. The monotypic genus ***Notorynchus*** is mostly a coastal species, often occurring in bays and estuaries, and along the open coast usually at less than 200 m depth. This species will not be discussed here further.

Literature: Garman (1913); Daniel (1928); Fowler (1941, 1967a); Bigelow and Schroeder (1948); Springer and Waller (1969); Garrick and Paul (1971); Bass, D'Aubrey and Kistnasamy (1975c); Compagno (1984); Ebert (1990); Shirai (1992a,b, 1996); De Carvalho (1996); Ebert and Compagno (In press).

List of Deep–sea Species Occurring in the Area:

Heptranchias perlo (Bonnaterre, 1788)
Hexanchus griseus (Bonnaterre, 1788)
Hexanchus nakamurai Teng, 1962

Key to Deep–sea Indian Ocean Genera:

1a. Six pairs of gill openings (Fig. 28) . . . . ***Hexanchus***

1b. Seven pairs of gill openings (Fig. 29) . . . . ***Heptranchias***

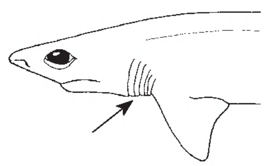


Fig. 28 *Hexanchus*

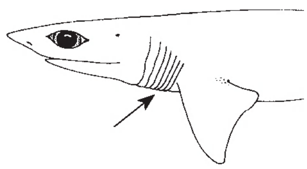


Fig. 29 *Heptranchias*

Heptranchias Rafinesque, 1810

Genus: ***Heptranchias*** Rafinesque, 1810, *Caratt. gen. sp. animal. piant. Sicilia,* pt. 1: 13.

Type species: "***Squalus cinereus*** Lacépède" by original designation, equals ***S. cinereus*** Gmelin, *in* Linnaeus and Gmelin, 1789 and a junior synonym of ***Squalus perlo*** Bonnaterre, 1788.

Number of Recognized Deep–sea Indian Ocean Species: 1.

Synonyms: Genus ***Heptanchus*** Müller and Henle, 1837a: 115; Müller and Henle, 1837b: 398; Müller and Henle, 1838a: 88; Müller and Henle, 1838b: 64 (two species, but names not mentioned); Müller and Henle, 1839: 81. Type species not designated, two species named, ***H. cinereus*** "Raf." (Rafinesque, = ***Squalus cinereus*** Gmelin, 1789, a junior synonym of ***S. perlo*** Bonnaterre, 1788) and ***H. indicus*** Müller and Henle, 1839 (= ***Notidanus indicus*** Agassiz, 1835, usually ascribed to the genus ***Notorynchus***). Genus ***Heptancus*** Agassiz, 1846: 178; Agassiz, 1848: 514 (emended spelling of ***Heptanchus*** "Rafinesque" and ***Heptranchias*** Rafinesque, 1810, cited as such); Jordan and Gilbert, 1883: 34. Genus ***Heptranchus*** Gray, 1851: 6 (emended spelling). Genus ***Heptrancus*** Costa, 1857: 5 (29) (emended spelling). Type species, ***Heptrancus angio*** Costa, 1857, by monotypy? Genus ***Heptabranchias*** Garman, 1884e (in part): 537, 538; Garman, 1888: 58, 67, 68, 72, 82, pl. 14. Possible emendation of ***Heptranchias*** Rafinesque, 1810, and ***Heptanchus*** Müller and Henle, 1837a. No type species indicated.

Diagnostic Features: Head acutely pointed in dorsoventral view, compressed and rounded or vertically oval in section at eyes. Eyes large. Seven paired gill openings. Mouth very narrow and angular–parabolic. Five rows of lower comb–shaped anterolateral teeth on each side; these long and low, with a few short mesial cusplets, and an abruptly high cusp, up to 7 or 8 distal cusplets in adults that increase and then decrease in size distal to cusp; total tooth counts including smaller posteriorlateral teeth 23 to 43 upper jaw, 20 to 33 lower jaw. Caudal peduncle elongated. Lateral line canal closed. Clasper apopyle dorsal, clasper groove and hypopyle dorsolateral; hypopyle without a lateral flap on its dorsal edge; clasper sack small, not pleated, not expanded far onto dorsomedial surface of clasper, and without a large dorsal fold; clasper with three enlarged mucous glands with corrugated surfaces along the clasper groove, a dorsal gland near the apopyle, a ventral gland on midlength of clasper, and a terminal gland at the clasper tip; clasper shaft large and stout. Vertebral counts: total vertebral counts 141 to 159, precaudal vertebral counts 72 to 94, monospondylous vertebral counts 51 to 58, diplospondylous vertebral counts 28 to 38, caudal vertebral counts 60 to 67. Intestinal valve count ranges from 18 to 22. Maximum total length 139 cm. **Colour:** uniform pale grey to olive above, lighter to white below; spots absent from body, dorsal fin and upper caudal–fin lobe with black tips, faded or absent in adults but prominent in young.

Local Names: Sharpnose sevengill shark.

Remarks: Following Garrick and Paul (1971), Bass, D'Aubrey and Kistnasamy (1975c), Ebert (1990) and Ebert and Compagno (In press), only a single wide–ranging species is recognized for this genus, ***Heptranchias perlo*** (Bonnaterre, 1788). Earlier references (Bigelow and Schroeder, 1948; Whitley, 1931) to other regional species within this genus prove to be related to sexual dimorphism with the position of the anal fin (more posterior in males than in females) relative to the dorsal fin (Garrick and Paul, 1971; Bass, D'Aubrey and Kistnasamy 1975c; Ebert, 1990).

Heptranchias perlo (Bonnaterre, 1788)

Squalus perlo Bonnaterre, 1788, *Tabl. encyclop. method. trois reg. Nat., Ichthyol., Paris*: 10. Holotype unknown. Type locality: "La Méditerranée", = Mediterranean Sea.

Synonyms: ***Squalus cinereus*** Gmelin, *in* Linnaeus and Gmelin, 1789: 1497. Holotype unknown. Type locality "in Mari Mediterraneo", = Mediterranean Sea. ***Squalus cinereus*** Walbaum, 1792: 517. No locality, independently proposed from ***S. cinereus*** Gmelin, 1789 and possibly not conspecific or confamilial according to Eschmeyer (2012). ***Heptrancus angio*** Costa, 1857: 5, pl. 13, 14, fig. 3. Existance of types uncertain. Type locality, Mediterranean Sea. ***Notidanus (Heptanchus) cinereus***, var. ***pristiurus*** (var. ***aetatis***) Bellotti, 1878: 60. Syntypes: Two, whereabouts unknown according to Eschmeyer (2012). Type locality, Mediterranean Sea. ***Heptranchias deani*** Jordan and Starks, 1901: 384. Holotype, Stanford University, Division of Systematic Biology, SU–12620, 954 mm TL adult (?) female, Misaki, Japan. ***Heptranchias dakini*** Whitley, 1931: 310. New name for ***Heptranchias perlo*** of McCulloch, 1911: 2, pl. 1, fig.1. Holotype as designated by Whitley is the female specimen figured by McCulloch, 1911, approximately 69 cm TL, one of seven specimens from off Cape Everard, southeastern Australia, in 110–128 m depth. This is possibly Australian Museum, Sydney, AMS I.10825 according to Paxton *et al.* (1989: 26) and Eschmeyer (2012), approximately 97 km South of Cape Everard, Victoria. Two other specimens (AMS I.10794–95) in the series are considered paratypes by Eschmeyer (2012).

Other Combinations: ***Heptanchus perlo*** (Bonnaterre, 1788), ***Heptanchus*** or ***Heptranchias cinereus*** (Gmelin, 1789).

FAO Names: En – Sharpnose sevengill shark; **Fr** – Requin perlon; **Sp** – Cañabota bocadulce.

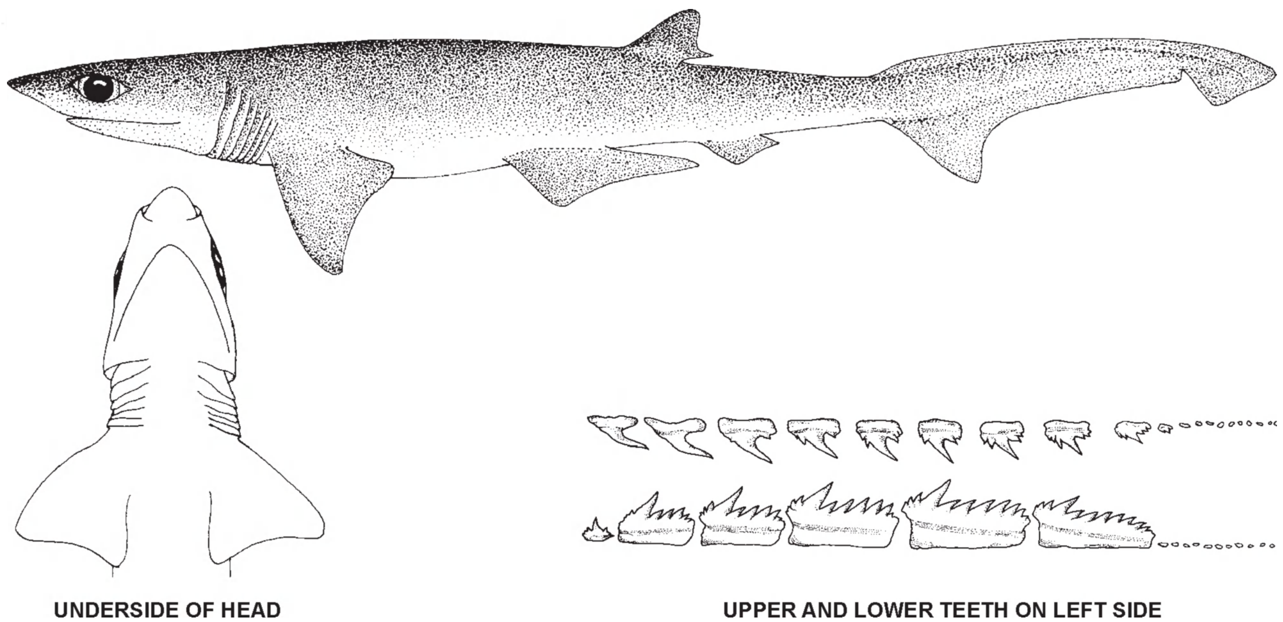


Fig. 30 ***Heptranchias perlo***

Field Marks: A narrow–headed, big–eyed, small seven–gilled shark with one dorsal fin, no dark spots, and a black blotch on the dorsal fin (inconspicuous in large individuals).

Diagnostic Features: See genus ***Heptranchias***.

Distribution: Wide–ranging but somewhat patchily distributed, the sevengill shark is found in most tropical and warm temperate seas except in the eastern Central and North Pacific. Indian Ocean: South Africa (Western Cape off Cape Agulhas, Eastern Cape, KwaZulu–Natal), southern Mozambique, Comores, Madagascar, Mascarine seamounts southeast of Madagascar, Mauritius–Seychelles area, Aldabra Island, Maldives, Gulf of Aden, southwestern India (Quilon), Sri Lanka, Indonesia (Bali, Java), Australia (Western Australia).

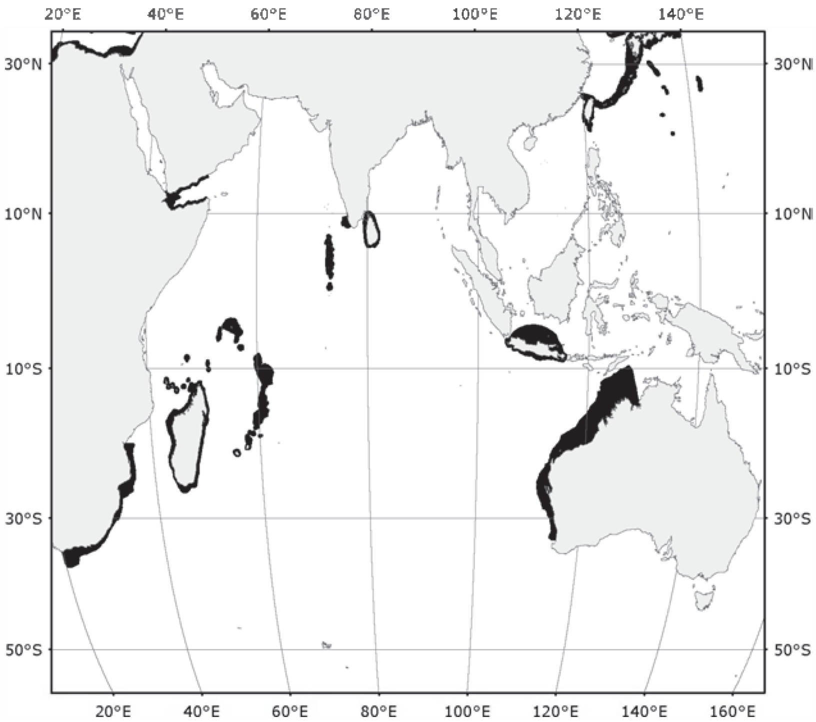


Fig. 31 *Heptranchias perlo*

Known distribution

Habitat: A primarily deepwater benthic and epibenthic species on the continental and insular shelves and upper slopes. Possibly moving well off the bottom but details little known. Depth mostly between 27 to 720 m, but usually below 100 m and down to 1000 m, although sometimes in shallower water close inshore.

Biology: Yolk–sac viviparous, with 6 to 20 young per litter. In the Mediterranean Sea and off Japan these sharks seem to be reproductively active throughout the entire year. Very little else is known about its reproductive biology.

Their diet includes crustaceans, mostly shrimps, crabs, lobsters, and cephalopods including squid (Ommastrephidae and Loliginidae) and cuttlefish (Sepiidae), and a wide variety of small to moderately large demersal and pelagic bony fishes, including lanternfishes (Myctophidae), lightfishes (Phosichthyidae), cods (Gadidae), lings (Phycidae), hake (Merluccidae), grenadiers (Macrouridae), roughies (Trachyichthyidae), hairtails (Trichiuridae), jack mackerel (***Trachurus,*** Carangidae), scorpionfish (Scorpaenidae), flatfish (Citharidae), dragonets (Callyonymidae), and small elasmobranchs including catsharks (Scyliorhinidae), lanternsharks (***Etmopterus,*** Etmopteridae), smaller hexanchids (including other ***Heptranchias perlo***), and skates (Rajidae). The presence of pelagic bony fishes, cephalopods and crustaceans in their diet suggest that these sharks are feeding well off the bottom (Ebert, 1990). The narrow jaws and prominent narrow needle–sharp cusps and cusplets on the teeth of these sharks suggest that they are well equipped for grabbing, holding and swallowing small, soft–bodied prey, but less capable of dismembering large–bodied tough prey than ***Hexanchus griseus***.

Size: Maximum total length 139 cm; reports of it reaching a total length of 214 cm or over 300 cm in literature (see Bigelow and Schroeder, 1948) are most likely erroneous. Size at maturity varies slightly by region, but generally males adolescent between 70 and 78 cm, adult at 75 to 107 cm; females adolescent between 89 and 98 cm, but adult at 97 cm and larger. Size at birth is about 26 to 27 cm.

Interest to Fisheries and Human Impact: Of no importance commercially in the Indian Ocean, but occasionally caught in small numbers as a bycatch of fisheries utilizing bottom trawls or as part of deepwater fisheries using bottom longlines. Used for human consumption, said to be good eating, and presumably for fishmeal. There is no data available on current and past catches, although species–specific catch data is desirable.

Although this shark is very active, will snap vigorously when captured and may on occasion bite its captor, there are no records of it having attacked divers. Its deepwater habitat likely precludes it from coming into contact with divers. It has been maintained occasionally in captivity at public aquariums in Japan.

Conservation status is considered Near Threatened due to suspected declines that may have occurred in places such as southern Mozambique where deepwater demersal trawl fisheries for shrimp and bony fishes have been operational over the past few decades. This shark is wide–ranging but relatively uncommon in most places where it occurs, but may be affected by a wide variety of deepwater demersal fisheries.

Local Names: Perlon shark, Sharp–snouted seven–gilled shark, Sharpsnouted sevengill, Seven–gilled shark, Seven–gilled cow shark (English); Sharpnose sevengill shark, Skerpneus–sewekiefhaai (South Africa); Indonesia: Hiu areuy (Jawa Barat), Hiu kucing (Bali), Cucut kapukan (Jakarta).

Literature: Fowler (1936, 1941, 1967a); Whitley (1940); Bigelow and Schroeder (1948); Forster *et al.* (1970); Garrick and Paul (1971); Boeseman *in* Hureau and Monod (1973); Pissarro and Sanches (1973); Bass, D'Aubrey and Kistnasamy (1975c); Smith (1975); Tanaka and Mizue (1977a,b); Penrith (1978); Capapé (1980); Boeseman *in* Whitehead *et al.* (1984); Compagno (1984a); Compagno and Talwar (1985); Lloris (1986); Compagno *et al.* (1989); Ebert (1990); Compagno *et al.* (1991); Anderson and Ahmed (1993); Last and Stevens (1994, 2009); Frentzel–Beyme and Köster (2002); Paul and Fowler (2003b); Braccini (2008); Barnett *et al*. (2012); Ebert and Compagno (n press); D.A. Ebert (unpubl. data).

Hexanchus Rafinesque, 1810

Genus: ***Hexanchus*** Rafinesque, 1810, *Caratt. gen. sp. anim. piant. Sicilia, Palermo*, pt. 1: 14.

Type species: "***Squalus griseus*** Lacépède", by original designation, a junior synonym of ***Squalus griseus*** Bonnaterre, 1788.

Number of Recognized Deep–sea Indian Ocean Species: 2.

Synonyms: Subgenus ***Monopterhinus*** Blainville, 1816 (Genus ***Squalus*** Linnaeus, 1758): 121. Type species: ***Squalus griseus*** Blainville, 1816, by subsequent designation of Jordan and Evermann, 1917: 95. Subgenus ***Notidanus*** Cuvier, 1816 (Genus ***Squalus*** Linnaeus, 1758): 128. Type species, ***Squalus griseus*** Bonnaterre, 1788, by subsequent designation of Jordan and Evermann, 1917: 97. Genus ***Hexanchias*** Swainson, 1838: 148 (emended or erroneous spelling of ***Hexanchus*** Rafinesque, 1810). Genus ***Holodus*** Agassiz, 1845: 3; Agassiz, 1846: 183; Agassiz, 1848: 529. Attributed by Agassiz, 1845 to "Msc. Coll." and indicated as "= ***Notidanus***". Apparently a manuscript name without description, but a valid junior synonym of ***Notidanus*** Cuvier, 1816 and a senior homonym of the lungfish genus ***Holodus*** Pander, 1858 according to Jordan (1923: 97) and White and Moy–Thomas (1940: 101). Genus ***Notidamus*** Münster, 1842: 66 (erroneous or emended spelling of ***Notidanus*** Cuvier, 1816). Genus ***Hexancus*** Agassiz, 1846: 181; Agassiz, 1848: 522 (emended spelling of ***Hexanchus*** Rafinesque, 1810).

Diagnostic Features: Head narrowly or broadly parabolic in dorsoventral view, depressed and transversely oval in section at eyes. Eyes small to large. Six paired gill openings. Mouth moderately wide to very wide and parabolic or arcuate. Five or 6 rows of lower comb–shaped anterolateral teeth on each side, these long and low in adults but higher in young; mesial edge smooth in young but with serrations in adults; a low to moderately high cusp, 8 to 10 distal cusplets present in adults that decrease in size distal to the cusp; total tooth counts including smaller posteriorlateral teeth 25 to 46 upper jaw, 15 to 38 lower jaw. Caudal peduncle is short to elongated. Lateral line canal closed. Clasper apopyle ventral, clasper groove ventral, hypopyle ventrolateral; hypopyle with a large triangular lateral flap on its dorsal edge; clasper sack greatly enlarged and baglike, pleated, expanded far onto dorsomedial surface of clasper and outside clasper sheath, and with a large dorsal fold; clasper without mucous glands; clasper shaft slender. Vertebral counts: total vertebral counts 118 to 155, precaudal vertebral counts 67 to 87, monospondylous vertebral counts 41 to 57, diplospondylous vertebral counts 18 to 30, caudal vertebral counts 50 to 77. Intestinal valve counts 22 to 39. Maximum size depending on the species can be either about 180 or up to 500 cm or more in length. **Colour:** body without spots or with irregular brown spots, no black tips on fins.

Local Names: Sixgill sharks.

Remarks: Following Springer and Waller (1969), Bass, D'Aubrey and Kistnasamy (1975c), Compagno (1984a), Ebert (1990), Taniuchi and Tachikawa (1991), and Ebert and Compagno (In press), two living species are presently recognized here for this genus, ***Hexanchus griseus*** (Bonnaterre, 1788) and ***H. nakamurai*** Teng, 1962 (senior synonym of ***H. vitulus*** Springer and Waller, 1969). However, a recent molecular study (Naylor *et al*., 2012) suggested that two species of bigeyed sixgill shark might indeed exist; an Atlantic form (?***H. vitulus***) and an Indian Ocean form (?***H. nakamurai***).

Key to Deep–sea Indian Ocean Species:

1a. Snout shorter, blunt and broad; lower jaw usually with 6 rows of large, comb–like anterolateral teeth on each side; dorsal–fin base separated from upper caudal–fin origin by a distance about equal to or slightly greater than its length; size very large, up to 470 cm TL (Fig. 32) . . . . ***Hexanchus griseus***

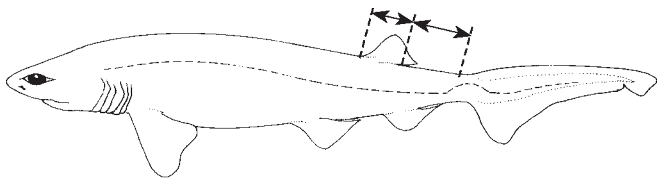


Fig. 32 ***Hexanchus griseus***

1b. Snout longer, more pointed and narrow; lower jaw usually with 5 rows of large, comb–like anterolateral teeth on each side; dorsal–fin base separated from upper caudal–fin origin by a distance much greater than its length; size smaller, up to 180 cm TL (Fig. 33) . . . . ***Hexanchus nakamurai***

Fig. 33 ***Hexanchus nakamurai***

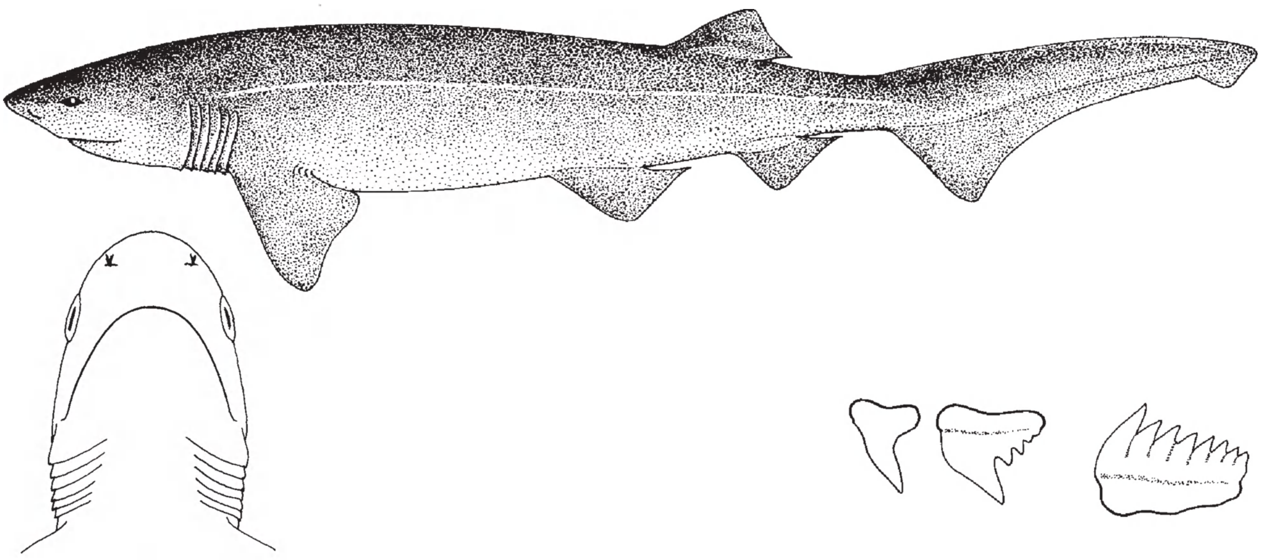
Hexanchus griseus (Bonnaterre, 1788)

Squalus griseus Bonnaterre, 1788, *Tabl. encyclop. method. trois reg. Nat., Ichthyol., Paris:* 9. Types unknown according to Boeseman *in* Hureau and Monod (1973, *CLOFNAM. Check–list. fish. NE Atlantic Mediterranean,* 1: 9). Type locality: "La Méditerranée", = Mediterranean Sea.

Synonyms: None.

Other Combinations: ***Notidanus griseus*** (Bonnaterre, 1788).

FAO Names: En – Bluntnose sixgill shark; **Fr** – Requin griset; **Sp** – Cañabota gris.



UNDERSIDE OF HEAD

UPPER AND LOWER TEETH

Fig. 34 ***Hexanchus griseus***

Field Marks: A heavy–bodied, broad–headed sixgill shark with a ventral mouth with 6 rows of lower bladelike, comb–shaped teeth on each side, one dorsal fin, a dark pupil prominently ringed with white, colour grey or tan to blackish with a conspicuous lighter lateral line and sometimes with darker spots on the sides and underside often lighter than the dorsal surface in newborn young but more uniform in larger juveniles and adults.

Diagnostic Features: Head broadly parabolic or bluntly pointed in dorsoventral view. Snout bluntly rounded to rounded–angular in dorsoventral view, preoral length shorter and 4.3 to 5.4% of total length. Eyes small. Mouth very broad with width over 2 times mouth length. Upper jaw and dental arcade is a rounded v–shape in ventral view. Six rows, usually, of lower comb–shaped anterolateral teeth; total tooth counts, including smaller posterior lateral teeth 26 to 46 upper jaw, 19 to 38 lower jaw. Body rather stout, body and fins very soft and supple. Caudal peduncle is short and stout. Pectoral fins broadly triangular. Ventral caudal–fin lobe poorly developed at all stages, postventral margin weakly concave to straight and not subdivided. Vertebral counts: total vertebral counts 118 to 148, monospondylous precaudal vertebral counts 41 to 52, diplospondylous vertebral counts 18 to 30, precaudal vertebral counts 67 to 77, and caudal vertebral counts 50 to 77. Intestinal valve counts 35 to 39. A giant shark, with a maximum length of at least 482 cm. **Colour:** body not sharply bicoloured (except in some neonatal animals), either dark above and below or with underside somewhat lighter than dorsal surface; fins with light posterior margins but not abruptly white (except in some neonates).

Distribution: Wide–ranging but patchily distributed in boreal, temperate and tropical seas, possibly absent in the Arctic and Antarctic oceans. Indian Ocean: off South Africa (Western and Eastern Cape, KwaZulu–Natal), southern Mozambique, Madagascar, Aldabra Island group (Aldabra and Assumption Islands, Zèlée and Geyser Banks, Cosmoleto Islands), Reunion Island, Comores Islands, Somalia, Maldives, India, Sumatra, and Australia (northern Western Australia and Tasmania).

Habitat: This is a mostly deepwater benthic and pelagic shark of the continental and insular shelves and slopes and off seamounts and underwater ridges, found close to and well off the bottom. Occurs at the surface in the tropics and close inshore near beaches, at the heads of submarine canyons, and in bays in cold temperate waters, but extending down to at least 2500 m on the upper continental slope. It may show equatorial submergence in the tropics as with some other deepwater sharks, and may not normally penetrate warm tropical inshore waters although it has been known to rise to the surface offshore in response to fishing operations.

Young are often found close inshore, occasionally in enclosed bays; adults, especially males are often in deeper water below 200 m in temperate areas, although adults and sub adults will enter shallow water in open and enclosed bays with adjacent deep–water canyons. These sharks are often associated with areas of upwelling and high biological productivity. Hydrographic data variously taken in areas where bluntnose sixgill sharks occur reveals a bottom temperature of 6.1 to 10.0 °C in waters with high nutrient levels.

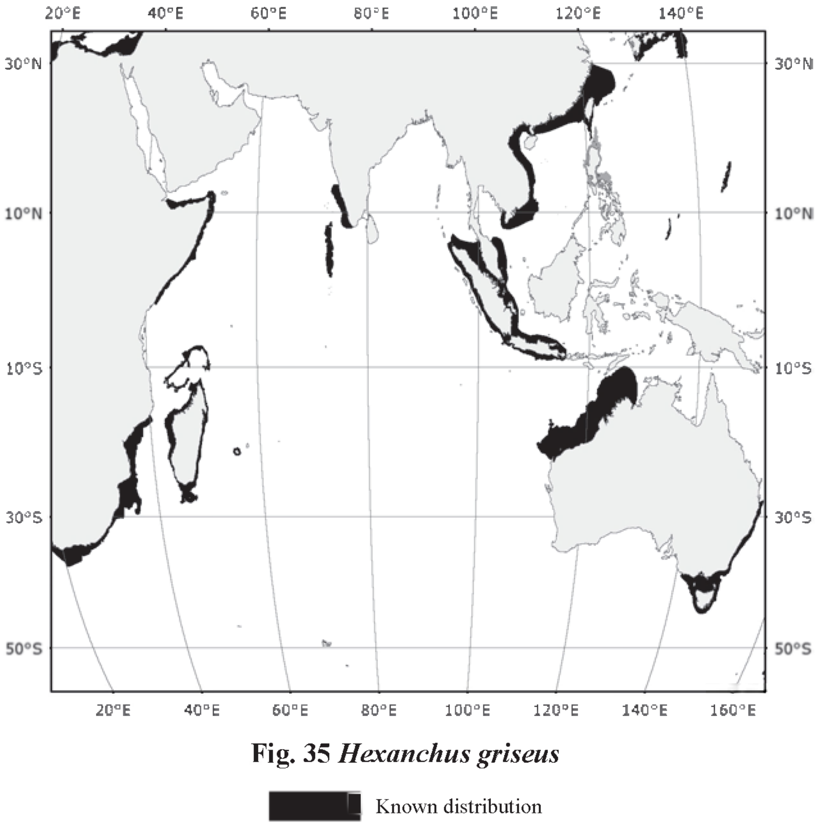


Fig. 35 *Hexanchus griseus*

Biology: Yolk–sac viviparous, with litters very large, 47 to 108. Reproductive cycle poorly defined, but may be biannual with females having a 12 month resting phase followed by a 12 month gestation period. Pupping grounds occur on the upper slopes and outer continental shelves; the Bay of Biscay may be one such pupping area as neonate bluntnose sixgill sharks appear seasonally (Desbrosses, 1938). Ebert (1994, 2002, 2003) suggested that this shark segregates over its life cycle with neonates living near the bottom on the upper slopes, outer shelves, and in high latitude nearshore areas where the continental shelf is relatively narrow to the continental landmass. Neonates and younger bluntnose sixgills feed largely on cephalopods and teleosts, but with growth in size, larger individuals move into deeper water and feed on a wide range of benthic and pelagic marine vertebrates and cephalopods. This species may be long–lived but it has yet to be aged. A study by McFarlane *et al.* (2002) found bands on the neural arches of these sharks, but were unable to determine if they were related to age.

The bluntnose sixgill shark is a voracious feeder consuming a wide range of marine organisms, but principally cephalopods and marine vertebrates, with cartilaginous fishes, bony fishes, marine mammals and cephalopods being the most important prey categories. It eats other cartilaginous fishes including catsharks (Scyliorhinidae), spurdogs (***Squalus***, Squalidae), houndsharks (Triakidae), skates (Rajidae), elephantfish (Callorhinchidae), hooked conspecifics (which it attacks and sometimes follows up to the surface from deep water); demersal and pelagic bony fish including anchovies (Engraulidae), sardines and round herrings (Clupeidae), lanternfish (Myctophidae), hake (Merlucciidae), cod and ling (Gadidae), grenadiers (Macrouridae), mackerel (Scombridae), snoek (***Thyrsites***, Gempylidae), swordfish (Xiphiidae), marlins (Istiophoridae), dolphinfishes (Coryphaenidae), flounders (Pleuronectidae), gurnards (Triglidae) and anglers (Lophiidae); marine mammals including unspecified seals (probably phocids), South African fur seals (***Arctocephalus p. pusillus***, Otariidae), and dolphins (Delphinidae); carrion; gastropods, squids (Ommastrephidae and Loliginidae), crabs, and shrimps.

The diet of bluntnose sixgill sharks changes with growth as those below 120 cm feed primarily on cephalopods and secondarily on bony fish, with very little chondrichthyan prey evident, while those 120 to 200 cm long feed primarily on cephalopods, bony fishes and chondrichthyans with small marine mammals comprising a small component. Large sixgills, those above 200 cm, feed primarily on marine mammals (South African fur seals and cetaceans) and large pelagic teleosts, with smaller components of cartilaginous fishes and cephalopods (Ebert, 1994). An indication of the voracious dietary nature of these sharks was demonstrated by an electric ray (***Torpedo*** cf. ***nobiliana***) that had the distinct scars of an immature ***Hexanchus griseus***, estimated at about 100 cm in length, but apparently was able to fend off the attacking predator by discharging an electric shock to halt the attack. A larger bluntnose sixgill likely would have been more successful. Sixgills apparently feed on the bottom and well above it, and may be able to take large active prey such as eared seals, cetaceans, and large pelagic bony fishes by stealthy stalking them. This is an infrequently taken bycatch species on pelagic longlines where these sharks are often caught hundreds of meters off the bottom.

Bluntnose sixgill sharks in some areas exhibit both seasonal and diurnal activity with these sharks appearing in high concentrations during summer months, but disappearing during the rest of the year. When present, these sharks appear to respond to environmental signals whereby they move onto relatively shallow reefs during the afternoon, but retreat later in the day. The wide bathymetric and geographic range of the species, the large size of adults, its ability to prey on pelagic organisms, and its scattered occurrence off seamounts and oceanic islands and well away from the bottom suggest that it may be capable of long–distance migration in the open ocean.

Larger captive individuals become greatly disturbed at even moderately high light levels, indicating a great sensitivity to light at very low levels, while those attracted to baits near submersibles either did not react or gave a minor to violent response when the lights were turned on. Smaller individuals in public aquaria appear to adapt better to artificial light with some individuals having been maintained for nearly a year. Large individuals offer little resistance when captured, but small ones may snap and thrash vigorously when boated.

The bluntnose sixgill shark has been observed both singly and in groups, and will readily attack conspecifics especially if injured, however very little else is known of their social behaviour.

Size: Maximum total length at least 482 cm and probably to about 550 cm (large, possibly gravid female sighted from a submersible). Males immature up to 281 cm, adolescent at 273 to 308 cm, mature at 309 to 330 cm and possibly reaching about 430 cm; females immature up to 320 cm, possibly adolescent or newly mature at 350 to 420 cm, mature at 421 cm, and reaching about 550 cm. Size at birth about 61 to 74 cm.

Interest to Fisheries and Human Impact: Bluntnose sixgill sharks are typically taken by line gear, gillnets, traps and pelagic and bottom trawls and utilized fresh, frozen, and dried and salted for human consumption, and for fishmeal and oil. These sharks are largely caught as a bycatch of other fisheries.

The global conservation status of the bluntnose sixgill shark is listed as Near Threatened. Although the species is taken in small numbers regionally, mostly as retained bycatch in other fisheries, there is inadequate population and fisheries data to show declines in its population.

Local Names: Sixgill shark, Six–gilled shark, Cow shark, Mud shark (English); Seskiefhaai (South Africa); Indonesia: Cucut meong (Jawa), Hiu tahu putih (Lombok).

Remarks: The bluntnose sixgill shark is one of the most common and wide–ranging shark species worldwide, ranking alongside the picked or spiny dogfish (***Squalus acanthias***) and blue shark (***Prionace glauca***). Small ***Hexanchus griseus***, usually less than 120 cm in length, may be confused with the bigeyed sixgill shark, ***H. nakamurai***.

Nominal regional names all appear to be referable to ***Hexanchus griseus*** based on the study by Ebert (1990) who examined available type material and collected morphological and meristic data from most geographic regions where this shark is known to occur.

Literature: Fowler (1936, 1941, 1967a); Bigelow and Schroeder (1948); Smith (1949); Fourmanoir (1961); Lynch (1964); Springer and Waller (1969); Forster *et al*. (1970); Boeseman *in* Hureau and Monod (1973); Bass, D'Aubrey and Kistnasamy (1975c); Smith (1975); Penrith (1978); Bass (1979); Boeseman *in* Whitehead *et al*. (1984); Compagno (1984a); Ebert (1984, 1986a, b, 1990, 1994, 2002, 2003); Lloris (1986); Compagno, Ebert and Smale (1989); Compagno, Ebert and Cowley (1991); Anderson and Ahmed (1993); Last and Stevens (1994, 2009); Cox and Francis (1997); McFarlane *et al*. (2002); Cook and Compagno (2005); Akhilesh *et al.* (2010); Barnett *et al*. (2012); Ebert and Compagno (In press); D.A. Ebert (unpubl. data).

2.2 Order SQUALIFORMES – Dogfish sharks

Order: Squali, suborder Squali: Gill, 1862, *Ann. Lyc. Nat. Hist. New York*, 7: 367, 394, 396.

Number of Recognized Deep–sea Indian Ocean Families: 7.

Synonyms: Part 1 Squali, Abtheilung [Division] 4: Müller and Henle, 1839, *Syst. Besch. Plagiost*. (2): 83. Ordo Plagiostomi, subordo Squalini, Sectio Aproctopterides: Bleeker, 1859: xii. Order Squali, suborder Galei: Gill, 1872: 23, 24. Order Plagiostomi Diplospondyli, suborder Plagiostomi Cyclospondyli, group 1. Laemargi: Hasse, 1879: 41. Order Plagiostomi Diplospondyli, suborder Plagiostomi Cyclospondyli, group 2. Spinacidae: Hasse, 1879. Order Plagiostomi Diplospondyli, suborder Plagiostomi Cyclospondyli, group 3. Echinorhini: Hasse, 1879: 41. Order Selachii, suborder Tectospondyli: Woodward, 1889: 30. Order Tectospondyli: Gill, 1893: 129. Order Cyclospondyli, suborder Cyclospondyli: Jordan and Evermann, 1896: 52, 53. Order Euselachii, suborder Pleurotremata, division Squaloidei: Regan, 1906a: 723. Order Selachii, group 2, division B, subdivision 2, suborder Squaliformes: Goodrich, 1909: 151. Order Plagiostoma, suborder Antacea, “group” Squaloidei: Garman, 1913: 11, 13. Order Pleurotremata, suborder Squaloidei: Engelhardt, 1913: 100. Order Tectospondyli, suborder Squaloidei: Jordan, 1923: 101. Order Plagiostomi, suborder Squaliformes or Esqualiformes: Lozano y Rey, 1928: 281. Order Squalea, suborder Squalida, superfamily Squaloidea: White, 1936: 5; White, 1937: 37, tab. 1. Order Euselachii, suborder Squaliformes: Bertin, 1939: 10. Order Squaliformes: Berg, 1940, *Trudy Zool. Inst. Akad. Nauk SSSR*, 5(2): 138 (for squaloids, pristiophoroids, and squatinoids); Berg and Svetovidov, 1955, *Trudy Zool. Inst. Akad. Nauk SSSR*, 20: 68 (for squaloids and squatinoids); Arambourg and Bertin, 1958: 2041; Rass and Lindberg, 1971: 304; Lindberg, 1971: 259; Compagno, 1973a: 26; Applegate, 1974: 743; Nelson, 1976: 38; Chu and Meng, 1979: 114, tab. 2; Pfeil, 1983: 24; Compagno, 1984a: 24; Nelson, 1984: 56; Gubanov, Kondyurin and Myagkov, 1986: 3, 168; Cappetta, 1987: 26, 50; Eschmeyer, 1990: 437; Shirai, 1992a: 122; Nelson, 1994: 54; de Carvalho, 1996: 55; Shirai, 1996: 33; Eschmeyer, 1998. Order Squaliformes, Suborder Squaloidei: Berg, 1940: 138; Berg and Svetovidov, 1955: 68; Arambourg and Bertin, 1958: 2042; Lindberg, 1971: 259; Nelson, 1976: 38; Nelson, 1984: 56; de Carvalho, 1996. Order Tectospondyli, suborder Squaloidei, superfamily Squaloidea: Whitley, 1940: 69. Order Cyclospondyli Fowler, 1941: 4, 222; Smith, 1949: 37, 55. Order Selachii, suborder Squaloidea: Romer, 1945: 577; Bigelow and Schroeder, 1948: 77, 449; Romer, 1966: 350; Order Squaloidea, suborder Squaloidea: Schultz and Stern, 1948: 225. Order Lamnida, suborder Squalina: Matsubara, 1955: 1–789. Order Pleurotremata, suborder Squaloidea: Norman, 1966: 24. Order Squatiniformes, suborder Squaloidei: Glikman, 1967: 215. Order Squatiniformes, suborder Echinorhinoidei: Glikman, 1967: 215. Order Lamniformes, suborder Squaloidei: Patterson, 1967: 670. Order Squalida, suborder Squalina: Fowler, 1968: 203, 204. Order Squalida, suborder Squalina, superfamily Squalicae: Fowler, 1968: 203, 204. Order Euselachii, suborder Squaloidei: Blot, 1969: 702–776. Order Squalida, suborder Squalina, superfamily Echinorhinicae: Fowler, 1969: 73. Order Pleurotremata, suborder Squaliformes: Budker and Whitehead, 1971: 6, tab. 2. Order Squaliformes, suborder Squaloidea: Chu and Meng, 1979: 114, tab. 2. Order Squaliformes, suborder Dalatioidea: Chu and Meng, 1979: 114, tab. 2. Order Squaliformes, suborder Echinorhinoidea: Chu and Meng, 1979: 114, tab. 2. Order Echinorhiniformes: Pfeil, 1983: 24; Shirai, 1992a: 122; de Carvalho, 1996: 55; Shirai, 1996: 33. Order Dalatiiformes: Shirai, 1992a: 122; Shirai, 1996: 33. Order Centrophoriformes: Shirai, 1992a: 122; Shirai, 1996: 33. Order Squalomorpha, suborder Squaloidea: Carroll, 1988: 599. Order Squaliformes, suborder Dalatioidei: de Carvalho, 1996: 55.

FAO Names: En – Dogfish sharks; **Fr** – Squales; **Sp** – Galludos.

Field Marks: Small to very large sharks with a cylindrical or compressed body, a flattened or conical snout, five paired lateral gill openings, two dorsal fins with or without spines, and no anal fin.

Diagnostic Features: Head conical to moderately depressed, but not expanded laterally. Snout short to moderately long, conical to moderately depressed, not laterally expanded and without sawteeth or rostral barbels. Eyes lateral or slightly dorsolateral on head, without nictitating lower eyelids, secondary lower eyelids or subocular pouches; upper eyelids not fused to eyeballs. Spiracles small to very large, close behind and about opposite level of eyes. Five pairs of gill openings present on sides of head, last in front of pectoral–fin origins. Nostrils transverse on snout, without separate barbels but with anterior nasal flaps expanded into barbels and reaching mouth in ***Cirrhigaleus barbifer*** but not in other squaloids; nasoral grooves and circumnarial grooves and folds absent from nostrils. Mouth small to large, usually subterminal on head (terminal in ***Trigonognathus***), Y–shaped, narrowly to broadly arched and parabolic to transverse and nearly straight, ending below or behind eyes. Labial furrows well developed on both jaws. Teeth weakly to strongly differentiated along the jaws, with (***Trigonognathus***) or usually without enlarged anterior teeth and without enlarged molariform posterior teeth; without a gap or small intermediate teeth between anterior and lateral teeth in the upper jaw. Trunk cylindrical to slightly depressed or somewhat compressed but not depressed and ray like. Tail without long thick lateral dermal folds that reach to caudal base but sometimes with short caudal keels. Denticles covering almost entire body (sparsely distributed in one species of ***Centroscyllium***), usually not enlarged as thorns or spines (except in ***Echinorhinus brucus***). Pectoral fins small to moderately large, not expanded and ray–like, without triangular anterior lobes that cover the gill slits. Pelvic fins small to moderately large, inner margins continuous with margin of vent. Two dorsal fins present, with spines on both fins in many taxa, a spine on the first dorsal fin only in one genus (***Squaliolus***), and spines absent in most Dalatiidae and some Somniosidae; origin of first dorsal fin varying from over the pectoral–fin bases or gill slits to over the anterior halves of the pelvic–fin bases. Anal fin absent. Caudal fin with a moderately long dorsal lobe and the ventral lobe absent to strong. Vertebral counts: total vertebral counts 35 to 131, precaudal vertebral counts 44 to 95, monospondylous vertebral counts 29 to 67, diplospondylous vertebral counts 4 to 49, and caudal vertebral counts 50 to 82. Intestinal valve of conicospiral or ring type, with 4 to 42 turns.

Dwarf to very large sized sharks with adults ranging from 22 cm to 600 cm or more in length. **Colour:** variable but may range from light to very dark hues or with intermediate shades of grey, brown, or black; some species uniformly coloured, while others are lighter below; prominent markings such as spots are present on some species, while others are relatively plain coloured.

Distribution: Circumglobal in tropical, temperate, cold boreal, polar and subantarctic marine waters. Most species occur in temperate and tropical seas and are most diverse in the Atlantic and Indo–West Pacific, and the least diverse in the eastern Pacific. Some of the small to moderate–sized oceanic species, and certain slope or epibenthic species, are circumglobal or wide–ranging. Many smaller benthic species have more limited ranges, with centres of endemicity in the North Atlantic and western Pacific.

Habitat: These sharks occur in most marine habitats from shallow enclosed and open bays, on continental shelves, slopes and rises of continental and insular waters, on submarine ridges, and in epipelagic, mesopelagic and bathypelagic zones. They inhabit rocky reefs, estuaries, sandy beaches, and under pack ice in Arctic waters. They range in depth from the intertidal to the outer shelves, slopes and rises to below 4000 m. Dogfish sharks generally dominate deepwater benthic shark faunas in diversity and abundance, and are the only sharks present in polar seas.

Biology: Reproductive mode is yolk–sac viviparity, with litters ranging from 1 to perhaps 300 in some of the larger species. Dogfish feed on small to large bony fishes and invertebrates, with some of the larger species known to consume chondrichthyans and, at least as carrion, marine mammals. Many are formidable predators, having large teeth and efficient cutting dentitions, with the lower teeth or teeth of both jaws forming a saw–like cutting edge. A few species are facultative parasites, and core plugs of flesh out of other chondrichthyans, large bony fishes, seals, and cetaceans. Dogfish sharks are active to sluggish swimmers and highly varied in size, however most species are small. Information on movements is limited or absent for most species; the picked dogfish (***Squalus acanthias***) is migratory, and changes habitat seasonally. Many dogfishes are social and are found in aggregates or schools, some of which are huge, but the sociobiology of most species is poorly known as is most other aspects of their behaviour.

Interest to Fisheries and Human Impact: Several members of this shark group are of moderate to major importance to fisheries, particularly members of the Squalidae. Some species are regular components of targeted shark fisheries and as utilized or discarded bycatch of other fisheries targeting teleost fishes or marine invertebrates. These sharks are caught in bottom and pelagic trawls, in fixed and pelagic gillnets, in fish traps, on bottom longlines, with harpoons, with hook and line and rod and reel. Several species are used for human consumption; the flesh of some species is excellent. Most squaloids are small (less than 100 cm long), have relatively small fins, and seem to have very limited importance for the oriental soup–fin trade.

The conservation status for the majority of squaloids is Least Concern or Data Deficient due to a lack of life history information and data on population trends. However, several species are considered Endangered to Critically Endangered due to impacts from either targeted or non–targeted fishing.

Local Names: None.

Remarks: The arrangement of the order as restricted here follows Ebert and Compagno (In press) in recognizing seven families in the order.

Key to Deep–sea Indian Ocean Families:

1a. First dorsal fin originating posterior to pelvic–fin origins (Fig. 36). . . . . **family Echinorhinidae**

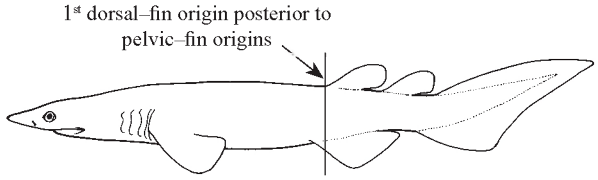


Fig. 36 *Echinorhinus*

1b. First dorsal fin originating anterior to pelvic–fin origins (Fig. 37) **2**

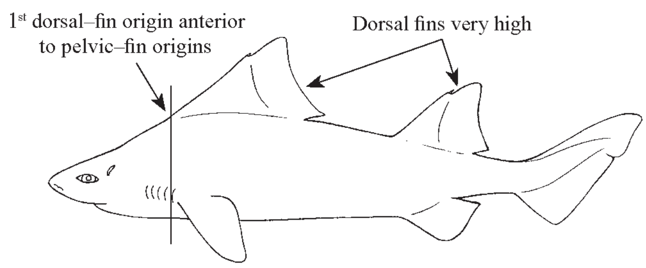


Fig. 37 *Oxynotus*

2a. Body very high and compressed, triangular in cross–section. Dorsal fins extremely high (Fig. 37) . . . . **family Oxynotidae**

2b. Body low and more cylindrical in cross–section. Dorsal fins low **3**

3a. Dorsal–fin spines without grooves. Teeth similar in both jaws. Upper precaudal pit usually present on caudal–fin base; strong lateral caudal keels always present on caudal peduncle. Subterminal notch absent from caudal fin (Fig. 38) . . . . **family Squalidae**

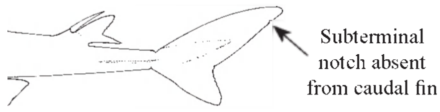


Fig. 38 ***Squalus***

3b. Dorsal–fin spines, if present, with lateral grooves. Teeth dissimilar in upper and lower jaws. Upper precaudal pit absent from caudal–fin base (Fig. 39); strong lateral caudal keels generally absent. Subterminal notch present on caudal fin **4**

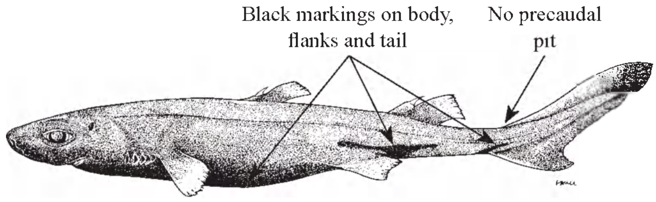
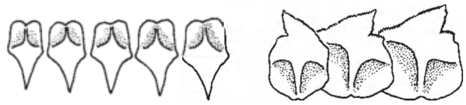


Fig. 39 ***Etmopterus***

4a. Underside of body, flanks, and tail usually with more or less conspicuous black markings with light organs (photophores)(Fig. 39) . . . . **family Etmopteridae**

4b. Underside of body, flanks, and tail without conspicuous black markings with light organs (photophores). **5**

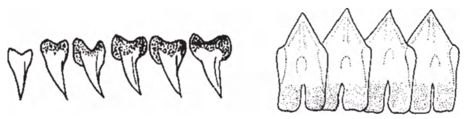


UPPER AND LOWER TEETH

Fig. 40 ***Centrophorus***

5a. Upper teeth relatively broad and bladelike, lowers low and wide (Fig. 40) . . . . **family Centrophoridae**

5b. Upper teeth relatively narrow and not blade–like, lowers high and wide (Fig. 41) **6**



UPPER AND LOWER TEETH

Fig. 41 ***Isistius***

6a. Head moderately broad and somewhat flattened or conical. Snout flat and narrowly rounded to elongate–rounded in dorsoventral view. Both dorsal fins either with or without fin–spines (Fig. 42). . . . . **family Somniosidae**

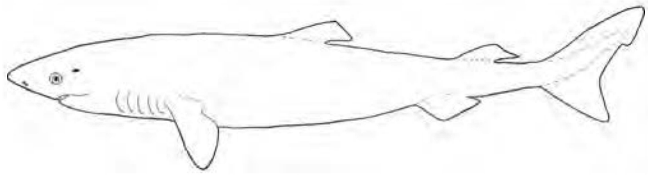


Fig. 42 ***Somniosus***

6b. Head narrow and rounded–conical; snout conical and narrowly rounded to elongate–rounded in dorsoventral view. Most genera lack dorsal–fin spines, except for a small spine present on the first dorsal fin of ***Squaliolus*** (Fig. 43) . . . . **family Dalatiidae**

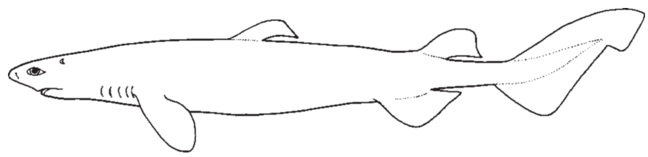


Fig. 43 ***Dalatias***

2.2.1 Family ECHINORHINIDAE

Family: Echinorhinoidae Gill, 1862, *Ann. Lyceum Nat. Hist. New York*, 7(32): 406.

Type genus: ***Echinorhinus*** Blainville, 1816. Emended to family Echinorhinidae by Gill, 1893, *Natn. Acad. Sci. USA, Mem.* 6, 6: 129.

Number of Recognized Deep–sea Indian Ocean Genera: 1.

Synonyms: None.

FAO Names: En – Bramble sharks; **Fr** – Squales boucles; **Sp** – Tiburones espinosos.

Field Marks: Short–nosed and flat–headed with a cylindrical, heavy–body. Short–tailed with no anal fin. Two small, spineless, posterior dorsal fins, the first behind the pelvic–fin origins, and covered with coarse spiky denticles or enlarged tack–like thorns.

Diagnostic Features: Head broad and flat. Snout flat and broadly rounded in dorsoventral view. Spiracles very small and far behind eyes. Fifth gill opening much larger than first four. Nostrils wide–spaced with internarial width much greater than nostril width; nostrils with small, simple anterior nasal flap. Mouth broadly arched, elongated, with thin, non–papillose lips. Labial furrows short, not encircling mouth, confined to mouth corners and falling well behind level of eyes, not elongated posteriorly into postoral grooves or anteriorly into preoral grooves. Labial folds thin and not papillose. Teeth with dignathic heterodonty, poorly developed, upper teeth about as large as lowers. Teeth of both jaws compressed, low–crowned, broad, bladelike, and forming a saw–like cutting edge, not arranged in a quincunx pattern but forming a single flat non–imbricated series in either jaw. Teeth with an oblique compressed, sharp–edged cusp (smooth–edged, undulated or serrated); one to three (usually two) pairs of mesial and distal cusplets on anterolateral teeth of adults (absent mesially and distally replaced by a blade in posterior teeth) but cusplets absent in young which have undivided mesial edges and distal blades on most teeth. Total tooth row counts 18 to 28 upper jaw, 18 to 27 lower jaw. Trunk broad and cylindrical with a circular cross section. Abdomen with weak lateral ridges. Interdorsal space very short and less than half the length of first dorsal–fin base. Pelvic–caudal space very short and less than half length of pelvic–fin bases. Caudal peduncle compressed, very short, and without lateral keels and precaudal pits. Body without photophores. Denticles large to enormous, sessile and not pedicellate. Denticle crowns flattened and leaf–shaped, but with a median cusp. Pectoral fins low, broadly rounded–angular and not falcate or leaf–shaped, anterior margins moderately large and about equal to or somewhat smaller than the prespiracular length, rear tips rounded and not elongated. Pelvic fins about as large or slightly larger than pectoral fins, over twice area of dorsal fins. Claspers with a lateral spine only. Dorsal fins rounded–angular, not falcate, and without spines. First dorsal fin very small, with length less than prespiracular length. First dorsal–fin base over the pelvic–fin bases and origin behind the pelvic–fin origins. Second dorsal fin about as large as first dorsal fin, base mostly behind pelvic–fin bases with origin over to slightly anterior or posterior to pelvic–fin insertions. Caudal fin moderately heterocercal, with ventral lobe poorly developed in adults, but absent in young and with subterminal notch absent or barely indicated. Vertebral counts: total vertebral counts 86 to 102, monospondylous vertebral counts 50 to 59, precaudal vertebral counts 58 to 62. Intestinal valve with 8 to 16 turns. Adults from 150 cm to over 400 cm long. **Colour:** light grey to blackish, plain or mottled, without black photophore markings on tail.

Distribution: This family includes two large, inshore to deep–water species with a patchy but virtually circumglobal distribution in cold temperate to tropical seas.

Habitat: Bramble sharks are found on the continental and insular shelves and upper slopes, at the heads of submarine canyons, down to at least 1100 m, and on or near soft bottom substrate. They move up submarine canyons into shallow water and in cold–temperate areas with strong upwelling. They appear to occupy a similar habitat to sleeper sharks (***Somniosus***) and the bluntnose sixgill shark (***Hexanchus griseus***).

Biology: The biology of bramble sharks is sketchily known. They exhibit yolk–sac viviparity in their reproductive mode, but little else is known about their reproductive cycle. Bramble sharks are large, soft–bodied and sluggish, but are formidable bottom predators that reach a maximum size of 310 to 450 cm. They feed on a variety of benthic and neritic bony fishes, other sharks, chimaeroids, as well as crabs and cephalopods. They have a moderately large mouth, a very large and long pharynx, and are believed to suck in their prey by suddenly expanding their mouths and pharynxes.

Interest to Fisheries and Human Impact: Bramble sharks attain a large size (310 to 450 cm), and are uncommon to rare in most areas where they occur, hence they are of minimal interest to fisheries. They generally occur as a sporadic and largely unutilised bycatch of other fisheries, including those for other sharks, although targeted fisheries for bramble sharks have existed outside the North Atlantic, most notably from off of south–western India and Namibia. They are taken on longline gear, deepset gillnets, and bottom trawls. No world or local fisheries records are available for these sharks.

The conservation status is poorly known, but depending on the species is Data Deficient or Near Threatened.

Local Names: Bramble sharks, Alligator dogfish, Prickly sharks, Pineapple sharks.

Remarks: This family has a single living genus ***Echinorhinus*** with two valid species. The family and genus ***Echinorhinus*** is divergent from all other squaloids and has been placed in its own separate order (Echinorhiniformes) by some authors (Shirai, 1992a, 1996; de Carvalho, 1996; Nelson, 2006) or separate suborder (Echinorhinoidei) by others (Günther, 1870; Woodward, 1889, 1898; Zittel *et al*., 1902; Regan, 1906a; Goodrich, 1909; Bridge, 1910; Engelhardt, 1913; Hubbs and McHugh (1951); Bigelow and Schroeder, 1957; Norman, 1966; Nelson, 1976, 1984, 2006; de Carvalho, 1996) with the remaining families being placed in the suborder Squaloidei as their probable primitive sister group.

Literature: Garman (1913); Bigelow and Schroeder (1948, 1957); Garrick (1960a); Cadenat and Blache (1981); Compagno (1984a); Shirai (1992a, 1996); Ebert (2003); Ebert and Compagno (In press).

List of Deep–sea Species Occurring in the Area:

Echinorhinus brucus (Bonnaterre, 1788)
Echinorhinus cookei Pietschmann, 1928

Echinorhinus Blainville, 1816

Genus: Subgenus ***Echinorhinus*** Blainville, 1816, *Bull. Sci. Soc. Philomat. Paris*, (8): 121 (genus ***Squalus*** Linnaeus, 1758).

Type species: "***Spinosus***" = ***Squalus spinosus*** Gmelin, *in* Linnaeus and Gmelin, 1788, by monotypy.

Number of Recognized Deep–sea Indian Ocean Species: 2.

Synonyms: Genus ***Goniodus*** Agassiz, 1835: Pl. E, fig. 13. Genus name only, with illustration of entire tooth set. *Ibid.*, 1838, 94. Apparently proposed as a replacement name for ***Echinorhinus*** Blainville, 1816, as this name was mentioned as being equivalent to ***Goniodus***. No type designation, but the only species mentioned was "***Sq. spinosus*** Schn." (= ***Squalus spinosus*** Gmelin, *in* Linnaeus and Gmelin, 1788) as the type of ***Echinorhinus***. *Ibid.*, 1843, Tab. Mat.: 12. Type species: "***Squalus spinosus*** de Blainville", by original designation, = ***Squalus spinosus*** Gmelin, *in* Linnaeus and Gmelin, 1788. Genus ***Echinorrhinus*** (Blainville) Müller and Henle, 1837a: 116; Müller and Henle, 1837b: 399. Probable emendation of or error for ***Echinorhinus*** Blainville, 1816. Müller and Henle (1838b: 65; 1839: 96) reverted to Blainville's original spelling. Genus ***Echinarrhinus*** (Blainville) Müller and Henle, 1838a: 89. Probable error for ***Echinorrhinus*** Müller and Henle, 1837a. Subgenus ***Rubusqualus*** Whitley, 1931: 311 (genus ***Echinorhinus*** Blainville, 1816). Type species: ***Echinorhinus (Rubusqualus) mccoyi*** Whitley, 1931, by original designation. Genus ***Echynorhynus*** Nobre, 1935: 410. Apparent error for ***Echinorhinus*** Blainville, 1816.

Field Marks: See family account above.

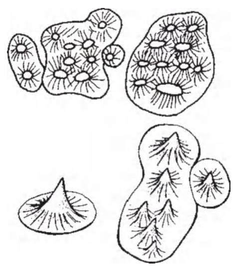
Diagnostic Features: See family account above.

Local Names: See family account above.

Key to Deep–sea Indian Ocean Species:

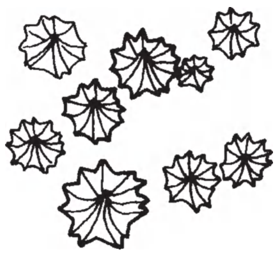
1a. Denticles of body few, sparse, relatively large, not stellate (in specimens 90 cm and larger, and with some fused into plates with multiple cusps) (Fig. 44). Ventral surface of snout and area around mouth with close–set, small denticles in young individuals, and large, scattered and conspicuous denticles in larger juveniles and adults . . . . ***Echinorhinus brucus***

1b. Denticles of body numerous, close–packed, relatively small, with stellate bases, and not fused into plates with multiple cusps (Fig. 45). Ventral surface of snout and area around mouth with very few minute denticles. . . . . ***Echinorhinus cookei***



DERMAL DENTICLES

Fig. 44 *E. brucus*



DERMAL DENTICLES

Fig. 45 *E. cookei*

Echinorhinus brucus (Bonnaterre, 1788)

Squalus brucus Bonnaterre, 1788, *Tabl. Encyclop. Method. Trois Reg. Nat., Ichthyol., Paris*: 11. Holotype lost according to Krefft and Tortonese (1973, *In* J. C. Hureau and T. Monod, *eds.*, *CLOFNAM. Check–list. fish. NE Atlantic Mediterranean*, 1: 45) and Eschmeyer (2012). Type locality: "L'Océan" (= Eastern North Atlantic.).

Synonyms: ***Squalus spinosus*** Gmelin, *in* Linnaeus and Gmelin, 1788: 1500. Holotype lost, based on same specimen as ***S. brucus*** Bonnaterre, 1788 according to Krefft and Tortonese (1973: 45). Type locality: "In Oceano" (= Eastern North Atlantic.); Lacepède, 1798: 167, pl. III (fig. 2); Schneider, 1801: 136; Risso, 1810: 42–43. ***Echinorhinus spinosus*** Blainville, 1816: 121; Blainville, 1825: 66–68, pl. XVI (fig. 1–2); Müller and Henle, 1841: 96; Duméril, 1865: 459–461, pl. XII (fig, 16–20); Bocage and Capello, 1866: 35; Günther, 1870: 428–429; Canestrini, 1872: 42; Döderlein, 1881: 104–105; Moreau, 1881: 365–367, fig. 64–65; Day, 1884: 323–325, pl CLXII (fig. 2); Goode and Bean, 1896: 8–9, pl III (fig. 9); Regan, 1908a: 42; Roule, 1912: 18, 25; Lozano y Rey, 1928: 485–490, fig. 161–163; Nobre, 1935: 463–464, pl. LXIV (fig. 201); Ehrenbaum, 1936: 290–291, fig. 255; ˇSoljan, 1963: 68, fig. ***Scymnus spinosus*** Cuvier, 1816: 131; Risso, 1826: 136. ***Echinorhinus obesus*** Smith, 1849: (no pagination), pl. 1. Types: A 6'6 1/2" (1995 mm) TL specimen (with detailed measurements) is the only one specifically mentioned in the text. A specimen illustrated in Pl. 4 may be an adult male. Type locality: Cape of Good Hope, South Africa, is the only locality mentioned in Smith's account. Smith's ***E. obesus*** was synonymised with ***Echinorhinus spinosus*** (Gmelin) by Gray (1851: 78), and by Günther (1870: 428); however, neither author mentions possible type material of this species in the British Museum (Natural History) although many other Smith specimens were deposited there. ***Echinorhinus (Rubusqualus) mccoyi*** Whitley, 1931: 311. New name for ***Echinorhinus spinosus*** of McCoy (1887: 165, pl. 144). Holotype is in National Museum, Melbourne, NMV 50760, ca 219 cm (7' 2") dry specimen, probably female, Portland, Victoria, Australia (Paxton *et al.* 1989: 34; Eschmeyer, 1998).

Other Combinations: ***Echinorhinus spinosus*** (Gmelin, 1788).

FAO Names: En – Bramble shark; **Fr** – Squale bouclé; **Sp** – Tiburón de clavos.

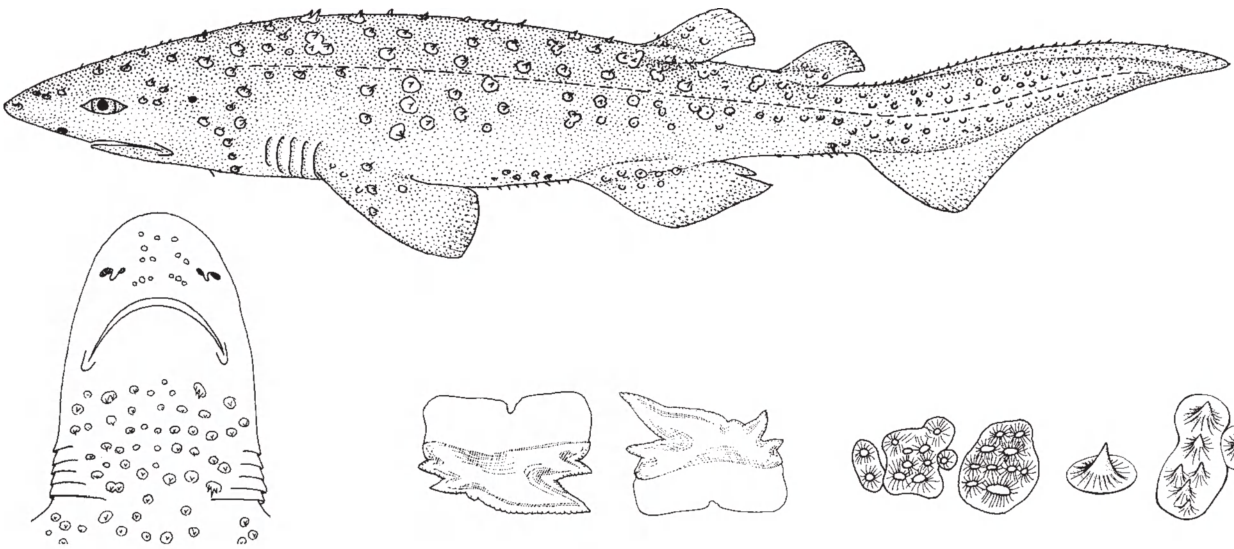


Fig. 46 ***Echinorhinus brucus***

Field Marks: A large, short–nosed and flat–headed, cylindrical, heavy–bodied shark. No anal fin, two spineless dorsal fins, the origin of the first set far posterior, originating behind the pelvic–fin origins. Denticles enlarged, tack–like, conspicuous and scattered over body and fins. Colour light to medium grey, grey–brown, brownish or blackish on the dorsal surface, often lighter below, sometimes with red or black spots or blotches on the body; fin edges blackish.

Diagnostic Features: Dermal denticles on body and fins in adults and large juveniles above 90 cm total length varying from small to very large, with many large, widely spaced, thorn or buckler–like denticles with bases not stellate and over a centimetre wide; some of these enlarged denticles are fused in groups of 2 to 10 and may form large plates over 25 mm across. Newborn specimens have no large plates and are densely covered with small and high denticles with narrow, semi–stellate bases. Ventral surface of snout and area around mouth with close–set small denticles in young, and large conspicuous denticles or thorns in larger juveniles and adults. Teeth similar in both jaws, cusps strongly oblique outwardly, with 1 to 3 lateral cusplets flanking a flat cutting edge; tooth row counts 20 to 26 upper jaw, 21 to 26 lower jaw. Vertebral centra poorly calcified, primary double cones not calcified or weakly developed. Total vertebral count 102. Intestinal valve 12 to 16 turns. Maximum total length to about 310 cm. **Colour:** uniformly grey or brownish to black or grey–black, usually lighter ventrally; photophores absent.

Distribution: Wide ranging, but patchily distributed throughout the Atlantic, western Indian, and western Pacific oceans, and in the Mediterranean Sea. Indian Ocean: South Africa (Western Cape, Eastern Cape and KwaZulu–Natal), southern Mozambique, Maldives, Gulf of Aden, Oman, and India (southwestern and southern coast off Quilon and Mandapan, Gulf of Mannar), Australia (South Australia, Victoria).

Habitat: This bottom–dwelling shark may occur in shallow water, inshore in cold–temperate areas and in places with upwelling, but primarily it is a deep–water species, occurring on the continental and insular shelves and the upper slopes. It

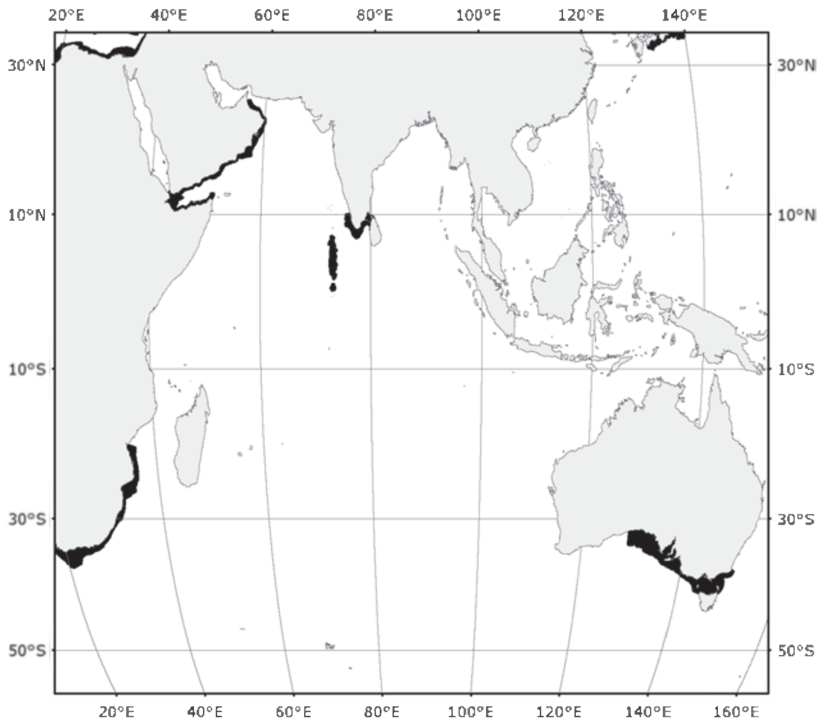


Fig. 47 ***Echinorhinus brucus***

Known distribution

is encountered on continental slopes usually between 200 to 900 m, but may extend inshore in cold water to 18 m or less and possibly into the surfline. On the cold–temperate west coast of South Africa and Namibia it may move close inshore up submarine canyons where it has been regularly caught by shore–side anglers on rod and reel.

Biology: Yolk-sac viviparity, with the number of young per litter ranging from 10 to 52. It has been suggested that in Indian waters these sharks may breed in the spring months (Silas and Severaj, 1972), but a more recent study that examined over 5,000 individuals throughout the year found that pregnant females had embryos in different stages of development and concluded that there does not appear to be a defined breeding season in Indian waters (Akhilesh *et al.*, 2013).

The diet of these sharks consists mostly of crustaceans and teleosts, but also includes cephalopods and elasmobranchs.

Size: Maximum total length is about 318 cm for females and 300 cm for males, although there is one record of this shark attaining 394 cm in Indian waters. Size at maturity varies, with females and males in Indian waters maturing at 189 cm and 187 cm, respectively. Elsewhere females have been found to mature at about 213 to 231 cm and males between 150 and 174 cm. Size at birth is between about 40 and 54 cm; late term embryos with reabsorbed yolk-sacs between 35 and 42 cm were observed in Indian waters (Akhilesh *et al.*, 2013).

Interest to Fisheries and Human Impact: The bramble shark in most locations is taken as bycatch on occasion in bottom fisheries, but there is little information available except for a recent study in Indian waters (Akhilesh *et al.*, 2013). Starting in 2005 a targeted fishery for ***Centrophorus*** species off southwestern Indian caught large numbers of bramble sharks as bycatch. The estimated catch of bramble sharks in this fishery declined from 132 mt to 49 mt between 2008 and 2011, but it is not clear if this was decline was due to fishing effort or a decline in fishing due to lack of a market for these sharks. The meat is of poor quality and other than use for liver oil it is not usually retained.

The conservation status of this species is Data Deficient.

Local Names: Braamhaai, Prickle shark, Alligator shark, Bramble shark, Pineapple shark (South Africa).

Remarks: Late foetuses and small free–living ***Echinorhinus brucus*** (40 to 50 cm) lack the large platelike denticles of juveniles (90 cm and larger) and adults.

Literature: Bonnaterre (1788); Gilchrist (1902); Thompson (1914); Barnard (1925); Fowler (1936, 1941); Bigelow and Schroeder (1948, 1957); Smith (1965); Nair and Lal Mohan (1971); Silas and Selvaraj (1972); Kreft and Tortonese (1973); Bass, D'Aubrey and Kistnasamy (1976); Cadenat and Blache (1981); Compagno (1984a); McEachran and Branstetter, *in* Whitehead *et al.* (1984); Compagno, Ebert and Smale (1989); Compagno, Ebert and Cowley (1991); Anderson and Ahmed (1993); Last and Stevens (1994, 2009); Hemida and Capapé (2002); Paul (2003a); Akhilesh *et al.* (2013); Ebert and Compagno (In press).

2.2.2 Family SQUALIDAE

Family: Genus or family ***Squalus*** Blainville, 1816, *Bull. Sci. Soc. Philomat. Paris*, (8): 121.

Type genus: ***Squalus*** Linnaeus, 1758.

Number of Recognized Deep–sea Indian Ocean Genera: 2.

Synonyms: Family Squalinidae Leach, 1818: 61. Type genus: ***Squalus*** Linnaeus, 1758. Family Squalidae Bonaparte, 1832: 99; Bonaparte, 1838: 206. Type genus: ***Squalus*** Linnaeus, 1758. Tribe Acantiana Gray, 1851: 69 (Family Squalidae). Type genus: ***Acanthias*** Risso, 1826. Possible error for Tribe Acanthiana? Family and subfamily Acanthias Hasse, 1879: 44, tab. 2. Type genus: ***Acanthias*** Risso, 1826. Subfamily Squalinae: 239 (family Squalidae). Type genus: ***Squalus*** Linnaeus, 1758.

FAO Names: En – Dogfish sharks; **Fr** – Squales; **Sp** – Galludos, Tollos.

Field Marks: Short–nosed, cylindrical body with no anal fin. Two dorsal fins with strong ungrooved spines. First dorsal fin with origin opposite or slightly behind the pectoral fins, second dorsal fin strongly falcate and with its origin opposite or well behind the pelvic–fin inner margins. Low, strong keels on the caudal peduncle. Caudal fin without a subterminal notch. Small to moderately large denticles with leaf–shaped, tricuspidate, lanceolate or cross–shaped crowns.

Diagnostic Features: Head moderately broad and flattened. Snout flat and broadly to narrowly rounded or angular in dorsoventral view. Spiracles large and close behind eyes. Fifth gill opening about as large as first four. Nostrils wide–spaced with internarial space greater than nostril width; anterior nasal flaps more or less bilobate, usually with short to greatly elongated medial barbels, these sometimes absent. Mouth nearly transverse and very short, with thin, non–papillose lips. Labial furrows short, not encircling mouth, confined to mouth corners but extending below eyes, and elongated posteriorly into postoral grooves. Labial folds thin. Teeth of both jaws compressed, low–crowned, broad and bladelike and forming a saw–like cutting edge with deep, imbricated series. Teeth not arranged in a quincunx pattern, are sharp–edged in both jaws, with an oblique compressed cusp, a distal blade, and no cusplets. Tooth rows 21 to 30 upper jaw, 19 to 27 lower jaw. Trunk cylindrical, and abdomen with or without inconspicuous lateral ridges. Interdorsal space elongated and greater than length of first dorsal base. Pelvic–caudal space elongated and several times length of pelvic–fin bases. Caudal peduncle cylindrical, elongated, and with lateral keels. Upper precaudal pits present in ***Squalus*** and absent or faintly indicated in ***Cirrhigaleus***. Body without photophores. Denticles small to moderate–sized and pedicellate, with flattened, narrow to broad–keeled, leaf–shaped, lanceolate or cross–shaped crowns and low bases. Pectoral fins moderately high, angular, falcate or subtriangular, anterior margins moderately large and subequal or slightly greater than the prespiracular length, rear tips rounded to angular but not greatly elongated. Pelvic fins smaller than pectoral fins and first dorsal fin, and subequal to or smaller than second dorsal fin. Claspers with a lateral spine on the accessory terminal cartilage (T3) and a medial hook–like process on the dorsal terminal cartilage. Dorsal fins falcate–angular and with strong ungrooved spines. First dorsal fin large, with length somewhat less than or subequal to the prespiracular space. First dorsal–fin base over pectoral–pelvic space and origin over pectoral–fin bases, inner margins or just behind pectoral–fin rear tips. Second dorsal fin about as large as first dorsal fin or considerably smaller, with base behind pelvic–fin bases and origin varying from about over pelvic–fin insertions to well behind pelvic–fin rear tips. Caudal fin strongly heterocercal, with ventral lobe weakly to strongly developed in adults, and with subterminal notch absent. Vertebral counts: total vertebral counts 96 to 124, monospondylous vertebral counts 37 to 53, diplospondylous precaudal vertebral counts 29 to 49. Intestinal valve with 8 to 14 turns. Adults may be up to 180 cm and possibly to 200 cm, but mostly between 40 and 120 cm in total length. **Colour:** plain or with light or dark markings on fins and sometimes with white spots on body, without black photophore markings on tail or flanks.

Distribution: Globally the family Squalidae has an almost circumglobal range in boreal, temperate and tropical seas often in association with continents, islands, submarine peaks and ridges. Members of the Squalidae are known from all temperate seas and the tropics of the western and eastern Atlantic, the Indian Ocean, and western–central Pacific but apparently are absent from the tropical eastern Pacific.

Habitat: Members of the Squalidae are found on continental and insular shelves and upper slopes near the bottom and on submarine ridges and seamounts that extend to near the surface. They may range close inshore and in shallow bays in cool temperate waters but are usually demersal and well offshore in the tropics, where they may be mostly replaced in inshore habitats by small species of the families Carcharhinidae, Sphyrnidae, and other carcharhinoid families. Squalids are mostly demersal although the neonates and young of some species occupy a pelagic habitat and live well off the bottom in inshore and offshore continental waters. Some species occur near the bottom on seamounts far from land, and at least one species ranges into the epipelagic zone in the middle of the North Pacific. Squalids range in depth from the intertidal and near the surface of the epipelagic zone to 1446 m on the deep slope, with most species on the shelves and uppermost slopes down to about 600 m. Squalids overlap in habitat on the slopes with other, more deep–dwelling squaloids of the families Centrophoridae, Etmopteridae, Oxynotidae, Somniosidae, and Dalatiidae, but are apparently largely replaced by members of these families below 700 to 1000 m.

Biology: All members of this family in which reproduction is known are viviparous with a yolk sac, having one to 32 young in a litter. Some squalid species are very slow growing, maturing at over 30 years in age, and may be very long–lived, up to 100 years in age. Squalids feed on a wide variety of prey, chiefly bony fishes, cephalopods and crustaceans but also other cartilaginous fishes and other invertebrates. Several species apparently feed communally, and may locally exhaust or drive away neritic prey species such as bony fishes. All species have powerful jaws with shear–like cutting dentitions in both jaws and can dismember relatively large prey including fishes and cephalopods larger than themselves. Several squalid dogfishes are social, with some species apparently forming large to immense schools that are highly nomadic and migratory, moving locally and on regular yearly migrations. Others are suspected of being solitary or occurring in small aggregations at most.

Interest to Fisheries and Human Impact: Dogfishes are taken in target fisheries and are often an important bycatch in mixed fisheries targeting benthic and pelagic bony fishes. These sharks are primarily caught in bottom trawls, but also by deep–set longlines, bottom longlines, handlines, pelagic and demersal gill nets, seines, pelagic trawls, and fish traps. They are caught on rod and reel by sports anglers in some areas. Some dogfish species, particularly several ***Squalus*** species, are among some of the most important fisheries for elasmobranchs globally, and are rivalled only by some of the carcharhinoid families (Triakidae, Carcharhinidae, and Sphyrnidae), the skates (especially Rajidae), and the longtailed stingrays (Dasyatidae) in world fisheries catches. The flesh is used for human consumption which is prepared fresh, fresh–frozen, smoked, dried–salted, boiled–marinated, and as fish cakes. Other products prepared from dogfish include liver oil for vitamins (and potentially squalene), fishmeal, pet food, fertilizer and leather.

Dogfishes can be a hazard to people who have to handle them since some species use their mildly toxic fin–spines and sharp teeth to defend themselves when captured and can inflict punctures or lacerations on unwary fishers. They also can cause damage to fishing gear while preying on the catch, and may drive away more desirable fisheries species. A few species are regularly kept in public aquaria for display, and do reasonably well in captivity.

The conservation status of the group ranges from Data Deficient to Vulnerable depending on the species and in some cases the regional assessment will also vary due to local fishing practices.

Local Names: Dogfish, Dog sharks, Spurdogs, Spiny dogfish.

Remarks: The family consists of 2 genera, ***Squalus*** and ***Cirrhigaleus***, which comprise 29 species. The ***Squalus*** is the more speciose genera with 26 species, a number likely to increase.

Literature: Garman (1913); Fowler (1941, 1968); Bigelow and Schroeder (1948, 1957); Garrick (1960c, 1961); Bass, D'Aubrey and Kistnasamy (1976), Compagno (1984a); Myagkov and Kondyurin (1986); Parin (1987); Muñoz–Chapuli and Ramos (1989a); Last and Stevens (2009); Ebert *et al.* (2010); Ebert and Compagno (In press).

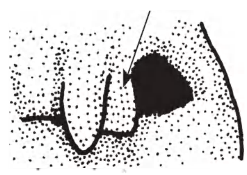
List of Deep–sea Species Occurring in the Area:

Cirrhigaleus asper (Merrett, 1973)
Cirrhigaleus australis White, Last, and Stevens, 2007
Squalus altipinnis Last, White, and Stevens, 2007
Squalus blainville (Risso, 1827)
Squalus chloroculus Last, White, and Motomura, 2007
Squalus crassispinus Last, Edmunds, and Yearsley, 2007
Squalus edmundsi White, Last, and Stevens, 2007
Squalus hemipinnis White, Last, and Yearsley, 2007
Squalus lalannei Baranes, 2003
Squalus megalops (Macleay, 1881)
Squalus mitsukurii Jordan and Snyder, *in* Jordan and Fowler, 1903
Squalus montalbani Whitley, 1931
Squalus nasutus Last, Marshall, and White, 2007

Key to Deep–sea Indian Ocean Genera:

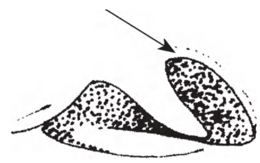
1a. Anterior nasal flaps with very large, broad secondary lobes, expanded into a long or very short barbel (Fig. 48); upper precaudal pit weak or absent; second dorsal fin almost as large as first; postventral caudal–fin margin shallowly concave; denticles very large, body surface rough . . . . ***Cirrhigaleus***

1b. Anterior nasal flaps with secondary lobe small and narrow to absent (Fig. 49); upper precaudal pit strong; second dorsal fin much smaller than first; postventral caudal–fin margin deeply notched; denticles smaller, body surface smooth. . . . . ***Squalus***



DETAIL OF NOSTRIL

Fig. 48 ***Cirrhigaleus***



DETAIL OF NOSTRIL

Fig. 49 ***Squalus***

Cirrhigaleus Tanaka, 1912

Genus: ***Cirrhigaleus*** Tanaka, 1912, *Fig. Descr. Fish. Japan.* 9: 151.

Type species: ***Cirrhigaleus barbifer*** Tanaka, 1912, by original designation.

Number of Recognized Deep–sea Indian Ocean Species: 2.

Synonyms: Genus ***Phaenopogon*** Herre, 1935: 122. Type species: ***Phaenopogon barbulifer*** Herre, 1935, by original designation, a junior synonym of ***Cirrhigaleus barbifer*** Tanaka, 1912; see also Herre (1936: 59).

Field marks: Heavy–bodied sharks with a short blunt snout, short anterior nasal flaps with broad–based, stubby to elongated medial barbels, low, bladelike cutting teeth in both jaws, no anal fin, very stout and high, ungrooved fin spines on both dorsal fins, second dorsal fin about as large as first, caudal peduncle with lateral keels but with precaudal pit little developed or absent and caudal fin without a subterminal notch.

Diagnostic Features: Head very flat and broadly rounded–angular in dorsoventral view. Snout flattened and very broadly rounded. Anterior nasal flaps with medial barbels enlarged and broad–based, either short and low or elongated and reaching mouth. Upper labial furrows very short, less than nostril width. Tooth counts: 26 to 27 upper jaw, 22 to 25 lower jaw. Caudal peduncle short, with dorso–caudal space slightly less than second dorsal–fin base. Precaudal pits weak or absent on caudal peduncle. Dermal denticles large, crowns of lateral trunk denticles in adults about one mm long, with broad flat crowns and triple cusps and ridges; skin rough. Pectoral fins with short, rounded, free rear tips. Pelvic fins high and broadly triangular, with anterior margins about 0.5 to 0.7 of pectoral–fin anterior margins. Second dorsal fin about as large as first and with bases of both about equally long. Second dorsal–fin origin over inner margins of pelvic fins. Caudal fin with short, broad dorsal caudal–fin lobe. Ventral caudal–fin lobe short and weak or virtually absent. Postventral caudal–fin margin shallowly concave in adults. Vertebral counts: total vertebral counts 111 to 117, monospondylous vertebral counts 47 to 50, precaudal vertebral counts 81 to 86. Moderate sized sharks to 122 cm total length. **Colour:** usually uniform grey to light brown above, lighter below. Fins with conspicuous and broad, white posterior margins but without black markings.

Remarks: The genus is comprised of three species, two of which occur in the Indian Ocean.

Key to Deep–sea Indian Ocean Species:

1a. Anterior nasal flaps with very short, broad and stubby medial barbels that do not reach mouth (Fig. 50) . . . . ***Cirrhigaleus asper***

1b. Anterior nasal flaps with elongated, tapering and moustache–like medial barbels that reach mouth (Fig. 51). . . . . ***Cirrhigaleus australis***

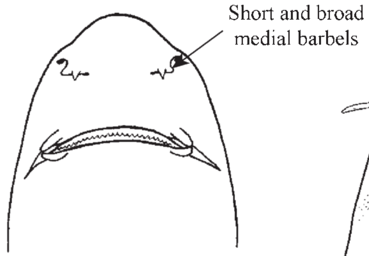


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Fig. 50 ***Cirrhigaleus asper***

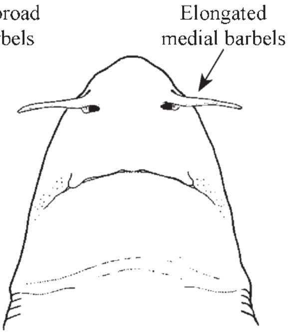

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Fig. 51 ***Cirrhigaleus australis***

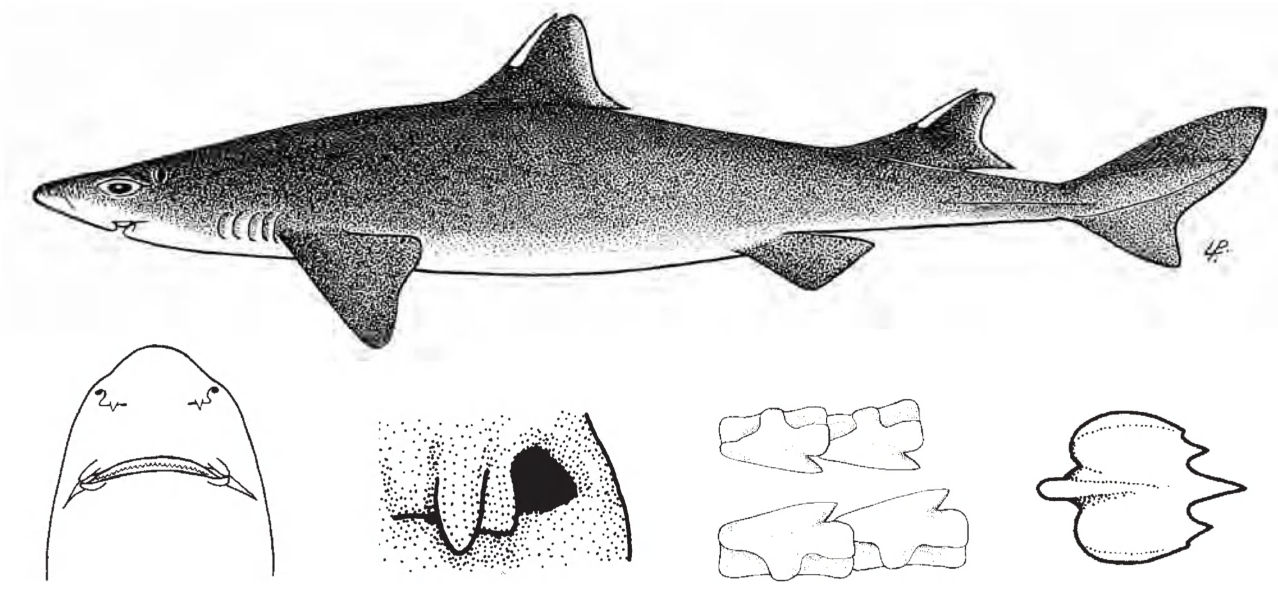
Cirrhigaleus asper (Merrett, 1973)

Squalus asper Merrett, 1973, *J. Zool. (London)* 171(1): 94, fig. 1–4, pl. 1b. Holotype: British Museum (Natural History), BMNH–1972.10.10.1, 901 mm TL adult male, 9°27'S, 46°23.5'E, 219 m.

Synonyms: None.

Other Combinations: None.

FAO Names: En – Roughskin spurdog; **Fr –** Aiguillat à peau rugueuse; **Sp –** Galludo raspa.



UNDERSIDE OF HEAD **DETAIL OF NOSTRIL** **UPPER AND LOWER TEETH** **DERMAL DENTICLE**

Fig. 52 ***Cirrhigaleus asper***

Field Marks: Heavy body and rounded, broad and blunt snout with broad, stubby, medial barbels, two equal–sized dorsal fins with ungrooved and very large spines, oblique–cusped cutting teeth in both jaws; no subterminal notch on caudal fin, very tall and large fin spines, first dorsal–fin spine origin behind pectoral–fin rear tips, no anal fin, upper precaudal pit variably reduced or absent, lateral keels on caudal peduncle present, and no white spots on sides but prominent white–edged fins.

Diagnostic Features: Anterior nasal flaps with a very large medial barbel that is usually as broad as distance from its base to inner end of nostrils, but not elongated behind the anterior nasal flaps and not reaching mouth. Tooth counts: 26 to 27 upper jaw, 22 to 25 lower jaw. Pectoral fins relatively low, broad, and weakly falcate, anterior margins 12.7 to 15.2% of total length. Dorsal fins relatively low and oblique; height of first dorsal fin 6.4 to 8.3% of total length; height of second dorsal fin 5.7 to 7.3% of total length; second dorsal fin less strongly falcate. Caudal fin with a short, low ventral caudal–fin lobe and a moderately to strongly concave postventral margin. Vertebral counts: total vertebral counts 111 to 117, monospondylous vertebral counts 47 to 49, precaudal vertebral counts 81 to 86. Size is up to 123.5 cm total length. **Colour:** uniform light brown to grey above, whitish below; fins conspicuously white–edged.

Distribution: Indian Ocean: South Africa (Eastern Cape and KwaZulu–Natal), southern Mozambique, Aldabra Island group, St. Paul and Amsterdam Islands, possibly India (west and east coasts). Records of this species from the western Atlantic and central Pacific are likely of a different species.

Habitat: A little–known but very distinctive spiny dogfish of the upper continental and insular slopes and outer continental shelves of warm temperate to tropical seas. Found on or near the bottom, at depths of 73 to 600 m. Often caught well offshore on the upper slopes, but sometimes found off bays and river mouths (Eastern Cape and KwaZulu–Natal, South Africa), at depths of 73 to 110 m.

Biology: Biology sketchily known. Viviparous with a yolk sac, and with large litters of 18 to 22 young. Eats bony fish and squid.

Size: Maximum total length 123.5 cm. Adult males 85 to 90 cm and adult females 89 to 118 cm. Size at birth about 25 to 28 cm.

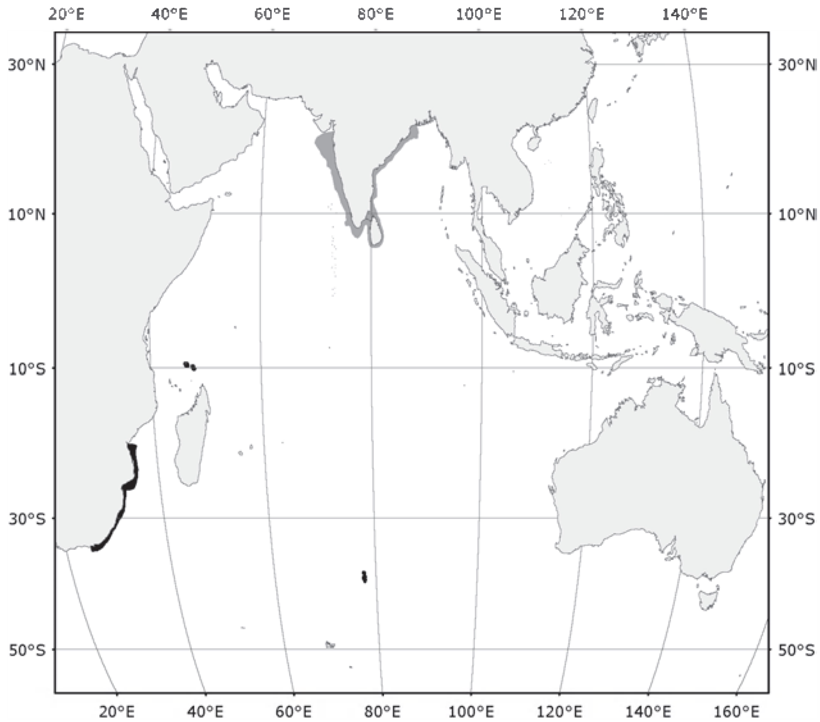


Fig. 53 *Cirrhigaleus asper*

Known distribution Possible distribution

Interest to Fisheries and Human Impact:
Interest to fisheries minimal at present. Probably caught as a discarded and possibly utilized bycatch of bottom trawl and deep longline fisheries in the western North Atlantic and western Indian Ocean, but details are lacking. Occasionally caught by inshore line fisheries in the Eastern Cape Province, South Africa.

Conservation status is Data Deficient.

Local Names: Roughskin dogfish, Roughskin spiny dogfish, Ruwevel penhaai (South Africa); Quelme rugosa (Mozambique).

Remarks: ***Cirrhigaleus asper*** records from the Gulf of Mexico and Hawaii were reported in Compagno (1984a), however, the recent recognition of ***C. australis*** being a separate species from Australian and New Zealand waters suggests that closer examination of this species from some of the widely dispersed areas it is reported to occur may be needed in order to confirm whether it is sporadically distributed or may represent additional species.

Literature: Merrett (1973); Bass, D'Aubrey and Kistnasamy (1976); Compagno (1984a); Bass, Compagno and Heemstra *in* Smith and Heemstra (1986); Myagkov and Kondyurin (1986); Compagno, Ebert and Smale (1989); Shirai (1992a); Herndon and Burgess (2006); Ebert and Compagno (In press).

Squalus Linnaeus, 1758

Genus: ***Squalus*** Linnaeus, 1758, *Syst. Nat., ed.* 10, 1: 233.

Type species: ***Squalus acanthias*** Linnaeus, 1758, by subsequent designation of Gill, 1862, *Ann. Lyceum Nat. Hist. New York*, 7(32): 405.

Number of Recognized Deep–sea Indian Ocean Species: 11.

Synonyms: Genus ***Squallus*** Scopoli, 1777: 464. Emended spelling for ***Squalus*** Linnaeus, 1758, according to Bigelow and Schroeder (1948: 452). Genus ***Acanthorhinus*** Blainville, 1816: 121 (genus ***Squalus*** Linnaeus, 1758). Type species: "***Squalus acanthias*** Lacépède", = ***S. acanthias*** Linnaeus, 1758, designated by Jordan (1919: 95). Genus ***Acanthias*** Leach, 1818: 62. Type species: ***Acanthias antiquorum*** Leach, 1818, by monotypy; a junior synonym of ***Squalus acanthias*** Linnaeus, 1758. Genus ***Acanthias*** Risso, 1826: 131. Type species: ***Squalus acanthias*** Linnaeus, 1758, by subsequent designation of Jordan and Evermann (1917:119), equivalent to ***Acanthias vulgaris*** Risso, 1826. Genus ***Acanthias*** Bonaparte, *in* Müller and Henle, 1837a: 115; also Bonaparte, *in* Müller and Henle, 1837b: 398 (no species mentioned); Bonaparte, 1838: 207. Proposed as a new name; type species: ***Squalus acanthias*** Linnaeus, 1758, by absolute tautonymy and monotypy. Genus ***Carcharias*** Gistel, 1848: x. Replacement name for ***Acanthias*** (probably of Risso, 1826), supposed by Gistel to be a junior synonym of ***Acanthia*** Fabricius, in Insecta; and hence taking the same type species, ***Acanthias vulgaris*** Risso, 1826, a junior synonym of ***Squalus acanthias*** Linnaeus, 1758. Not ***Carcharias*** Rafinesque, 1810 (Odontaspididae). Genus ***Acantias*** Vaillant, 1888: (c5) c13. Probably erroneous spelling, as correctly spelled in Vaillant (1888: 75). Subgenus ***Acantherinus*** (Blainville) Bigelow and Schroeder, 1948: 471. Error for ***Acanthorhinus*** Blainville, 1816.

Field Marks: Short to rather long snouts, short anterior nasal flaps with very small medial barbels, low bladelike cutting teeth in both jaws, rather slender sharks, with lateral keels on caudal peduncle and a precaudal pit, stout, ungrooved fin spines on both dorsal fins, with second dorsal fin smaller than first, no anal fin, and caudal fin without a subterminal notch.

Diagnostic Features: Head flat and rounded angular to conical in dorsoventral view. Snout flattened and rounded to narrowly pointed and short to very elongated. Anterior nasal flaps with medial barbels variably developed but always short and narrow. Upper labial furrows longer, more than nostril width. Tooth counts 21 to 30 upper jaw, 19 to 27 lower jaw. Dermal denticles small, crowns of lateral trunk denticles in adults usually less than 0.5 mm long, with low, pedicellate, lanceolate or tricuspidate and triridged flat leaf–shaped crowns; skin smooth. Free rear tips of pectoral fins narrowly rounded to acutely angular. Pelvic fins low and obtusely triangular, with anterior margins about a third to one–half length of pectoral–fins anterior margins. Second dorsal fin smaller than first dorsal fin and with base length about three–fourths of first dorsal–fin base; second dorsal–fin origin usually behind free rear tips of pelvic fins, but occasionally over them. Caudal peduncle elongated and with dorso–caudal space much greater than second dorsal–fin base; upper precaudal pit prominently developed on caudal peduncle. Caudal fin with more or less slightly elongated, narrower dorsal lobe. Ventral caudal–fin lobe strong; postventral caudal–fin margin usually deeply concave in adults. Vertebral counts: total vertebral counts 93 to 127, monospondylous vertebral counts 35 to 51, precaudal vertebral counts 67 to 93. Intestinal valve with 8 to 14 turns. Moderately large, adults up to 180 cm total length. **Colour:** blackish brown or greyish brown above, lighter below; fins plain or with conspicuous white and black margins or tips but usually without continuous broad white posterior margins.

Local Names: None.

Remarks: The present taxonomic arrangement of ***Squalus*** follows the recent work by Last, White, and Pogonoski (2007), and the various publications therein that volume, and Ebert, *et al.* (2010). Of the 26 currently recognized species, 11 are considered deep–sea and occur in the Indian Ocean.

The below key to ***Squalus*** species is provisional pending a review and resolution of the ***S. blainville*** and ***S. megalops*** complexes.

Key to Deep–sea Indian Ocean Species:

1a. Distance from snout tip to inner margin of nostril shorter than distance from inner edge of nostril to front of upper labial furrow (Fig. 54) **2**

1b. Distance from snout tip to inner margin of nostril longer than distance from inner edge of nostril to front of upper labial furrow (Fig. 55) **6**

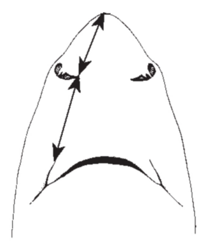


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Fig. 54 *Squalus altipinnis*

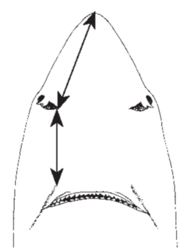

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Fig. 55 *Squalus nasutus*

2a. First dorsal fin with a more oblique anterior margin . **3**

2b. First dorsal fin with a more erect anterior margin (Fig. 56) . . . . ***Squalus altipinnis***

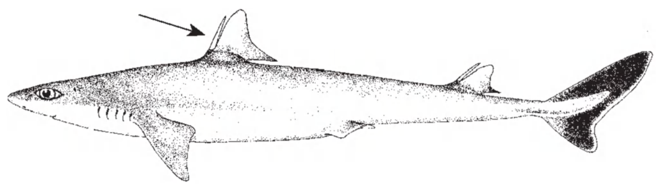

Fig. 56 *Squalus altipinnis*

3a. Preoral length 2.3 or more times internarial space (Fig. 57); total vertebral counts 107 to 113, precaudal vertebral counts 82 to 86. . . . . . ***Squalus crassispinus***

3b. Preoral length 2.3 or less times internarial space (Fig. 58); total vertebral counts 93 to 110, precaudal vertebral counts 67 to 84. . . . . **4**

4a. Anterior nasal flaps not bifurcate (Fig. 58); total vertebral counts 93 to 95; precaudal vertebral counts 67 to 69 . . . . ***Squalus lalannei***

4b. Anterior nasal flaps bifurcate; total vertebral counts 96 to 110; precaudal vertebral counts 78 to 84 . . . . . . **5**

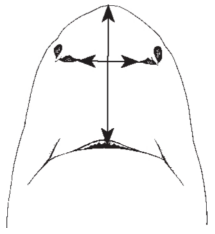

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Fig. 57 *Squalus crassispinus*

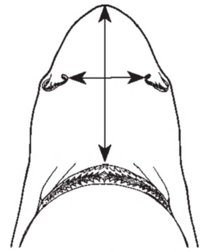

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Fig. 58 *Squalus lalannei*

5a. Head relatively narrow, width at anterior of mouth 8.9 to 10.0% total length; snout short, mouth width less than 7.7% total length (Fig. 59); dorsal–fin spines robust; total vertebral counts 96 to 100; precaudal vertebral counts 72 to 76. . . . . *Squalus hemipinnis*

5b. Head relatively wide, width at anterior of mouth 10.9 to 12.8% total length; snout short, mouth width more than 7.8% total length (Fig. 60); dorsal–fin spines not very robust; total vertebral counts 102 to 110; precaudal vertebral counts 78 to 84 . . . . *Squalus megalops*

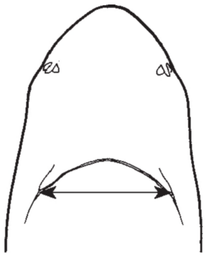
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Fig. 59 ***Squalus hemipinnis***

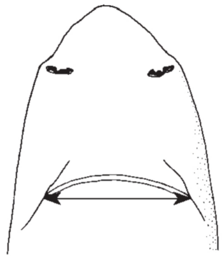
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Fig. 60 ***Squalus megalops***

6a. Preoral snout short to moderately elongated, usually less than 1.4 times mouth width; head broad with distance from snout tip to orbit less than interorbital space; eyes closer to snout tip than first gill slits; inner corners of nostrils closer to snout tip than mouth **7**

6b. Preoral snout greatly elongated, about 1.5 to 2.4 times mouth width; head fairly narrow to broad with distance from snout tip to orbit greater than interorbital space; eyes about equidistant between snout tip and first gill slits or closer to first gill slits; inner corners of nostrils about equidistant between mouth and snout tip or closer to mouth **8**

7a. First dorsal fin high and erect, about 0.75 of fin length, with first dorsal spine about as long as fin base (Fig. 61); precaudal vertebral counts 90 to 96. . . . . *Squalus blainville*

7b. First dorsal fin lower, about 0.67 of fin length or less, first dorsal–fin spine shorter than fin base (Fig. 62); precaudal vertebral counts 83 to 89. . *Squalus mitsukurii*

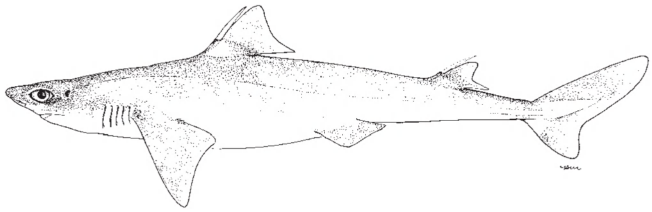


Fig. 61 ***Squalus blainville***

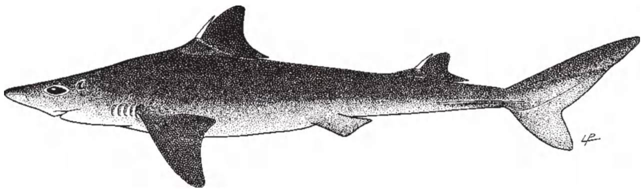


Fig. 62 ***Squalus mitsukurii***

8a. First dorsal fin and its associated spine almost upright (Fig. 63) . . . . *Squalus edmundsi*

8b. First dorsal fin and its associated spine angled . . . rearwards **9**

9a. Snout narrow, very long (Fig. 55); preoral length 84 to 103% of head width; monospondylous vertebral counts 36 to 42 (Fig. 64) . . . . *Squalus nasutus*

9b. Snout relatively broad, moderately long; preoral length 62 to 81% of head width; monospondylous vertebral counts 41 to 47. . . . . **10**

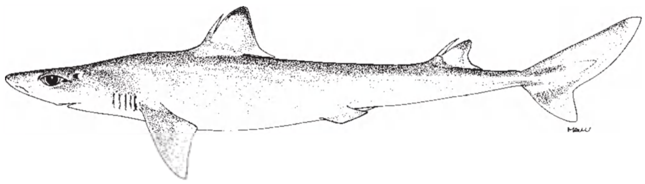


Fig. 63 ***Squalus edmundsi***

10a. Second dorsal fin moderately large, its length 12.2 to 13.9% of total length, 4.2 to 4.9 in pre–second dorsal fin length (Fig. 65); adult claspers relatively long (outer length 4.5 to 5.6% of total length) . *Squalus montalbani*

10b. Second dorsal fin relatively smaller, its length 10.9 to 12.2% of total length, 5.0 to 5.8 in pre–second dorsal fin length (Fig. 66); adult claspers shorter (outer length 3.8 to 4.6% of total length). . . . . *Squalus chloroculus*

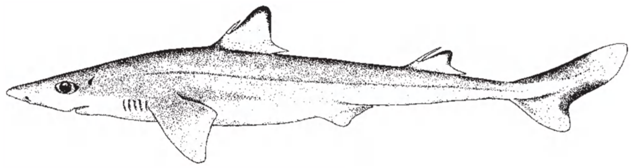


Fig. 64 ***Squalus nasutus***

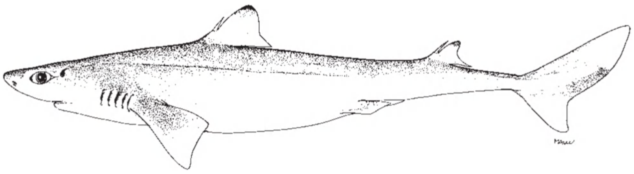


Fig. 65 ***Squalus montalbani***

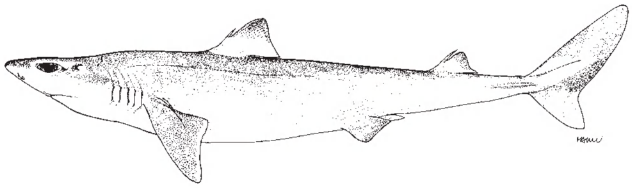


Fig. 66 ***Squalus chloroculus***

Squalus chloroculus Last, White, and Motomura, 2007

Squalus chloroculus Last, White, and Motomura, 2007, *In*: Last, White and Pogonoski (eds). *CSIRO Marine and Atmospheric Research Paper* 014: p. 62, figs 6–10, table 3. Holotype: CSIRO H 4775–01, adult male 753 mm TL, off Portland, Victoria, Australia, 38° S, 141° E, 17 April 1998.

Synonyms: ***Squalus mitsukurii*** (not Jordan and Snyder), in part, Last and Stevens, 1994: 49, 101, figs. 8.24, 8.39, pl. 5; Gomon *et al.*, 1994: 105, 107, 108, figs 56, 57.

Other Combinations: None.

FAO Names: En – Greeneye spurdog; **Fr** – Aiguillat aux yeux verts; **Sp** – Galludo ojo verde.

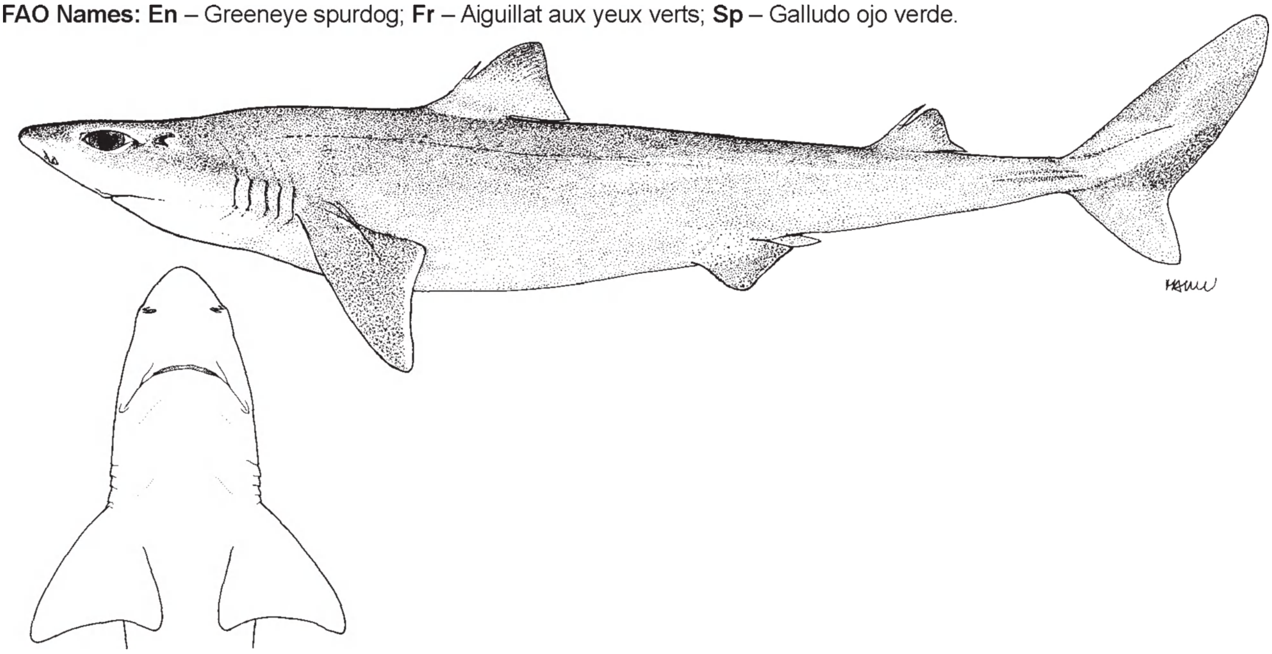


Fig. 67 ***Squalus chloroculus***

Field Marks: A moderate sized dogfish with a moderately elongated, blunt snout, teeth unicuspidate, blade–like, and similar in both jaws, dorsal–fin spines prominent, with the first originating over the pectoral–fin free rear tips, dorsal precaudal pit well developed, ventral precaudal pit less developed, lateral keels on caudal peduncle well developed, originating under or slightly behind insertion of second dorsal fin and terminating just posterior to caudal–fin origin, colour uniform grey except for upper half of dorsal fins and along caudal–fin notch and centre of upper lobe.

Diagnostic Features: Head somewhat broad, subtriangular, and slightly depressed anterior to spiracles. Snout with a bluntly pointed tip, moderately elongate; snout to inner nostril distance about equal to distance of nostril to upper labial furrow. Eye moderate, orbit strongly notched on anterior and posterior margins; length about five times into head length; preorbital length shorter than interorbital width. Spiracles moderate, broadly crescentic, with lobe–like fold on posterior margin. Gill openings nearly upright, height of first four subequal; fifth greatest in height. Mouth is nearly transverse, weakly concave; width about 1.1 to 1.3 times preoral length. Upper labial furrows relatively long. Teeth similar in both jaws; unicuspidate, blade–like, cusps directed laterally and low; tooth base broader than cusp length. Tooth count for upper jaw from a single specimen was 29 and lower jaw 24. Nostrils small, nearly transverse; anterior nasal flap is very well developed, weakly single– or bifurcate; internarial space about 2.2 times in preoral length. Body moderately elongate to robust, fusiform, nape prominently humped. Lateral trunk denticles small, tricuspidate, and imbricate. Pectoral fins large (more so in large females than males), apex narrowly rounded, weakly lobe–like but not falcate; anterior and inner margins convex; posterior margin weakly to moderately concave; free rear tip narrowly rounded to angular; base very short. Pelvic fins large, subtriangular, anterior and posterior margins almost straight, apex broadly rounded, free rear tip acute. First dorsal fin small, low, broadly rounded at apex; anterior margin strongly convex; posterior margin weakly concave; free rear tip relatively thick basally and very short; inner fin margin nearly straight; insertion of base well forward of pelvic–fin origin, well posterior to free rear tip of pectoral fin. Second dorsal fin small, anterior margin convex, posterior margin strongly concave, apex broadly rounded; free rear tip elongated, inner margin 1.1 to 1.4 times fin height. Dorsal–fin spines without lateral grooves, slender, broad based, tapering towards tip. First dorsal–fin spine anterior margin nearly straight, height less than three–fourths of fin height, much shorter than second dorsal–fin spine; fin spine origin slightly posterior to pectoral–fin insertion. Second dorsal–fin spine is moderately broad based, tip very acute, apex about level to fin insertion. Caudal fin relatively long, dorsal caudal–fin margin 1.1 in head length; upper lobe length 4.6 to 5.2 into total length; upper caudal–fin lobe without subterminal notch; lower lobe acute; postventral margin weakly convex; length of lower caudal–fin lobe 1.7 to 1.9 in upper lobe length. Vertebral counts: total vertebral counts 111 to 115, precaudal vertebral counts 84 to 86, monospondylous vertebral counts 43 to 46. Size is moderate with adults up to 99 cm total length. **Colour:** mostly uniform grey along dorsal surface and flanks, with the underside becoming paler. Dorsal fins mostly grey except for blackish margins extending from above the fin spine and along the outer margin to the notch in posterior margin. Posterior edge of caudal fin at the notch and at the centre of the lobe is usually dark, more noticeable (darker) in juveniles, but pale to fading in adults.

Distribution: Southern Australia from off Jervis Bay, New South Wales, to Eucla, Western Australia.

Habitat: Upper continental slope in water from 216 to 1360 m.

Biology: Virtually unknown, but presume to be viviparous with a yolk sac.

Size: Maximum total length about 99 cm for females; males mature at 68 cm and reach a maximum length of at least 86 cm. Size at birth about 23 to 24 cm.

Interest to Fisheries and Human Impact: Interest to fisheries none or limited at present, but is likely taken as part of a ***Squalus*** complex as bycatch of deepwater demersal fisheries but details are not available.

Conservation status is Near Threatened due to intensive fishing pressure within its range.

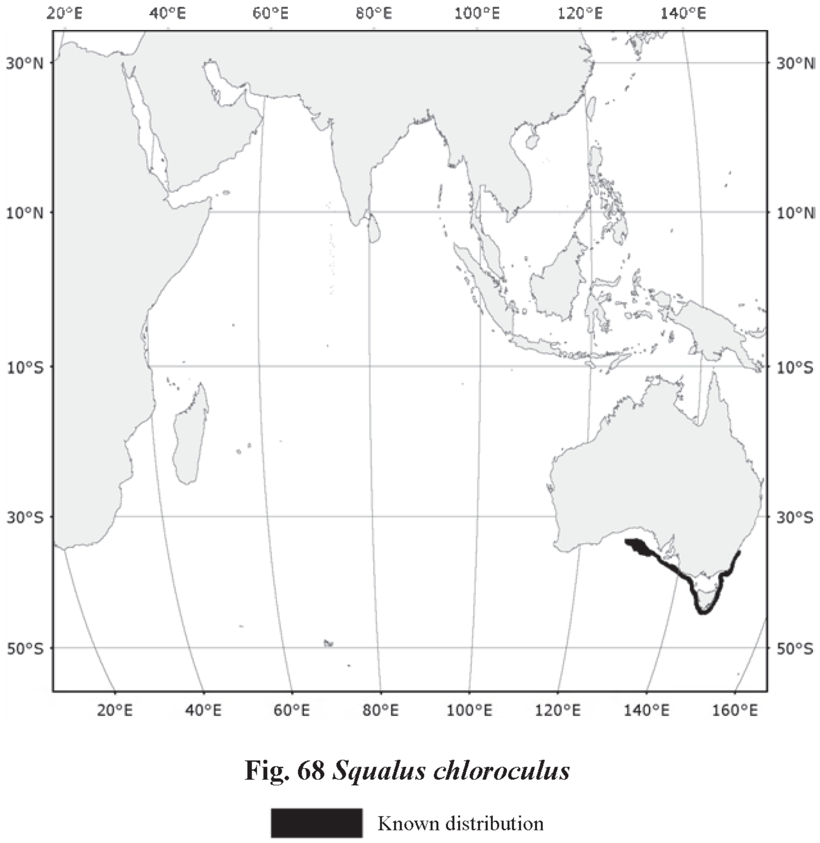


Fig. 68 *Squalus chloroculus*

Local names: None.

Remarks: This species and ***Squalus montalbani*** are very similar morphologically, but they differ molecularly in the structure of the CO1 gene. Slight differences in coloration were noted between the two species by Last and Stevens (1994), but both "forms" were nominally grouped under ***S. mitsukurii***. Morphologically, there are three characteristics that distinguish Australian population of these two species: the pre–first dorsal–fin length of ***S. chloroculus*** is 2.4 to 2.8 times the second dorsal–fin length (versus 1.9 to 2.4 in ***S. montalbani***), the pre–second dorsal–fin length is slightly longer at 5.0 to 5.8 times the second dorsal–fin length in ***S. chloroculus*** than in ***S. montalbani*** (4.2 to 4.9), and the second dorsal–fin length is slightly shorter (10.9 to 12.2 versus 12.2 to 13.9% total length) in ***S. chloroculus*** versus ***S. montalbani***. The dorsal fins also are smaller but with broader fin spine bases in ***S. chloroculus*** than observed in ***S. montalbani***. ***Squalus chloroculus*** differs from ***S. mitsukurii***, a species it was long confused with in Australian waters, by slightly lower average total vertebral counts (111 to 115 versus 118 to 127) and in caudal–fin coloration; the caudal bar is upright and marginal rather than oblique.

Literature: Jordan and Snyder, *in* Jordan and Fowler (1903); Last and Stevens (1994, 2009); Gomon *et al*. (1994); Last, White and Pogonosky (2007); Valenti, Stevens and White (2009); Ebert and Compagno (In press); W.T. White (*pers. comm.*).

Squalus edmundsi White, Last, and Stevens, 2007

Squalus edmundsi White, Last and Stevens, 2007, *In*: Last, White and Pogonoski (eds). *CSIRO Marine and Atmospheric Research Paper* 014: p. 72, figs 1–5, table 1. Holotype: CSIRO H 2566–01, adult male 614 mm TL, west of Bernier Island, Western Australia, Australia, 24° 55′ S, 112° 11′ E, 344 m, 28 January 1991.

Synonyms: ***Squalus*** sp. C (in part) Last and Stevens, 1994: 49, 94, fig. 8.33, pl. 6; ***Squalus*** sp. C, Compagno, Dando and Fowler, 2005: 79–80, fig, pl. 2; ***Squalus*** sp. C, White *et al*., 2006: 72–73.

Other Combinations: None.

FAO Names: En – Edmunds' spurdog; **Fr** – Aiguillat d'Edmund; **Sp** – Galludo Edmund.

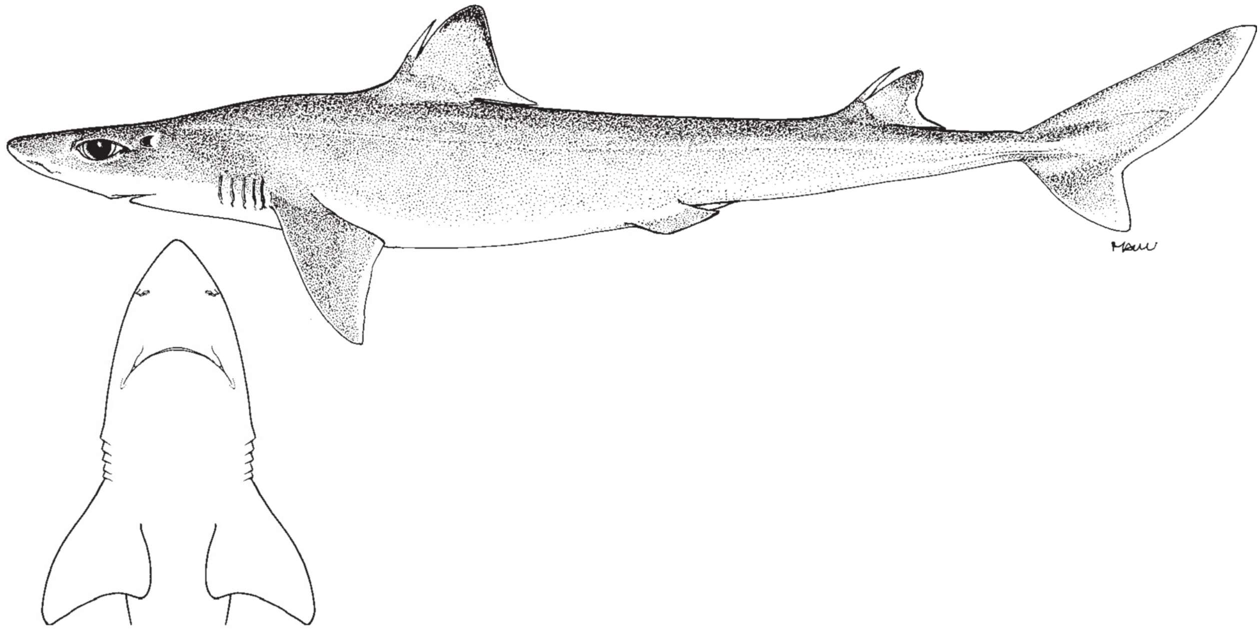


Fig. 69 ***Squalus edmundsi***

Field Marks: A moderate sized, slender dogfish with a fairly narrow, triangular snout, long preoral snout about 2.2 to 2.4 times prenarial length, teeth are oblique and blade–like, similar in both jaws, first dorsal–fin spine, prominent, originates above pectoral–fin insertion, second dorsal–fin spine is slightly higher than first, about equal in height to apex of second dorsal fin, both dorsal spines slender, without lateral grooves, and gradually tapering at tips, no anal fin, caudal fin short, less than five times total length, lower lobe without subterminal notch and usually with a dark oblique bar across base of lower lobe; precaudal pits present, body is pale grey along flanks, but paler ventrally, fin apices dark, free rear tips white and a dark median stripe between second dorsal fin and caudal fin.

Diagnostic Features: Head narrow, subtriangular, snout tip bluntly pointed, with distance from snout tip to preorbital length more than interorbital width. Prenarial length is about 2.2 to 2.4 times into preoral length. Eyes are moderate, narrowly oval, and length less than five times into head length; strong posterior notch. Spiracle is broadly crescentic, greatest distance 3.3 to 4.4 in eye length. Gill openings are subequal in size, with first being noticeably smaller than fifth opening which is the largest. Mouth is nearly transverse, weakly concave, width 1.3 to 1.4 into preoral length. Upper labial furrows less than twice the length of lower furrows. Teeth are oblique and blade–like, similar in both jaws. Tooth counts for a single specimen was upper jaw 25 and lower jaw 22. Lateral trunk denticles imbricate, crowns broad, strongly tricuspidate with a median ridge originating well forward of the rest of the crown and with a mesial furrow developing anteriorly and converging towards posterior tip of crown; lateral cusps well developed. First dorsal fin is moderate, erect, and broadly rounded at apex; originates over pectoral–fin insertion. First dorsal fin is preceded by a slender fin spine that is shorter than the fin apex. Second dorsal fin moderate sized, apex narrowly rounded, and originates well behind free rear tip of pelvic fin. Second dorsal fin spine is slender, tapering to sharp tip, and with height about equal to height of second dorsal fin. Both fin spines without lateral grooves. Interdorsal space less than 1.0 times into prepectoral length and slightly more than 1.0 times into pre–first dorsal–fin length; interdorsal groove weak. Pectoral fin relatively small, length about 6.4 to 7.1% of total length; apex is narrowly rounded, lobe–like, but not falcate; anterior and inner margins each weakly convex; posterior margin slightly concave; free rear tip broadly rounded. Pelvic fins small, anterior and posterior margin almost straight, apex broadly rounded, and with an acute free rear tip. Caudal peduncle long, tapering to caudal fin, with a well developed ventral groove and well developed lateral keels. Caudal fin short, less than five times total length; lower lobe without subterminal notch; caudal keels and precaudal pits present. Vertebral counts: total vertebral counts 113 to 120, precaudal vertebral counts 86 to 91, monospondylous vertebral counts 43 to 44. Size small with adults to 87 cm total length. **Colour:** grey to greyish brown dorsally fading to a light grey ventrally. First dorsal fin dusky, except for black–tipped apical margin and free rear tip which is slightly paler. Second dorsal fin similar in colour. Caudal fin mostly dusky except for narrow black upper caudal fringe; white margin on upper and lower lobes of caudal fin well demarcated; a darker, blackish bar is present along the base of the anterior lower lobe.

Distribution: Eastern Indonesia and Western Australia between Bunbury and Rowley Shoals.

Habitat: Upper continental slope in water from 200 to 850 m, but mostly between 300 and 500 m.

Biology: Viviparous with a yolk sac, litters between 3 and 6, but virtually nothing else is unknown. Diet unknown, but may consist of small bony fishes, cephalopods, and crustaceans.

Size: Maximum total length about 87 cm (females), but males smaller maturing at 53 cm and reaching a maximum length of at least 61 cm. Size at birth over 21 cm in length; smallest neonates were a 31 cm and 28 cm female and male, respectively.

Interest to Fisheries and Human Impact: Commonly caught in longline fisheries and utilized for its meat, fins, and high value liver oil.

Conservation status for this species is Near Threatened, but may be locally vulnerable to deepwater fisheries.

Local names: Indonesian highfin spurdog; Indonesia: Hiu botol (Jawa Barat), Hiu taji (Lombok), Hiu senget (Bali), Cucut botol (Jakarta).

Remarks: This rather distinctive "***Squalus mitsukurii* group**" species can be separated from other members of the subgroup by its oblique caudal bar on the base of the lower caudal–fin lobe as opposed to a vertical posterior margin. It is morphologically most similar to ***Squalus chloroculus***, ***S. mitsukurii***, and ***S. montalbani*** but can be separated in by its having a more erect dorsal fin and more robust dorsal–fin spines.

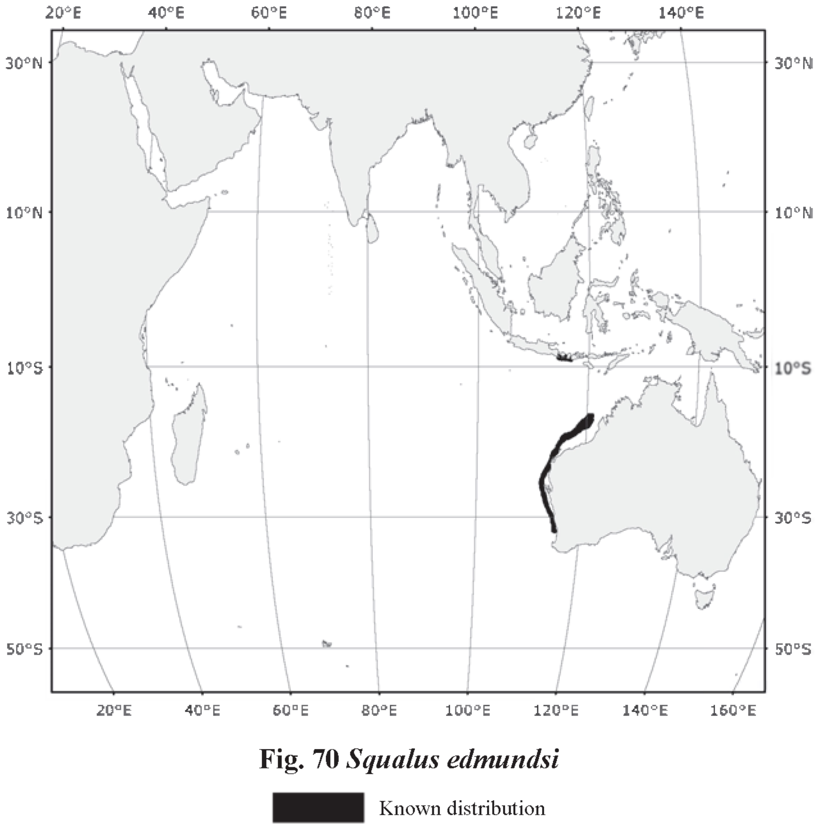


Fig. 70 *Squalus edmundsi*

Literature: Last and Stevens (1994, 2009); Compagno, Dando and Fowler (2005); White *et al.* (2006); White, Last and Stevens (2007b); White (2009a); White and Dharmadi (2010); Ebert and Compagno (In press); W.T. White (*pers. comm.*).

Squalus hemipinnis White, Last, and Yearsley, 2007

Squalus hemipinnis White, Last and Yearsley, 2007, *In*: Last, White and Pogonoski (eds). *CSIRO Marine and Atmospheric Research Paper* 014: p. 101, figs 1–5, table 1. Holotype: MZB 15040, female 637 mm TL, Kedonganan fish landing site, Bali, Indonesia, 08° 45′ S, 115° 10′ E, July 2002.

Synonyms: ***Squalus*** sp. 3, White *et al.* 2006: 70–71.

Other Combinations: None.

FAO Names: En – Indonesian shortsnout spurdog; **Fr** – Aiguillat à nez court d'Indonésie; **Sp** – Galludo ñato Indonésico.

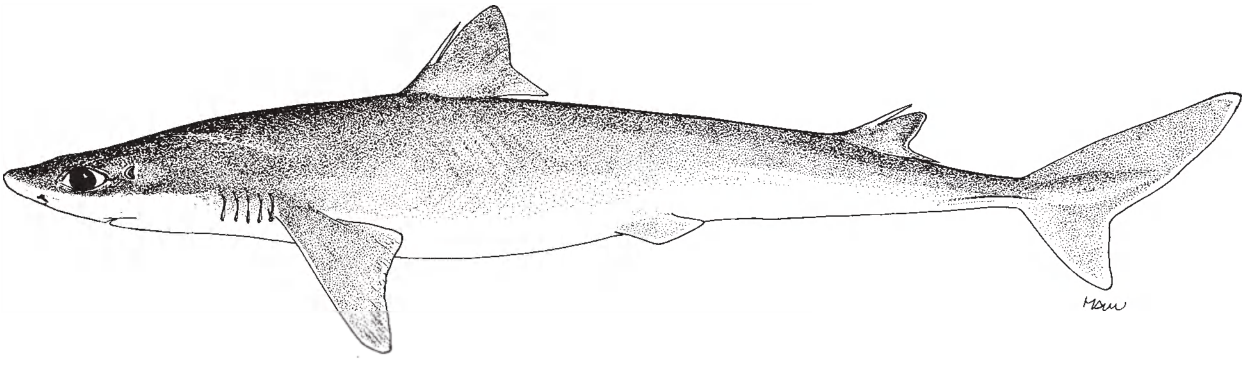
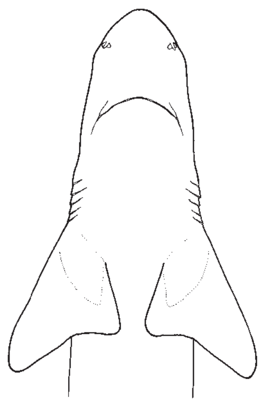


Fig. 71 *Squalus hemipinnis*

Field Marks: A moderate sized, slender dogfish, with a short, broadly pointed snout, teeth of upper and lower jaws similar in size and shape, dorsal fins unequal in size, overall dimensions of first dorsal fin much larger than that of second dorsal fin, first dorsal fin tilted slightly backwards, first dorsal–fin spine broad–based, its origin slightly posterior to pectoral–fin insertion, second dorsal–fin rear tip moderately long, with a v–shaped upper posterior margin, colour slate grey above, with light and dark areas on head, ventral surface white, first dorsal fin greyish, with dark blotch on fin apex and whitish fin base, second dorsal fin similar in coloration, caudal fin mainly greyish with a broad white posterior margin and slightly darker black caudal stripe present and no obvious caudal bar or other prominent black blotches or markings.



UNDERSIDE OF HEAD AND TRUNK

Diagnostic Features: Head narrow, depressed forward of spiracles, subtriangular; snout short, tip bluntly pointed, with distance from tip to preorbital length more than interorbital width. Body fusiform, slender, with humped nape, slender caudal peduncle. Prenarial length is about 2.4 to 2.5 times into preoral length. Eye oval, large, length 4.0 to 4.2 in head; strongly notched posteriorly, notch deep anteriorly, usually weakly connected to anteroventral margin of spiracle. Spiracle is moderate, broadly crescentic, with greatest distance about 3.0 to 3.3 time into eye length. Gill openings directed slightly anterodorsally from bottom to top; first four subequal in size, fifth longest, height of fifth slit 1.9 to 2.3% total length. Mouth width is nearly transverse, upper jaw weakly concave, width about 1.2 into preoral length. Upper labial furrows about 1.5 times length of lower furrows. Teeth are blade–like, unicuspidate, similar in upper and lower jaws; tooth counts for a single specimen were 26 upper jaw and 23 lower jaw. Nostrils small, almost transverse; anterior nasal flap strongly bifurcate; anterior lobe broad, posterior lobe much shorter, narrow, somewhat flattened. Lateral trunk dermal denticles very small, non–imbricate, crowns well elevated, quadrate, broadly unicuspidate to weakly tricuspidate with pronounced median ridge commencing well anterior of rest of crown, and a mesial furrow developing anteriorly and converging rapidly towards posterior tip of crown; posterior portion of cusp strongly produced, acute; lateral portion of crown very short, cusps weakly developed or forming an obtuse angle. Dorsal fins unequal in size, first much larger than second. First dorsal fin small, tilted slightly backwards, apex narrowly rounded to sometimes angular; anterior margin moderately convex; upper posterior margin nearly straight, weakly concave near free rear tip; free rear tip very thick basally, short; inner margin of fin almost straight; insertion of base well posterior to free rear tip of pectoral fin; fin–spine origin slightly posterior to pectoral–fin insertion; spine base broad, but tapering slightly distally, anterior margin almost straight; spine longer than exposed portion of second dorsal–fin spine, exposed base more elevated than exposed base of second dorsal–fin spine; exposed first dorsal spine length 0.6 to 0.7 times height of fin. Second dorsal fin very small; anterior margin moderately convex, apex narrowly angular; posterior margin very deeply concave, forming a V–shape at about mid–point of margin; free rear tip moderately elongate, inner margin length 1.1 times fin height; second dorsal–fin length 2.9 to 3.5 times its height; spine length 1.0 to 1.4 in height of fin; fin–spine origin well behind free rear tip of pelvic fin; spine robust, bluntly pointed distally, tapering rapidly just above point of exposure, spine tip not extending to level of insertion of fin; interdorsal space, weakly ridged, and about 1.0 in length from snout tip to pectoral–fin origin, 1.2 in pre–first dorsal length. Pectoral fin moderate sized, with anterior and inner margins moderately convex; apex narrowly rounded, lobe–like, weakly falcate; posterior margin moderate to weakly concave, free rear tip broadly angular; fin base very short, 2.8 to 3.2 in length of anterior margin. Pelvic fins moderate, anterior and posterior margins almost straight, apex broadly rounded, free rear tip broadly angular, but more acute in mature males. Caudal peduncle very long, tapering slightly to caudal fin; ventral groove well developed; lateral keels well developed, originating slightly posterior to or below insertion of second dorsal fin; dorsal caudal pit well developed, ventral caudal pit rudimentary. Caudal fin short, upper postventral margin nearly straight to weakly convex, apex of lower lobe narrowly angular; dorsal caudal margin about 1.1 in head length; length of lower caudal lobe 1.7 to 1.8 in upper lobe length. Vertebral counts: total vertebral counts 96 to 100, precaudal vertebral counts 72 to 76, monospondylous vertebral counts 35 to 38. Size is moderate with adults to 78 cm total length. **Colour:** slate grey above, with light and dark areas sharply demarcated on head, extending from snout adjacent suborbit, across head and through top of gill slits; differentiation indistinct on trunk; ventral surface white. First dorsal fin greyish, except darker on fin apex and appearing as a weak blotch rather than a marginal marking; anterior base and extremity of rear tip slightly paler; base of first dorsal fin white; second dorsal–fin greyish except anterior base white, with a small prominent black blotch distally, free rear tip pale. Caudal fin mainly greyish with a broad white posterior margin, but pale edge extending along full length of posterior margin, from near apex of upper lobe to near apex of lower lobe, its width constricted slightly at caudal fork; slightly darker black caudal stripe present; no obvious caudal bar or other prominent black blotches or markings.

Distribution: Possibly endemic to eastern Indonesia as it is known only from Cilacap in Central Java and Tanjung Luar, eastern Lombok.

Habitat: Virtually unknown, but presumably found on or near the bottom of upper continental and insular slopes, and most likely from depths greater than 100 m, although may occur shallower than other members of this genus.

Biology: Viviparous with a yolk sac, litters range between 3 and 10, with an average of 6 to 7. Uncertain whether there is any seasonality to the reproductive cycle, but early term embryos have been observed in March with near term embryos observed in July. Diet unknown, but likely consists of small fishes, cephalopods, and crustaceans.

Size: Maximum total length about 78 cm for females, but males smaller at 52 cm; females mature at about 60 to 74 cm and males mature at about 42 cm. Size at birth possibly about 16 to 20 cm.

Interest to Fisheries and Human Impact: A common catch in deepwater demersal longline fisheries in Indonesia, it is the most abundant squaloid targeted by demersal longliners in eastern Indonesia. It is utilized for its meat, fins, and liver oil.

Conservation status is Near Threatened.

Local names: Indonesia: Hiu botol (Jawa Barat), Hiu taji (Lombok), Hiu senget (Bali), Cucut botol (Jakarta).

Remarks: This relatively abundant species, where it occurs in eastern Indonesia, is morphologically similar to some members of the "***Squalus megalops* highfin group**", but can be distinguished from other members of this group by a combination of its short snout, deeply notched posterior margin on its second dorsal fin, a strongly demarcated dorsal coloration, and low precaudal vertebral count among other characters. It possesses a distinct caudal bar in juveniles typical of members of the "***Squalus mitsukurii* group**" and the "***S. japonicus* group**", but lacking in the "***S. megalops* group**". This species differs from members of the "***S. mitsukurii***" and "***S. japonicus***" groups in having a short snout and a strongly notched, v–shaped posterior margin on the second dorsal fin.

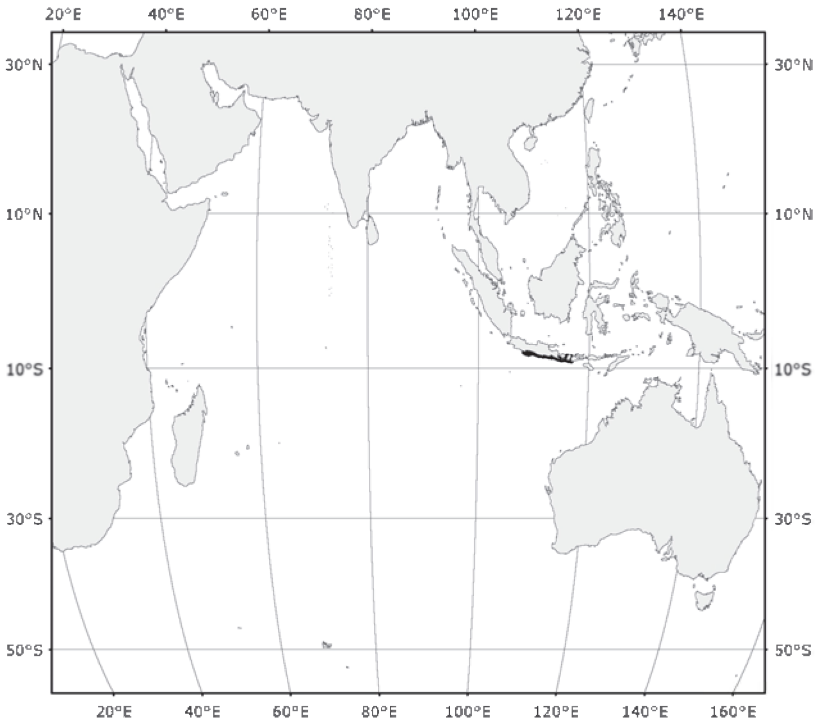


Fig. 72 ***Squalus hemipinnis***

Literature: White *et al.* (2006); White, Last and Yearsley (2007); White and Couzens (2009); White and Dharmadi (2010); Ebert and Compagno (In press); (W.T. White, *pers. comm.*).

Squalus montalbani Whitley, 1931

Squalus montalbani Whitley, 1931: 310. In: *Aust. Zool.* v. 6 (pt 4). Replacement name for ***Squalus philippinus*** Smith and Radcliffe 1912 (junior homonym of ***S. philippinus*** Shaw, 1804 = ***Heterodontus portusjacksoni*** (Meyer, 1793)). In: Smith 1912: 677, pl. 51, fig. 1, *Proc. U. S. Natl. Mus.* v. 41 (no. 1877). Holotype (unique): USNM 70256. Holotype: USNM 70256, immature male 311 mm TL, off Sombrero I., west coast of Luzon Island, 13°45′ N, 120°46′ E, Philippines, Albatross sta. 5111, ca. 425 m.

Synonyms: ***Squalus mitsukurii***: (not Jordan and Snyder), in part, Last and Stevens, 1994: 49, 101, figs 8.24, 8.39, pl. 5; ***Squalus*** sp. 1: White *et al.*, 2006: 68–69, figs.

Other Combinations: None.

FAO Names: En – Philippine spurdog; **Fr** – Aiguillat des Philippines; **Sp** – Galludo Filipino.

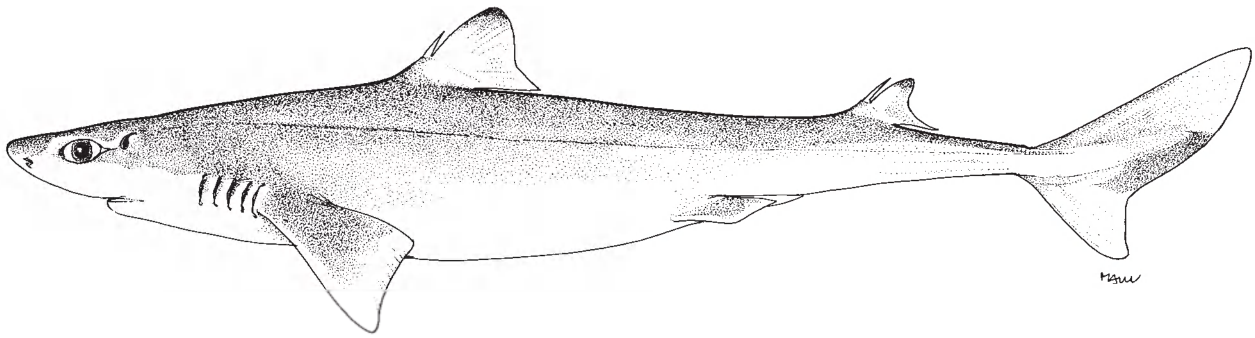
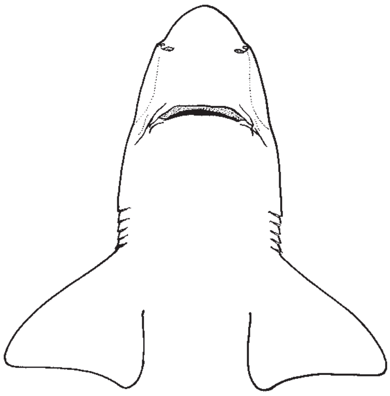


Fig. 73 ***Squalus montalbani***

Field Marks: A medium sized dogfish with a moderately elongated and narrowly pointed snout, teeth similar in both jaws, first dorsal fin much larger than the second, first dorsal fin tilted backwards, two prominent dorsal–fin spines, first dorsal–fin spine originates over free rear tip of pectoral fins, colour a uniform grey dorsally, but paler ventrally; upper half of first dorsal fin and tip of second dorsal fin darker, posterior notch of caudal fin and centre of upper lobe usually darker.



UNDERSIDE OF HEAD AND TRUNK

Diagnostic Features: Body fusiform, moderately elongate to robust, with a relatively broad head, and a broadly triangular, somewhat pointed snout. Distance from snout tip to preorbit shorter than interorbital width, and to inner nostril equal to or slightly longer than distance from nostril to upper labial furrow. Mouth width is nearly transverse, upper jaw weakly concave, width about 1.7 to 2.3 times prenarial length. Upper labial furrows longer than lowers. Teeth are blade–like, unicuspidate, similar in upper and lower jaws. Anterior nasal flaps, bifurcate, well developed. Lateral trunk denticles tricuspidate. Dorsal–fin spines prominent, slender, and without lateral grooves; first dorsal–fin spine about three–fourth height of dorsal fin, but equal to height of second fin spine; first originating over pectoral–fin free rear tips. Caudal–fin upper lobe length is 4.3 to 4.8 in total length; upper lobe without subterminal notch; caudal keels and precaudal pits present. Vertebral counts: total vertebral counts: 105 to 114; precaudal vertebral counts 79 to 85, monospondylous vertebral counts 41 to 47. Size is moderate with adults to 91 cm total length. **Colour:** dorsal surface grey above, paler below. Caudal fin notch and centre of upper lobe are usually darker.

Distribution: Eastern Indian Ocean: Indonesian waters off Java and Western Australia from the Timor Sea to Rottnest Island. Western Pacific: Philippines and Australia from Flinders Reef (Queensland) to Terrigal (New South Wales).

Habitat: Upper continental slope, usually found on or near the bottom at depths of 154 to 1370 m.

Biology: Viviparous with a yolk sac, and gives birth to between 4 and 16 young per litter. There does not appear to be any seasonal reproductive cycle. Gestation period is unknown. Diet consists primarily of small benthic fishes, cephalopods, and crustaceans.

Size: Maximum total length about 91 cm for females, with maturity occurring at greater than 80 cm total length; males smaller, maturing at 62 to 67 cm, with maximum length of at least 72 cm. Size at birth uncertain, but near term embryos are about 24 cm.

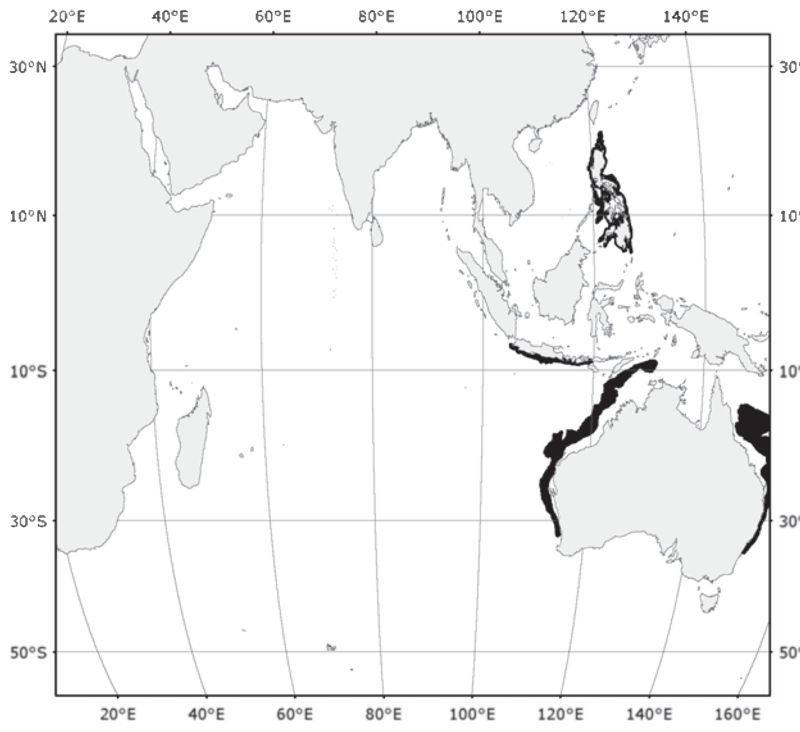


Fig. 74 *Squalus montalbani*

Interest to Fisheries and Human Impact: A commonly caught species by longline fisheries operating in deepwater in Indonesia, and likely elsewhere. It is utilized for its meat, fins, and liver oil.

Conservation status is Vulnerable due to population declines of this species in Philippine waters.

Local names: Indonesian greeneye spurdog; Indonesia: Hiu botol (Jawa Barat), Hiu taji (Lombok), Hiu senget (Bali).

Remarks: This species is very similar in appearance to ***Squalus chloroculus*** (an endemic species to southern Australia) and to the western North Pacific ***S. mitsukurii***, but is distinguishable externally by its caudal fin coloration and markings (see these species colour descriptions), which are especially striking in juveniles, and by several subtle morphological differences including larger dorsal fins and a shorter predorsal length.

Literature: Meyer (1793); Shaw (1804); Jordan and Snyder, *in* Jordan and Fowler (1903); Smith and Radcliffe (1912); Whitley (1931); Last and Stevens (1994, 2009); White *et al.* (2006); Last, White and Pogonosky (2007); White (2009b); White and Dharmadi (2010); Ebert and Compagno (In press); W.T. White (*pers. comm.*).

2.2.3 Family CENTROPHORIDAE

Family: Centrophoroidei Bleeker, 1859, *Act. Soc. Sci. Ind. Neerl.* 4(3): xii.

Type genus: ***Centrophorus*** Müller and Henle, 1837a.

Number of Recognized Deep–sea Indian Ocean Genera: 2.

Synonyms: Subfamily Centrophorus (family Acanthias) Hasse, 1879: tab. 2. Type genus: ***Centrophorus*** Müller and Henle, 1837a. Subfamily Deaniinae Compagno, 1973a: 26 (family Squalidae). Type genus: ***Deania*** Jordan and Snyder, 1902.

FAO Names: En – Gulper sharks; **Fr** – Squale chagrins; **Sp** – Quelvachos.

Field Marks: Short to long–nosed, cylindrical to somewhat compressed sharks with no anal fin, denticles small to large and variable in shape, with leaf–shaped, tricuspidate or polycuspidate crowns and slender pedicels, high pitchfork–shaped erect crowns on high pedicels, or low ridged sessile crowns, no keels on the caudal peduncle, two dorsal fins with strong grooved spines, first dorsal fin with origin usually opposite the pectoral–fin bases or pectoral–fin inner margins and exceptionally just behind the pectoral–fin free rear tips, second dorsal fin not falcate and with its origin usually opposite the pelvic–fin bases or inner margins, but exceptionally somewhat behind the pelvic–fin free rear tips and caudal fin with a strong subterminal notch.

Diagnostic Features: Head moderately broad to narrow and somewhat flattened. Snout flat and narrowly rounded to elongate–rounded in dorsoventral view. Spiracles large, close behind eyes. Fifth gill opening about as large as first four. Nostrils wide–spaced with internarial width greater than nostril width. Nostrils with simple anterior nasal flaps and no medial barbels. Mouth nearly transverse and very short, with thin, non–papillose lips. Labial furrows short, not encircling mouth, confined to mouth corners but extending anteriorly to below eyes, elongated posteriorly into postoral grooves and sometimes anteromedial preoral grooves (***Deania***); thin labial folds. Teeth with dignathic heterodonty well developed, upper teeth much smaller than lowers. Teeth of both jaws moderately compressed, high–crowned, broad–based and bladelike; upper teeth not imbricated or weakly so, with broad high roots that are closely adjacent and sometimes overlapping and not forming a quincunx pattern; lower teeth forming a deep, strongly imbricated series and a continuous saw–like cutting edge; all teeth with a compressed cusp, a distal blade, sometimes a medial blade, and no cusplets; upper cusps narrow, erect to oblique, and broad–based; lower cusps oblique to semierect. Tooth rows 22 to 45 upper jaw, 24 to 35 lower jaw; upper teeth usually somewhat more numerous than lowers (averaging 1.2:1). Trunk cylindrical or slightly compressed, abdomen without lateral ridges. Interdorsal space elongated and usually greater than length of first dorsal–fin base but subequal to or slightly longer than it in a few species. Pelvic–caudal space moderately long and about two or three times pelvic–fin bases. Caudal peduncle slightly compressed, short to moderately elongated, and without lateral keels or precaudal pits. Body without photophores. Denticles moderate–sized and pedicellate or sessile, when pedicellate having flattened, narrow to broad–keeled, leaf–shaped (***Centrophorus***) or pitchfork–like (***Deania***) crowns, slender pedicels and low bases. Pectoral fins low, angular or rounded, and not falcate; anterior margins moderately large and about 0.5 to 1.2 times the prespiracular length; pectoral–fin rear tips rounded and short to angular and greatly elongated. Pelvic fins smaller than pectoral and first dorsal fins, and subequal to or smaller than second dorsal fin. Claspers with a lateral spine only (***Centrophorus***), or with no spine (***Deania***). Dorsal fins large, broad, angular or rounded–angular but not falcate, with strong grooved spines. First dorsal fin large, with length usually greater than prespiracular space, exceptionally slightly shorter, and up to over 2.5 times its length; first dorsal–fin base over pectoral–pelvic space and well anterior to pelvic fins, first dorsal–fin origin over pectoral–fin bases or inner margins (slightly behind them in some ***Deania*** species). Second dorsal fin usually smaller than or sometimes as large as first dorsal fin; second dorsal–fin base partly over or just behind pelvic–fin bases; second dorsal–fin origin usually over rear halves of pelvic–fin bases, pelvic–fin insertions, or pelvic–fin inner margins but sometimes slightly behind pelvic–fin free rear tips (some ***C. moluccensis*** specimens). Caudal fin heterocercal, with ventral lobe poorly to strongly developed in adults, and with a strong subterminal notch. Vertebral centra strongly calcified, primary double cones well developed. Vertebral counts: total vertebral counts 106 to 131, monospondylous vertebral counts 49 to 65, diplospondylous precaudal vertebral counts 24 to 37. Intestinal valve with 10 to 25 turns. Adults are small to moderate–sized, between 43 to 170 cm long. **Colour:** plain or with light or dark markings on fins, without black photophore markings on tail or flanks.

Distribution: The family Centrophoridae has an almost circumglobal range in cold temperate to tropical seas, in association with landmasses including continents, islands, seamounts and ridges. Gulper sharks are generally absent from very high latitudes, except ***Centrophorus squamosus*** which ranges up to Iceland in the North Atlantic, and are most diverse in warm temperate waters and in the tropics. Several of the species are wide–ranging in the Atlantic but the greatest known diversity of the family is in the Indo–West Pacific. These sharks are apparently absent from the eastern North Pacific, though ***C. squamosus*** and ***Deania calcea*** occur in the eastern South Pacific off South America. Geographic and bathymetric ranges are imperfectly known for most species, a result of problems in identifying individual centrophorid species and uneven sampling of deepwater slope–dwelling sharks. Several ***Centrophorus*** species may be regional endemics.

Habitat: Members of the Centrophoridae are primarily bottom dwelling, deepwater bathic inhabitants of the continental and insular slopes and more rarely the upper rises, but also occur on submarine ridges and seamounts. They range in depth from 200 to below 4000 m, but most species do not appear to extend below 1500 m. These sharks occasionally occur on the continental and insular shelves offshore in water up to 50 m depth, although this is most exceptional. The family apparently lacks specialized epipelagic species but at least one bottom dwelling centrophorid may venture into the open ocean: ***Centrophorus squamosus*** was once collected at a depth between the surface and 1250 m in water about 4000 m deep.

Biology: Reproductive mode is viviparous with a yolk sac, with females having from one to 17 young in a litter. There have only been a few studies on the age and growth of these sharks, but most appear to be very slow growing, maturing between 8.5 and 30 years, with a maximum age estimated at 70 years or more for at least one species. Gulper sharks feed mostly on bony fishes and cephalopods but also eat crustaceans (lobsters and shrimps), small sharks (including batoids and chimaeras), and tunicates. Centrophorids have moderately strong to very powerful jaws with a shear–like cutting dentition in the lower jaw, and holding or cutting dentition in the upper jaw.

Several centrophorids are social, and form small to huge schools or aggregations, making them among the commonest deep–water sharks in temperate and tropical seas, but general biology, including behaviour, sociobiology and population biology is little known.

Interest to Fisheries and Human Impact: Globally, the Centrophoridae are perhaps one of the most important families of deepwater sharks as they are the subject of targeted and non–target deepwater fisheries. In the western Indo–Pacific and eastern North Atlantic, these sharks are commonly fished as part of targeted deepwater shark fisheries and also form an important bycatch of deepwater fisheries for bony fishes. Some species are regularly caught as discarded bycatch of fisheries for deepwater teleosts. They are caught with longlines, bottom trawls, and fixed bottom gillnets. Gulper sharks are used for human consumption: dried–salted or fresh, for fishmeal, and for their livers, which are extremely large, oily, and have a high squalene content.

The conservation status of gulper sharks is poorly known largely due to the poor taxonomic resolution of this group, inadequate monitoring in most areas, and limited knowledge on their biology, and possibly from the extreme limits in life–history parameters such as fecundity, life span, age at maturity, and gestation period.

Local Names: Gulper sharks, Birdbeak dogfish, Oil tankers.

Remarks: The current arrangement of the Centrophoridae is comprised of two genera, with 15 nominal species currently recognized. Both genera and 13 species have been reported from the Indian Ocean.

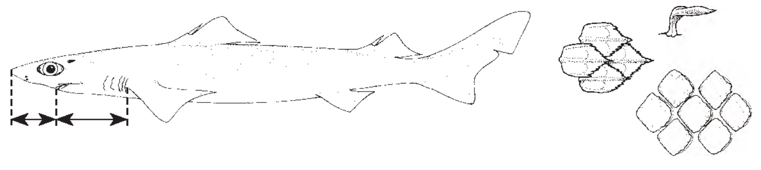
Literature: Müller and Henle (1839); Gray (1851); Duméril (1865); Günther (1870); Regan (1908a); Garman (1913); Fowler (1941, 1968, 1969); Bigelow and Schroeder (1948, 1957); Cadenat (1959a, b, c), Garrick (1959a, 1960b); Bass, D'Aubrey and Kistnasamy (1976); Cadenat and Blache (1981); Chen and Cheng (1982); Compagno (1984a, 1999); Muñoz–Chapuli and Ramos (1989b); Shirai (1992a, 1996); Last and Stevens (1994, 2009); Kyne and Simpfendorfer (2010); Ebert and Compagno (In press).

List of Deep–sea Species Occurring in the Area:

Centrophorus atromarginatus Garman, 1913
Centrophorus granulosus (Bloch and Schneider, 1801)
Centrophorus harrissoni McCulloch, 1915
Centrophorus isodon (Chu, Meng, and Liu, 1981)
Centrophorus lusitanicus Bocage and Capello, 1864
Centrophorus moluccensis Bleeker, 1860
Centrophorus seychellorum Baranes, 2003
Centrophorus squamosus (Bonnaterre, 1788)
Centrophorus westraliensis White, Ebert, and Compagno, 2008
Centrophorus zeehaani White, Ebert, and Compagno, 2008
Deania calcea (Lowe, 1839)
Deania profundorum (Smith and Radcliffe, 1912)
Deania quadrispinosa (McCulloch, 1915)

Key to Deep–sea Indian Ocean Genera:

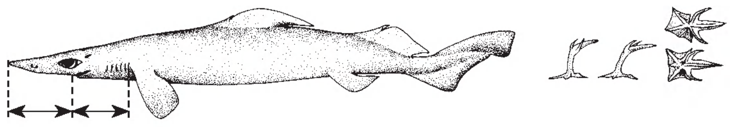
1a. Preoral snout length less than distance from mouth to pectoral–fin origin (Fig. 75a); dermal denticles of back leaf–shaped with pedicels, or sessile with low ridges, and without erect pitchfork–shaped crowns (Fig. 75b). . . . . ***Centrophorus***



a) LATERAL VIEW b) DERMAL DENTICLES

Fig. 75 *Centrophorus*

1b. Preoral snout length greater than distance from mouth to pectoral–fin origin (Fig. 76a); dermal denticles of back with tall, slender pedicels and pitchfork–shaped crowns (Fig. 76b) . . . . ***Deania***



a) LATERAL VIEW b) DERMAL DENTICLES

Fig. 76 *Deania*

Centrophorus Müller and Henle, 1837

Genus: ***Centrophorus*** Müller and Henle, 1837a, *Ber. K. preuss. Akad. wiss. Berlin*, 2: 115; Müller and Henle, 1837b, *Arch. Naturg.*, 3: 398.

Type species: ***Squalus granulosus*** Bloch and Schneider, 1801, by monotypy. "***Sq. squamosus*** Bl. Schn." (= ***Squalus squamosus*** Bonnaterre, 1788) was mentioned by Müller and Henle (1837a, b) in the account of ***Centrophorus***, but who thought a new genus was required. Müller and Henle (1838a, *Mag. Nat. Hist.*, n. ser., 2: 89) confusingly included one species in ***Centrophorus***, "***S. squamosus***, Bl. Schn." (possibly a mistake for ***S. granulosus***), but also noted that "***Squalus squamosus***, Bl. Schn." was allied to ***Centrophorus*** but probably belonged to a new genus. Bonaparte (1838, *Nuov. Ann. Sci. Nat., Bologna, ser.* 1, 2: 207) apparently followed their suggestion and named a new genus ***Lepidorhinus*** for ***S. squamosus***, but Müller and Henle (1839, *Syst. Beschr. Plagiost.*, pt. 2: 90) reversed their previous opinion and included ***S. squamosus*** in ***Centrophorus***.

Number of Recognized Deep–sea Indian Ocean Species: 10.

Synonyms: Genus ***Lepidorhinus*** Bonaparte, 1838: 207. Type species: "***Squalus Squamosus*** Brousson (–et? 1788), Lac. 1. X. 3." by monotypy, equals ***Squalus squamosus*** Bonnaterre, 1788. Genus ***Machephilus*** Johnson, 1867: 713. Type species: ***Machephilus Dumérilli*** Johnson, 1867, by original designation. Genus ***Atractophorus*** Gilchrist, 1922: 48. Type species: ***Atractophorus armatus*** Gilchrist, 1922, by monotypy. Genus ***Actractophorus*** Gilchrist, 1922: 48. Probable error for ***Atractophorus*** Gilchrist, 1922. Subgenus ***Gaboa*** Whitley, 1940: 146 (genus ***Centrophorus*** Müller and Henle, 1837a). Type species: ***Centrophorus harrissoni*** McCulloch, 1915, by original designation. Subgenus ***Somnispinax*** Whitley, 1940: 146 (genus ***Centrophorus*** Müller and Henle, 1837a). Type species: ***Centrophorus nilsoni*** Thompson, 1930, by original designation; a junior synonym of ***Squalus squamosus*** Bonnaterre, 1788. Subgenus ***Somnisphinax*** Neave, 1950: 252. Probable error for ***Somnispinax*** Whitley, 1940. Genus ***Encheiridiodon*** Smith, 1967b: 128. Type species: ***Encheiridiodon hendersoni*** Smith, 1967b, by original designation; a junior synonym of ***Squalus squamosus*** Bonnaterre, 1788. Genus ***Attractophorus*** Bass, D'Aubrey and Kistnasamy, 1976: 27. Apparent error for ***Atractophorus*** Gilchrist, 1922. Genus ***Encheridiodon*** Shiino, 1976: 11. Apparent error for ***Encheiridiodon*** Smith, 1967b. Genus ***Pseudocentrophorus*** Chu, Meng, and Liu, 1981: 100. Type species: ***Pseudocentrophorus isodon*** Chu, Meng, and Liu, 1981, by original designation.

Field Marks: Deepwater sharks with a moderately long and broad snout, and huge, iridescent green eyes, bladelike upper and lower teeth without cusplets, lower teeth imbricated and much larger than uppers, cylindrical bodies with very tough skin and large leaf–like, thornlike or pebble–shaped denticles, pectoral–fin free rear tips more or less angular to attenuated, two dorsal fins each with a strong grooved spine, no anal fin, caudal fin with a strong subterminal notch, body coloration light grey or grey–brown to blackish grey, sometimes lighter below and fin webs dusky or with dark and light bars.

Diagnostic Features: Snout flattened and broadly parabolic to slightly pointed in dorsoventral view, angular to rounded–angular in lateral view; snout short to moderate with preoral length less than distance from mouth to pectoral–fin origins and half length of head or less. Labial furrows not extended anteromedially as elongated preoral grooves. Upper and lower teeth with broader, thicker crowns and roots. Lower teeth with vertical basal grooves on their lingual roots and with broader cusps than the upper teeth; edges of lower teeth often serrated in adults. Tooth rows 30 to 45 upper jaw, 24 to 35 lower jaw. Dermal denticles with low, flat, ridged crowns, varying from leaf–shaped and with low pedicels and posterior cusps, to cuspless, block–shaped, and without pedicels; denticle crowns flat and not elevated or pitchfork–like, with a short medial cusp (sometimes absent), lateral cusps short or absent, and single or multiple ridges; denticle bases broader and quadrangular. Surface of skin rough in the leaf–scaled ***Centrophorus squamosus*** but smooth in species with sessile crowns and low bases. Pectoral fins with free rear tips varying from squared–off and angular to elongated and acutely pointed, not broadly lobate. Claspers with a lateral spine. Second dorsal fin smaller than first and with its base about half to 3/4 length of first dorsal–fin base; second dorsal–fin origin varying from over last third of pelvic–fin bases to slightly posterior to pelvic–fin free rear tips; second dorsal–fin spine equal to or slightly larger than first dorsal–fin spine but not greatly enlarged, spine moderately curved, spine apex usually falling well below fin apex. Vertebral counts: total vertebral counts 106 to 131, monospondylous vertebral counts 49 to 64, precaudal vertebral counts 77 to 92. Intestinal valve with 10 to 30 turns. Adults are small to moderately large from 90 to 170 cm total length. **Colour:** light to dark grey, greyish brown to black above, usually lighter below; depending on the species fin edges may be plain to light or dark edged.

Local Names: Gulper sharks.

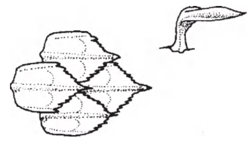
Remarks: The genus ***Centrophorus*** has a complex and convoluted taxonomic history, in part because many researchers have had difficulty interpreting differences in denticles, fin spines, teeth, body and fin morphology within and between species that are related to growth and sexual dimorphism. Also, until recently researchers have tended to concentrate on the same few external characters without examining other characters that are less subject to growth and sexual changes. Poor or inadequate sampling of ***Centrophorus*** species from most localities where these deep–water sharks occur has exacerbated these problems.

The genus currently has 11 recognized species, but the taxonomic status of most ***Centrophorus*** species is very poor with most species having been inadequately described and with type material missing or in poor condition. At the present, 10 or 11 nominal ***Centrophorus*** species have been reported from the Indian Ocean, but this number is likely to change.

The current key of species below is provisional and should be used with caution pending further examination of adequate growth series of several of the species, improved sampling, and exploration of deepwater habitats where these sharks occur. A comprehensive systematic review of the genus ***Centrophorus***, including detailed examination of external morphological, anatomical and molecular characters is currently being carried out by the author and W.T. White (CSIRO, Hobart, Tasmania, Australia) and should resolve some of the current taxonomic issues within this group in the near future. This includes the confused systematics of ***Centrophorus*** species referred to as ***C.*** cf. ***acus***, ***C.*** cf. ***granulosus***, ***C.*** cf. ***niaukang***, ***C.*** cf. ***tessellatus***, and ***C.*** cf. ***uyato*** as well a long–snouted species very similar to ***C.*** cf. ***harrissoni***.

Key to Deep–sea Indian Ocean Species (Provisional):

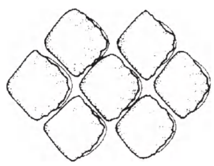
1a. Lateral trunk denticles with leaf–like flattened crowns on elevated narrow to broad pedicels extending above the denticle bases; crowns with strong medial and lateral cusps on their posterior ends (Fig. 77) . . . . ***Centrophorus squamosus***



DERMAL DENTICLES

Fig. 77 *Centrophorus squamosus*

1b. Lateral trunk denticles with flat sessile crowns on the denticle bases, without separate pedicels; crowns usually with or sometimes without a posterior medial cusp but no lateral cusps (Fig. 78) **2**



DERMAL DENTICLES

Fig. 78 *Centrophorus granulosus*

2a. Second dorsal fin very small, half height of first dorsal fin or less, with second dorsal–fin spine origin usually well posterior to pelvic–fin rear tips (Fig. 79) . . . . ***Centrophorus moluccensis***

2b. Second dorsal fin larger, nearly or quite as high as first dorsal fin, with second dorsal–fin spine origin usually over pelvic–fin inner margins **3**

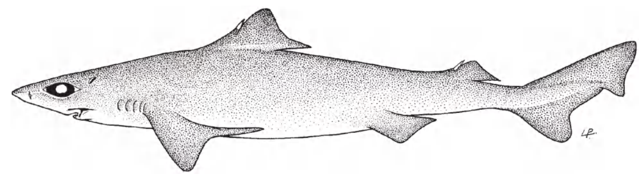


Fig. 79 *Centrophorus moluccensis*

3a. First dorsal fin very low and greatly elongated, first dorsal–fin height 2.4 to 3.8 in base length, first dorsal–fin base 16.2 to 22.4% of total length (Fig. 80) . . . . ***Centrophorus lusitanicus***

3b. First dorsal–fin base higher and shorter, first dorsal–fin height 1.4 to 2.5 in base length, first dorsal–fin base 8.8 to 15.8% of total length **4**

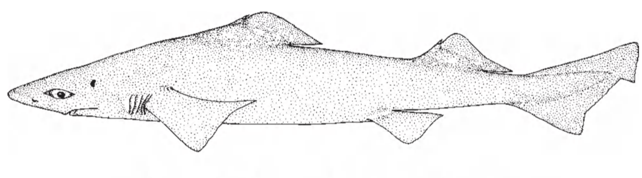


Fig. 80 *Centrophorus lusitanicus*

4a. Snout elongated and narrow, narrowly parabolic in dorsoventral view, narrowly wedge–shaped in lateral view; preoral length 1.4 to 1.8 times mouth width and 0.9 to 1.1 times head width at mouth corners; mouth narrower, width 5.2 to 7.3% of total length. Body usually slender **5**

4b. Snout short and broad, broadly parabolic in dorsoventral view, broadly wedge–shaped in lateral view; preoral length 0.9 to 1.5 times (usually less than 1.3 times) mouth width and 0.6 to 0.9 times head width at mouth corners; mouth broader, 6.6 to 9.5% of total length. Body is usually stout **9**

5a. Body colour light grey above, white below; dorsal fins with a dark grey to blackish oblique blotch from the middle of the anterior margin to the free rear tip, and a light apex; caudal fin with a dark to blackish blotch on the terminal lobe, more prominent in young than adults; pectoral fins with light posterior margins **6**

5b. Body colour blackish–grey above, lighter below, dark above gill openings; anterior margin of second dorsal fin and upper caudal–fin web blackish, webs of fins dusky without prominent light or black spots **8**

6a. Snout relatively short, thick, depth at front of mouth is less than 1.9 in preoral distance; dorsal–fin apices and posterior margins dark (fades somewhat in adults) (Fig. 81) . . . . ***Centrophorus zeehaani***

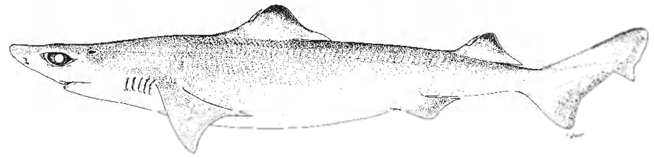


Fig. 81 ***Centrophorus zeehaani***

6b. Snout relatively long, slender, depth in front of mouth is more than 1.9 in preoral distance; dorsal–fin apices with a dark anterior blotch (sometimes may extend posteriorly as a submarginal bar; fades somewhat in adults) **7**

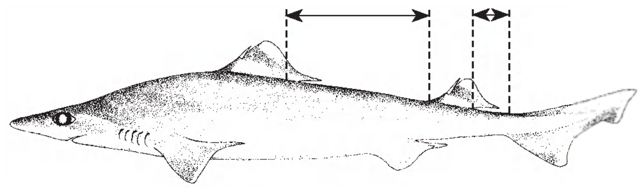


Fig. 82 ***Centrophorus harrissoni***

7a. Dorsal fins well separated, interdorsal space more than 2.8 times dorsal–caudal space (Fig. 82); mouth relatively narrow, width more than 3.1 in head length . . . . ***Centrophorus harrissoni***

7b. Dorsal fins relatively close, interdorsal space less than 2.8 times dorsal–caudal space (Fig. 83); mouth relatively broad, width less than 3.1 in head length. . . . . ***Centrophorus westraliensis***

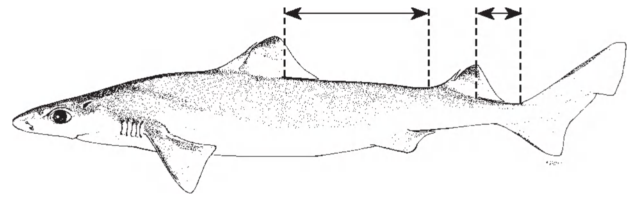


Fig. 83 ***Centrophorus westraliensis***

8a. Dorsal–caudal space relatively short, less than 7% total length; flank denticles block–like, widely spaced (Fig. 84) . . . . ***Centrophorus isodon***

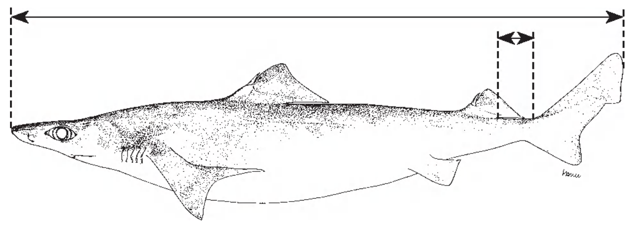


Fig. 84 ***Centrophorus isodon***

8b. Dorsal–caudal space relatively long, more than 8% total length (Fig. 85); flank denticles not block–like, more pointed, close–set . ***Centrophorus seychellorum***

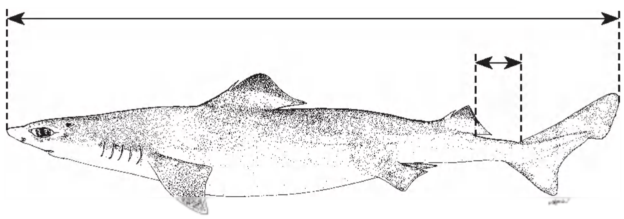


Fig. 85 ***Centrophorus seychellorum***

9a. Fins of adults and subadults prominently marked with black tips and margins, including pectoral and sometimes pelvic fins, both dorsal fins, and both lobes of the caudal fin (Fig. 86) . . . . ***Centrophorus atromarginatus***

9b. Fins of adults and subadults not prominently marked, light to dusky (Fig. 87) . . . . ***Centrophorus granulosus***

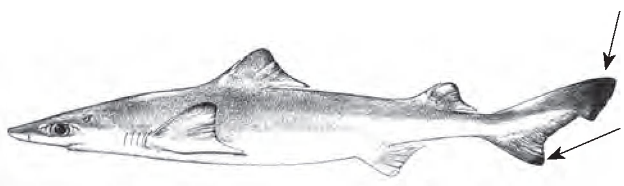


Fig. 86 ***Centrophorus atromarginatus***

Fig. 87 ***Centrophorus granulosus***

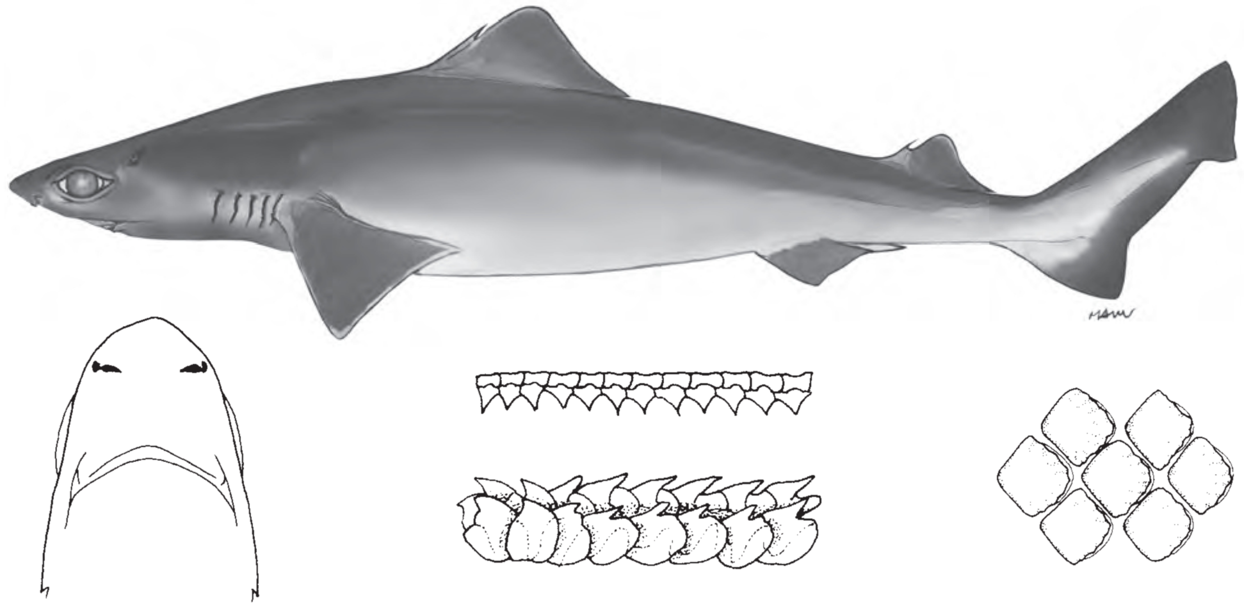
Centrophorus granulosus (Bloch and Schneider, 1801)

Squalus granulosus Schneider *In* Bloch and Schneider, 1801, *Syst. Ichthyol.*: 135. No locality mentioned. Holotype: A single large stuffed specimen without jaws, "5 ped. longum" or 1570 mm long; lost according to Krefft and Tortonese (1973, *In* J. C. Hureau and T. Monod, eds., CLOFNAM. Check–list. fish. NE Atlantic Mediterranean, 1: 38) and Paepke and Schmidt (1988, *Mitt. Zool. Mus. Berlin* 64[1]: 161).

Synonyms: ***Dalatias nocturnus*** Rafinesque, 1810: 11, pl. 14, fig. 3. Apparently no type material, Sicily, Mediterranean Sea. ?***Centrophorus bragancae*** Regan, 1906b: 438. Syntypes: British Museum (Natural History), BMNH–1904.11.30.11, cited as 460 mm but measured as a 490 mm immature male (labelled 'holotype', and with a closed umbilical scar suggesting that it was close to birth size) off Cezimbra, Portugal in water 842 m deep; and BMNH–1904.11.30.12, cited as 440 mm but measured as a 475 mm immature female, off Cezimbra, Portugal, in water 505 m deep. Regan (1906b) did not designate types in his description; however, Regan (1908a: 53) mentioned the same two specimens as "types of the species" without designating either of them as a holotype (or properly, lectotype). ***Centrophorus machiquensis*** Maul, 1955: 5, fig. 13–16. Holotype: Museu Municipal do Funchal, no. 3767, 1050 mm TL female, off Machico, Madeira, ca. 400 m.

Other Combinations: ***Centrophorus*** or ***Entoxychirus uyato*** or ***uyatus*** (not ***Squalus uyato*** Rafinesque, 1810).

FAO Names: En – Gulper shark; **Fr** – Squale–chagrin commun; **Sp** – Quelvacho.



UNDERSIDE OF HEAD — UPPER AND LOWER TEETH — DERMAL DENTICLES

Fig. 88 ***Centrophorus granulosus***

Field Marks: Snout moderately long and thick, bladelike monocuspidate teeth in upper and lower jaws, with lowers much larger than uppers, low rhomboidal monocuspidate lateral trunk denticles, rear tips of pectoral fins narrowly angular and greatly elongated, two dorsal fins with large grooved spines, first dorsal fin higher than second dorsal fin, first dorsal fin short and high, second dorsal fin with spine base over pelvic–fin inner margins, no anal fin, colour dark grey or grey–brown above, lighter below, with dusky fin webs but no prominent blackish fin markings.

Diagnostic Features: Snout moderately long, preoral length 0.9 to 1.2 times mouth width, 1.0 to 1.4 in space from mouth to pectoral–fin origins, and 0.7 to 0.9 times head width at mouth. Snout broadly parabolic in dorsoventral view, broadly wedge–shaped in lateral profile, depth at mouth 1.3 to 1.9 in preoral length. Mouth width 7.4 to 8.8% of total length. Upper anterolateral teeth with erect to semioblique cusps, lower teeth with oblique or semioblique cusps; tooth row counts 36 to 43 upper jaw, 28 to 32 lower jaw. Body moderately stocky to slender. Distance from first dorsal–fin insertion to second dorsal–fin spine origin 24.7 to 29.0% of total length. Dorsal–caudal space 6.1 to 8.0% of total length. Lateral trunk denticles with rhomboidal to nearly circular sessile crowns on very low, thick pedicels; crowns close–set but not overlapping one another, with a narrow to broad, very short, thornlike to blunt or obsolete medial cusp (broader and shorter in adults than young), no lateral cusps, and several low blunt ridges. Pectoral–fin free rear tips elongated into narrow, angular lobes that reach behind first dorsal–fin spine; pectoral–fin inner margin 10.1 to 15.6% of total length. First dorsal fin moderately high and short, height 1.7 to 2.5 in base; base 11.0 to 15.8% of total length. Second dorsal–fin height about 0.7 to 0.8 times first dorsal–fin height; second dorsal–fin base 7.6 to 10.5% of total length and about 0.5 to 0.8 times first dorsal–fin base; second dorsal–fin spine origin over inner margins of pelvic fins. Caudal fin with broadly notched postventral margin in adults. Vertebral counts: total vertebral counts 113 to 125, monospondylous vertebral counts 53 to 59, precaudal vertebral counts 79 to 89. Intestinal valve counts 11 to 15. Size large, adults to 170 cm total length. **Colour:** body dark grey or grey–brown above, slightly lighter below; fins with dark grey or blackish webs but without prominent black tips and margins.

Distribution: Widespread in the Atlantic, Indian, and western Pacific oceans, but geographic range uncertain due to misidentification with similar species. Western Indian Ocean: southern Mozambique, the Madagascar Ridge, Aldabra Island, Maldives. Eastern Indian Ocean: Indonesian (Java) and Australian (Western Australia) records attributed to ***C. acus*** and ***C. niaukang,*** appear in fact to be of this species.

Habitat: A deepwater dogfish of the outer continental shelves and upper slopes, usually on or near the bottom at depths from 50 to 1440 m, but most records between 200 to 600 m.

Biology: Viviparous with a yolk sac, number of young per litter 1 to 6, averaging 3. Nothing is known of its reproductive cycle. Like other members of this genus, ***C. granulosus*** is slow growing, with females maturing in about 16.5 years and males in about 8.5 years. The maximum estimated age for this shark is 39 and 25 years for females and males, respectively.

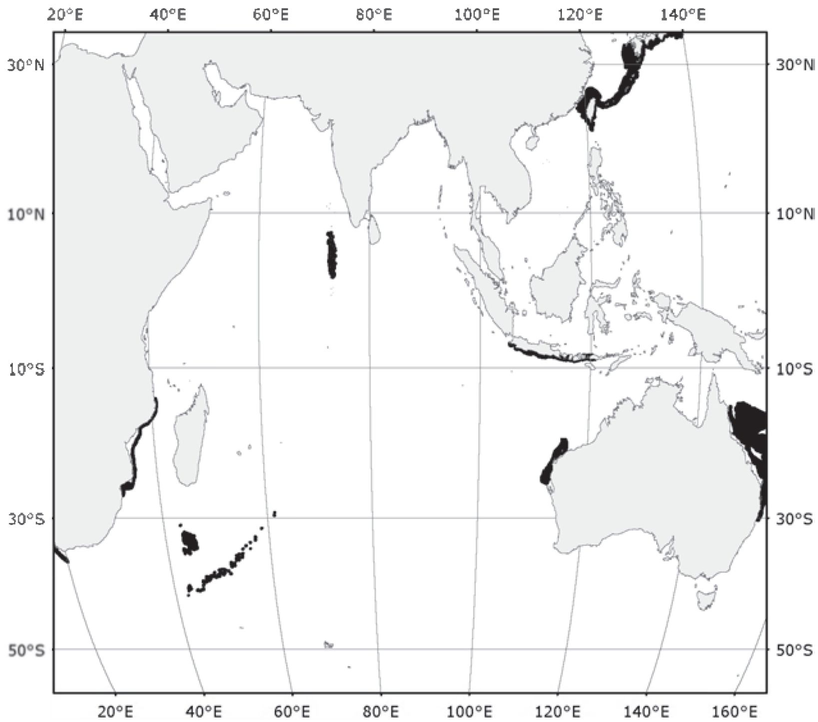


Fig. 89 ***Centrophorus granulosus***

Its diet includes bony fishes, including herring–smelts (Argentinidae), hake (Merluccidae), cods (Gadidae), rattails (Macrouridae), epigonids (Epigonidae) and lanternfish (Myctophidae), cephalopods (Ommastrephidae), and crustaceans (brachyurid crabs, Calappidae and Geryonidae).

Size: Maximum total length is about 170 cm. Males mature at 110 to 128 cm and females mature over 130 cm; the size at maturity will need to be reassessed for this species due to misidentification with other ***Centrophorus*** species. Size a birth between 35 and 45 cm.

Interest to Fisheries and Human Impact: Primarily fished with bottom trawls, long lines, and fixed bottom nets, but also caught as discarded or utilized bycatch of deepwater slope fisheries elsewhere. The flesh of this species is utilized smoked and dried salted for human consumption or processed for fishmeal and liver oil. It is also valuable for its large oily liver with high squalene content.

The conservation status is Vulnerable globally, but in some regions it is considered to be Critically Endangered, e.g. eastern North Atlantic due to massive, expanding, and often uncontrolled deepwater fisheries in many parts of its range, including European seas.

Local Names: None.

Remarks: The nomenclature and systematic status of this species is currently undergoing an extensive revision by the author and W.T. White (CSIRO, Hobart, Tasmania, Australia).

Literature: Bloch and Schneider (1801); Rafinesque (1810); Blainville (1825); Müller and Henle (1839); Gray (1851); Duméril (1865); Günther (1870); Regan (1908a); Garman (1913); Fowler (1936, 1941, 1969); Bigelow, Schroeder and Springer (1955); Bigelow and Schroeder (1957); Forster *et al.* (1970); Nair and Mohan (1972); Krefft and Tortonese *in* Hureau and Monod (1973); Bass, D'Aubrey and Kistnasamy (1976); Compagno (1984a); McEachran and Branstetter *in* Whitehead *et al.* (1984); Bass, Compagno and Heemstra *in* Smith and Heemstra (1986); Compagno, Ebert and Smale (1989); Muñoz–Chapuli and Ramos (1989b); Compagno, Ebert and Cowley (1991); Ebert, Compagno and Cowley (1992); Last and Stevens (1994, 2009); Guallart *et al.* (2006); Bañón, Piñeiro and Casas (2008); Ebert and Compagno (In press); W.T. White (*pers. comm.*).

Centrophorus moluccensis Bleeker, 1860

Centrophorus moluccensis Bleeker, 1860, *Act. Soc. Sci. Indo–Neerl.*, 1860, 8: 3. Holotype: Rikjsmuseum van Natuurlkjke Histoire, Leiden, RMNH–7415, 188 mm late foetus, Ambon, Indonesia.

Synonyms: ***Centrophorus scalpratus*** McCulloch, 1915: 97, pl. 13, fig. 2–7. Syntypes: Australian Museum, Sydney, AMS E.5211 (jaws as I.15605–001), 870 mm TL female (illustrated), on which the description was mostly based, also AMS I.13535, 907 mm TL male (not illustrated), was mentioned and contrasted with the female; both were from 38°50'S, 148°15'E, coast of Victoria, Australia, 128–146 m. There were no type–designations in McCulloch's account. McCulloch (*ibid.*: 9) mentioned several differences between the two specimens in body, fin, and tooth shapes, including a much larger and more anterior first dorsal fin in the male, and notes: "All these differences suggest that the two specimens belong to different species, but taking into consideration the fact that they were obtained at almost the same locality, I prefer to regard them as sexual forms of the same species." Catalog numbers are from Paxton *et al.* (1989: 31) and Eschmeyer (2012), who regard these two specimens as holotype and paratype respectively. I have not examined either of the types, but suggest that if the specimens are syntypes then the female should be designated as lectotype. McCulloch may very well have had two species in his type material. ***Atractophorus armatus*** Gilchrist, 1922: 48, pl. 7, fig. 3. Holotype: 355 mm TL female, 30°9'45"S, 30°58'02"E, SE of Durban, Natal, South Africa, 293 m, possibly lost. The whereabouts of the holotype are unknown according to Eschmeyer (2012).

Other Combinations: ***Centrophorus armatus*** (Gilchrist, 1922).

FAO Names: En – Smallfin gulper shark; **Fr** – Squale–chagrin cagaou; **Sp** – Quelvacho de aleta corta.

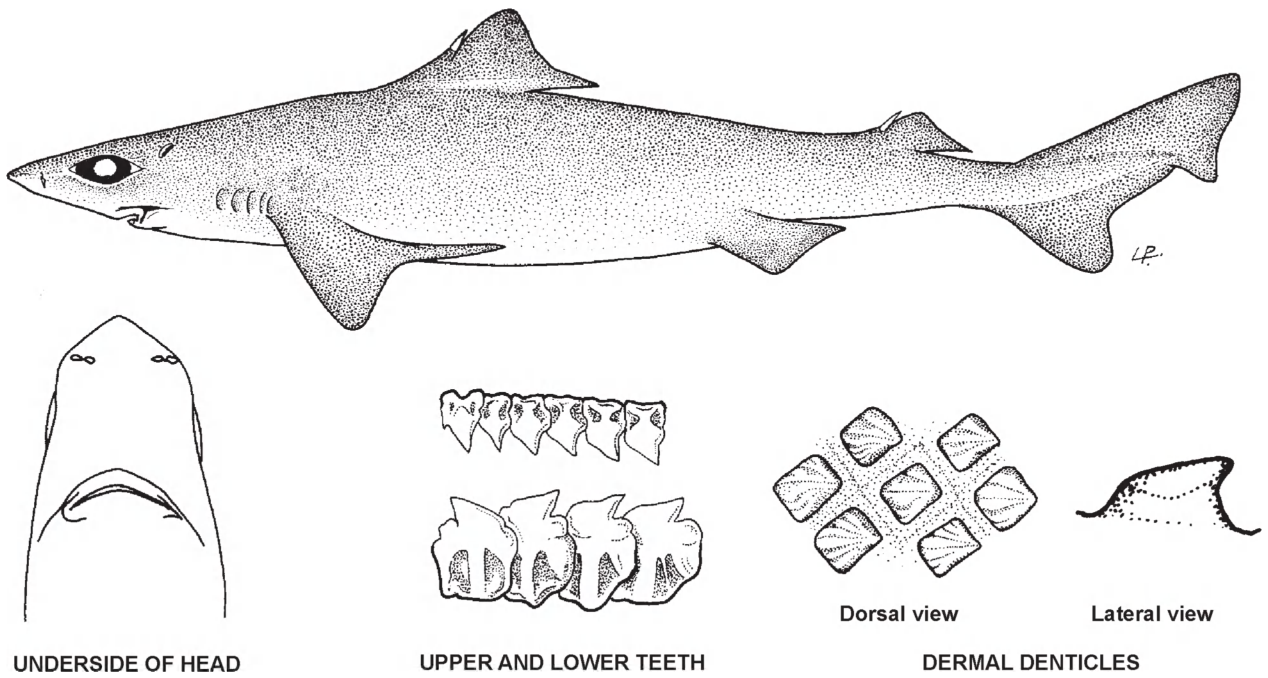


Fig. 90 ***Centrophorus moluccensis***

Field Marks: Snout moderately long and flat, bladelike monocuspidate teeth in upper and lower jaws, with lowers much larger than uppers, low thornlike to rhomboidal monocuspidate lateral trunk denticles, rear tips of pectoral fins narrowly angular and greatly elongated, two dorsal fins with large grooved spines, first dorsal fin much higher and larger than second dorsal fin, first dorsal fin is relatively short and high, second dorsal fin with spine base usually behind pelvic–fin rear tips, postventral margin of caudal fin conspicuously notched, colour grey–brown or grey above, conspicuously lighter below, with dusky fin webs.

Diagnostic Features: Snout moderately elongated, with preoral length 1.1 to 1.7 times mouth width, 0.9 to 1.5 times space from mouth to pectoral–fin origins, and 0.8 to 1.1 times head width at mouth. Snout broadly parabolic or angular–parabolic in dorsoventral view, broadly wedge–shaped in lateral profile, depth at mouth 1.3 to 1.9 in preoral length. Mouth width is 6.2 to 7.9% of total length. Upper anterolateral teeth with erect to semioblique cusps, lower teeth with oblique cusps; tooth row counts 36 to 45 upper jaw, 29 to 35 lower jaw. Body relatively slender. Distance from first dorsal–fin insertion to second dorsal–fin spine origin is 23.0 to 28.5% of total length. Dorsal–caudal space is 6.3 to 8.6% of total length. Lateral trunk denticles with thornlike to rhomboidal or rounded sessile crowns on very low, thick pedicels; crowns close–set but not overlapping one another, with a narrow to broad, very short, thornlike to blunt medial cusp (broader in adults than young), no lateral cusps, and several low blunt ridges. Pectoral–fin free rear tips elongated into very narrow, angular lobes that reaches well behind first dorsal–fin spine base, pectoral–fin inner margin 10.9 to 15.8% of total length. First dorsal fin relatively high and short, height 1.4 to 2.3 in base; base 10.4 to 13.2% of total length. Second dorsal fin very low, only 0.4 to 0.6 times height of first dorsal fin; second dorsal–fin base 5.1 to 8.3% of total length and about 0.4 to 0.8 times first dorsal–fin base; second dorsal–fin spine origin usually well behind free rear tips of pelvic fins. Caudal fin has a deeply notched postventral margin in adults. Total vertebral counts 113 to 131, precaudal vertebral counts 83 to 93, monospondylous vertebral counts 50 to 58. Intestinal valve counts 20 to 30. Size moderate, adults to 102 cm total length. **Colour:** light grey–brown or pearly grey above, conspicuously lighter below. Dorsal fins with black anterodorsal margins and light posteroventral margins, sometimes a dark spot on apex of dorsal fins and on the base of the terminal lobe of the caudal fin or dark webs on dorsal and caudal fins. Pectoral fins with conspicuous light posterior margins.

Distribution: Indo–West Pacific: scattered localities off the east coast of South Africa (KwaZulu–Natal), southern Mozambique, Malaysia (Sabah, Borneo), Philippines (northeastern Luzon), Indonesia (Ambon), Australia (Queensland, New South Wales, Victoria and Western Australia, possibly from Tasmania and South Australia), New Hebrides, New Caledonia, Taiwan (Province of China), and Japan (Okinawa and Okinawa Trough). Confirmable Indian records as ***Centrophorus armatus*** are apparently ***C. atromarginatus***, so the status of ***C. moluccensis*** off the Indian subcontinent is uncertain. This species probably has a more extensive range than indicated by available records (as with several other members of this family).

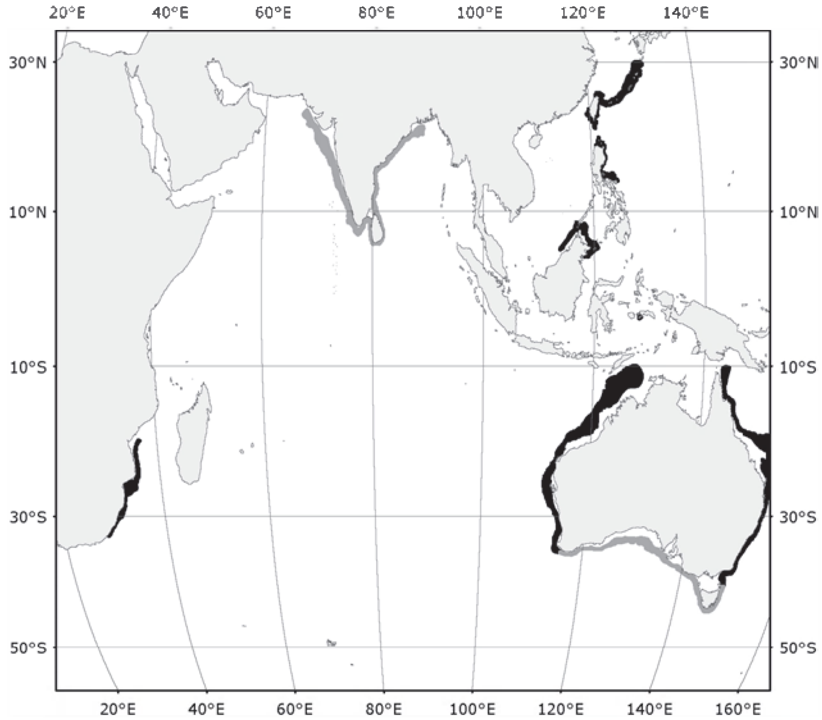


Fig. 91 *Centrophorus moluccensis*

Known distribution Possible distribution

Habitat: A common to rare deepwater dogfish where it occurs of the outer continental and insular shelves and upper slopes of the warm–temperate and tropical Indo–West Pacific. Found on or near the bottom at depths from 128 to 823 m.

Biology: Viviparous with a yolk sac, number of young two per litter. Full term foetuses were found in summer off South Africa, suggesting a gestation period of at least a year and possibly two years because of the large size of the foetuses and by analogy to slow–reproducing dogfishes of the family Squalidae. Off southern Australia there does not appear to be a defined birthing season with pregnant females carrying embryos at different stages of development observed year–round.

Eats primarily bony fish, including lanternfish (Myctophidae), pomfrets (Bramidae), jacks (Carangidae), worm–eels (Ophichthyidae), bonito (Scombridae), hairtails (Trichiuridae), oilfishes (Gempylidae), as well as other dogfish sharks, squid, octopi, shrimps, and even tunicates.

Size: Maximum about 102 cm; males maturing between 69 and 77 cm and adult at 67 to 91 cm; females maturing at 85 to 90 cm and reaching at least 101.7 cm. Size at birth about 31 to 37 cm; free–living young specimens 35 to 37 cm had open umbilical scars.

Interest to Fisheries and Human Impact: Of minor to moderate interest to fisheries, frequently taken by bottom trawlers, along with other ***Centrophorus*** species, off South Africa and Australia but little utilized. It was potentially important for its abundance or former abundance off the coasts of South Africa and southern Mozambique and has figured in very small–scale directed shark fisheries off the KwaZulu–Natal coast of South Africa. Populations of this species along with other ***Centrophorus*** species may have declined by as much as 95% over a 20 year period of intensive trawling off New South Wales, Australia. It is mostly caught as bycatch of other fisheries targeting shrimp and bony fishes.

Conservation status is Data Deficient, although this species may have declined markedly in numbers off the east coasts of southern Africa and Australia after being caught as bycatch of fisheries targeting shrimp and bony fishes.

Local Names: Arrowspine dogfish, Pylstekel–hondhaai (South Africa); Liza barbatana curta (Mozambique); Endeavour dogfish (Australia); Indonesia: Hiu botol danten (Jawa Barat), Hiu taji (Lombok), Hiu senget (Bali); Cucut botol (Jakarta).

Remarks: ***Centrophorus moluccensis*** Bleeker, 1860 was described from a fetal specimen from Ambon, Indonesia (RMNH 7415, holotype of the species), and has either been recognized as a valid species (Regan, 1908a; Garman, 1913) or a dubious species (Duméril, 1865; Günther, 1870; Fowler, 1941; Bigelow and Schroeder, 1957) of ***Centrophorus***. Günther

(1870) noted that Bleeker sent a specimen of ***C. moluccensis*** to the British Museum (Natural History), which Günther, and later Regan (1908a) incorrectly regarded as the "type of ***Centrophorus moluccensis*** Bleeker" (Günther, 1870). Compagno (1984a) examined this specimen (BMNH 1867.11.28.201, a 220 mm late fetal female in good condition), and found it agrees with published accounts of ***C. scalpratus*** in its relatively narrow–based first dorsal fin, first dorsal origin well behind pectoral origins, very small second dorsal fin with its height about half the first dorsal–fin height and its origin well behind the pelvic fins, and long, attenuated pectoral–fin inner margins. Ebert and Compagno (In press) reported additional information including good photographs of two specimens of Bleeker's ***C. moluccensis*** catalogued under RMNH 7415, the 188 mm holotype and another 208 mm specimen, that was obtained for examination through the courtesy of Drs. M. Boeseman and M.J.P. van Oijen of the Rijksmuseum van Natuurlijke Historie, Leiden. The holotype is in poor condition at present, but agrees with ***C. scalpratus*** in the positions of its first and second dorsal fins. The 208 mm fetus agrees with the BMNH fetus and published data on ***C. scalpratus*** in the above particulars. It is not known for certain if the three foetuses came from different mothers, except that the mention of only the 188 mm specimen in Bleeker's original description of ***C. moluccensis*** suggests that at least this specimen had different parentage than the two other foetuses. In any event, the three foetuses are apparently conspecific. Following Compagno (1984a), these specimens are also considered conspecific with published material of ***C. scalpratus***, and this species is ranked as a junior synonym of ***C. moluccensis***. ***Atractophorus armatus*** Gilchrist, 1922 was described from South Africa as a distinct genus and species, but Bass, D'Aubrey and Kistnasamy (1976) synonymized it with ***C. scalpratus***. Compagno (1984a) in turn synonymized ***A. armatus*** with ***C. moluccensis***.

Literature: Bleeker (1860); Günther (1870); Regan (1908a); McCulloch (1915); Gilchrist (1922); Whitley (1940); Fowler (1941, 1969); Smith (1949, 1967b); Bigelow and Schroeder (1957); Bass, D'Aubrey and Kistnasamy (1976); Compagno (1984a); Compagno, Ebert and Smale (1989); Yano and Kugai (1993); Last and Stevens (1994, 2009); Compagno (1998); White *et al*. (2006); Graham and Daley (2011); Graham and Kyne (2013); Ebert and Compagno (In press).

Deania Jordan and Snyder, 1902

Genus: ***Deania*** Jordan and Snyder, 1902, *Proc. U.S. Natn. Mus*. 25(1279): 80.

Type species: ***Deania eglantina*** Jordan and Snyder, 1902, by monotypy, a junior synonym of ***Acanthidium calceum*** Lowe, 1839.

Number of Recognized Deep–sea Indian Ocean Species: 3.

Synonyms: Genus ***Acanthidium*** Lowe, 1839, *Proc. Zool. Soc. Lond*., pt. 7: 92, Type species: without designation of type species, new based in part on ***Acanthidium calceus*** and ***A. pusillum***. Type location Madeira. Genus ***Nasisqualus*** Smith and Radcliffe, *in* Smith, 1912: 681. Type species: ***Nasisqualus profundorum*** Smith and Radcliffe, *in* Smith, 1912, by original designation. Genus ***Deaniops*** Whitley, 1932: 326. Type species: ***Acanthidium quadrispinosum*** McCulloch, 1915, by original designation. Genus ***Daeniops*** Bigelow and Schroeder, 1957: 101. Apparently an error for ***Deaniops*** Whitley, 1932.

Field Marks: Deepwater sharks with an extremely long, broad snout, bladelike upper and lower teeth without cusplets, and lower teeth much larger than uppers and imbricated, cylindrical or compressed bodies with delicate but rough skin and large erect or semierect denticles with pitchfork–like crowns and three sharp cusps, pectoral–fin free rear tips rounded, not angular or attenuated, two dorsal fins with strong grooved spines on both dorsal fins but with the second dorsal–fin spine much larger than the first, no anal fin, caudal fin with a strong subterminal notch, body colour light grey or grey–brown to blackish, fin webs dusky and without conspicuous markings, eyes huge and iridescent green or yellowish.

Diagnostic Features: Snout spatulate in dorsoventral view, a thin depressed elongated wedge in lateral view; snout greatly elongated with preoral length over half head length and greater than distance from mouth to pectoral origins. Labial furrows extended anteromedially as elongated preoral grooves. Upper and lower teeth with narrower and more compressed crowns and roots. Tooth rows 22 to 36 upper jaw, 24 to 32 lower jaw. Dermal denticles with high pedicels, high erect crowns resembling tiny pitchforks, with slender narrow elongate triple cusps and ridges; bases narrow and stellate. Surface of skin very rough due to the erect large denticles. Pectoral fins with narrowly rounded or angular free rear tips but not acutely attenuated. Claspers without a lateral spine. Second dorsal fin about as large or slightly larger than first, with its base subequal to about 2/3 length of first dorsal–fin base. Second dorsal–fin origin about over middle of pelvic–fin bases; second dorsal–fin spine usually over twice as long as first and with a broader base, strongly curved and with spine usually reaching apex of fin. Vertebral counts: total vertebral counts 118 to 128, precaudal vertebral counts 85 to 95. Intestinal valve turn counts not available. Moderately large, with adults from 97 to 122 cm total length. **Colour:** blackish brown or grey to greyish brown above and below.

Local Names: Pylkop–hondhaai or Arrowhead dogfishes (South Africa).

Remarks: As with ***Centrophorus***, the genus ***Deania*** has had a rather convoluted taxonomic history (Ebert and Compagno, In press). The genus has four species recognized, but there are a few problems with the present arrangement, including identifying criteria for separation of ***Deania hystricosa*** from ***Deania calcea*** other than larger denticles and often but not always a darker coloration. Bigelow and Schroeder (1957) and Compagno (1984a) had synonymized ***D. rostrata*** (Garman, 1906) with ***D. eglantina*** or ***D. calcea***, but Yano and Tanaka (1983) suggested that it was separable from ***D. calcea*** without giving details on how the two species differed. This problem needs to be further investigated. Although ***D. profundorum*** and ***D. quadrispinosa*** are readily separable from each other and from ***D. calcea*** or ***D. hystricosa***, it is necessary to critically compare adequate samples within all of the ***Deania*** species and across their very broad ranges to confirm the current arrangement.

Key to Deep–sea Indian Ocean Species:

1a. A subcaudal keel on the lower surface of the caudal peduncle (Fig. 92) . . . . ***Deania profundorum***

1b. No subcaudal keel on the lower caudal peduncle . . **2**

2a. First dorsal fin rather high, angular, and short, distance from its spine origin to free rear tip about one–half to 2/3 of distance from free rear tip to origin of second dorsal–fin spine (Fig. 93). . . . . ***Deania quadrispinosa***

2b. First dorsal fin rather low, rounded, and long, distance from its spine origin to its free rear tip equal to or greater than distance from free rear tip to origin of second dorsal–fin spine (Fig. 94). . . . . . ***Deania calcea***

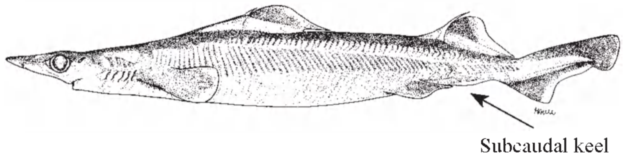


Fig. 92 ***Deania profundorum***

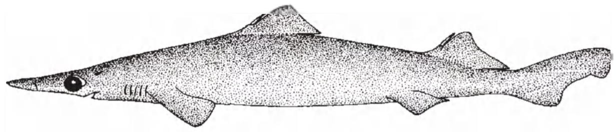


Fig. 93 ***Deania quadrispinosa***

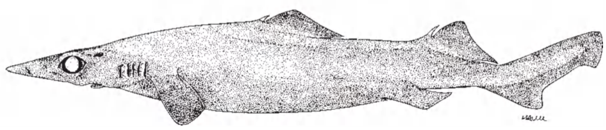


Fig. 94 ***Deania calcea***

Deania calcea (Lowe, 1839)

Acanthidium calceum Lowe, 1839, *Proc. Zool. Soc. London*, 1839 (7): 92. No type material, Madeira. Eschmeyer (2012) notes that the whereabouts of types for this species was unknown.

Synonyms: ***Deania eglantina*** Jordan and Snyder, 1902: 80, fig. 2. Holotype: U. S. National Museum of Natural History, USNM–49524, ca. 305 mm immature female, Albatross Sta. 3735, off Numazu, Totomi Bay, Omai Zaki Light, east coast of Honshu, Japan, “N 15° E. 11.4 m”, 36 fm” (figure coordinates). Status of holotype confirmed by Howe and Springer (1993: 7). ***Acanthidium aciculatum*** Garman, 1906: 207. Holotype: Museum of Comparative Zoology, Harvard, MCZ–1128–S, 88 cm (34 1/2”) adult male, Yokohama, Sagami Bay, Japan, illustrated by Garman (1913: pl. 12, fig. 1–4). Status of holotype confirmed by Hartel and Dingerkus (1997, *in* Garman: xl), who give the current length as 870 mm ?***Acanthidium rostratum*** Garman, 1906: 206. Holotype: Museum of Comparative Zoology, Harvard, MCZ–1047–S, 86 cm (34”) adult female, Yenoura, Suruga Gulf, Japan, illustrated by Garman (1913: pl. 11, fig. 1–4). Status of the holotype confirmed by Hartel and Dingerkus (1997**, *in*** Garman, The Plagiostoma: xl), who give the current length as 870 mm ***Centrophorus kaikourae*** Whitley, 1934: 199, no type designation or description. New species name based on the description of ***Centrophorus calceus*** by Thompson (1930: 275, pl. 42, fig. a–i) from Kaikoura, New Zealand. Thompson based his account on a 107 cm female in the collection of the Canterbury Museum, New Zealand, which he regarded as representing a range extension of the Northern Hemisphere ***C. calceus*** (= ***Deania calcea***) to New Zealand waters. This specimen becomes the holotype of ***C. kaikourae*** Whitley, 1934, but may be lost. Garrick (1960b: 490) synonymized this species with ***Deania calcea*** and noted that, “Thompson’s specimen can no longer be found in the Canterbury Museum”.

Other Combinations: ***Acanthidium eglantina*** or ***Acanthidium eglantinum*** (Jordan and Snyder, 1902), ***Centrophorus calceus*** (Lowe, 1839), ***Centrophorus rostratus*** (Garman, 1906), ***Deania calceus*** (Lowe, 1839), ***Deania calceus calceus*** (Lowe, 1839), ***Deania kaikourae*** (Whitley, 1934).

FAO Names: En – Birdbeak dogfish; **Fr** – Squale savate; **Sp** – Tollo pajarito.

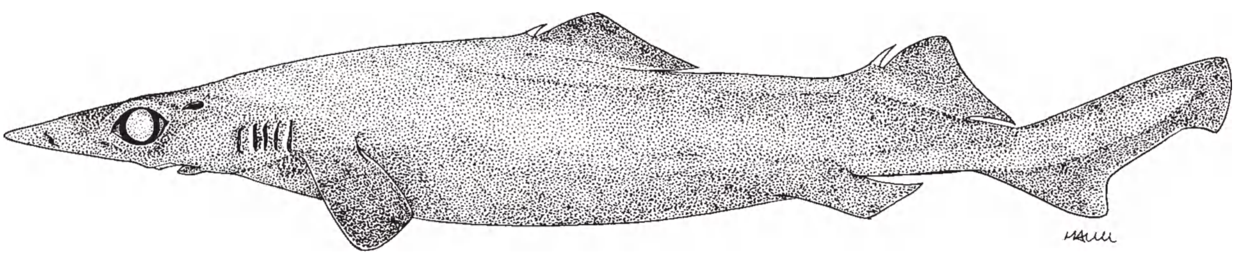
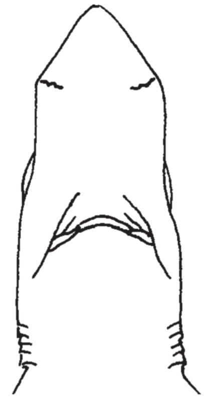
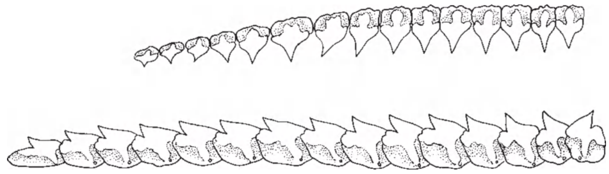


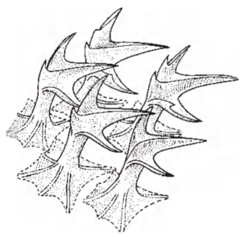
Fig. 95 ***Deania calcea***



UNDERSIDE OF HEAD



UPPER AND LOWER TEETH



DERMAL DENTICLES

Field Marks: Extremely long flat snout, compressed cutting teeth in both jaws, small pitchfork–shaped denticles that make the skin rough, extremely long and low first dorsal fin, grooved dorsal–fin spines with the second dorsal–fin spine much higher than the first, no anal fin and no subcaudal keel on caudal peduncle, coloration often grey or grey–brown.

Diagnostic Features: Snout extremely long and flattened. Teeth dissimilar in shape; upper teeth with a single, erect cusp, lowers with a single smooth–edged, blade–like cusp; tooth counts 25 to 35 upper jaw, 27 to 33 lower jaw. No subcaudal keel on underside of caudal peduncle. Denticles fairly small, crown length about 0.5 mm long in adults. First dorsal fin long and low, origin over bases of pectoral fins; distance from origin of first dorsal–fin spine to first dorsal–fin rear tip equal or greater than distance from free rear tip to second dorsal–fin spine. Vertebral counts: total vertebral counts 118 to 127, precaudal vertebral counts 85 to 95. Intestinal valve counts not available. Maximum size about 122 cm total length. **Colour:** varying from uniform light or dark grey or grey–brown above and below to dark brown, fins darker, fin webs dusky to blackish.

Distribution: Wide–ranging, but scattered in the Atlantic, Pacific, and Indian oceans. Indian Ocean: South Africa, seamounts and ridges south of Madagascar, western Indonesia, and Australia (southern Western Australia, South Australia, Victoria, and Tasmania).

Habitat: A common deepwater dogfish, sometimes collected in large groups, of the outer continental and insular shelves and upper, middle, and lower slopes from 60 to 1490 m depth, on or near the bottom or well above it.

Biology: Viviparous with a yolk sac, with litters of 1 to 17, averaging 7. Estimated ages range from 11 to 35 years for females and 13 to 29 years for males. Length at fifty–percent maturity for females is estimated at 105 cm total length and at 25 years. Age at maturity in Australia waters is about 14 years for males and 22 years for females with a maximum age of 24 to 33 and 31 to 37 years. A two year reproductive cycle has been proposed for the south Australian population of this species, which if accurate allows for only a maximum of seven litters, or about 42 pups, over the life time of an individual female.

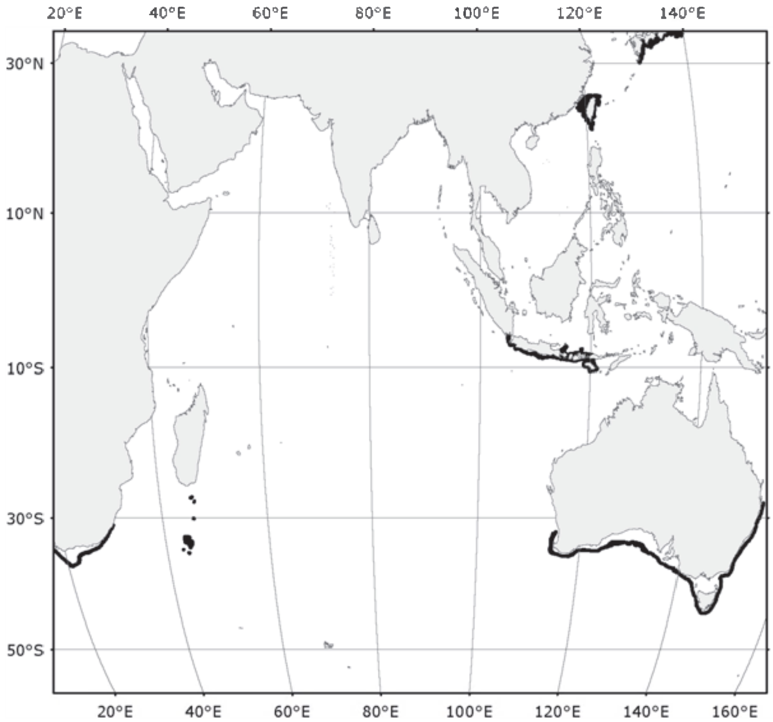


Fig. 96 ***Deania calcea***

Known distribution

Diet includes hatchetfish (Sternoptychidae), scaly dragonfishes, black dragonfishes (Stomiidae), barracudinas (Paralepididae), lanternfish (Myctophidae), cod–like fishes, scorpionfish (Scorpaenidae), squids (Ommastrephidae and ***Abraliopsis*** sp.) and shrimps (including penaeids). Off the west coast of South Africa a single species of lanternfish (***Diaphus ostenfeldi***) was by far the dominant prey, with small fractions of cephalopods, black dragonfish (***Melanostomias spilorhynchus***), and other fishes and penaeid shrimps (Ebert *et al.*, 1992).

Size: Maximum total length about 122 cm; males mature at 73 to 94 cm; females mature at 93 to 106 cm. Size at birth about 28 to 34 cm.

Interest to Fisheries and Human Impact: Although little utilized, it is caught in considerable numbers as bycatch of demersal trawl fisheries off southern Africa and Australia, with catch rates of up to 500 kg per hour off Australia. A fishery in southern Australia peaked at 1500 tonnes in 2000 and because of concerns a combined deep–water dogfish catch limit of 30 tonnes was implemented across southern Australia with most commercial fishing below 700 m banned. In Australia it is marketed for their flesh and squalene–rich liver. It is caught in bottom trawls, and by longline and gillnets fisheries.

The global conservation status is Least Concern, but in the eastern North Atlantic it is has been assessed as Vulnerable.

Local Names: Arrowhead dogfish, Pylkop–hondhaai (South Africa); Brier shark, Dorian Grey, Shovelnose spiny dogfish, Thompsons shark, Thompsons deep–sea dogfish, Birdbeak dogfish (Australia); Hiu botol monyong (Jawa Barat, Indonesia).

Literature: Lowe (1839); Jordan and Snyder (1902); Garman (1906, 1913); Whitley (1934, 1940); Fowler (1936, 1941, 1969); Bigelow and Schroeder (1957); Garrick (1960b, c); Bass, D'Aubrey and Kistnasamy (1976); Cadenat and Blache (1981); Compagno (1984a); McEachran and Branstetter *in* Whitehead *et al.* (1984); Bass, Compagno and Heemstra *in* Smith and Heemstra (1986); Compagno, Ebert and Smale (1989); Compagno, Ebert and Cowley (1991); Yano (1991); Ebert, Compagno and Cowley (1992); Nakaya and Shirai (1992); Last and Stevens (1994, 2009); Clarke *et al.* (2002b); Stevens (2003c); Irvine (2004); Irvine *et al*. (2012); Ebert and Compagno (In press).

2.2.4 Family ETMOPTERIDAE

Family: Subfamily Etmopterinae Fowler, 1934, *Proc. Acad. Nat. Sci. Philadelphia*, 85: 239 (family Squalidae).

Type genus: ***Etmopterus*** Rafinesque, 1810.

Number of Recognized Deep–sea Indian Ocean Genera: 2.

Synonyms: Subfamily Spinacini Bonaparte, 1838: 206 (family Squalidae). Also as family Spinaces Müller and Henle, 1839 (1): 83; family Spinacidae Owen, 1846: 51; family Spinacoidae Gill, 1862: 404; and family Spinacida Schmarda, 1871: 309. Type genus: ***Spinax*** Cuvier, 1816. Subfamily Centroscyllium (family Acanthias) Hasse, 1879 *(1)*: tab. 2. Type genus: ***Centroscyllium*** Müller and Henle, 1841.

FAO Names: En – Lantern sharks; **Fr** – Sagres lanterne; **Sp** – Tollos linternas.

Field Marks: Dwarf to moderate–sized sharks (usually less than 100 cm long and mostly below 80 cm long) with short to long snouts, cylindrical to slightly depressed bodies and no anal fin. Teeth similar in both jaws or varying between jaws, upper teeth with a cusp and sometimes cusplets, lower teeth similar to upper teeth (***Aculeola, Centroscyllium, Trigonognathus***) or compressed and bladelike (***Etmopterus***) with a cusp and cusplets, except for ***Etmopterus sheikoi*** that has a cusp and blade (***Etmopterus***), denticles small to moderately large and variable in shape, with slender to stout, pointed, wedge–shaped or hooked erect crowns without pedicels, or with low concave sessile crowns, no keels on the caudal peduncle, two dorsal fins with strong grooved spines, the first dorsal fin usually smaller than the second and with origin varying from opposite the pectoral–fin inner margins or somewhat behind the pectoral–fin free rear tips; the second dorsal fin falcate or not and with its origin usually opposite the pelvic–fin bases or inner margins. Caudal fin with subterminal notch moderately strong to lacking; body and fin bases with photophores, inconspicuous and diffuse or in black photophore patches on the ventrolateral surface.

Diagnostic Features: Head moderately broad to narrow and somewhat flattened or cylindrical. Snout flat to conical and narrowly to broadly rounded, undulated or distally truncated in dorsoventral view. Spiracles moderate–sized to large and close behind eyes. Fifth gill opening not enlarged relative to first four but gill openings may increase slightly in width from first to fifth. Nostrils wide–spaced and with internarial width greater than or subequal to nostril width. Nostrils with simple, anterior nasal flaps that lack medial lobes or barbels. Mouth varying from broadly arched or Y–shaped and elongated to nearly transverse and very short, with thin, non–papillose lips. Labial furrows rudimentary to short, not encircling mouth, confined to mouth corners and under or exceptionally posterior to level of eyes, elongated posteriorly into postoral grooves or not; labial folds thin where present. Teeth with dignathic heterodonty well developed or not, upper teeth as large as lowers or with uppers smaller than lowers. Upper teeth high–crowned, never compressed and blade–like and not forming a cutting edge, usually arranged in a quincunx pattern (except ***Trigonognathus***) and not overlapping, with narrow erect or flexed conical cusps and often one to three pairs of conical cusplets (***Centroscyllium*** and ***Etmopterus sheikoi***); lower teeth either similar to upper teeth (***Aculeola***, ***Centroscyllium***, ***Trigonognathus***) or compressed, high–crowned, broad and blade–like, imbricating, and forming a saw–like cutting edge, with a compressed oblique cusp and either a distal blade (***Etmopterus***) and no cusplets or with compressed cusplets (***Etmopterus sheikoi***). Tooth rows 15 to 68 upper jaw, 15 to 68 lower jaw; upper teeth about as numerous as lowers or much fewer than lowers. Trunk cylindrical and without lateral ridges on abdomen. Interdorsal space usually longer than first dorsal–fin base but ranging from about 0.6 to several times its length; pelvic–caudal space elongated or short and equal to about twice pelvic–fin bases. Caudal peduncle cylindrical or slightly compressed, short to moderately elongated, and without lateral keels or precaudal pits. Head, trunk, and tail with photophores in many species and possibly all members of the family; denticles small to moderate–sized, either sessile and without cusps or with spike–like hooked crowns on low bases; denticles without flattened leaf–shaped crowns and slender pedicels and low bases. Pectoral fins low, rounded–angular or almost circular, not falcate, anterior margins shorter than the prespiracular length, rear tips rounded or rounded–angular and not greatly elongated. Pelvic fins subequal in size or larger than pectoral fins. Claspers usually with both medial and lateral clasper spines. Dorsal fins small to moderately large, broad, angular or rounded–angular, both with strong grooved spines; second dorsal spine usually much larger than the first dorsal spine. First dorsal fin small, not falcate, with length usually less than prespiracular space (except ***Aculeola***, in which it is longer than the prespiracular space); first dorsal–fin base over pectoral–pelvic space and well anterior to pelvic fins; first dorsal–fin origin varying from exceptionally over pectoral–fin bases to more commonly over pectoral–fin inner margins or behind pectoral–fin rear tips. Second dorsal fin usually much larger than first dorsal fin but sometimes about as large as it; second dorsal–fin base partly over or just behind pelvic–fin bases with second dorsal–fin origin over pelvic–fin bases or above inner margins of pelvic fins. Caudal fin heterocercal, with ventral lobe weakly to moderately developed in adults, and with subterminal notch weak to (usually) strong. Vertebral counts: total vertebral counts 71 to 99, monospondylous vertebral counts 35 to 56, diplospondylous precaudal vertebral counts 7 to 27, total precaudal vertebral counts 50 to 73, caudal vertebral counts 18 to 31. Intestinal valve with 4 to 19 turns. Adults dwarf to moderate–sized and between 16 to 107 cm long but mostly below 80 cm long. **Colour:** plain or with conspicuous light or dark markings on fins and body. Head, trunk, tail and fin bases with photophores, sometimes forming distinct black photomarks or broad black areas on the ventrolateral surface of the abdomen, flanks or tail. Photophores sometimes confined to ventral surface but often–denser there than on dorsal surface.

Distribution: Lantern sharks have an essentially circumglobal range in boreal, austral, temperate and tropical seas.

Habitat: These are primarily bottom–dwelling deepwater bathic inhabitants of the continental and insular slopes and more rarely the upper rises, but also occur on submarine ridges and seamounts and on the outer continental shelves in water greater than 50 m deep. They range in depth between 70 to at least 2250 m, with one species (***Etmopterus princeps***) descending to between 3550 and 4500 m on the lower rises of the eastern North Atlantic but with most species not found below 1500 m or above 200 m. A few species (***E. gracilispinis***, ***E. pusillus***, and possibly several others) are semioceanic and occur in the epipelagic and mesopelagic zones of the open ocean as well as on the continental and insular slopes, but as currently known the family apparently lacks specialized oceanic species such as some members of Somniosidae and most Dalatiidae.

Biology: Reproductive biology is sketchily known for most species, but those species for which information is available are viviparous with a yolk sac, and have between 3 and 20 young per litter. The reproductive cycle for most species is unknown, while other species for which some data is available have an undefined reproductive cycle. Age and growth studies for this group are few, but depending on the species may have a maximum longevity of 13 years or as long as 57 years.

Lantern sharks feed mostly on bony fishes including sardines (Clupeidae), lanternfish (Myctophidae), viperfish (Stomiidae), barracudinas (Paralepididae), cod–like fishes (gadoids) including grenadiers (Macrouridae), mackerel (Scombridae), and cephalopods (including cuttlefish and histioteuthid squids), but also eat small squaloid sharks, crustaceans (decapod crabs, penaeid and euphausiid shrimp), jellyfish, and brittle stars. Several etmopterid species are highly social, and form small to huge schools or aggregations, and it has been hypothesized that these sharks may hunt in packs to subdue larger prey items such as cephalopods.

Recent studies by Claes, Aksnes and Mallefet (2010), Claes *et al.* (2010, 2011) and Claes and Mallefet (2008, 2010a, b) have demonstrated the functionality and bioluminescence of the photophores of ***Etmopterus spinax***. It appears that at least for ***E. spinax***, and likely many other etmopterids, the photophores provide a means of camouflage for these sharks in the midwater. This ability allows them to both hide from potential predators and ambush prey items. The diet of many etmopterids, which includes midwater fishes, crustaceans, and cephalopods, supports this foraging behaviour.

Interest to Fisheries and Human Impact: Lantern sharks have little importance for fisheries because of the generally small size (below 60 cm) of most species. In part because of limited fisheries interest, the biology of the family is sketchily known compared to other, more important fisheries for dogfish such as members of the families Squalidae and Centrophoridae. Lantern sharks are often caught and discarded as bycatch of fisheries utilizing bottom trawls, pelagic trawls, fixed bottom nets, line gear including hook–and–line, and in sablefish traps. Some of the more abundant species are dried–salted for human consumption and processed for fishmeal and probably liver oil, which has a high content of squalene. However, the livers of most species are small and probably not of much commercial use except for the few relatively large (over 60 cm maximum length) species of ***Etmopterus*** and ***Centroscyllium***. Separate fisheries statistics are seldom reported for the family or for individual species at present.

The conservation status of lantern sharks globally is very poorly known, but with expanding deepwater fisheries worldwide, inadequate monitoring of deepwater sharks in most areas, limited interest in this group, a high degree of regional endemism, and low public profile these sharks may be of concern. Some etmopterid species may have protection and management under existing regional governmental legislation, but imperfect monitoring of etmopterid bycatch and mortality from trawling makes conservation difficult even in protected areas.

Local Names: Lanternsharks or Lantern sharks (general).

Remarks: Most etmopterids have distinctive black patches with densely arrayed spherical, multicellular light–emitting organs or **photophores** on the ventral and lateral surfaces of the body and caudal fins. These luminescent markings are useful for the systematics of many etmopterids, particularly the genus ***Etmopterus***. The use of photophores or photomarks, and there terminology, in etmopterid taxonomy and identification is presented in Ebert and Compagno (In press).

Literature: Müller and Henle (1839, 1841); Gray (1851); Duméril (1865); Günther (1870); Regan (1906a, 1908a); Garman (1913); Bigelow and Schroeder (1948, 1957); Bigelow, Schroeder and Springer (1953); Bass, D'Aubrey and Kistnasamy (1976); Cadenat and Blache (1981); Compagno (1984a); Springer and Burgess (1985); Burgess and Springer (1986); Yamakawa, Taniuchi and Nose (1986); Tachikawa, Taniuchi and Arai (1989); Shirai and Nakaya (1990a, b); Shirai (1992a, 1996); Shirai and Tachikawa (1993); Schofield and Burgess (1997); Last, Burgess and Seret (2002); Compagno, Dando and Fowler (2005); Schaaf–Da Silva and Ebert (2006); Claes and Mallefet (2008, 2010a, b); Last and Stevens (2009); Claes, Aksnes and Mallefet (2010), Claes *et al.* (2010, 2011); Straube *et al.* (2010); Straube, Kriwet and Schliewen (2011); Ebert and Compagno (In press).

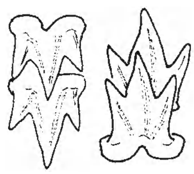
List of Deep–sea Species Occurring in the Area:

Centroscyllium kamoharai Abe, 1966
Centroscyllium ornatum (Alcock, 1889)
Etmopterus bigelowi Shirai and Tachikawa, 1993
Etmopterus brachyurus Smith and Radcliffe, 1912
Etmopterus compagnoi Fricke and Koch, 1990
Etmopterus evansi Last, Burgess, and Seret, 2002
Etmopterus fusus Last, Burgess, and Seret, 2002
Etmopterus gracilispinis Krefft, 1968
Etmopterus granulosus (Günther, 1880)
Etmopterus lucifer Jordan and Snyder, 1902
Etmopterus pusillus (Lowe, 1839)
Etmopterus sculptus Ebert, Compagno, and DeVries, 2011
Etmopterus sentosus Bass, D'Aubrey, and Kistnasamy, 1976
Etmopterus unicolor (Engelhardt, 1912)
Etmopterus viator Straube, 2011

Key to Deep–sea Indian Ocean Genera:

1a. Lower teeth similar to uppers, not compressed and blade–like, and overlapping or abutting one another (Fig. 97). Mouth arcuate and moderately long . . . . ***Centroscyllium***

1b. Lower teeth dissimilar to uppers, compressed, blade–like, and with adjacent teeth overlapping or abutting one another (Fig. 98). Mouth short, nearly straight and transverse . . . . ***Etmopterus***



UPPER AND LOWER TEETH

Fig. 97 *Centroscyllium*

UPPER AND LOWER TOOTH

Fig. 98 *Etmopterus*

Centroscyllium Müller and Henle, 1841

Genus: ***Centroscyllium*** Müller and Henle, 1841, *Syst. Beschr. Plagiost.*, pt. 3, suppl.: 191.

Type Species: ***Centroscyllium fabricii*** Müller and Henle, 1841 (new combination) by monotypy, equals ***Spinax fabricii*** Reinhardt, 1825.

Number of Recognized Deep–sea Indian Ocean Species: 2.

Synonyms: Genus ***Paracentroscyllium*** Alcock, 1889, *Ann. Mag. Nat. Hist.* (6), 4(23): 379. Type species: ***Paracentroscyllium ornatum*** Alcock, 1889, by monotypy. Genus ***Centrocyllium*** Jordan and Fowler, 1903, *Proc. U. S. Natn. Mus.* 26 (1324): 635. Apparent misspelling for ***Centroscyllium*** in two places (species account and figure legend of ***C. ritteri***), but properly spelled elsewhere in their account.

Field Marks: Greyish or blackish–brown, no anal fin, dorsal–fin spines present and large, short to moderately long snout, comb–like teeth with cusps and cusplets in both jaws.

Diagnostic Features: Head broad and flattened, wider than deep. Snout moderately rounded or slightly pointed, flattened and truncated; snout short, preoral length about 0.5 to 1.0 of mouth width. Gill openings about equally wide or increasing in width posteriorly. Spiracles subangular–oval and much shorter than eyes. Mouth subterminal on head, not extending anterior to eye and ending far behind nostrils; mouth broadly arcuate and relatively long to short, length 0.2 to 0.5 of width. Labial furrows usually with post–labial grooves present. A shallow groove between upper lips and upper jaws. Teeth similar in upper and lower jaws, not fang–like, small, with conical straight cusps and one or two pairs of prominent cusplets, not compressed and blade–like and not imbricated; tooth row counts 45 to 75 upper jaw, 43 to 76 lower jaw. Body stocky to moderately slender. Lateral trunk denticles, where present, with bluntly conical, thorn or bristle–like cusps and stellate bases, denticles usually sparse and spaced well apart. Dorsal–fin spines long, usually stout, and curved, second dorsal–fin spine much larger than the first and with its tip extending just below or opposite apex of second dorsal fin. Dorsal fins high and short, first dorsal–fin length much less than interdorsal space; first dorsal–fin origin usually about opposite or just behind pectoral–fin free rear tips; second dorsal fin usually larger than first but slightly larger or subequal in some species. Body with photophores more dense on the ventral surface than the dorsal surface or absent from the dorsal surface, but usually no conspicuous black photomarks on underside of head and body, flanks, tail and caudal fin (except in ***Centroscyllium ritteri***, which has discrete photomarks). Vertebral counts: total vertebral counts 81 to 97, monospondylous vertebral counts 37 to 46, diplospondylous vertebral counts 14 to 22, total precaudal vertebral counts 54 to 67, caudal vertebral counts 29 to 31. Intestinal valve with 4 to 10 turns. Size small to moderate with adults to 84 cm, and possibly 107 cm total length. **Colour:** greyish to blackish–brown above and below; fin webs varying from mostly about as dark as bases to abruptly white or with black and white markings; no naked patch of white skin on edge of upper eyelid.

Local Names: Combtooth dogfishes.

Remarks: Seven species are currently recognized, with ***Centroscyllium fabricii*** (Reinhardt, 1825) as the only species known to occur in the Atlantic Ocean, and the other six members of the genus occurring in the Pacific or Indian Oceans.

Key to Deep–sea Indian Ocean Species:

1a. Denticles few and wide–spaced, skin of body virtually naked . . . . ***Centroscyllium kamoharai***

1b. Denticles numerous and close set on body, not naked . . . . ***Centroscyllium ornatum***

Centroscyllium ornatum (Alcock, 1889)

Paracentroscyllium ornatum Alcock, 1889, *Ann. Mag. Nat. Hist.* (6), 4(23): 379. Syntypes: 2 males and 1 female in Zoological Survey of India, Calcutta, ZSI–11664 (sex uncertain) and ZSI–11666 (immature male), both about 120 mm TL (badly damaged), and ZSI–11665, now in British Museum (Natural History) and catalogued as BMNH 1890.7.31.16; all three from India, Bay of Bengal, Swatch of No–ground, 741 to 522 m. Status of syntypes confirmed by L.J.V. Compagno (ZSI specimens) and by Eschmeyer (2012).

Synonyms: None.

Other Combinations: None.

FAO Names: En – Ornate dogfish; **Fr** – Aiguillat élégant; **Sp** – Tollo negro elegante.

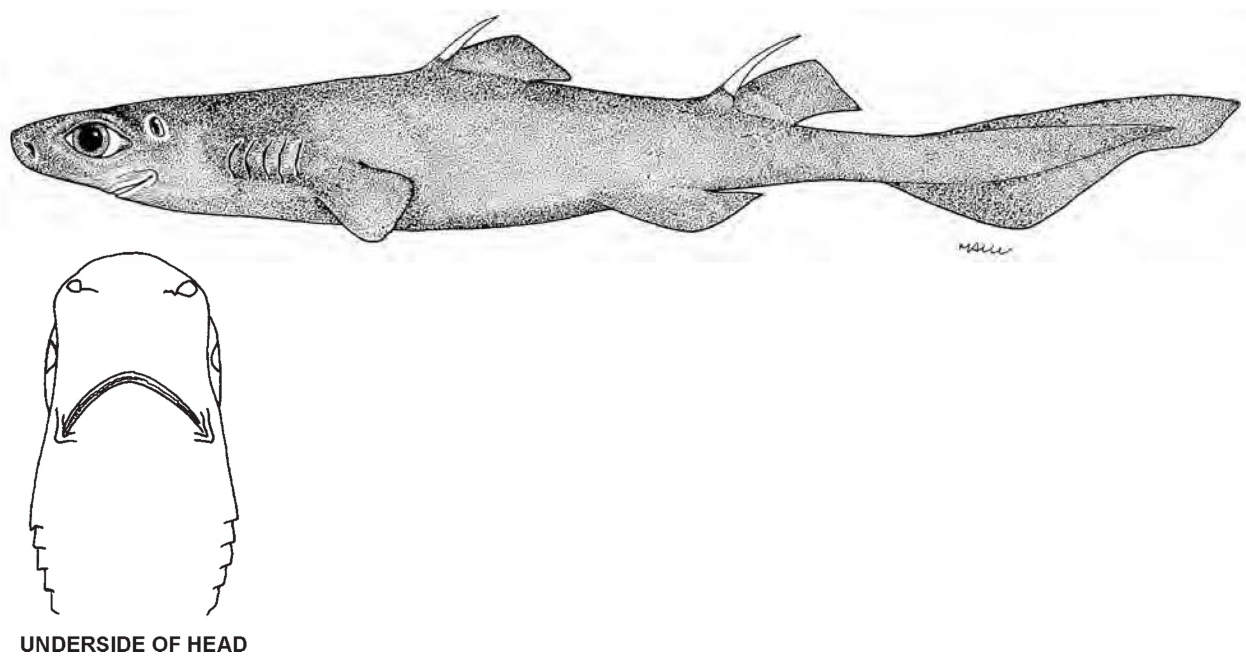


Fig. 99 ***Centroscyllium ornatum***

Field Marks: No anal fin, first dorsal fin possibly with a low subangular fin web, two grooved dorsal–fin spines, both very high and probably taller than the dorsal fins, teeth with narrow cusps and cusplets in both upper and lower jaws, denticles high, conical and sharp–cusped, dense and numerous on dorsal and ventral surfaces of body, skin firm, abdomen and caudal peduncle short, colour uniform blackish above and below, without white fin markings or discrete black photomarks on body.

Diagnostic Features: Preoral snout about 32% of head length. Mouth narrowly arched and about 45% as high as wide. Body moderately stout and compressed. Caudal peduncle moderately elongated with pelvic–caudal space 14% of total length. Denticles close–set and numerous on body; lateral trunk denticles conical and with sharp hooked cusps. Pectoral–fin apices when laid back ending about opposite to first dorsal–fin spine origin. First dorsal fin low with height 0.5 times base length, fin rounded–subtriangular in shape; first dorsal–fin spine very elongated, nearly as high as second dorsal–fin spine, and reaching above first dorsal–fin apex and posteriorly to nearly opposite it. Second dorsal fin somewhat larger than first dorsal fin; second dorsal–fin spine very long, extending above second dorsal–fin apex and ending posteriorly nearly opposite it; origin of second dorsal–fin spine over pelvic–fin insertions. Vertebral counts not available. Intestinal valve counts unknown. Maximum total length 51.4 cm. **Colour:** body blackish above and below, without conspicuous black markings on ventral surface or sides of tail; fins without white markings.

Distribution: Northern Indian Ocean: confirmed records from the Arabian Sea and Bay of Bengal.

Habitat: A little known and possibly rare deepwater dogfish from the upper continental slopes of India near bottom at depths from 521 to 1262 m.

Biology: Essentially unknown, but its reproductive mode is presumed to be yolk–sac viviparous as in other members of this family.

Size: Maximum total length to 51.4 cm; immature specimens to at least 30 cm.

Interest to Fisheries and Human Impact: Interest to fisheries none.

The conservation status of this little known shark is Data Deficient.

Local Names: None.

Literature: Alcock (1889, 1899); Burckhardt (1900); Regan (1908a); Garman (1913); Fowler (1941, 1969); Bigelow and Schroeder (1948, 1957); Misra (1969); Compagno (1984a); Shirai and Nakaya (1990a); Compagno, Dando and Fowler (2005); McCormack (2009); Ebert and Compagno (In press).

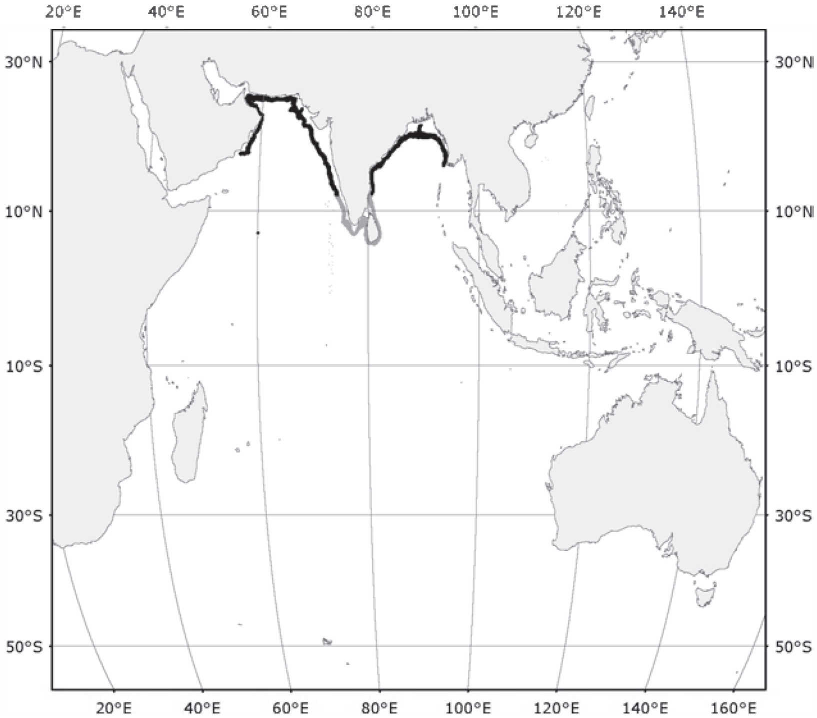


Fig. 100 ***Centroscyllium ornatum***

Etmopterus Rafinesque, 1810

Genus: ***Etmopterus*** Rafinesque, 1810, *Caratt. gen. sp. anim. piant. Sicilia, Palermo*, pt. 1: 14.

Type Species: ***Etmopterus aculeatus*** Rafinesque, 1810, by monotypy, equals ***Squalus spinax*** Linnaeus, 1758.

Number of Recognized Deep–sea Indian Ocean Species: 13.

Synonyms: Genus or subgenus ***Spinax*** Cloquet, 1816, *Dict. Sci. Nat.*, ed. 1 (2?), 1, suppl., 93 (not seen); Subgenus ***Spinax*** Cuvier, 1816, *Reg. Anim.*, ed. 1, 2: 129 (genus ***Squalus*** Linnaeus, 1758). Type species: ***Squalus spinax*** by absolute tautonymy. Probably also subgenus ***Spinax*** Bosc 1816–1819, *Nouvelle Dictionnaire d'Histoire Naturelle*, according to Whitley (1935, *Aust. Zool.* 8[2]: 136). Genus ***Centrina*** Lowe, 1833, *Proc. Zool. Soc. London*, 1833 (1): 144; not ***Centrina*** Cuvier 1816 = ***Oxynotus*** Rafinesque, 1810. Genus ***Acanthidium*** Lowe, 1839, *Proc. Zool. Soc. London*, 1839 (7): 91. Type species: ***A. pusillum*** Lowe, 1839 (= ***Etmopterus pusillus***), by subsequent designation by Jordan and Evermann (1896, *Bull. U.S. Natn. Mus.* (47, pt. 1): 55) and Goode and Bean (1896, *Oceanic Ichthyol., Smithson. Inst. Spec. Bull.*: 10); genus ***Acanthidim*** Sollas, 1906, *Zool. Rec.* 43, Pisces, 1907: 58. Erroneous spelling.

Field Marks: Moderately long snout, upper teeth with cusp and cusplets, lower teeth blade–like, no anal fin, second dorsal fin and fin spine larger than first dorsal fin and spine.

Diagnostic Features: Head broad and flattened, wider than deep, or cylindroconical and about as wide as deep. Snout broadly rounded to slightly pointed and with a wedge–shaped tip, flattened or subconical; snout moderately elongated, preoral length about 0.9 to 1.7 of mouth width. Spiracles subangular–oval and much shorter than eyes. Gill openings about equally wide. Mouth subterminal on head, not extending anterior to eye and ending far behind nostrils; mouth short and very broadly arched, nearly transverse, length 0.2 to 0.5 of mouth width. Labial furrows with postlabial grooves present. A shallow groove between upper lips and upper jaws. Teeth strongly differentiated in upper and lower jaws, upper teeth small, not fang–like, with a strong, conical nearly straight cusp and one, two or several pairs of prominent cusplets; lower dentition compressed, imbricated, and blade–like, with a flattened cusp, no cusplets, and a distal blade; tooth row counts upper jaw 18 to 38, lower jaw 24 to 55. Body stocky to slender. Lateral trunk denticles with thorn or bristle–like conical or hooked cusps, or flat, truncate, and without cusps, bases cross–shaped; denticles usually spaced close together. Dorsal–fin spines usually large and strongly curved; second dorsal–fin spine usually much larger than first and extending to apex of second dorsal fin. Dorsal fins high and short; first dorsal–fin length much less than interdorsal space; first dorsal–fin origin varying from opposite pectoral–fin free rear tips to well behind them; second dorsal fin noticeably larger than first. Vertebral column with primary calcification present, including centra with calcified double cones, notochord constricted, without septa; vertebral column with haemal arches extending five to nine centra anterior to the monospondylous–diplospondylous transition. Vertebral counts: total vertebral counts 68 to 99, precaudal vertebral counts 51 to 73, monospondylous vertebral counts 36 to 56. Intestinal valve with 8 to 19 turns. **Colour:** variable, from blackish to tan above, often black below; fin webs varying from not much lighter than the bases to abruptly lighter; a hemicircular or elongated patch of white skin on edge of upper eyelid in some species. Body often with photophores more dense on the ventral surface than the dorsal surface, conspicuous black photophore patches often present on underside of head and abdomen, flanks, tail and caudal fin but obscure or absent in some species.

Biology: Reproduction is yolk–sac viviparous with litters ranging from 1 to 21. Virtually nothing is known on the reproductive cycle of these sharks. Most of those whereby some data is available indicates that they have an undefined reproductive cycle with gravid females being present in some populations year round. Virtually nothing is known about the age and growth of these sharks. Depending on the species some may mature in as little as 5 to 8 years or as much as 20 to 30 years. Some species may live for only 13 years while others may have longevity of up to 57 years.

It has long been speculated that the social behavior of some ***Etmopterus*** species to forage in packs (pack–hunting) allows these relatively small sharks to capture and consume prey items that a single individual would not be able to capture alone. The elaborate photomarks and photolines of many ***Etmopterus*** species may help groups or schools to coordinate their movements while hunting or when engaged in other social activities. ***Etmopterus*** species may be successful by combining relatively small size, social feeding, and powerful feeding structures (a grabbing, cutting and dismembering dentition in strong, short jaws), which allows them to take advantage of a broad variety of small to large prey on the slopes including bony fish and invertebrates that are larger than they can swallow whole and are too large for a single individual to overcome.

Local Names: Lantern sharks (general); Lanternhaaie (South Africa).

Remarks: This is one of the most speciose genera of sharks worldwide with 37 nominal species currently recognized, of which 13 species are currently recognized as occurring in the Indian Ocean deep–sea. The genus has several species–complexes that will likely reveal additional species making it, along with the ***Apristurus***, among the most species–rich genera of sharks. The group appears to exhibit a high degree of endemism with several species having a restricted distributional range. The scientific names for several of these nominal species will likely change with improved taxonomic resolution of the group.

The vernacular name 'lantern shark' is descriptive of the minute photophores of these sharks that are also found in other members of the family.

Key to Deep–sea Indian Ocean Species (Provisional):

1a. Two or three longitudinal rows of conspicuous, enlarged thornlike denticles on flanks above pectoral fins (Fig. 101). . . . . ***Etmopterus sentosus***

1b. No enlarged thornlike denticles on flanks above pectoral fins **2**

2a. Skin smooth, denticles with low, flat, concave, sessile crowns atop low bases (Fig. 102). **3**

2b. Skin with a fuzzy or rough texture, denticles with erect, thorn–like, cuspidate crowns, more or less elevated from their bases (Fig. 103) **4**

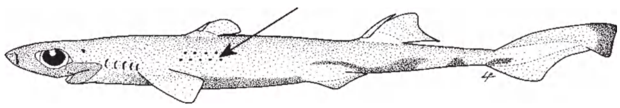
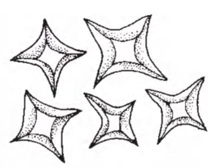
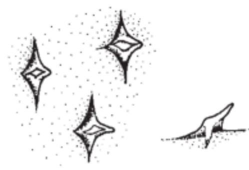


Fig. 101 ***Etmopterus sentosus***



DERMAL DENTICLES

Fig. 102 ***Etmopterus pusillus***



DERMAL DENTICLES

Fig. 103 ***Etmopterus lucifer***

3a. 19 to 24 rows of upper teeth. Upper tooth cusps stout and thick, lower tooth cusps become erect with growth. First dorsal fin more anterior, distance from pectoral–fin insertion to first dorsal–fin base three or more times in interdorsal space (Fig. 104). First dorsal–fin spine longer and stouter, equal or longer than first dorsal–fin base length. 49 to 57 monospondylous centra. 16 to 19 turns to the intestinal valve. . . . . ***Etmopterus bigelowi***

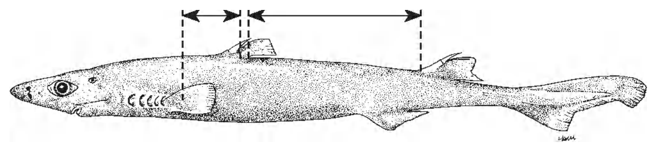


Fig. 104 *Etmopterus bigelowi*

3b. 22 to 31 rows of upper teeth. Upper tooth cusps slender, lower tooth cusps do not become erect with growth. First dorsal fin more posterior, distance from pectoral–fin insertion to first dorsal–fin base less than three times in interdorsal space (Fig. 105). First dorsal–fin spine shorter and slenderer, equal or less than first dorsal–fin base length. 46 to 53 monospondylous centra. 10 to 13 turns to the intestinal valve . . . . ***Etmopterus pusillus***

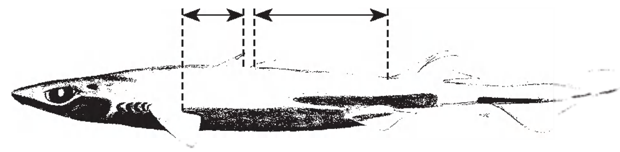


Fig. 105 *Etmopterus pusillus*

4a. Denticles on dorsal surface of head arranged in linear rows, which extend to the flanks, caudal peduncle and caudal base **5**

4b. Denticles on dorsal surface of head not arranged in linear rows; flanks, caudal peduncle and caudal base with or without linear rows of denticles **7**

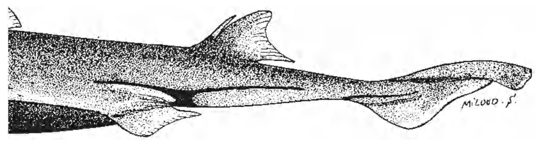


Fig. 106 *Etmopterus brachyurus*

5a. Lateral flank marking with long anterior branch, length about equal to or more than twice length of posterior branch (Fig. 107 & 108) **6**

5b. Lateral flank marking with short anterior branch, length of posterior branch much longer than anterior branch (Fig. 106). . . . . ***Etmopterus brachyurus***

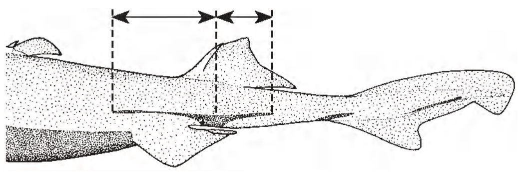


Fig. 107 *Etmopterus lucifer*

6a. Length of anterior lateral flank marking more than twice length of posterior branch (Fig. 107) . . ***Etmopterus lucifer***

6b. Length of anterior lateral flank marking about equal to or slightly longer than posterior branch (Fig. 108) . . . . ***Etmopterus sculptus***

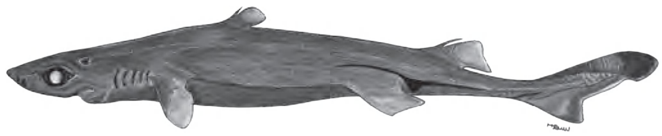


Fig. 108 *Etmopterus sculptus*

7a. Denticles on flanks, caudal peduncle, and caudal bases in regular longitudinal lines **8**

7b. Denticles on sides of body randomly arranged, not in regular lines. **10**

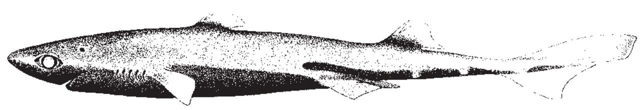
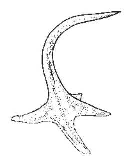


Fig. 109 *Etmopterus fusus*

8a. Bodies fusiform, ***Squaliolus***–like; mostly small etmopterid species (mostly Australasian species)(Fig. 109). . . . . ***Etmopterus fusus***

8b. Bodies fusiform, but not ***Squaliolus***–like; small to very large etmopterid species **9**



DERMAL DENTICLE

Fig. 110 *Etmopterus evansi*

9a. Lateral trunk denticles slender, hook–shaped (Fig. 110). Caudal peduncle with dark saddle; caudal fin with dark band across middle of upper lobe and at fin tip; anterior flank marking branch, long and thin; posterior branch flank marking elongated and slender, length about equal to, or slightly longer than anterior branch (Fig. 111). . . . . *Etmopterus evansi*

9b. Lateral trunk denticles more short and stout. Caudal peduncle without dark saddle; caudal fin without dark band across middle of upper lobe or at fin tip; flank marking, if present, with anterior branch, long and thick; posterior branch flank marking truncated (Fig. 112) . . . . *Etmopterus granulosus*

10a. Lateral flank marking with long, thick, curving anterior branch, posterior branch thick, short to medium in length (Fig. 113). . . . . . . *Etmopterus gracilispinis*

10b. Lateral flank marking, if present, with long, thin, linear anterior branch, posterior branch absent or truncated **11**

11a. Coloration brown above, becoming dark to blackish below, transition from dorsal to ventral colour rather abrupt (Fig. 114) . . . . . *Etmopterus compagnoi*

11b. Coloration a uniform dark brown to brownish black above and below, without a rather abrupt transition from dorsal to ventral surface **12**

12a. Dermal denticles dense, bristle–like; matures at relatively large body size, over 53 cm total length, with a maximum length of about 79 cm TL (Fig. 115) . . . . *Etmopterus unicolor*

12b. Dermal denticles not dense or bristle–like; matures at smaller body size, about 50 cm or less total length, with a maximum length of about 58 cm total length (Fig. 116) . . . . *Etmopterus viator*

Fig. 111 ***Etmopterus evansi***

Fig. 112 ***Etmopterus granulosus***

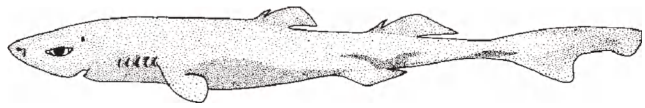


Fig. 113 ***Etmopterus gracilispinis***

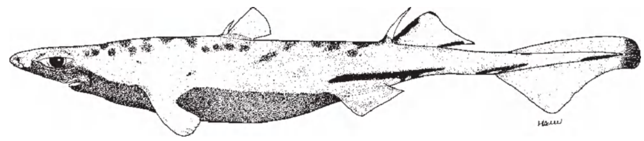


Fig. 114 ***Etmopterus compagnoi***

Fig. 115 ***Etmopterus unicolor***

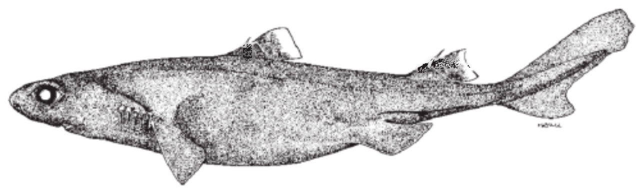


Fig. 116 ***Etmopterus viator***

Etmopterus granulosus (Günther, 1880)

Spinax granulosus Günther, 1880, *Rep. Sci. Res. Voy. H. M. S. Challenger, Zool.*, 1(6): 19, pl. 2C. Holotype: British Museum (Natural History), BMNH–1879.5.14.460, 256 mm TL adol. male, off Chile, *Challenger* Sta. 305A, 47°47'S to 47°48.5'S, 74°47'W to 74°46'W, 220 m.

Synonyms: None.

Other Combinations: None.

FAO Names: En – Southern lanternshark; **Fr** – Sagre long nez; **Sp** – Tollo negro narigón.

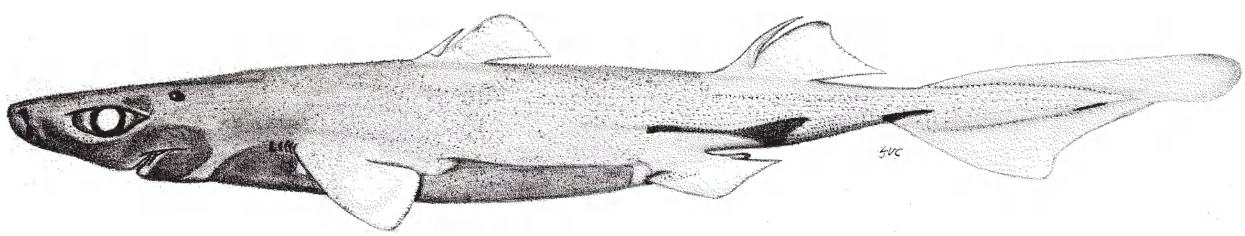
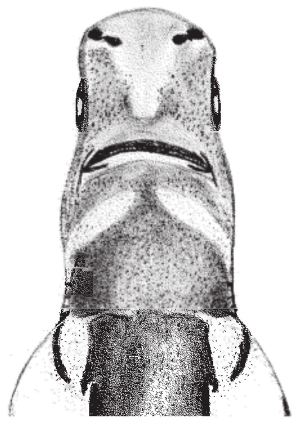


Fig. 117 ***Etmopterus granulosus***

Field Marks: Two spined dorsal fins, no anal fin, blade–like unicuspidate teeth in lower jaw and teeth with cusps and cusplets in upper jaw; body stocky, conspicuous lines of denticles on body, conspicuous black markings on underside of body and tail, with tail marking short and not extending far posteriorly.



UNDERSIDE OF HEAD

Diagnostic Features: Head shallow and flattened, not deep and conical; head relatively long, about 22 to 24% of total length and 2.3 times in snout–vent length; head width about 1.1 times preoral snout; head low, height 11% of total length. Prespiracular length 1.2 times spiracle–pectoral space. Snout broad and flattened, not bulbous; preoral length short and 9.5 to 11% of total length. Eyes narrow and elongated; upper eyelid apparently without a pale naked patch. Gill openings about as wide as spiracle; width of third gill opening less than one–third of eye length. Mouth relatively broad and 1.4 times eye length. Total tooth row counts upper jaw 27, lower jaw 28 (holotype); upper teeth with one or two pairs of cusplets, cusps expanded, about 2.5 times higher than adjacent cusplets; upper teeth of adolescent males with a cusp and a pair of long cusplets. Body moderately firm, cylindrical or slightly depressed, and moderately stout. Predorsal spine length about 35% of total length; interdorsal space slightly shorter than prebranchial length; pectoral–pelvic space about equal to head length in adolescent; snout tip to rear flank marking base 105% of snout tip to second dorsal–fin spine origin; dorso–caudal space about 9% of total length and about 2.1 in interdorsal space; pelvic–caudal space 16% of total length, about 1.5 times first dorsal fin length, 1.2 in interdorsal space, 0.8 of prebranchial length, slightly greater than prespiracular length, much shorter than head, and about 1.5 times in pectoral–pelvic space. No rows of greatly enlarged denticles on flanks above pectoral fins; denticles largely absent from underside of snout except for lateral patches; denticles on head not in longitudinal rows, but in regular longitudinal rows on flanks, tail, and caudal base; denticles present on second dorsal fin, densely covering it; lateral trunk denticles short, robust, wide spaced, with moderately stout, high, curved conical crowns. Distal margins of fins not fringed with naked ceratotrichia. Pectoral fin small with anterior margin length about 9% of total length, rounded–angular in shape. First dorsal–fin origin slightly in front of pectoral–fin free rear tips and over inner margins, base considerably closer to pectoral–fin bases than pelvic fins; first dorsal–fin spine stout, short, and lower than first dorsal–fin apex, origin nearer snout tip than upper caudal–fin origin. Second dorsal fin much larger than first but less than twice its area, height 31% of second dorsal–fin length, apex more or less pointed, posterior margin broadly concave; second dorsal–fin spine stout and strongly recurved, but with its tip obliquely vertical in subadult. Dorsal caudal–fin margin slightly longer than head length. Vertebral counts: total vertebral counts 86 to 94, precaudal vertebral counts 59 to 67, caudal vertebral counts 23 to 33, monospondylous vertebral counts 46 to 53. Intestinal valve counts 10 to 13. Size large with adults to 88 cm total length. **Colour:** grey–brown on dorsal surface, underside of snout, branchial region and abdomen abruptly black, dorsal surface lighter in preservative, ventral surface conspicuously dark; fins light distally, no conspicuous dark bands at tip and through middle of caudal fin; apparently no small white pineal blotch on dorsal surface of head. No photolines on body although individual photophores are scattered on flanks. Suprapelvic photomark present anteriorly on pelvic–fin bases but not extending behind pelvic fins. Flank photomarks present; flank photomark base well behind second dorsal–fin spine; anterior branch of flank photomark long, slender and tapering posteriorly, much longer than posterior branch, posterior branch 27% of anterior branch; posterior branch of flank photomark short broad and extending slightly behind pelvic fins, not merging ventrally with post–pelvic photomark, and not extending behind free rear tip of second dorsal fin. Ventral saddle–shaped precaudal photomark absent from middle of caudal peduncle. Caudal photomarks present; caudal base photomark present, with anterior branch very narrow, not enveloping ventral surface and not extending onto sides of caudal peduncle; caudal base photomark with a sharp–tipped, moderately elongated posterior branch about 4% of total length; oval central caudal photomark absent. Upper caudal photomark present, straight and short, and about 3% of total length.

Distribution: Southern Indian Ocean: South Africa (Western Cape and Eastern Cape), the southern Madagascar Ridge (29° to 40°S, 43° to 54°E) area south of Madagascar and east of South Africa, and near Marion Island; Australia (southern New South Wales, Victoria, Tasmania, and seamounts south of Tasmania).

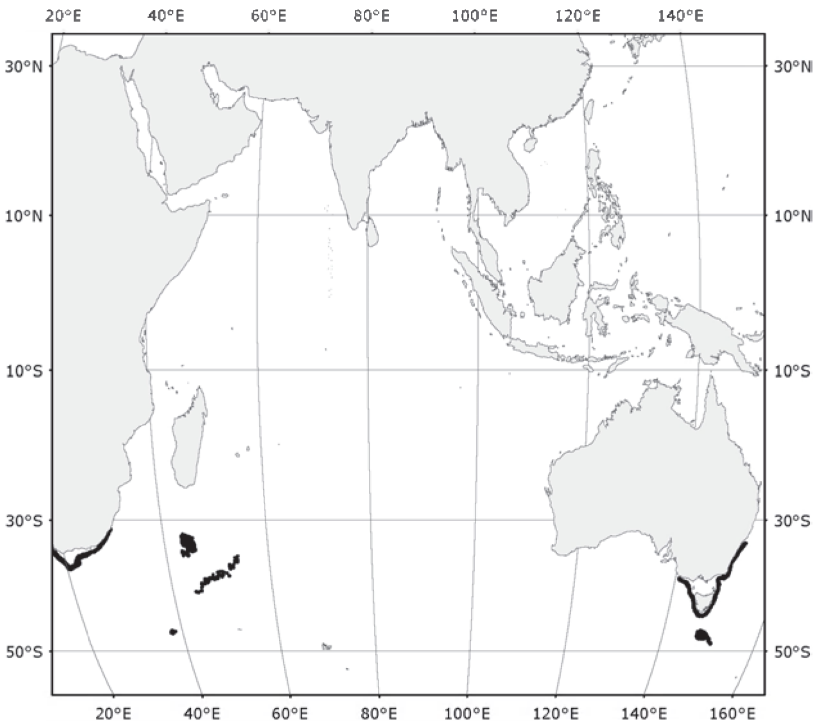


Fig. 118 ***Etmopterus granulosus***

Known distribution

Habitat: A large lanternshark from the upper continental and insular slopes, found on or near the bottom at depths of about 250 to 1500 m, commoner below 600 m. Recorded at 830 to 1200 m off Australia, about 250 to 1500 m off New Zealand, and 383 to 1300 m off South Africa.

Biology: Viviparous with a yolk-sac, with litter size of 9 to 16 off Australia and 6 to 15 off New Zealand. Wetherbee (1996) counted 7 to 30 large ovarian eggs (over 10 mm in diameter) and 9 to 15 large uterine eggs (40 to 55 mm in diameter) in each uterus and up to 39 in both uteri for New Zealand females, suggesting larger litters than indicated by fetal counts alone. New Zealand sharks may breed all year long, as there were mature males with semen-filled seminal vesicles and mature females with large ovarian and uterine eggs in July (winter) and October (late spring) off New Zealand (Wetherbee, 1996).

Age at maturity has been estimated at 30 years for females and 20 years for males, with a maximum age estimated for females and males of 57 and 48 years, respectively.

Off South Africa this shark feeds heavily on the large deepwater histioteuthid squid ***Histioteuthis miranda*** and is capable of dismembering individual squid much larger than it can swallow whole. It also eats the squid ***Todarodes angolensis*** (Ommastrephidae), unidentified octopuses, penaeid shrimp, unidentified decapod crustaceans, lanternfish (Myctophidae, including ***Diaphus*** sp.), barracudina (Paralepididae), deepwater eels (Synaphobranchidae), and other, unidentified teleosts (Ebert, Compagno and Cowley, 1992, and unpubl. data). Clark, King and McMillan (1989) found that off New Zealand this shark eats primarily bony fishes, cephalopods and decapod crustaceans (mostly unidentified), but also salps (Thaliacea), sponges (Porifera), and ribbonworms (Nemertina). Fish prey from New Zealand ***Etmopterus granulosus*** included oreo dories (Oreosomatidae), lanternfish (Myctophidae), hake (Merluccidae including hoki, ***Macrouronus novaezelandiae***), rattails (Macrouridae), Bathylagidae, and Idiacanthidae; cephalopod prey included octopods and squids (particularly ***Brachioteuthis*** sp.); and crustaceans included unidentified decapods, euphausiids, and mysids. Some of the prey fish found in New Zealand ***E. granulosus*** may have been scavenged from fisheries catches (oreo dories and ***Macrouronus***), but also suggested active feeding on small fishes (swallowed whole) and on larger fishes (eaten in bite-sized chunks).

Size: Maximum total length 88 cm; size at maturity varies by region, but this may be an artefact of multiple species being involved. In general, males are adult at 46 to 68 cm and females are adult at 62 to 86 cm. Size at birth about 17 to 20 cm.

Interest to Fisheries and Human Impact: Interest to fisheries none at present, although taken as an incidental bycatch of trawl fisheries for deepwater hake (***Merluccius paradoxus***) fisheries off the west coast of South Africa, and probably caught in deep–water trawl fisheries for orange roughy (***Hoplostethus atlanticus***). This species is discarded from bottom trawl catches off South Africa.

Conservation status is Least Concern.

Local Names: None.

Remarks: A recent taxonomic study of this species has concluded that it appears to be a large, wide-ranging, southern hemisphere etmopterid species and not endemic to southern Patagonia as previously thought (N. Straube, pers. comm.). The New Zealand ***E. baxteri*** is a junior synonym of this species.

Literature: Günther (1880); Bass, D'Aubrey and Kistnasamy (1976); Tachikawa, Taniuchi and Arai (1989); Clark, King and McMillan (1989); Compagno, Ebert and Smale (1989); Compagno, Ebert and Cowley (1991); Ebert, Compagno and Cowley (1992); Last and Stevens (1994, 2009); Wetherbee (1996); Yano (1997); Compagno, Dando and Fowler (2005); Irvine, Stevens and Laurenson (2006); Straube, Kriwet and Schliewen (2011).

2.2.5 Family SOMNIOSIDAE

Family: Somniosidae Jordan, 1888, *Man. Vert. Ani. Northern U.S.*, ed. 5: 15.

Type genus: ***Somniosus*** Lesueur, 1818.

Number of Recognized Deep–sea Indian Ocean Genera: 6.

Synonyms: None.

FAO Names: En – Sleeper sharks; **Fr** – Laimargue dormeurs; **Sp** – Tiburones Tollos.

Field Marks: Short to long–nosed, cylindrical to somewhat compressed sharks with no anal fin, 2 dorsal fins with or without spines, the first with origin in front of pelvic–fin origins and usually opposite the pectoral–fin bases or pectoral–fin inner margins and exceptionally just behind the pectoral–fin free rear tips, the second dorsal fin not falcate and with its origin usually opposite the pelvic–fin bases or inner margins, but exceptionally somewhat behind the pelvic–fin free rear tips, caudal fin with a strong subterminal notch, no keels on the caudal peduncle, denticles small to large and variable in shape, with leaf–shaped, tricuspidate or polycuspidate crowns and slender pedicels, high pitchfork–shaped erect crowns on high pedicels, or low ridged sessile crowns.

Diagnostic Features: Head moderately broad and somewhat flattened or conical. Snout flat and narrowly rounded to elongate–rounded in dorsoventral view. Spiracles large, close behind eyes. Fifth gill opening about as large as first four. Nostrils wide–spaced with internarial width greater than nostril width; nostrils with simple anterior nasal flaps. Mouth nearly transverse and usually very short (more elongated in ***Scymnodon ringens***), with thin, non–papillose lips. Labial furrows short to greatly elongated, encircling mouth or not, confined to mouth corners or extending partway around mouth (***Centroselachus crepidater***) and under posterior corners of eyes, elongated posteriorly into postoral grooves and also anteromedial preoral grooves (***C. crepidater***); labial folds thin. Teeth with dignathic heterodonty well–developed, upper teeth much smaller than lowers. Teeth of upper jaw lanceolate, high–crowned, needlelike, with narrow erect to semioblique cusps and no cusplets or blades, in quincunx arrangement and not imbricated; lower teeth compressed, high–crowned, narrow and bladelike, imbricated, forming a saw–like cutting edge, with a compressed erect to oblique cusp, a distal blade, and no cusplets. Tooth rows 30 to 70 upper jaw, 31 to 68 lower jaw. Trunk cylindrical or slightly compressed, abdomen with lateral ridges. Interdorsal space elongated and greater than length of first dorsal–fin base; pelvic–caudal space short and between one and two times pelvic–fin bases. Caudal peduncle slightly compressed, short to moderately elongated, and without lateral keels or precaudal pits (some ***Somniosus*** with low keels on the caudal base). Body without photophores. Denticles moderate–sized and pedicellate, with flattened, narrow to broad–keeled or smooth leaf–shaped, round, or narrow thornlike crowns, slender pedicels and low bases. Pectoral fins low, angular or rounded, and not falcate, anterior margins moderately large and shorter or equal to the prespiracular length, rear tips rounded and short. Pelvic fins subequal or larger than pectoral fins and first dorsal fin and subequal to or smaller than second dorsal fin. Claspers with a lateral spine only. Dorsal fins small, broad, rounded–angular but not falcate, with small grooved spines on both dorsal fins or no spines. First dorsal fin length variable from slightly larger, subequal to, or slightly smaller than second dorsal fin in size; first dorsal–fin base over pectoral–pelvic space and well anterior to pelvic fins, origin over pectoral–fin bases or inner margins. Second dorsal fin usually smaller than first dorsal fin or about as large, base partly over pelvic–fin bases with origin over to slightly anterior to pelvic–fin insertions. Caudal fin heterocercal, with ventral lobe weakly to strongly developed in adults, and with subterminal notch strong. Vertebral counts: total vertebral counts 35 to 120, monospondylous vertebral counts 43 to 67, diplospondylous precaudal vertebral counts 13 to 23. Intestinal valve with 12 to 41 turns. Adults small to gigantic, total length to between 49 and 600 cm or more. **Colour:** plain or with light or dark markings on fins and body, without photophores and black photomarks on tail or flanks.

Distribution: The family has an almost circumglobal range in polar, boreal and austral to tropical seas, mostly in association with land masses including continents, islands, submarine peaks and ridges. The giant sleeper sharks of the genus ***Somniosus*** (subgenus ***Somniosus, S. antarcticus, S. microcephalus***, and ***S. pacificus***) are among the few non–batoid sharks penetrating deeply into polar waters, but the family is most diverse in cool to warm temperate seas and possibly in the tropics (in deep water, but with distributions poorly known). Several of the species are wide–ranging in both the eastern and western Hemispheres. These sharks have very low diversity in the eastern Pacific, with only the sleeper shark ***Somniosus pacificus*** in the eastern North Pacific and ***S. antarcticus*** and ***Centroselachus crepidater*** in the eastern South Pacific off South America. Several of the species are wide–ranging in the Atlantic but the greatest known diversity of the family is in the Indo–West Pacific. Geographic and bathymetric ranges are imperfectly known for most species, and reflect uneven sampling of deepwater slope–dwelling sharks as well as problems in identifying somniosid species.

Habitat: The Somniosidae primarily are bottom dwelling, deepwater inhabitants of continental and insular slopes and occasionally on upper rises (***Centroscymnus coelolepis*** and possibly ***Somniosus*** species), but also occur on submarine ridges and seamounts. They range in depth between 200 to at least 3675 m but with most species not known to extend below 1000 to 1500 m. Most species are bottom dwellers, but some species are apparently oceanic. These sharks occasionally occur on the continental and insular shelves offshore in water up to 50 m depth, although this is most exceptional. In high latitudes members of the genus ***Somniosus*** occur on the continental shelves to the intertidal. The family has one apparently epipelagic species (***Scymnodalatias albicauda***) and one bottom–dwelling species that is semioceanic (***Zameus squamulosus***) and may occur in the epi– and mesopelagic zones of the open ocean.

Biology: Reproduction is yolk–sac viviparous, with 4 to 59 young per litter. Virtually nothing is known about the age and growth of these sharks although where some information is available (particularly for the large ***Somniosus*** species) they appear to be quite long–lived and very slow growing. Sleeper sharks feed on bony fishes, other chondrichthyans, cephalopods and other molluscs, crustaceans, seals, whale meat, carrion, sea birds, echinoderms and jellyfish; at least one species (***Centroscymnus coelolepis***) takes chunks of meat out of living marine mammals and bony fishes.

Interest to Fisheries and Human Impact: In the Far East and the eastern Atlantic these sharks are fished with line gear and bottom trawls for human consumption and for their livers, which are extremely large, oily, and have a high squalene content.

Local Names: Sleeper sharks, Gurry sharks, Velvet dogfishes.

Remarks: The family is small, but rather diverse with seven genera and about seventeen species, of which eight species occur within the area.

Literature: Müller and Henle (1839); Gray (1851); Duméril (1865); Günther (1870); Regan (1908a); Garman (1913); Fowler (1941); Bigelow and Schroeder (1948, 1957); Cadenat (1959a, b, c), Garrick (1959b, c, 1960b); Bass, D'Aubrey and Kistnasamy (1976); Cadenat and Blache (1981); Chen and Cheng (1982); Compagno (1984a, 2005); Taniuchi and Garrick (1986); Shirai (1992a, 1996); Last and Stevens (1994, 2009); Compagno (1998); Hernández *et al.* (1998); Yano, Stevens and Compagno (2004); Ebert and Compagno (In press).

List of Deep–sea Species Occurring in the Area:

Centroscymnus coelolepis Bocage and Capello, 1864
Centroscymnus owstonii Garman, 1906
Centroselachus crepidater (Bocage and Capello, 1864)
Proscymnodon plunketi (Waite, 1910)
Scymnodalatias albicauda Taniuchi and Garrick, 1986
Scymnodalatias sherwoodi (Archey, 1921)
Somniosus antarcticus Whitley, 1939
Zameus squamulosus (Günther, 1877)

Key to Deep–sea Indian Ocean Genera:

1a. Dorsal–fin spines present, though sometimes short and partly covered by skin (Fig. 119a). **2**

1b. Dorsal–fin spines absent **5**

2a. Snout greatly elongated, preoral length about equal to distance from mouth to pectoral–fin origins. Upper labial furrows greatly elongated, their lengths greater than distance between their anterior ends (Fig. 119b) . . . . ***Centroselachus***

2b. Snout shorter, preoral length much less than distance from mouth to pectoral–fin origins (Fig. 120a). Upper labial furrows shorter, their lengths less than distance between their anterior ends **3**

3a. Lower teeth with relatively high, more or less erect cusps (Fig. 121) . . . . ***Zameus***

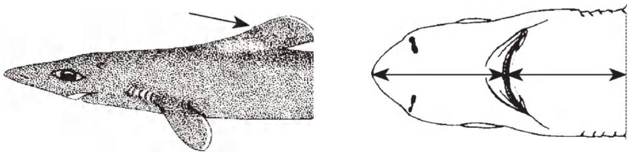
3b. Lower teeth with relatively low, more or less oblique cusps (Fig. 120b) **4**

4a. Dorsal–fin spines inconspicuous, with only tips slightly protruding or not at all. Body not tapering from pectoral fins, dorsoventral contours nearly parallel to pelvic–fin bases. Lateral trunk denticles enlarged, with smooth, rounded crowns in adults, resembling bony fish scales (Fig. 120c). Pectoral fins smaller, their apices falling well ahead of first dorsal–fin spine when laid back . . . . ***Centroscymnus***

4b. Dorsal–fin spines rather stout and prominent, exposed anterior margin of first spine nearly half length of fin base from insertion to rear end of spine. Body strongly tapering rearwards from pectoral fins. Lateral trunk denticles small and with tricuspidate ridged crowns in adults, not resembling bony fish scales (Fig. 122). Pectoral fins large, their apices nearly or quite reaching first dorsal–fin spine when laid back . . . . ***Proscymnodon***

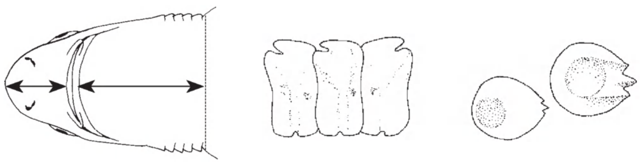
5a. Lower teeth with high, erect cusps (Fig. 123a). Ventral caudal margin half as long as dorsal caudal margin (Fig. 123b). Eyes horizontally elongated . . . . ***Scymnodalatias***

5b. Lower teeth with low, oblique cusps (Fig. 124a). Ventral caudal margin about 2/3 as long as dorsal caudal margin (Fig. 124b). Eyes nearly circular . . . . ***Somniosus***



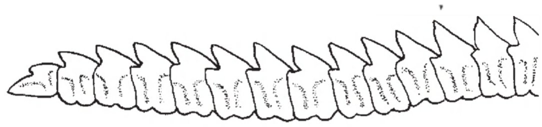
a) LATERAL VIEW b) UNDERSIDE OF HEAD

Fig. 119 ***Centroselachus***



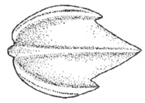
a) UNDERSIDE OF HEAD b) LOWER TEETH c) DERMAL DENTICLES

Fig. 120 ***Centroscymnus***



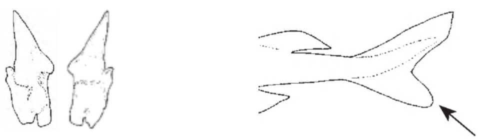
LOWER TEETH

Fig. 121 ***Zameus***



DERMAL DENTICLES

Fig. 122 ***Proscymnodon***



a) LOWER TEETH b) CAUDAL FIN

Fig. 123 ***Scymnodalatias***

a) LOWER TEETH b) CAUDAL FIN

Fig. 124 ***Somniosus***

Centroscymnus Bocage and Capello, 1864

Genus: ***Centroscymnus*** Bocage and Capello, 1864, *Proc. Zool. Soc. London*, 24: 263.

Type species: ***Centroscymnus coelolepis*** Bocage and Capello, 1864, by monotypy.

Number of Recognized Deep–sea Indian Ocean Species: 2.

Synonyms: None.

Field Marks: Greyish or blackish–brown, no anal fin, small fin spines present on both dorsal fins though sometimes inconspicuous (***Centroscymnus owstonii***), short to moderately long snout, slender–cusped teeth without cusplets in upper jaw, bladelike, oblique and short–cusped, interlocked cutting teeth in lower jaw, caudal fin with a strong subterminal notch, and pectoral fins with broadly rounded free rear tips.

Diagnostic Features: Anterior nasal flaps short, not expanded as barbels. Snout flattened, broadly parabolic, length varying from about equal to distance from mouth to pectoral–fin origins to considerably less than that space, and about half length of head or less. Gill openings moderately wide and about equal–sized. Lips thick but not pleated or suctorial. Teeth very different in upper and lower jaws, uppers with very slender, acute cusps and no cusplets, not bladelike, lower teeth high compressed, bladelike, interlocked with short, oblique cusps, distal blades, and no cusplets; tooth rows 39 to 70 upper jaw, 32 to 42 lower jaw. Small, grooved fin–spines present on both dorsal fins, these sometimes covered with skin and inconspicuous. First dorsal–fin origin varying from over the pectoral–fin bases to well posterior to their free rear tips, insertion well in front of pelvic–fin origins and closer to the pectoral–fin bases than the pelvic–fin bases; second dorsal–fin origin about over the middle of the pelvic–fin bases; second dorsal fin about as large or slightly smaller than first, but first often with an anteriorly elongated base up to about twice as long as that of first. Pectoral fins with short, broadly rounded free rear tips and inner margins, not broadly lobate or acute and attenuated. Caudal fin asymmetrical, not paddle–shaped, upper lobe long, lower lobe short but well–developed, subterminal notch present and strong. No precaudal pits or lateral keels on caudal peduncle. Dermal denticles with low, pedicellate, flat, ovoid crowns, varying from triridged and tricuspidate to smooth and acuspidate in adults, triridged and tricuspidate in young. Cloaca without a luminous gland. Vertebral counts: total vertebral counts 96 to 114, monospondylous vertebral counts 54 to 64, precaudal vertebral counts 68 to 84. Intestinal valve with 11 to 21 turns. Moderately large, adults up to 122 cm total length. **Colour:** blackish brown or greyish brown above and below.

Local Names: Portuguese sharks.

Remarks: The main differences separating ***Centroscymnus*** and ***Scymnodon***, two very similar genera, by previous authors stem from divergent views on the relative importance of lower tooth shape as opposed to dermal denticle morphology as the primary criteria separating these two genera. Compagno (1984a) commented that the separation of this genus from ***Scymnodon*** was unsatisfactory with the criteria in current usage at the time, but hesitated to merge them pending further work on the problem. Subsequently, Taniuchi and Garrick (1986) clarified the situation somewhat by re–examining these primary characters and concluded that those species with "***Scymnodon***" denticles (***ringens***, ***plunketi***, ***ichiharai***, and ***macracanthus***) lacked ridges on the juvenile denticles, but these were replaced by fully ridged denticles in adults. Those species with "***Centroscymnus***" denticles (***coelolepis***, ***owstonii***, ***cryptacanthus***, and ***crepidater***) by contrast had partly ridged juvenile denticles, but are replaced by denticles in which the ridging is progressively reduced with growth. These authors further went on to note that the cusp height to root height values, although not as well defined, could be used as a subjective means to separate these genera. However, among the aforementioned species they examined, ***S. ringens*** had a significantly higher cusp height to root height ratio (124%) than the other seven species they considered which ranged from 14 to 74%. Taniuchi and Garrick (1986) stated that if ***Scymnodon*** were only to include ***S. ringens***, as there is clearly a define demarcation between it and the other species, and the others remained in ***Centroscymnus*** it would agree with Compagno (1984a). Compagno (1999) somewhat followed this generic framework, except left ***ichiharai*** within ***Scymnodon***, but later and without explanation Compagno (2005) moved ***ichiharai*** to ***Zameus*** and resurrected the genera ***Centroselachus*** (***crepidater***) and ***Proscymnodon*** (***macracanthus*** and ***plunketi***) leaving ***coelolepis*** and ***owstonii*** as the only species within the genus ***Centroscymnus***. The arrangement of this genus and its separation from the genus ***Scymnodon*** follows Ebert and Compagno (In press), but acknowledges that further work, particularly at the molecular level, will help further clarify the status of this group.

Key to Deep–sea Indian Ocean Species:

1a. Snout short, preoral length about 2/3 as long as distance from mouth to first gill slits, and less than mouth width (Fig. 125). Abdomen without lateral ridges. . . . . ***Centroscymnus coelolepis***

1b. Snout moderately long, preoral length about as long as distance from mouth to first gill slits, and about equal to mouth width (Fig. 126). Abdomen with lateral ridges. . . . . ***Centroscymnus owstonii***

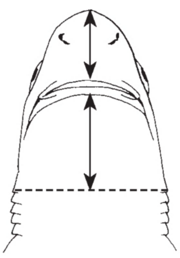


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Fig. 125 ***C. coelolepis***

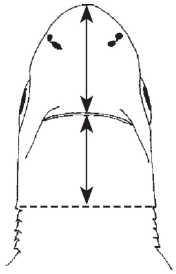

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Fig. 126 ***C. owstonii***

Centroscymnus coelolepis Bocage and Capello, 1864

Centroscymnus coelolepis Bocage and Capello, 1864, *Proc. Zool. Soc. London*, 24: 263, fig. 4. Holotype: Museu Bocage, Lisbon, MB T113, destroyed in fire, off Portugal.

Synonyms: ?***Centroscymnus fuscus*** Gilchrist and von Bonde, 1924, *Rep. Fish. Mar. Biol. Surv. Un. S. Africa*, (3): 2. Holotype: 1100 mm TL, probably lost, 32°3'00"S, 16°2'00"E, off St. Helena Bay, Western Cape, South Africa, 658 m. This species was tentatively synonymized with ***Centrophorus squamosus*** by Hulley (1971, *Ann. S. African Mus.* 57(11): 265–270) and Bass, D'Aubrey and Kistnasamy (1976, *S. African Ass. Mar. Biol. Res., Oceanogr. Res. Inst., Invest. Rep.* (45): 27) but details of its original description suggests that it may have been based on ***Centroscymnus coelolepis***, which is common off the west coast of South Africa below 600 m (Compagno, Ebert and Smale, 1989; Compagno, Ebert and Cowley, 1991) and has been taken in the area and at the depth where the type of ***C. fuscus*** was collected. In contrast ***Centrophorus squamosus*** is rare south of central Namibia. ***Scymnodon melas*** Bigelow, Schroeder and Springer, 1953, *Bull. Mus. Comp. Zool. Harvard*, 109(3): 233, fig. 5. Holotype: Museum of Comparative Zoology, Harvard, MCZ–37452, 462 mm TL immature female, 40°00'N, 68°52'W, off Georges Bank, 769–878 m. ***Centroscymnus macrops*** Chu, Hu and Li, *in* Chu *et al.*, 1982, *Ocean. Limn. Sinica*, 13(1): 305, 310, fig. 4. Holotype: South China Sea Fisheries Research Institute, no. O0150, 792 mm female, 19°24'N, 114°15.4'E, South China Sea, 964 m.

Other combinations: None.

FAO Names: En – Portuguese dogfish; **Fr** – Pailona commun; **Sp** – Pailona.

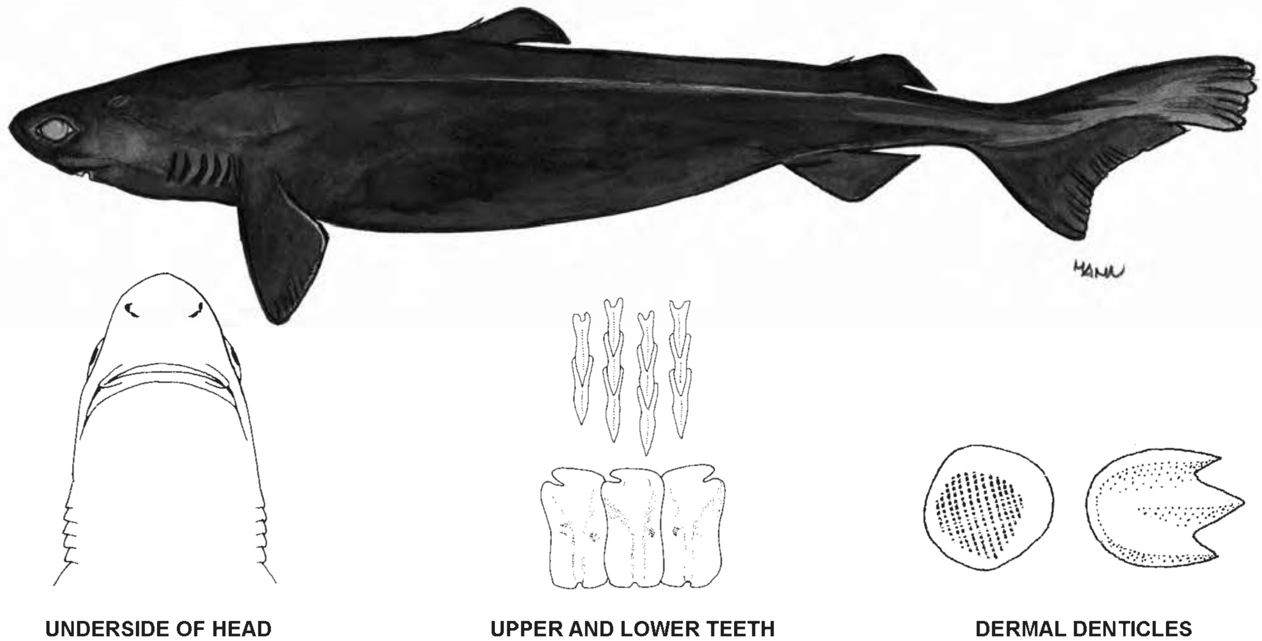


Fig. 127 *Centroscymnus coelolepis*

Field Marks: Body stocky, not tapering abruptly from pectoral region, snout very short, lanceolate upper teeth and bladelike lower teeth with short, oblique cusps, very large lateral trunk denticles with smooth, circular, acuspidate crowns in adults and subadults; dorsal fins with very small fin spines, no anal fin, colour a uniformly light to dark brown.

Diagnostic Features: Body stocky, not strongly tapering back from pectoral region. Snout very short, preoral length much less than distance from mouth to first gill slits and less than mouth width. Lips not thick and fleshy. Upper labial furrows very short, their lengths much less than distance between their front ends. Lower teeth with very short, strongly oblique cusps and high, narrow roots; total tooth counts for upper jaw 43 to 68 and lower jaw 29 to 42. Lateral trunk denticles very large, with smooth, circular, ridgeless and acuspidate crowns, giving shark an almost teleost–like appearance. Pectoral fins moderately large, apices falling well in front of first dorsal–fin spine when laid back. Free rear tips of pelvic fins extending behind second dorsal–fin insertion. Dorsal fins about equal in size and height, fin spines very small but with tips protruding from fins. First dorsal–fin base not extending forwards as a prominent ridge, origin behind pectoral fins. Second dorsal–fin base shorter than space between it and upper caudal–fin origin, free rear tip well in front of upper caudal–fin origin. Vertebral counts: total vertebral counts 102 to 114, monospondylous vertebral counts 56 to 64, precaudal vertebral counts 68 to 84. Intestinal valve with 16 to 21 turns. Moderately large, up to 122 cm total length. **Colour:** uniformly light to blackish brown.

Distribution: Wide–ranging in the Atlantic, Indian and western Pacific oceans. Indian Ocean: South Africa (Eastern Cape), submarine seamounts including the Madagascar range south of Madagascar, southern East Indian range between Africa and Australia. South Australia, Victoria, Tasmania and Western Australia to off Perth, Cape Leeuwin.

Habitat: A common, wide–ranging but little–known deepwater shark, on or near the bottom on the continental slopes and upper and middle rises. Occurs mostly at depths below 400 m, but with a depth range of 128 to 3675 m. Bottom water temperatures where this species has been captured ranges from 5 to 13 °C.

Biology: Viviparous with a yolk sac, with 1 to 29 young per litter, but mostly from 12 to 14. The number of embryos per litter increases slightly with the total length of the mother. There does not appear to be a defined reproductive cycle as females give birth year–round. These sharks segregate by size, sex, and reproductive stage with depth.

Feeds mostly on bony fishes including hake (Merluccidae), epigonids (Epigonidae) and bramids (Bramidae), other sharks, benthic invertebrates including squid, octopuses, gastropods, and crabs. Similar to the cookiecutter sharks (***Isistius*** species) this shark will core flesh out of live cetaceans, deep–diving pinnipeds, and possibly large driftfishes (Nomeidae).

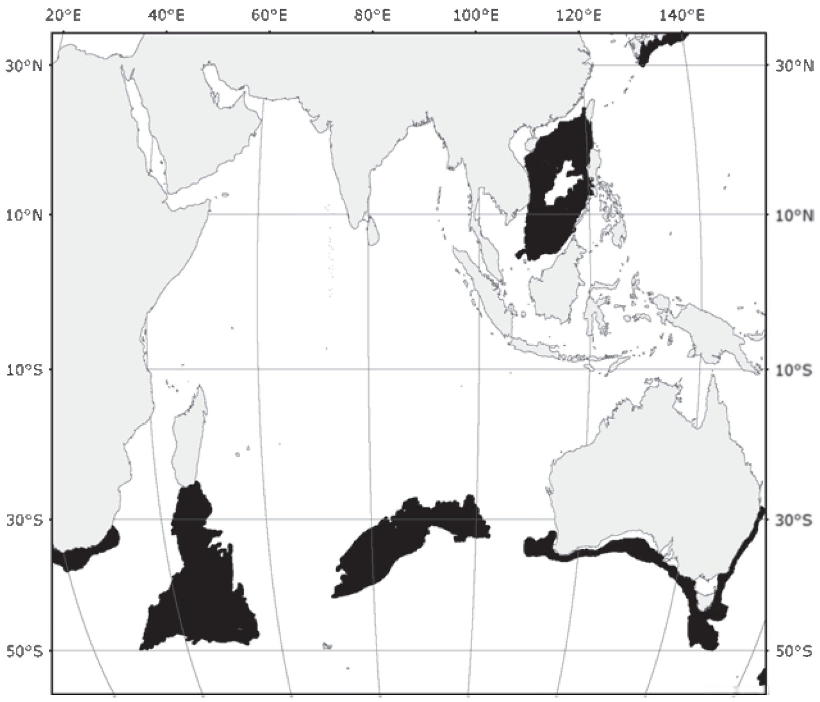


Fig. 128 *Centroscymnus coelolepis*

Known distribution

Size: Maximum total length about 122 cm; males mature at 72 to 100 cm; females mature at 92 to 110 cm. Size at birth about 23 to 35 cm; smallest free swimming individual was 34 cm total length.

Interest to Fisheries and Human Impact: A common deepwater shark, caught in bottom trawls, fixed bottom nets, and longline gear, in targeted deepwater shark fisheries and as bycatch in other deepwater demersal fisheries. This species is not targeted in the Indian Ocean, but is taken incidentally as bycatch. It is utilized for fishmeal, dried salted for human consumption, and for its squalene–rich liver oil. In Australian waters it is discarded because of the high mercury content in its flesh.

Conservation status is Near Threatened globally.

Local Names: Portugese shark (English).

Literature: Bigelow and Schroeder (1948, 1957); Krefft and Tortonese (1973); Cadenat and Blache (1981); Yano and Tanaka (1983, 1987, 1988); Compagno (1984a); Compagno, Ebert and Smale (1989); Compagno, Ebert and Cowley (1991); Ebert, Compagno and Cowley (1992); Last and Stevens (1994, 2009); Girard and Du Buit (1999); Clarke, Connolly and Bracken (2001); Stevens and Correia (2003); Verissimo, Gordo and Figueiredo (2003); Bañón, Piñeiro and Casas (2006); Kyne and Simpfendorfer (2010); Ebert and Compagno (In press); D.A. Ebert (unpubl. data).

Centroselachus Garman, 1913

Genus: *Centroselachus* Garman, 1913, *Mem. Harvard Mus. Comp. Zool.*, 36: 206.

Type species: *Centroselachus crepidater* Garman, 1913, new combination, by monotypy, equals ***Centrophorus crepidater*** Bocage and Capello, 1864 (listed in synonymy).

Number of Recognized Deep–sea Indian Ocean Species: 1.

Synonyms: None.

Field Marks: See the single species.

Diagnostic Features: Body fairly slender, not strongly tapering back from pectoral region. Snout very long, preoral length about equal to distance from mouth to pectoral origins and much greater than mouth width. Lips not thick and fleshy. Upper labial furrows very long, their lengths greater than distance between their front ends. Lower teeth with moderately long, semioblique cusps and moderately high, fairly broad roots; total tooth counts for upper jaw 36 to 51 and for the lower jaw 30 to 36. Lateral trunk denticles moderately large, with anteriorly smooth but posteriorly ridged, oval, cuspidate crowns. Pectoral fins moderately large, apices falling well in front of first dorsal–fin spine when laid back. Free rear tips of pelvic fins extending to about opposite second dorsal–fin insertion. Dorsal fins about equal in size and height, fin spines very small but with tips protruding from fins. First dorsal–fin base expanded forwards as a prominent ridge, origin over pectoral–fin bases. Second dorsal–fin base longer than space between it and upper caudal–fin origin, free rear tip nearly reaching upper caudal–fin origin. Vertebral counts: total vertebral counts 105 to 119 and precaudal vertebral counts 73 to 85. Intestinal valve turn counts unavailable. Moderate sized, with a maximum length of 105 cm. **Colour:** blackish brown.

Local Names: Longnose Velvet Dogfishes.

Centroselachus crepidater (Bocage and Capello, 1864)

Centrophorus crepidater Bocage and Capello, 1864, *Proc. Zool. Soc. London*, 24: 262, fig. 3. Holotype: Museum Bocage, Lisbon, MB T112 (49), destroyed in fire, off Portugal.

Synonyms: ***Centrophorus rossi*** Alcock, 1898, *Ann. Mag. Nat. Hist.* (7), 2(8): 143. Holotype: Zoological Survey of India, ZSI F225/1, ca. 233 mm TL female, Laccadive Sea, off Travancore coast, 787 m. ***Centrophorus jonssonii*** Jensen, *in* Saemundsson, 1922, *Vidensk. Meddel. Dansk Naturhist. Foren. Kobenhaven*, 74: 192, pl. 5, fig. 1–2. Holotype: 81 cm, from off Vestmannaeyjar, Iceland, 700–920 m, probably lost, according to Krefft and Tortonese, *in* Hureau and Monod, 1973, *Check–list fish. N.E. Atlantic Mediterranean*, 1: 41. ***Centrophorus jonsonii*** *Ibid.*: 178, is apparently an error for ***jonssonii***, which is consistantly spelled as such elsewhere in the text and is named after Th. Jonsson. ***Centroscymnus furvescens*** de Buen, 1960, *Rev. Biol. Mar., Est. Biol. Mar. Univ. Chile*, 10(1–3): 20, fig. 7. Holotype: Estacion de Biologia Marina, U. Chile, possibly lost, 760 mm TL female, off Valparaiso, Chile.

Other combinations: None.

FAO Names: En – Longnose velvet dogfish; **Fr** – Pailona à long nez; **Sp** – Sapata negra.

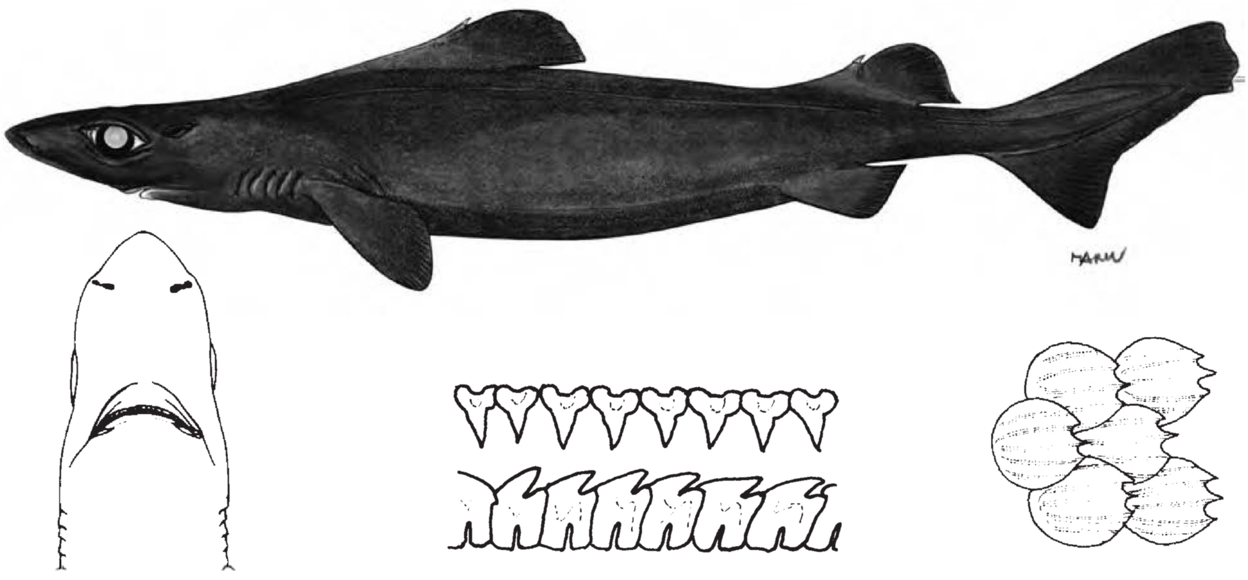


Fig. 129 *Centroselachus crepidater*

Field Marks: Dorsal fins with very small fin spines, very long snout, greatly elongated labial furrows that nearly encircle mouth, lanceolate upper teeth and bladelike lower teeth with moderately long, oblique cusps, fairly slender body that does not taper abruptly from pectoral region, moderately large lateral trunk denticles with partly smooth, oval, cuspidate crowns in adults and subadults, colour a uniform black or blackish brown.

Diagnostic Features: See genus ***Centroselachus***.

Distribution: Wide–ranging in the eastern Atlantic and Indo–Pacific oceans. Indian Ocean: Aldabra Island, Madagascar range of seamounts south of Madagascar, India (Travancore Coast), Australia (Western Australia, South Australia, Victoria, and Tasmania).

Habitat: Found on the upper continental and insular slopes on or near the bottom at depths of 200 to 1500 m.

Biology: A little–known but common deepwater dogfish, with yolk–sac viviparity; litters range from 1 to 9, with an average of 6. Females appear capable of breeding throughout the year. Age at maturity is about 9 years for males and 20 years for females; oldest individual was a female estimated at 54 years and the oldest male about 34 years. Diet consists of bony fishes, including lanternfishes (Myctophidae), crustaceans and cephalopods.

Size: Maximum total length about 105 cm; males mature at 60 to 68 cm; females mature at 77 to 88 cm. Size at birth about 28 to 35 cm.

Interest to Fisheries and Human Impact: Interest to fisheries limited, it is caught as bycatch and utilized for fishmeal, and marketed for its flesh and high squalene content. Catches of this species are now limited, banned below 700 m, by a small quota in Australian waters due primarily to its low productivity.

Conservation status for this species is Least Concern due to its wide, but patchy distribution and apparent population increases in some regions.

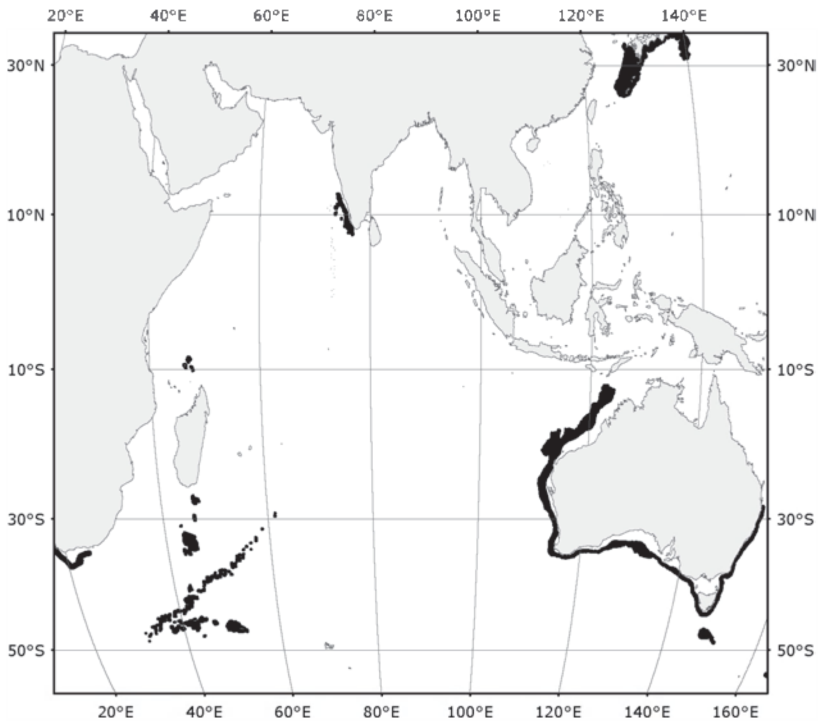


Fig. 130 ***Centroselachus crepidater***

Known distribution

Local Names: Golden dogfish, Deepwater dogfish (Australia).

Remarks: The possible synonymy of ***Centrophorus rossi*** Alcock, 1898 with this species was discussed by Bigelow and Schroeder (1957) and Garrick (1959b), both of whom recognize ***C. rossi*** because of its supposedly longer head. Compagno (1984a) noted that the holotype of ***C. rossi*** in the Zoological Survey of India, Calcutta, ZSI F 225/1 (233 mm female possibly newborn) had a head length, 29.6% of total length, that fell in the range reported for ***Centroscymnus crepidater*** by Cadenat and Blache (1981), 21.3 to 29.7% of total length. As the specimen apparently had no other characters that distinguish it from ***C. crepidater***, ***C. rossi*** was synonymized with ***C. crepidater*** by Compagno (1984a) and is followed here. The holotype of ***C. rossi*** is not the only record of this species from the western Indian Ocean, as records of ***C. owstonii*** from the Aldabra Island group by Forster *et al.* (1970) were based on ***C. crepidater*** (Bass *in* Smith and Heemstra, 1986) and Shcherbachev (1987) found the species on the Madagascar range of seamounts. In fact, this species is rather common at depth along the southern Madagascar range of seamounts (P. Clerkin, Moss Landing Marine Laboratories, pers. comm.).

Literature: Bigelow and Schroeder (1948, 1957); Garrick (1959b); Krefft and Stehmann (1973); Cadenat and Blache (1981); Compagno (1984a); Bass *in* Smith and Heemstra (1986); Compagno, Ebert and Smale (1989); Compagno, Ebert, and Cowley (1991); Ebert, Compagno and Cowley (1992); Last and Stevens (1994, 2009); Stevens *et al.* (2003); Irvine, Stevens and Laurenson (2006); Kyne and Simpfendorfer (2010); Ebert and Compagno (In press); (P. Clerkin, Moss Landing Marine Laboratories, unpubl. data).

Proscymnodon Fowler, 1934

Genus: Subgenus ***Proscymnodon*** Fowler, 1934, *Proc. Acad. Nat. Sci. Philadelphia*, 85: 239 (Genus ***Scymnodon*** Bocage and Capello, 1864).

Type species: ***Centrophorus plunketi*** Waite, 1910, by original designation.

Number of Recognized Deep–sea Indian Ocean Species: 1.

Synonyms: None.

Field Marks: Snout long, body stocky and tapering back from pectoral region, two dorsal fins each with a prominent fin spine, thick fleshy lips, upper labial furrows very short, pectoral fins large, apices falling about well in front of or opposite first dorsal–fin spine when laid flat against body, colour dark grey to brown or blackish.

Diagnostic Features: Body stocky, tapering back from pectoral region. Snout short to moderately long, preoral length less than to about equal to distance from mouth to 1st gill openings and less than to equal to mouth width. Lips thick and fleshy. Upper labial furrows very short, their lengths much less than distance between their front ends. Lower teeth with short, oblique cusps and moderately high, fairly broad roots. Lateral trunk denticles large, with triple ridges and cusps. Pectoral fins large, apices falling about well in front of or opposite first dorsal–fin spine when laid back. Free rear tips of pelvic fins falling well in front of second dorsal–fin insertion. Dorsal fins about equal in size or second slightly higher than first; fin spines small. Second dorsal–fin base about as long as space between it and upper caudal–fin origin, free rear tip well in front of upper caudal–fin origin. **Colour:** black to dark brown or grey brown; some species with lighter fin edges.

Local Names: Largespine Velvet Dogfishes.

Proscymnodon plunketi (Waite, 1910)

Centrophorus plunketi Waite, 1910, *Trans. New Zealand Inst.*, 1910, 42: 384, pl. 37, figs. 1–3. Holotype: adult female 1414 mm TL, South Island of New Zealand, 220 m.

Synonyms: ***Centrophorus waitei*** Thompson, 1930, *Rec. Canterbury Mus.*, 3(4): 277, pl. 44. Holotype: Canterbury Museum, Christchurch, New Zealand, CMNZ 179, 32 cm immature female, deep water off Kaikoura, New Zealand; slides of teeth and denticles in National Museum of New Zealand as NMNZ P.20517 according to Hardy, 1990, *Nat. Mus. New Zealand, Misc. Ser.* (21): 5.

Other combinations: None.

FAO Names: En – Plunket shark; **Fr** – Pailona austral; **Sp** – Pailona austral.

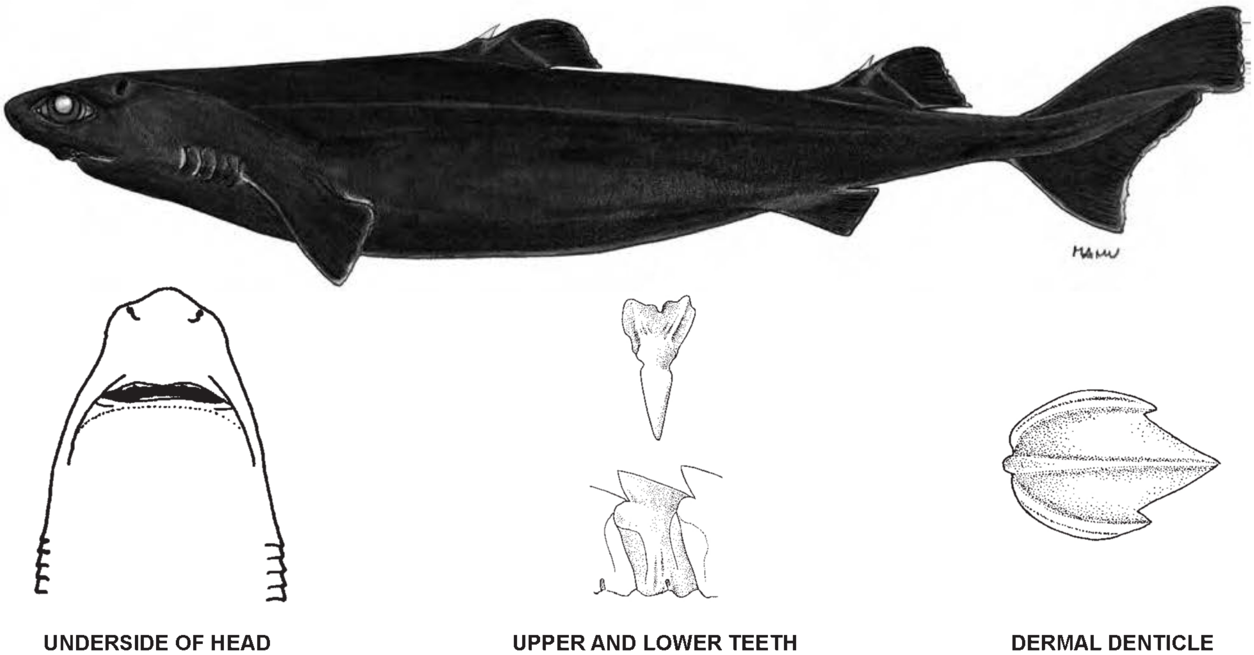


Fig. 131 ***Proscymnodon plunketi***

Field Marks: Body, stocky, tapering abruptly from pectoral region, snout very short, upper teeth lanceolate, blade–like, lower teeth short, with oblique cusps, moderately large dermal denticles with triple cusps and ridges in adults and subadults, dorsal fins with very small fin spines, coloration uniform dark grey–brown.

Diagnostic Features: Body stocky, tapering back from pectoral region. Snout short, preoral length much less than distance from mouth to first gill slits and less than mouth width. Lips not thick and fleshy. Upper labial furrows very short, their lengths much less than distance between their front ends. Upper teeth erect, dagger–like, becoming more oblique laterally; lower teeth with short, strongly oblique cusps and high, fairly broad roots; total tooth counts for upper jaw 48 and for lower jaw 32 to 35. Lateral trunk denticles moderately large, with triple cusps and ridges. Pectoral fins moderately large, apices falling well in front of first dorsal–fin spine when laid back. Free rear tips of pelvic fins falling well in front of second dorsal–fin insertion. Dorsal fins about equal in size and height, fin spines very small but with tips protruding from fins. First dorsal fin extending forwards as a prominent ridge, origin behind pectoral fins. Second dorsal–fin base about as long as space between it and upper caudal–fin origin, free rear tip well in front of upper caudal–fin origin. Vertebral counts: total vertebral counts 114 to 119, precaudal vertebral counts 84 to 87, monospondylous vertebral counts 63 to 65. A large species, maximum total length up to 170 cm. **Colour:** uniformly grey–brown.

Distribution: Indian Ocean: Melville Ridge south of Madagascar, Australia (Victoria, Tasmania, and adjacent seamounts; Cape Leeuwin, Western Australia). Western Pacific: Australia (New South Wales) and New Zealand.

Habitat: A common bottom shark of the continental and insular slopes at depths of 219 to 1550 m though commonest between 550 to 732 m.

Biology: Development viviparous with a yolk sac and with large litters of up to 36 young. Feeds on cephalopods, bony fishes and also ***Etmopterus lucifer***. Occurs in large schools near the bottom, with schools segregated by size and sex.

Size: Maximum total length about 170 cm; females mature at 129 to 170 cm total length; males mature at 100 to 131 cm total length. Size at birth is between 32 and 36 cm.

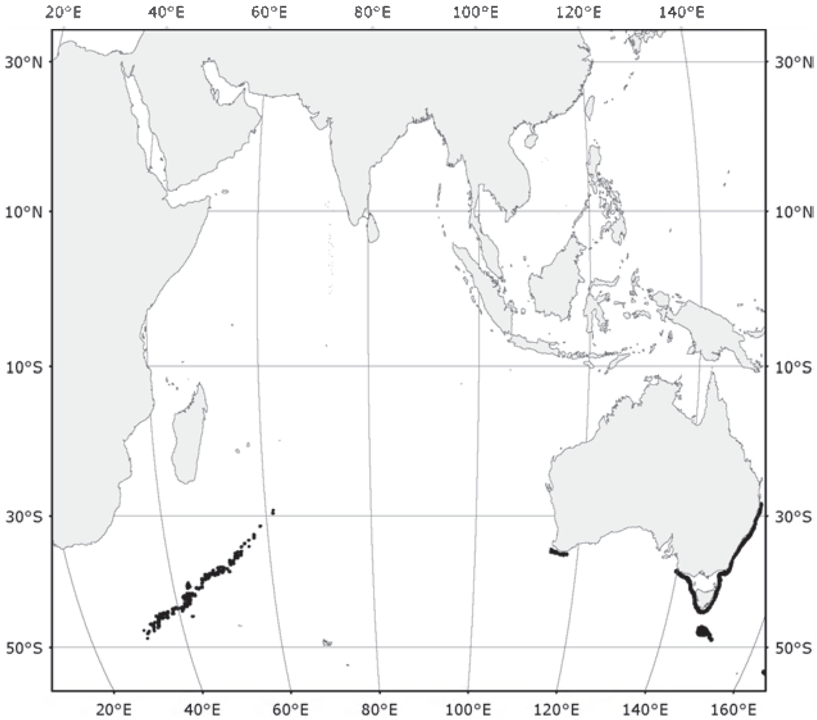


Fig. 132 *Proscymnodon plunketi*

Known distribution

Interest to Fisheries and Human Impact: This is a very common deepwater shark off New Zealand and Australia in waters deeper than 550 m. It is caught with deepset longlines and with deepwater demersal trawls targeting orange roughy (***Hoplostethus atlanticus***). Discarded in Australia but presumably utilized in New Zealand for fishmeal and for squalene in its liver oil. Live individuals have been photographed at baits in Kaikoura Canyon, New Zealand.

The conservation status of this shark is Near Threatened.

Local Names: Plunket's shark, Plunket's dogfish, Lord Plunkets shark, Plunkets dogfish, Waite's deep–sea dogfish.

Literature: Whitley (1940); Fowler (1941); Bigelow and Schroeder (1957); Garrick (1959c); Compagno (1984a); Taniuchi and Garrick (1986); Last and Stevens (1994, 2009); Paul (2003b); Dunn *et al.* (2010); Ebert and Compagno (In press).

Scymnodalatias Garrick, 1956

Genus: ***Scymnodalatias*** Garrick, 1956, *Trans. Roy. Soc. New Zealand*, 83(3): 564.

Type species: ***Scymnodon sherwoodi*** Archey, 1921, by original designation.

Number of Recognized Deep–sea Indian Ocean Species: 2.

Synonyms: None.

Field Marks: Snout broadly rounded, elongated, somewhat flattened, not bulbous, mouth long and broadly arched, eyes horizontally elongated, upper teeth smaller than lowers, narrow, acute, without cusplets, lower teeth larger, blade–like, lacking serrations, imbricate, two spineless dorsal fins, the second being slightly larger than the first which originates about mid–body, pectoral fins elongated, caudal fin asymmetrical, upper caudal–fin margin nearly twice the length of the lower caudal–fin margin with a short lower lobe, dark brown to mottled grey above, lighter below, fins with or without conspicuous fin markings or prominent light edges and light blotches on caudal–fin base.

Diagnostic Features: Head length 17.8 to 28.1%, snout moderately long, pointed and flattened, preorbital snout 4.2 to 8.4% of total length. Anterior nasal flaps short, not expanded into barbels. Gill openings moderately wide, fifth one slightly broader than first four; upper teeth with straight slender cusps; cusps of lower teeth erect or slightly oblique, cusp covering root and apparently without a small distal blade; tooth row counts upper jaw 33 to 62, lower jaw 32 to 42, upper rows more numerous than lowers. Dermal denticles with moderately high, narrow pedicels and broad, flat, leaf–shaped, tricuspidate and tri–ridged crowns. Predorsal length less than to nearly half of total length. Both dorsal fins spineless; first dorsal–fin free rear tip anterior to pelvic–fin origins. Second dorsal–fin origin above rear third of pelvic–fin base, free rear tip just anterior to upper caudal–fin origin; second dorsal–fin origin above pelvic–fin midbase, free rear tip just anterior to upper caudal–fin origin. Pectoral fins broadly angular or leaf–shaped, with angular or bluntly rounded apices, anterior margins 10.6 to 18.6% of total length. Cloaca normal, not expanded as a luminous gland. No precaudal pits, lateral or midventral keels on caudal peduncle. Caudal fin asymmetrical. Vertebral counts: total vertebral counts 81 to 84, monospondylous vertebral counts 43 to 45, and precaudal vertebral counts 57 to 61. Adult size to at least 111 cm. **Colour:** dark brown or mottled greyish above, dark to lighter brown or grey below; fins with or without whitish grey margins, or conspicuous white blotches on caudal–fin base.

Local Names: None.

Remarks: This genus is very close to the genus ***Scymnodon***, as suggested by the original placement of ***Scymnodon*** (=***Scymnodalatis***) ***sherwoodi*** in it own genus by Archey (1921) based on a specimen found stranded on a beach on the east coast of the South Island, New Zealand. Garrick (1956) later in a detailed revision erected a new genus (***Scymnodalatias***) separating it from other squaloid genera. In addition to lacking fin spines, this genus differs from ***Scymnodon*** in having the first dorsal fin slightly more posterior on the back; see Garrick (1956) and Taniuchi and Garrick (1986) for a detail discussion of this genus and comparison to other closely related genera.

Key to Deep–sea Indian Ocean Species:

1a. Pectoral fins elongated, anterior margin 17.2 to 18.6% of total length; preorbital snout 4.2 to 4.6% of total length; conspicuous white blotches on caudal fin (Fig. 133) . . . . ***Scymnodalatias albicauda***

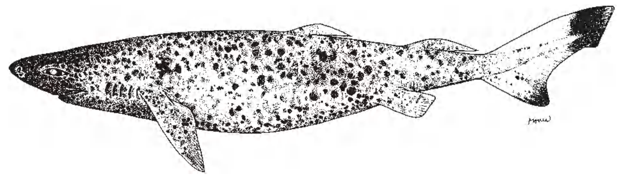


Fig. 133 *Scymnodalatias albicauda*

1b. Pectoral fins relatively short, length of anterior margin 10.6% of total length; preorbital snout 6.2% of total length; no conspicuous white blotches on caudal fin (Fig. 134) . . . . ***Scymnodalatias sherwoodi***

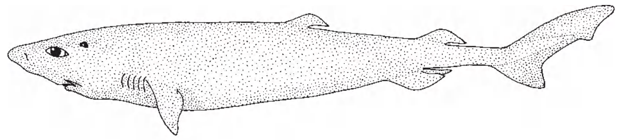


Fig. 134 *Scymnodalatias sherwoodi*

Scymnodalatias albicauda Taniuchi and Garrick, 1986

Scymnodalatias albicauda Taniuchi and Garrick, 1986, *Japanese J. Ichthyol.* 33(2): 120, fig. 1–2. Holotype: University Museum, University of Tokyo, FUMT P–197, 914 mm female, southeastern Indian Ocean between Kerguelen Islands and Cape Leeuwen, Western Australia, ca. 45°S, 92 °E, 150–200 m on longline near surface in water ca. 1400–1800 m deep.

Synonyms: None.

Other combinations: None.

FAO Names: **En** – Whitetail dogfish; **Fr** – Squale grogneur à queue blanche; **Sp** – Bruja cola blanca.

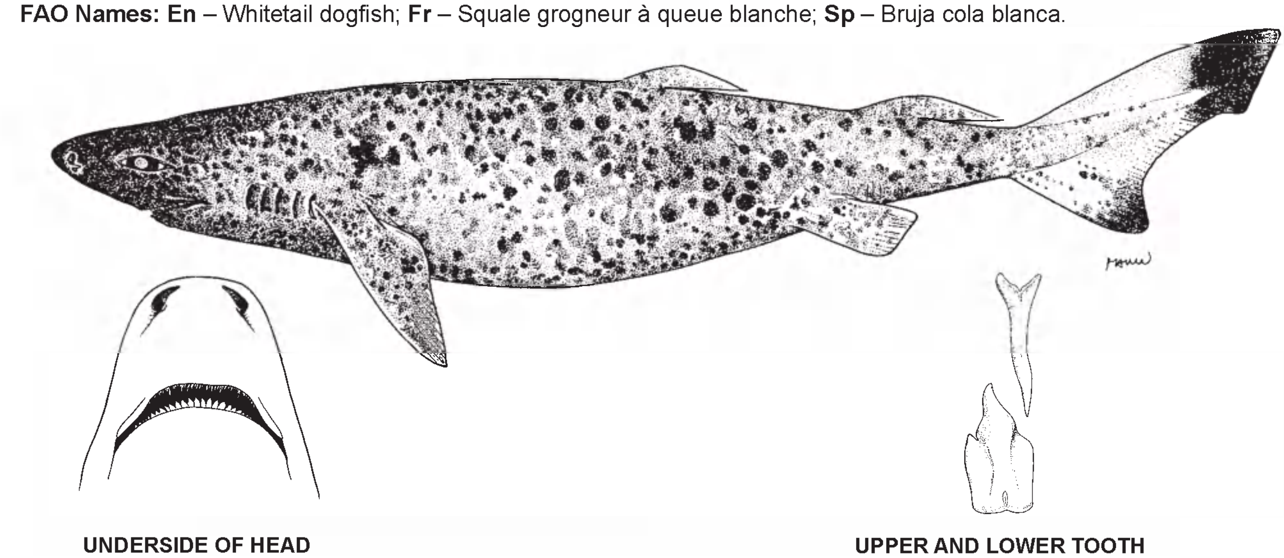


Fig. 135 *Scymnodalatias albicauda*

Field Marks: Short, broadly rounded snout, eyes horizontally elongated, and a long broadly arched mouth, upper teeth small, narrow with acutely erect cusps, lowers large blade–like smooth–edged, imbricate, with high, erect cusps, two spineless dorsal fins, second dorsal fin slightly larger than the first, pectoral fins elongated, upper caudal–fin margin nearly twice the length of the lower caudal–fin margin, colour a dark brown to mottled grey above, lighter below, with conspicuous white blotches on the caudal–fin base.

Diagnostic Features: Head length 17.8 to 18.9% and preorbital snout 4.2 to 4.6% of total length. Upper teeth with straight slender cusps; cusps of lower teeth erect or slightly oblique, cusp covering part of root and with small distal blade; tooth row counts 57 to 62/35, upper rows more numerous than lowers, ratio 1.3:1. Predorsal length less than half or 41.0 to 44.7% of total length. Pectoral fins elongated and leaf–shaped, with angular and acute apices, anterior margins 17.2 to 18.6% of total length. First dorsal–fin free rear tip far anterior to pelvic–fin origins by over dorsal–fin base length. Second dorsal–fin origin above rear third of pelvic–fin base, free rear tip just anterior to upper caudal–fin origin; ventral caudal–fin lobe short and strong. Vertebral counts: total vertebral counts 82 to 84, precaudal vertebral counts 57 to 61, monospondylous vertebral counts 43 to 44. A moderate sized shark that reaches 111 cm. **Colour:** dark brown or mottled greyish above, lighter brownish grey below, fins with whitish grey margins, conspicuous white blotches on caudal–fin base and web except for dark terminal lobe.

Distribution: A few scattered records from the southeastern Indian Ocean, eastern South Atlantic, and western South Pacific. Southwest of southern Africa and between Kerguelen Islands and Cape Leeuwin. Also southwest of Tasmania.

Habitat: Oceanic in the epipelagic zone, where it is a rare catch on tuna longlines from 0 to approximately 200+ m in water approximately 1400 to 4000 m deep, also off a submarine ridge at 512 m near bottom. It may be mesopelagic or bathypelagic as suggested by its dark body coloration, and could rise to near the surface at night, but this is speculative.

Biology: Viviparous with a yolk sac. A pregnant female from the South Atlantic had a litter of 59 near–term foetuses, which is higher than any other squaloid (with the possible exception of the large ***Somniosus*** spp.) and surpassed by few other sharks; it is not certain if any additional foetuses had been lost during capture. A second specimen from New Zealand waters had 36 embryos (A. Stewart, Te Papa Museum, pers. comm.).

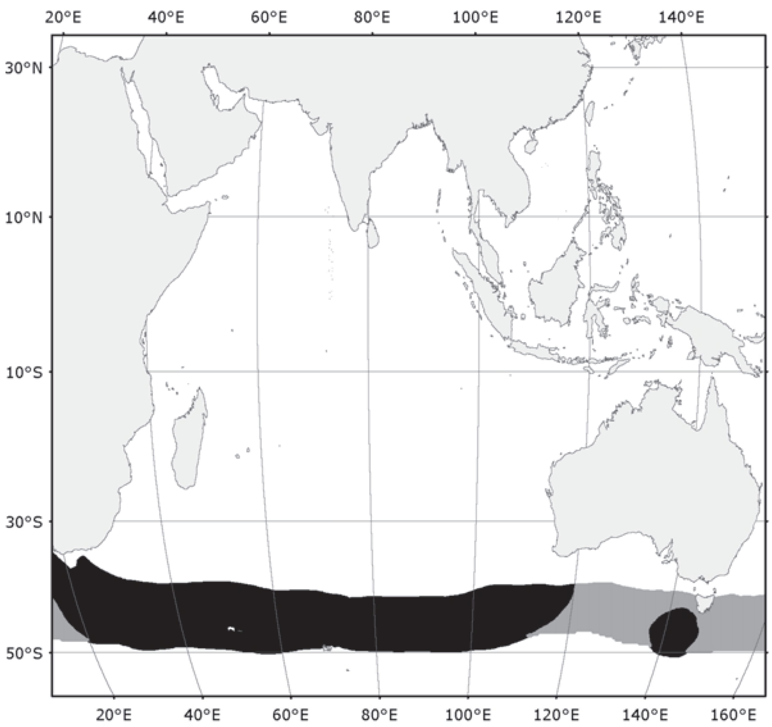


Fig. 136 *Scymnodalatias albicauda*

Known distribution Possible distribution

Size: Maximum total length to 111 cm; females were adult at 74, 91 and 111 cm long. Size at birth uncertain, but near–term foetuses with moderately large yolk sacs were 15.7 to 19.2 cm total length.

Interest to Fisheries and Human Impact: An incidental and rare bycatch of tuna longliners, utilization not recorded.

The conservation status of this poorly known species is Data Deficient.

Local Names: None.

Literature: Taniuchi and Garrick (1986); Kukuyev and Konovalenko (1988); Last and Stevens (1994, 2009); Nakaya and Nakano (1995); Duffy (2003); Andrew Stewart (pers. comm.).

Somniosus Lesueur, 1818

Genus: ***Somniosus*** Lesueur, 1818, *J. Acad. Sci. Philadelphia* 1(2): 222. Proposed as a subgenus of ***Squalus*** Linnaeus, 1758, but used in generic form.

Type species: ***Somniosus brevipinna*** or ***Squalus brevipinna*** Lesueur, 1818, by monotypy; a junior synonym of ***Squalus microcephalus*** Bloch and Schneider, 1801.

Number of Recognized Deep–sea Indian Ocean Species: 1.

Synonyms: Subgenus ***Somnolentus*** (Lesueur) Swainson, 1838, *Nat. Hist. Fish. Amphib. Rept., Monocard. Anim.*, 1: 146. Apparently an erroneous misspelling or correction of ***Somniosus*** Lesueur, 1818; regarded by Swainson as a synonym of ***Scymnus*** Cuvier, 1816. Genus ***Laemargus*** Müller and Henle, 1837a, *Ber. K. preuss. Akad. wiss. Berlin*, 2: 116; Müller and Henle, 1837b, *Arch. Naturg.* 3: 399; Müller and Henle, 1838, *Mag. Nat. Hist., n. ser.*, 2: 89; Müller and Henle, 1838, L'Institut, 6: 65 (no species mentioned). Reduced to subgenus ***Laemargus*** Müller and Henle, 1839, *Syst. Beschr. Plagiost.*, pt. 2: 93 (Genus ***Scymnus*** Cuvier, 1816), with three species. Type species: "***Squalus borealis*** Scoresby", by subsequent designation of Jordan, 1919, *Stanford U. Pub., U. Ser., Gen. Fish.* (3): 192, equals ***Scymnus borealis*** Fleming, 1828 as cited by Müller and Henle, 1839, a junior synonym of ***Squalus microcephalus*** Bloch and Schneider, 1801. Genus ***Leiodon*** Wood, 1846, *Proc. Boston Soc. Nat. Hist.*, 2, 174. Type species: ***Leiodon echinatum*** Wood, 1846, by monotypy. Genus ***Rhinoscymnus*** Gill, 1864 (published 1865?), *Proc. Acad. Nat. Sci. Philadelphia*: 264, ftn. 5. Type species: ***Scymnus rostratus*** Risso, 1826, by monotypy. Genus ***Heteroscymnus*** Tanaka, 1912, *Fig. Descr. Fish. Japan*, 6: 102. Type species: ***Heteroscymnus longus*** Tanaka, 1912, by original designation. Subgenus ***Brevisomniosus*** Quéro, 1976, *Rev. Trav. Inst. Peches Marit.* 39(4): 463, 467. (Genus ***Somniosus*** Lesueur, 1818). Type species not indicated, two species, ***Somniosus rostratus*** (Risso, 1826) and ***S. bauchotae*** Quéro, 1976, included in it.

Field Marks: Short to moderately long snout, no fin spines on dorsal fins, no anal fin, slender–cusped teeth without cusplets in upper jaw, bladelike, oblique and relatively short–cusped teeth in lower jaw, denticles with narrow, hooked, cuspidate crowns, lips not fringed and pleated, first dorsal fin on middle of back and usually behind pectoral fins, but well ahead of pelvic fins, second dorsal fin slightly smaller than first, caudal fin somewhat paddle–shaped, with a long lower lobe, size moderately large to very large.

Diagnostic Features: Anterior nasal flaps short, not expanded into barbels; snout short to moderately long, broadly rounded to pointed and somewhat flattened, length 2/5 to less than 1/3 of head length and 2/3 to less than 2/5 of distance from mouth to pectoral–fin origins; gill openings moderately wide, last one about as long as first four; lips thin, not fringed, pleated or suctorial; teeth strongly different in upper and lower jaws, upper small, with narrow, acute, erect cusps and no cusplets, not bladelike, lowers much larger, bladelike, interlocked, with a low to moderately high, oblique or semierect cusps and distal blade, edges serrated or not; tooth counts 30 to 60 upper jaw, 31 to 63 lower jaw. Both dorsal fins spineless; first dorsal fin on middle of back, with origin sometimes extended forward as a low ridge over pectoral–fin bases but usually well behind pectoral fins, insertion far in front of pelvic–fin origins but slightly closer to pelvic–fin bases than pectoral fins; second dorsal fin slightly smaller than first and with base 3/4 length of first dorsal–fin base or less; origin of second dorsal fin varying from over anterior half of pelvic–fin bases to somewhat posterior to pelvic–fin free rear tips; pectoral fins with short, narrowly to broadly rounded free rear tips and inner margins, not expanded and acute or lobate; caudal fin semi–symmetrical and paddle–shaped, with a relatively short upper lobe and long lower lobe, and a strong subterminal notch. No precaudal pits, or lateral keels, or midventral keels on caudal peduncle. Dermal denticles with oblique to erect, ridged hooked, cuspidate narrow crowns, not flat, depressed and block–like. Cloaca normal, not expanded as a luminous gland. Vertebral counts: total vertebral counts 35 to 78, monospondylous vertebral counts 21 to 46, and precaudal vertebral counts 28 to 59, caudal vertebral counts 6 to 10. Intestinal valve with 23 to 41 turns. Moderate to gigantic sharks with adults from 140 to more than 600 cm total length. **Colour:** medium grey to blackish, without conspicuous light fin edges.

Local Names: Sleeper sharks, Greenland sharks, Gurry sharks.

Remarks: Following Yano *et al.* (2004), five species are recognized with one species occurring in the Indian Ocean.

Somniosus antarcticus Whitley, 1939

Somniosus antarcticus Whitley, 1939, *Aust. Zool.* 9(3): 242. Macquarie Island. Based on the ***Somniosus*** sp. of Waite (1916, *Australas. Antarct. Exped.*, 1911–1914, Sci. Rept. C, vol. 3(1): 51, fig. 10), a 249 cm shark apparently of this genus.

Synonyms: ***Somniosus microcephalus*** Bass, D'Aubrey and Kistnasamy (1976): 43. Duhamel and Hureau (1982): 73. Duhamel and Compagno (1985): 209. Gushchin *et al.* (1986): 514. Compagno (1990): 81. ***Somniosus pacificus*** Francis, Stevens and Last (1988): 402. Pequeño *et al.* (1991): 117. Last and Stevens (1994): 89. Diaz De Astarloa *et al.* (1999): 303.

Other Combinations: ***Somniosus pacificus***, ***Somniosus microcephalus***.

FAO Names: En – Southern sleeper shark; **Fr** – Laimargue de l'Antarctique; **Sp** – Tollo meridional dormilón.

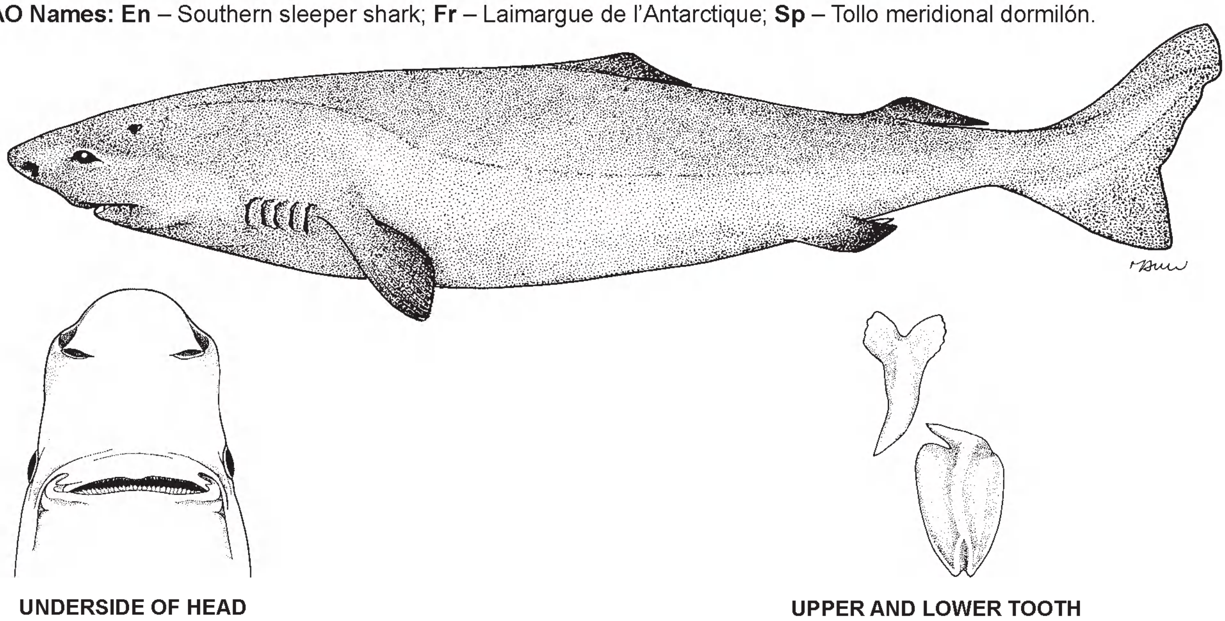


Fig. 137 ***Somniosus antarcticus***

Field Marks: Short, rounded snout, heavy cylindrical body and small precaudal fins, two spineless, equal–sized dorsal fins, no anal fin, long ventral caudal–fin lobe, first dorsal fin on back slightly closer to pelvic fins than pectoral fins, interdorsal space greater than distance from snout to second gill slits, no keels on base of caudal fin, upper teeth lanceolate, lower teeth with short, low, strongly oblique cusps and high, narrow roots.

Diagnostic Features: Snout short and broadly rounded. Head moderately long, length from snout to pectoral fins 23% TL in specimen 299 cm TL. Cusps of lower teeth short and low, strongly oblique, roots very high. Total tooth counts upper jaw 37 to 48, lower jaw 49 to 59. Lateral trunk denticles with erect, narrow–crowns and hooked cusps, giving skin a rough, bristly texture. Insertion of first dorsal fin slightly closer to pelvic–fin bases than pectoral–fin bases. Interdorsal space greater than distance from snout tip to second gill slits. No lateral keels present on base of caudal fin. Caudal peduncle short, distance from second dorsal–fin insertion to upper caudal–fin origin less than twice second dorsal–fin base; distance from pelvic–fin insertions to lower caudal–fin origin less than dorsal caudal–fin margin. Vertebral column without well–defined calcified centra, notochord secondarily expanded. Vertebral counts: total vertebral counts 36 to 38, precaudal vertebral counts 30 to 31. Spiral valve turn counts: 36 to 41 (mode = 39). Size large, exceeding 400 cm total length. **Colour:** uniformly grey to blackish, without conspicuous light or dark fin edges.

Distribution: Recorded in the Indian Ocean from the southern Madagascar Ridge; Kerguelen, Heard, and Macquarie islands and Australia (including seamounts south of Tasmania, and off Perth, Western Australia).

Habitat: An abundant littoral and epibenthic shark of the continental and insular shelves and upper slopes down to at least 1440 m. In the southern hemisphere it is found in deep water (677 m) off South Africa, in 245 to 370 m depth off Kerguelen Island, and off Macquarie Island between 300 to 1440 m. Water temperatures of places inhabited by these sharks range from 0.6 to 12 °C.

Biology: Viviparous with a yolk sac, but litter sizes mostly unknown. Diet consists of fishes, pinnipeds, cetaceans, and especially cephalopods where they appear

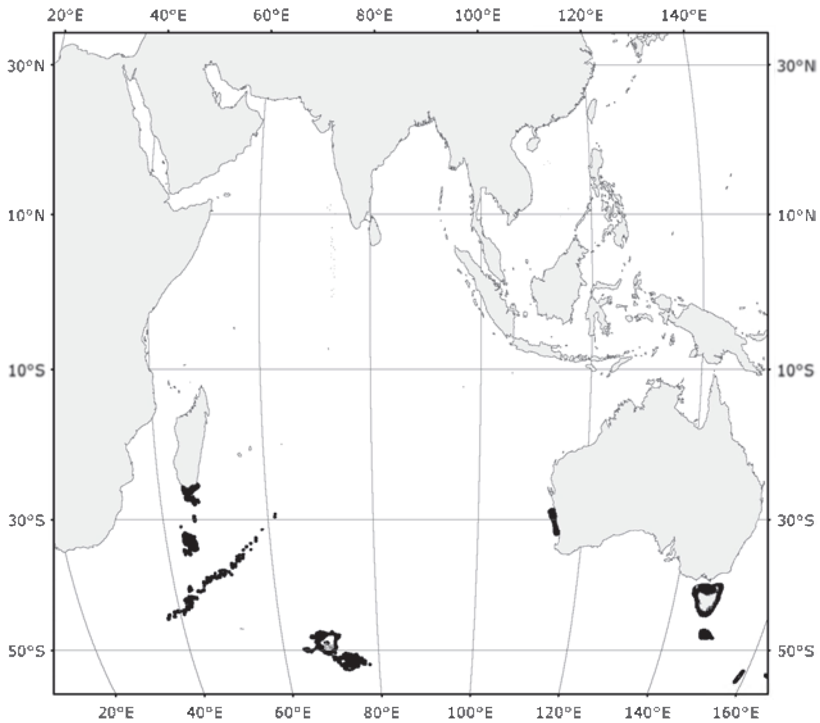


Fig. 138 ***Somniosus antarcticus***

Known distribution

to target giant squid (***Mesonychoteuthis hamiltoni***). Much like the other giant members of this genus these sharks consume fast–swimming prey, but whether it taken as carrion or alive is unknown.

Size: Maximum to at least 456 cm, but possibly 600 cm or more; males adult at about 400 cm and females at about 435 cm. Size at birth about 40 cm.

Interest to Fisheries and Human Impact: Apparently not fished commercially, but caught as bycatch of trawl fisheries for hake and other bottom fishes along most of its range, and as non–utilized bycatch of longline fisheries for Patagonian toothfish (***Dissostichus eleginoides***, Nototheniidae).

The conservation status is Data Deficient.

Local Names: Blimp shark (South Africa).

Remarks: ***Somniosus antarcticus*** was named by Whitley (1939) based on a sketch and descriptive data from a ***Somniosus*** specimen found dead on a beach at Macquarie Island in the Antarctic. The specimen itself was not preserved, but tooth and skin samples were saved; however, it is uncertain whether these samples still exist. The descriptive data and sketch definitely indicate that the specimen represented a member of the subgenus ***Somniosus*** closest to ***S. microcephalus***, but these are sufficiently generalized to prohibit the differentiation of ***S. antarcticus*** from ***S. microcephalus***. As with certain other sharks, Whitley apparently named ***S. antarcticus*** primarily because of its southern hemisphere locality. However comparison of large southern oceans ***Somniosus*** to the two northern hemisphere forms have revealed that this species is indeed valid and could be separated by morphometric characteristics, and meristics including tooth, vertebral, and spiral valve turn counts (Yano *et al.* 2004). A molecular study (Murray *et al.*, 2008) on the three large ***Somniosus*** species confirm the separation of ***S. microcepahlus*** from ***S. pacificus***, but the genetic structure within the ***S. antarcticus–S. pacificus*** clade was more ambiguous and showed little to no variation. Furthermore, molecular examination using mtDNA and nuclear markers is required to determine the species status of ***S. antarcticus*** and ***S. pacificus***.

Literature: Whitley (1939); Bigelow and Schroeder (1948); Bass, D'Aubrey and Kistnasamy (1976); Duhamel and Hureau (1982); Compagno (1984a); Stevens (2003a); Cherel and Duhamel (2004); Yano, Stevens and Compagno (2004); Yano *et al.* (2007); Murray *et al.* (2008); Ebert and Compagno (In press).

Zameus Jordan and Fowler, 1903

Genus: ***Zameus*** Jordan and Fowler, 1903, *Proc. U. S. Natn. Mus.* 26 (1324): 632.

Type species: ***Centrophorus squamulosus*** Günther, 1877, by monotypy.

Number of Recognized Deep–sea Indian Ocean Species: 1.

Synonyms: ***Scymnodon*** Barbosa du Bocage and Brito Capello, 1864, *Proc. Zool. Soc. Lond.*, 24: 263.

Field Marks: Small to moderate, slender bodied sharks, with low flat head, snout moderately long to short, mouth short, narrow, transverse, upper labial furrows short, teeth of upper jaw small, spear–like, lower jaw teeth larger, highly erect, knife–like, fin spine preceding each dorsal fin, pectoral fins small, leaf–shaped to rounded, caudal fin with strong subterminal notch and short lower lobe, colour a uniform black to dark brownish.

Diagnostic Features: Head rather low and flat. Snout narrow, relatively long to short. Eyes moderately large. Mouth broad to fairly narrow and transverse. Teeth dissimilar in upper and lower jaws; upper teeth small, with a single cusp, smooth–edged, lanceolate, lower teeth triangular, oblique, erect–cusped, knife–like. Tooth counts for upper jaw 42 to 60, lower jaw 28 to 38. Gill slits rather short, longest less than half eye length. Lateral trunk denticles with or without tricuspidate ridges. First dorsal fin dissimilar in shape to second dorsal fin; length of first dorsal–fin base greater than second. Dorsal–fin spines present; first dorsal–fin spine relatively large, but decreases proportionally with growth; second dorsal–fin spine slightly shorter than first. Pectoral fins narrow to moderately broad, rounded, or leaf–shaped; apices of pectoral fins fall anterior to, or posterior to origin of first dorsal–fin spine. Pelvic fins small, about equal to second dorsal fin. Caudal peduncle long, distance from second dorsal–fin base to upper caudal–fin origin about equal to second dorsal–fin base. Caudal fin with a strong subterminal notch and a short lower lobe. Vertebral counts: total vertebral counts 93 to 105, precaudal vertebral counts 66 to 76, monospondylous vertebral counts 50 to 57. Spiral valve turns: 12 to 16. Small to moderate sized sharks between 84 to 101 cm. **Colour:** uniformly black to dark brownish with no conspicuous markings.

Local Names: Velvet dogfish.

Remarks: Taniuchi and Garrick (1986) based on distinct morphological, including dermal denticles, and meristic (tooth and vertebral) differences from ***Scymnodon*** resurrected the genus ***Zameus***. The genus as presently restricted includes two species, ***Zameus ichiharai*** known only from the western North Pacific (Japan) and a wide ranging, but sporadically distributed species ***Z. squamulosus***. The species name ***Scymnodon*** (=***Zameus***) ***obscurus*** is sometimes seen in the literature for the North Atlantic, but that species appears to be a junior synonym of ***Z. squamulosus*** (See Remarks section below species account).

Zameus squamulosus (Günther, 1877)

Centrophorus squamulosus Günther, 1877, *Ann. Mag. Nat. Hist. ser.* 4, 20(119): 433. Holotype: British Museum (Natural History), BMNH–1880.5.1.1, 670 mm female, *Challenger* sta. 232, off Inosima, Japan, 35°11'N, 139°28'E, BT – 41.4°F, 631 m.

Synonyms: *Centroscymnus obscurus* Vaillant, 1888, Exped. Sci. "Travailleur" et "Talisman", Zool., Poiss. 67–68, pl. 2, fig. 2a–e. Holotype: Museum National d'Histoire Naturelle, Paris, MNHN–84–388, 590 mm female, `côtes du Soudan', 1400–1435 m. ***Scymnodon niger*** Chu and Meng, *in* Chu *et al.* 1982, *Ocean. Limn. Sinica*, 13(1): 303, 310, fig. 3. Holotype: South China Sea Fisheries Research Institute, no. S07561, 482 mm TL adult male, 19°27.6'N, 114°19.3'E, South China Sea, 964 m.

Other combinations: *Scymnodon squamulosus* (Regan, 1908a), ***Scymnodon obscurus*** Bigelow and Schroeder (1957).

FAO Names: En – Velvet dogfish; **Fr** – Squale–grogneur velouté; **Sp** – Bruja terciopelo.

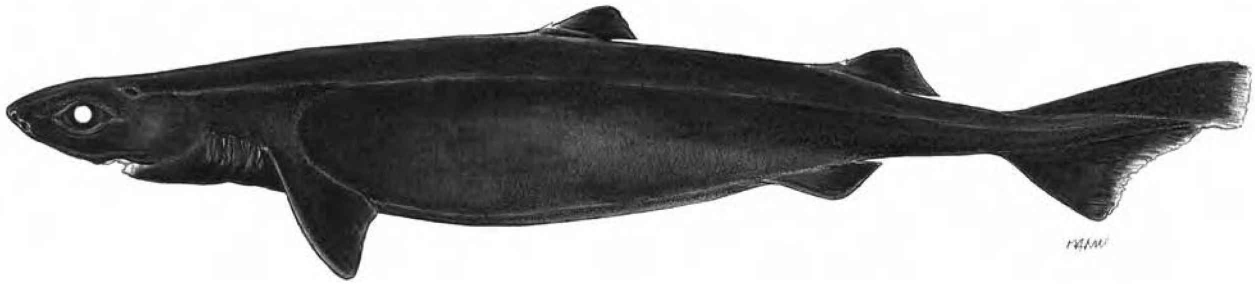


Fig. 139 ***Zameus squamulosus***

Field Marks: A small slender bodied shark, with a low flat head, fairly long snout, short narrow mouth, postoral grooves much longer than the short upper labial furrows. A small fin spine preceding each dorsal fin, no anal fin, small lanceolate teeth without cusplets in upper jaw and large high, knife–cusped cutting teeth in lower jaw, mouth moderately wide and nearly transverse, caudal fin with strong subterminal notch and short lower lobe, colour uniformly black to dark brownish.

Diagnostic Features: Head rather low and flat. Snout rather narrow and long, preoral length greater than mouth width and almost equal to distance from lower symphysis to first gill slits. Mouth fairly narrow, short and transverse. Postoral grooves very long, much longer than upper labial furrows. Teeth of upper jaw small, spear–like, lower jaw high–cusped, knife–like. Tooth counts for upper jaw 47 to 60, lower jaw 32 to 38. Gill slits rather short, longest less than half eye length. Lateral trunk denticles with cross–ridges on crowns. Dorsal–fin spines present, relatively small. Pectoral fins narrow to moderately broad and leaf–shaped; apices of pectoral fins falling well in front of first dorsal–fin spine. Pelvic fins small, about equal to second dorsal fin. Caudal peduncle long, distance from second dorsal–fin base to upper caudal–fin origin about equal to second dorsal–fin base. Caudal fin with a strong subterminal notch and a short lower lobe. Spiral valve turns: 16. Vertebral counts: total vertebral counts 93 to 105, monospondylous vertebral counts 50 to 54, precaudal vertebral counts 66 to 76. Moderate size with a maximum total length of 84 cm. **Colour:** uniformly black to dark brownish with no conspicuous markings.

Distribution: Indian Ocean: South Africa, Melville Ridge south of Madagascar, Réunion and Mauritius, India (collected at a landing site in Cochin), Indonesia (Java), and Australia (Western Australia, Tasmania). Elsewhere, occurs throughout the Atlantic and Pacific oceans.

Habitat: A poorly known epipelagic and oceanic deepwater shark usually found off continental and insular slopes, on or near the bottom at depths of 550 to 1450 m, but also well off the bottom at depths between 0 to 580 m in water 2000 to 6000 m deep.

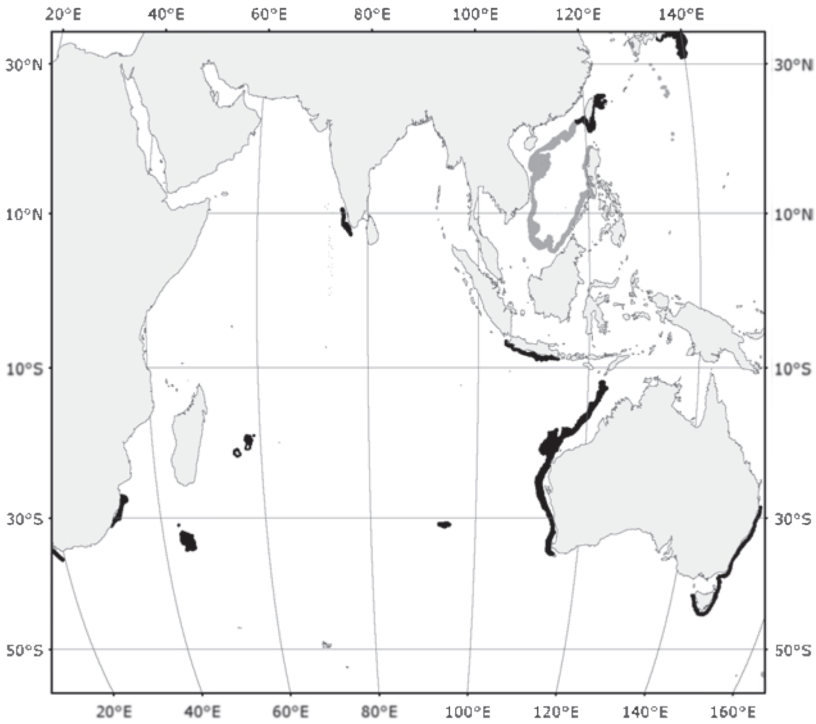


Fig. 140 ***Zameus squamulosus***

Known distribution Possible distribution

Biology: Viviparous with a yolk sac, litter possibly 3 to 10 based on the examination of mature females with ovarian eggs. A predator on bottom fishes and invertebrates, but its smaller teeth and mouth, and weaker jaws suggest that it is a predator less capable of killing large prey than ***Scymnodon ringens***.

Size: Maximum total length about 84 cm; adult males 47 to 51 cm, and adult females 59 to 69 cm long. Size at birth about 20 cm.

Interest to Fisheries and Human Impact: This relatively small somniosid is of limited fisheries interest. It is caught incidentally by bottom trawls and set gillnets, and by bottom and pelagic longline gear. There is no species–specific information on the numbers of these sharks that are caught as bycatch, but it is likely low since they do not seem to be abundant where they are known to occur. Also caught infrequently by tuna longliners in the epipelagic zone.

Conservation status is Data Deficient due to a lack of information on the life history, abundance, and population status of this widespread, but sporadically distributed dogfish shark.

Local Names: None.

Remarks: The Japanese ***Scymnodon*** (=***Zameus***) ***squamulosus*** and the eastern North Atlantic ***Scymnodon obscurus*** were considered to be separable by the presence (***S. obscurus***) or absence (***S. squamulosus***) of transverse ridges on their dermal denticles; a character said by Bigelow and Schroeder (1957) to differentiate these two species. However, comparison of dermal denticles between ***S.*** (=***Z.***) ***squamulosus*** and ***S. obscurus*** by several authors (Krefft, 1980; Yano and Tanaka, 1984; Taniuchi and Garrick, 1986) revealed the presence of transverse ridges on the denticles of both species. Furthermore, comparison of proportional measurements of the type specimen of ***Z. squamulosus*** to North Atlantic specimens of ***S. obscurus*** further confirmed that there were no differences between these species, thus ***S. obscurus*** is considered a junior synonym of ***Z. squamulosus***.

Literature: Bigelow and Schroeder (1957); Krefft and Stehmann (1973); Bass, D'Aubrey and Kistnasamy (1976); Yano and Tanaka (1984); Taniuchi and Garrick (1986); Burgess and Chin (2006); Last and Stevens (2009); Ebert and Compagno (In press).

2.2.6 Family OXYNOTIDAE

Family: Oxynotidae Gill, 1872, *Smiths. Misc. Coll.* (247): 24. Also separately proposed as Subfamily Oxynotinae Fowler, 1934, *Proc. Acad. Nat. Sci. Philadelphia*, 85: 239 (Family Squalidae).

Type genus: ***Oxynotus*** Rafinesque, 1810.

Number of Recognized Deep–sea Indian Ocean Genera: 1.

Synonyms: Subfamily Centrinae Swainson, 1838: 143, 155; Emended spelling as Subfamily Centrininae Swainson, 1839: 191, 314 (Family Squalidae). Also Hasse, 1879: tab. 2 as Subfamily Centrina, Family Acanthias. Type genus: ***Centrina*** Cuvier, 1816.

FAO Names: En – Rough sharks; **Fr** – Centrines; **Sp** – Cerdos marinos.

Field Marks: Unmistakable compressed, rough–skinned small to moderately large sharks with high, sail–like spined dorsal fins and no anal fin.

Diagnostic Features: Head moderately broad and somewhat flattened. Snout flat and bluntly rounded or rounded–angular in dorsoventral view. Spiracles large to enormous, close behind eyes. Fifth gill opening about as large as first four. Nostrils close together with internarial width much less than nostril width; nostrils with simple but enlarged anterior nasal flaps. Mouth nearly transverse and very short and small, with thick, papillose lips. Labial furrows elongated, entirely encircling mouth, and under posterior halves of eyes, elongated posteriorly into postoral grooves but not into anteromedial preoral grooves; labial folds thick and papillose. Teeth with dignathic heterodonty well developed, upper teeth much smaller than lowers. Upper teeth small, lanceolate, with narrow erect uncompressed, stout smooth–edged cusps and no cusplets or blades, in quincunx formation in a narrow triangular pad and not imbricated; lower teeth highly compressed, high–crowned, broad and bladelike, and imbricated, a single series of functional teeth forming a continuous saw–like cutting edge, teeth with a compressed, medially erect but distally mostly oblique broad, sharp–edged, serrated cusp, a short distal blade (except medial tooth with a pair of distal blades), and no cusplets; tooth row counts 9 to 18 upper jaw, 9 to 15 lower jaw. Trunk strongly compressed, very high, with a triangular cross–section, abdomen with strong lateral ridges. Interdorsal space short and variably less than or somewhat larger than length of first dorsal base; pelvic–caudal space short and subequal to less than twice length of pelvic–fin bases. Caudal peduncle slightly compressed, short, and without lateral keels or precaudal pits. Body without photophores. Denticles large and pedicellate, with flattened, broad–keeled, erect or semierect, trident–like crowns with medial and lateral cusps, sometimes auxiliary anterior and posterior cusps, slender tall pedicels and low bases; surface of skin extremely rough. Pectoral fins high, narrow, distally lanceolate, leaf–shaped, subangular or falcate, length of anterior margins varying from about equal to the prespiracular length to about equal to the head length, rear tips rounded and not elongated. Pelvic fins smaller than pectoral fins and dorsal fins. Claspers with a lateral spine only. Dorsal fins very large, broad, angular, high, sail–like and often falcate, with strong stout spines nearly completely buried in the fins and with ungrooved exposed tips. First dorsal fin large, with length greater than prespiracular space and sometimes slightly longer than head; first dorsal–fin base over pectoral–fin bases and pectoral–pelvic space and well anterior to pelvic fins, origin over pectoral–fin bases and sometimes anterior to pectoral–fin origins. Second dorsal fin smaller than first dorsal fin, base over pelvic–fin bases with origin about opposite to well in front of pelvic–fin origins. Caudal fin heterocercal, with ventral lobe weakly developed in adults, and with subterminal notch strong. Vertebral counts: total vertebral counts 84 to 95, monospondylous vertebral counts 41 to 50, diplospondylous vertebral counts 16 to 18, total precaudal vertebral counts 58 to 66, caudal vertebral counts 26 to 31. Intestinal valve with 9 to 11 turns. Adults small to moderately large, 49 to 150 cm long. **Colour:** plain or with light and dark markings on body, without black photophore markings on tail or flanks.

Distribution: Rough sharks as currently known are mostly regional endemics scattered throughout the eastern Atlantic, including the Mediterranean, western Central Atlantic, western Pacific, eastern Indian Ocean off southern Australia and possibly the south–western Indian Ocean off Mozambique.

Habitat: Oxynotids are temperate to tropical, poorly known, deepwater bottom sharks of distinctive and bizarre appearance, that live on the upper continental and insular slopes and outer shelves at depths of 40 to 1067 m.

Biology: The reproductive mode is yolk–sac viviparity, with litters of 7 to 23, but little else is known about the biology of these sharks. These are relatively small sharks, with all five known species maturing at a size mostly smaller than 70 cm but exceptionally up to 118 to 150 cm in two species.

The feeding habits of rough sharks are little known, but include polychaetes, crustaceans, sipunculids and molluscs. The mouth of these sharks is very small, have papillose lips, and their teeth are small though strong and confined to the tips of the stout jaws. This suggests a primary diet of small bottom invertebrates and possibly small benthic fishes that are dismembered by the clipper–like lower cutting teeth and retained by the broad triangular pad of short–cusped lanceolate teeth on the upper jaw. The very large nostrils and nasal organs (exceptionally large for squaloids and more resembling those of benthic scyliorhinids) and unusual labial structures may be especially important in locating prey. The large close–set denticles, with erect crowns and sharp, very prickly cusps, may serve as armor to protect these sharks from benthic predators.

The behaviour of these unusual sharks is poorly known, but judging from their distinct body form and rough scales, they are likely sluggish swimmers. They may rely on their expanded body cavities and large oily livers, estimated at 16 to 23% of total weight in one species, to attain neutral buoyancy, so they can hover and slowly swim above the substrate without needing forward motion for lift. Underwater videos of ***Oxynotus*** species *in situ* show that they hover or slowly swim off the bottom and tip their heads downwards to feed on the bottom. The strong pectoral radial muscles, expanded lanceolate pectoral fins and fanlike pectoral radials suggest that the pectoral fins may be actively used for manoeuvring off the substrate, but this needs to be studied by analysing videos of live animals in the wild or in captivity.

Interest to Fisheries and Human Impact: Rough sharks are of limited interest to fisheries since they do not appear to occur in concentrated numbers or in any abundance, and are a relatively uncommon bycatch of bottom trawl fisheries. In the eastern Atlantic where they are occasionally retained they are utilized mostly for fishmeal and oil, but also are prepared smoked and dried–salted for human consumption. World and local catch statistics are limited to non–existent for these sharks.

The conservation status of rough sharks is poorly known, but may be of concern since they seem to be rare to uncommon where they occur, have limited geographic and bathymetric ranges, and occur in areas with significant demersal trawl fisheries that take them as bycatch. However, given their apparent ability to gain neutral buoyancy and to ‘hover’ they may occur more commonly in areas of rocky, high relief bottom substrates that precludes them from being caught in bottom trawls and given their relatively small mouths they would likely not be as vulnerable to longline gear as would other large–mouth shark species. This combination of characteristics, habitat preference and body morphology, may therefore minimize the bycatch of these sharks.

Local Names: Rough sharks, Prickly dogfishes, Sea pigs or Porkfishes.

Remarks: This monotypic family includes the distinctive living genus ***Oxynotus***. This small family with a single genus currently has five recognized species, but depending on the taxonomic resolution of the group one or two additional species may eventually be described. At least one and possibly a second species (***O. centrina***) occur in the area.

Literature: Garman (1913); Norman (1932); Bigelow and Schroeder (1957); Cadenat and Blache (1981); Compagno (1984a); Yano and Murofushi (1985); Yano and Matsuura (2002); Capapė (2008); Ebert and Compagno (In press).

List of Deep–sea Species Occurring in the Area:

Oxynotus bruniensis (Ogilby, 1893)

Oxynotus Rafinesque, 1810

Genus: ***Oxynotus*** Rafinesque, 1810, *Indice Ittiol. Sicil.*: 45, 60.

Type species: ***Oxynotus centrina*** Rafinesque, 1810, by monotypy, equals ***Squalus centrina*** Linnaeus, 1758.

Number of Recognized Deep–sea Indian Ocean Species: 1.

Synonyms: Subgenus ***Centrina*** Cuvier, 1816: 130. Type species: ***Squalus centrina*** Linnaeus, 1758, by absolute tautonymy. Genus ***Centrinus*** Swainson, 1838: 151. Apparent erroneous spelling of ***Centrina*** Cuvier, 1816, as ***Centrina*** is consistently used elsewhere in Swainson's work (vols. 1 and 2, 1838 and 1839).

Remarks: Several prominent 19th and early 20th Century researchers followed Cuvier (1816, 1829) in using ***Centrina*** rather than ***Oxynotus*** Rafinesque, 1810 for these sharks, including Bonaparte (1838, 1839), Müller and Henle (1839), Bleeker (1859), Günther (1870), and Goodrich (1909). However, ***Oxynotus*** achieved recognition as a senior synonym of ***Centrina*** following the reviews of Gray (1851), Gill (1862), Duméril (1865), Regan (1906a), and Garman (1913).

Oxynotus bruniensis (Ogilby, 1893)

Centrina bruniensis Ogilby, 1893, *Rec. Australian Mus.* 2(6): 62. Holotype in Tasmanian Museum, Hobart, TMH D154 (old no. 3079, a dry mounted skin) according to Eschmeyer (2012), who noted that the species was independently published by Morton (1894, *Pap. Proc. R. Soc. Tasmania*, 1893: 211, from Ogilby). Type locality, on the beach at Bruny Island, Tasmania.

Synonyms: None.

Other Combinations: ***Centrina salviana*** Hutton, 1890 (not ***Centrina salviani*** Risso, 1826, = ***Oxynotus centrina***).

FAO Names: En – Prickly dogfish; **Fr –** Centrine aiguille; **Sp –** Cerdo marino agujeta.

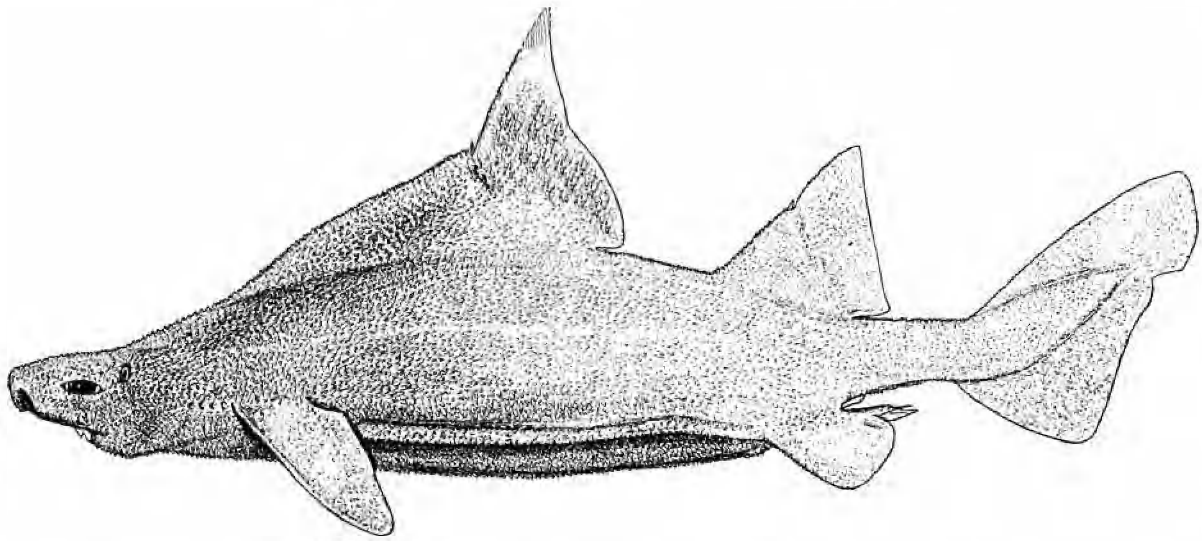


Fig. 141 ***Oxynotus bruniensis***

Field Marks: Short, blunt snout, high, sail–like dorsal fins with spines and broad apices, no anal fin, first dorsal–fin spine inclined forwards, high, thick, triangular body with large, rough denticles, circular spiracles, lanceolate upper teeth, lower bladelike teeth in 11 to 13 rows, uniform grey–brown coloration.

Diagnostic Features: Spiracle small and circular. Supraorbital ridges not greatly expanded and not forming a knob in front of spiracles. Teeth on upper and lower jaws dissimilar; uppers lanceolate, narrowly erect, central rows awl–shaped, posterior rows broadly triangular and blade–like; cusp smooth–edged with no lateral cusplets or blades, in quincunx formation in a narrow triangular pad, not imbricated; lower teeth imbricated, erect, with a distally oblique broad, sharp–edged, serrated cusp, and no lateral cusplets; tooth row counts upper jaw 12 to 19, lower jaw 11 to 13. Pectoral fins leaf–shaped, not strongly falcate. Predorsal spine length from snout to first dorsal–fin spine 2.0 to 2.3 in precaudal length. Apices of dorsal fins broadly triangular, posterior margins straight or weakly concave. First dorsal– fin spine inclined forwards. First dorsal–fin anterior margin from spine to apex 1.0 to 1.8 in first dorsal spine height, second dorsal–fin anterior margin from spine to apex 1.0 to 1.3 in second dorsal–fin spine height. Second dorsal–fin base 0.7 to 1.1 in interdorsal space, second dorsal–fin origin well anterior to pelvic–fin origins. Vertebral counts: total vertebral counts 84 to 94, total precaudal vertebral counts 58 to 64. Intestinal valve turn counts 10 to 11. Adults to at least 75 cm total length. **Colour:** uniform grey–brown, without prominent markings.

Distribution: Eastern Indian and southwestern Pacific Oceans: confined to temperate waters of southern Australia (southeast coast of Western Australia, South Australia, Victoria, New South Wales, and Tasmania) and from off New Zealand.

Habitat: A little–known but fairly common deepwater bottom shark of the outer continental and insular shelves and upper slopes, at depths from 46 to 1067 m, but most frequently recorded at depths of 350 to 650 m; off New Zealand it ranges from 126 to 1067 m, with a mean depth of 485 m and with most records between 200 to 900 m (Anderson *et al.*, 1998). Locally common off New Zealand, where it is widely distributed around the North and South Islands and on adjacent submarine ridges and seamounts, and sporadically caught off southern Australia, but poorly known biologically. Filmed hovering off the bottom in Kaikoura Canyon (National Geographic Society).

Biology: Yolk–sac viviparous, with a litter of 7 embryos reported for one female. Little else known about its biology.

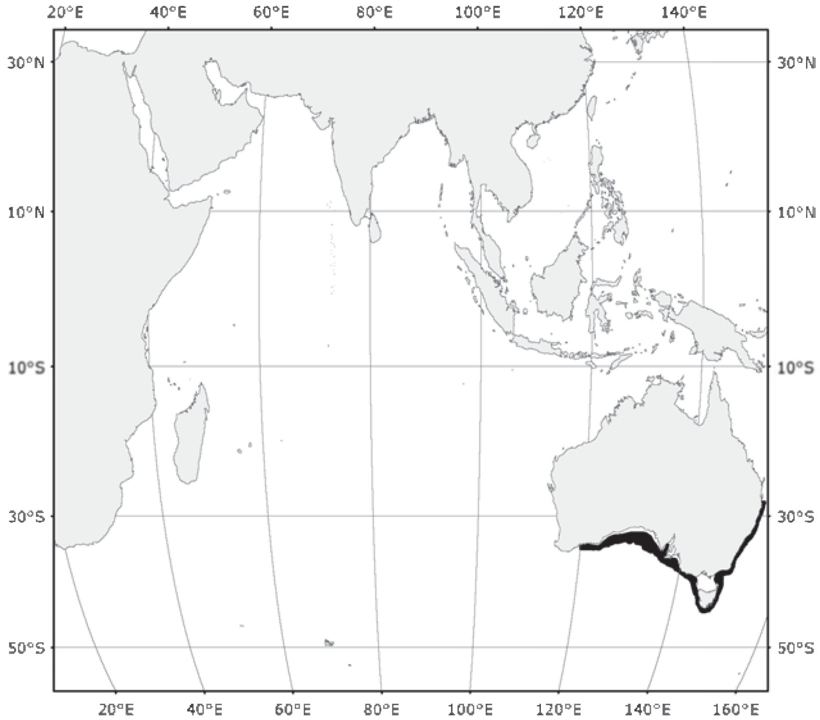


Fig. 142 ***Oxynotus bruniensis***

Known distribution

Size: Maximum total length about 75 cm, possibly 91 cm; adult males mature at about 60 cm, adult females to 72 cm. Size at birth is about 24 cm.

Interest to Fisheries and Human Impact: Interest to fisheries none at present, taken incidentally as bycatch by bottom trawlers but probably not used.

The conservation status of this poorly known species is Data Deficient.

Local Names: Prickly dogfish, Prickly shark, Pepeke.

Literature: Ogilby (1893); McCulloch (1914); Whitley (1940); Fowler (1941); Bigelow and Schroeder (1957); Garrick (1960b, c); Stead (1963); Cadenat and Blache (1981); Compagno (1984a); Yano and Murofushi (1985); Paulin *et al.* (1989); Last and Stevens (1994, 2009); Cox and Francis (1997); Anderson *et al.* (1998); Yano and Matsuura(2002); Francis (2003); Ebert and Compagno (In press).

2.2.7 Family DALATIIDAE

Family: Tribe Dalatiana Gray, 1851, *List Fish British Mus., Pt. 1,* Chondropterygii, British Mus. (Nat. Hist.): 74 (Family Squalidae).

Type genus: ***Dalatias*** Rafinesque, 1810.

Number of Recognized Deep–sea Indian Ocean Genera: 5.

Synonyms: Subfamily Scymnini Bonaparte, 1838: 207 (Family Squalidae). Type genus: ***Scymnus*** Cuvier, 1816. Family Scymni Müller and Henle, 1839: 91. Type genus: ***Scymnus*** Cuvier, 1816. Family Scymnorhinidae Gill, *in* Goode and Bean, 1896: 6. Type genus: ***Scymnorhinus*** Bonaparte, 1846. Family Isistiidae Garman, 1899: 32. Type genus: ***Isistius*** Gill, 1865a). Subfamily Euprotomicrinae (Family Dalatiidae) Shirai, 1992a: 122. Type genus: ***Euprotomicrus*** Gill, 1865a.

FAO Names: En – Kitefin sharks.

Field Marks: Short to moderately long–nosed, usually cylindrical or somewhat compressed (***Euprotomicroides***) sharks with no anal fin, snout and head narrow and conical, denticles small and mostly sessile, but with short pedicels and elongated lanceolate crowns in a few genera, keels present or absent on the caudal peduncle, two dorsal fins usually without spines (***Squaliolus*** with spined first dorsal fin but with spineless second dorsal fin), the first dorsal fin with origin varying from opposite the pectoral–fin bases to far behind the pectoral fins and somewhat anterior to the pelvic–fin origins, the second dorsal fin not falcate and with its origin usually opposite the pelvic–fin bases or inner margins, but exceptionally slightly anterior to the pelvic–fin origins (***Euprotomicroides***), caudal fin with a strong subterminal notch, mostly small (50 cm long or less) to dwarf (less than 30 cm) oceanic species, often dark brown or blackish with light fins and ventral photophores (***Dalatias*** moderately large at up to 182 cm long and without photophores).

Diagnostic Features: Head narrow and rounded–conical. Snout conical and narrowly rounded to elongate–rounded in dorsoventral view. Photophores on the ventral surface of the head and body dense in the genera ***Euprotomicrus***, ***Isistius*** and ***Squaliolus***, but ***Dalatias*** apparently lack them. Spiracles large, close behind eyes. Fifth gill opening about as large as first four in most genera; ***Euprotomicroides*** with gill openings increasingly wider posteriorly. Nostrils wide to narrow–spaced with internarial width equal to or much greater than nostril width; nostrils with simple anterior nasal flaps. Mouth nearly transverse and short, with lips thin and smooth or thickened and fringed or pleated. Labial furrows short to moderately long, not encircling mouth or partially encircling it, confined to mouth corners and under or behind posterior corners of eyes, elongated posteriorly into postoral grooves and anteromedial preoral grooves; labial folds thin or thickened. Teeth with dignathic heterodonty well–developed, upper teeth much smaller than lowers; tooth row counts 16 to 37 upper jaw, 17 to 34 lower jaw. Upper teeth small, lanceolate, with narrow erect cusps and no cusplets or blades, in quincunx formation and not imbricated; lower teeth highly compressed, high–crowned, broad and bladelike, imbricated, forming a saw–like cutting edge, teeth with a compressed, erect to oblique cusp, a distal blade present or absent, and no cusplets. Trunk cylindrical or slightly compressed, abdomen without lateral ridges. Interdorsal space elongated and usually much greater than length of first dorsal–fin base (subequal to it in ***Isistius plutodus***); pelvic–caudal space short to moderately long and about equal to over twice pelvic–fin bases. Caudal peduncle cylindrical, short to moderately elongated, with or without lateral keels but without precaudal pits. Body with or without photophores. Denticles small and usually with low ridged sessile crowns but some genera (***Dalatias*** and ***Mollisquama***) with leaf–shaped, monocuspidate and lanceolate crowns on low pedicels. Pectoral fins rounded–angular or rounded–lobate, not lanceolate or falcate, anterior margins short and mostly shorter than or sometimes subequal to the prespiracular length, rear tips rounded and short. Pelvic fins subequal to or smaller than pectoral fins, smaller to larger than dorsal fins. Claspers with or without a lateral spine. Dorsal fins small or moderate–sized, angular or rounded–angular but not falcate, without spines except for a small fin spine on the first dorsal fin of ***Squaliolus***. First dorsal fin small to moderate–sized, with length less than prespiracular space; first dorsal–fin base usually over pectoral–pelvic space and behind pectoral–fin bases and well anterior to or partially over pelvic fins, first dorsal–fin origin usually behind pectoral fins (over pectoral–fin inner margins in ***Squaliolus*** and over the pectoral–fin bases in ***Heteroscymnoides***). Second dorsal fin subequal, slightly larger, or much larger than first dorsal fin, second dorsal–fin base over or just behind pelvic–fin bases, second dorsal–fin origin slightly anterior to pelvic–fin origins to posterior to pelvic–fin insertions. Caudal fin markedly heterocercal to almost diphycercal, with ventral lobe low (***Dalatias***) to strongly developed in adults, and with subterminal notch weak to strong. Vertebral counts: total vertebral counts 60 to 92, monospondylous vertebral counts 29 to 46, diplospondylous precaudal vertebral counts 8 to 22. Intestinal valve with 6 to 42 turns. Adults dwarf to moderately large, between 15 to about 182 cm long. **Colour:** plain or with fin edges transparent, without black photophore markings on tail or flanks but with photophores, where present, often very closely spaced on the ventral surface.

Distribution: An almost circumglobal range in most temperate to tropical seas, but most species distribution sketchily to poorly known, particularly for the oceanic species, which may reflect uneven and inadequate sampling and patchy distributions.

Habitat: The Dalatiidae include species that represent at least two ecomorphotypes (Compagno, 1990), with most showing the oceanic or *microceanic habitus* of spindle–shaped bodies, large eyes, small smooth denticles, long abdomens, small precaudal fins (often transparent), and more or less symmetrical caudal fins and the bathic or *bathic habitus* with larger fins but resembling oceanic dalatiids in having a narrower head and stronger jaws and larger teeth than is typical of other bathic squaloids such as echinorhinids, large centrophorids, and many somniosids. The oceanic species are best known from epipelagic records with some species being caught at or near the surface at night drawn by surface lights or in surface gill–nets; trawl records of these sharks extend down to at least 3500 m, and they have been caught near the surface at night in waters over 9000 m deep. Some oceanic species seem to be vertical migrators with a daily cycle, and may make transits of 1500 to 3000 m or more to rise to the surface at night and descend to the ocean bottom during the day. The bottom–dwelling deepwater bathic species are mostly inhabitants of continental and insular slopes, submarine ridges and seamounts, with occasional records from inshore in shallow water on the continental shelves (***Dalatias***). The bathic species range in depth between 20 m to at least 1800 m but with most records between 200 and 1000 m.

Biology: The family is very poorly known biologically. Reproduction is yolk–sac viviparous with litters of 6 to 16 young, but virtually nothing is known about their life cycle or age and growth. These sharks, relative to their size, proportionally have very powerful jaws with large teeth interlocked to form a shear–like cutting dentition in the lower jaw, and a holding dentition of very small hook–like teeth in the upper jaw, which allow them to capture and dismember relatively large prey. ***Dalatias licha*** feeds on a wide variety of bony fishes, cartilaginous fishes, crustacea, cephalopods, polychaetes, siphonophores, and tunicates. Species of ***Isistius*** are ectoparasitic on larger pelagic marine vertebrates including cetaceans, phocid seals, elasmobranchs, and especially large bony fishes and attach to the skin of these animals with their suctorial lips and cut out plugs of flesh with their lower teeth; they can also catch and consume smaller fishes and cephalopods. Proportionately, ***Isistius*** species have the largest teeth relative to their body–size of any modern shark species. Their mouth and jaw apparatus are uniquely designed to remove large chunks of flesh from prey items many times their size. Very little is known of their socio–biology except that of the commoner species, ***Dalatias licha*** may be solitary while ***Isistius*** and ***Squaliolus*** species may occur in aggregations as well as single individuals.

Interest to Fisheries and Human Impact: This family is of limited interest for fisheries purposes, as most of the species are apparently oceanic or semioceanic and are far too small to be caught in conventional pelagic fishing gear. Most catches of the small species are from research vessels, at night lights at the surface or with pelagic or bottom trawls. Exceptions include species of ***Isistius*** and ***Squaliolus*** that are caught as bycatch by commercial bottom trawlers and oceanic gillnets. The large bathic ***Dalatias licha*** is an exception by being the only known commercial species in the family. It is commonly fished in targeted deepwater shark fisheries in many places where it occurs and also is taken as bycatch in deep benthic fisheries for bony fishes.

Kitefin sharks are not regularly kept in public aquaria and are apparently too deep–dwelling or sparse in oceanic waters to be a current subject of conventional ecotouristic diving. There is at least one confirmed account of a cookie–cutter shark (***Isistius*** spp.) biting a swimmer at the surface in the open ocean off the Hawaiian Islands as well as several anecdotal accounts of this species biting swimmers in the open ocean.

The conservation status of kitefin sharks is poorly known, but given their general small size and the rarity with which many are caught, most are either Least Concern or Data Deficient. The one exception though is ***Dalatias licha***, which is listed as Data Deficient worldwide.

Local Names: Kitefin sharks, Black sharks, Spineless dogfish, Scymnoid sharks (English).

Remarks: The Family Dalatiidae is comprised of seven genera, five of which are monotypic genera, and ten species worldwide. Several of these genera (***Euprotomicroides, Euprotomicrus, Heteroscymnoides, Isistius,*** and possibly ***Mollisquama***) are considered to be oceanic. The geographic and bathymetric ranges are poorly known for all species within this family.

Five genera and six species occur in the deep waters of the Indian Ocean.

Literature: Müller and Henle (1839); Gray (1851); Bleeker (1859); Gill (1862); Duméril (1865); Günther (1870); Regan (1908a); Garman (1913); Fowler (1941, 1969); Bigelow and Schroeder (1948, 1957); Hubbs and McHugh (1951); Garrick (1956, 1960b); Hubbs, Iwai and Matsubara (1967); Bass, D'Aubrey and Kistnasamy (1976); Cadenat and Blache (1981); Compagno (1984a); Shirai (1992a, 1996); Last and Stevens (1994, 2009); Compagno, Dando and Fowler (2005); Ebert and Compagno (In press).

List of Deep–sea Species Occurring in the Area:

Dalatias licha (Bonnaterre, 1788)
Euprotomicrus bispinatus (Quoy and Gaimard, 1824)
Heteroscymnoides marleyi Fowler, 1934
Isistius brasiliensis (Quoy and Gaimard, 1824)
Squaliolus aliae Teng, 1959
Squaliolus laticaudus Smith and Radcliffe, 1912

Key to Deep–sea Indian Ocean Genera:

1a. First dorsal–fin insertion about over pelvic–fin origins (Fig. 143). Cusps of lower teeth covering the entire crown foot, without a convex accessory blade separated from the cusp by a notch . . . . ***Isistius***

Fig. 143 *Isistius*

1b. First dorsal–fin insertion well anterior to pelvic–fin origins (Fig. 144). Cusps of lower teeth covering part of the crown foot, with a convex distal blade separated from the cusp by a notch **2**

2a. Second dorsal–fin base at least twice as long as first dorsal–fin base. Upper caudal–fin lobe shortened, caudal paddle–shaped **3**

2b. Second dorsal–fin base as long as first dorsal–fin base or shorter. Upper lobe not shortened, caudal fin not paddle–shaped **4**

3a. First dorsal fin with a spine (sometimes concealed by skin) and closer to pectoral–fin bases than to pelvic–fin bases. Second dorsal–fin base about twice as long as first dorsal–fin base. Snout more elongated and pointed, snout length about half length of head (Fig. 144). . . . . ***Squaliolus***

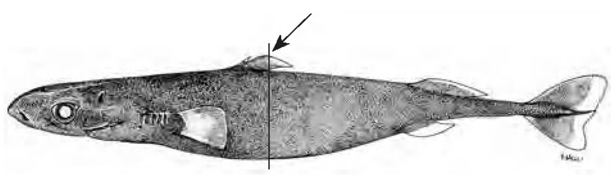


Fig. 144 *Squaliolus*

3b. First dorsal fin spineless; fin closer to pelvic–fin bases than to pectoral–fin bases (Fig. 145). Second dorsal–fin base about four times as long as first dorsal–fin base. Snout shorter and more bluntly rounded, snout length about 2/5 of head length. . ***Euprotomicrus***

Fig. 145 ***Euprotomicrus***

4a. Preoral snout very short, less than 1/3 of head length. Lips thick and pleated. Lower teeth with strongly serrated edges (Fig. 146a). Caudal fin with weak ventral lobe (Fig. 146b) . . . . ***Dalatias***

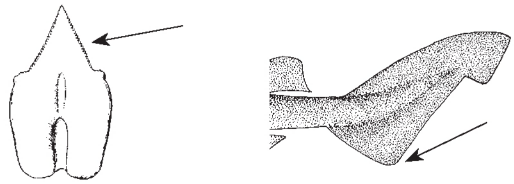


Fig. 146 ***Dalatias***

4b. Preoral snout very long, more than 1/3 of head length. Lips thin and not pleated. Lower teeth with smooth edges. Caudal fin with a strong ventral lobe (Fig. 147) . . . . ***Heteroscymnoides***

Fig. 147 ***Heteroscymnoides***

Dalatias Rafinesque, 1810

Genus: ***Dalatias*** Rafinesque, 1810, *Caratt. gen. sp. anim. piant. Sicilia, Palermo*, pt. 1: 10.

Type species: ***Dalatias sparophagus*** Rafinesque, 1810, by subsequent designation of Jordan, Tanaka and Snyder, 1913, *J. Coll. Sci. Imp. U. Tokyo*, 33(1): 22, considered by these authors to be equivalent to ***Squalus licha*** Bonnaterre, 1788.

Number of Recognized Deep–sea Indian Ocean Species: 1.

Synonyms: Subgenus ***Scymnus*** Cuvier, 1816, *Reg. Anim., ed.* 1, 2: 130. (Genus ***Squalus*** Linnaeus, 1758). Type species: ***Squalus americanus*** Gmelin, 1789, by monotypy, a junior synonym of ***Squalus licha*** Bonnaterre, 1788. A junior homonym of ***Scymnus*** Kugelann, 1794 in Class Insecta. Whitley (1935, *Australian Zool.* 8[2]: 137) and [Eschmeyer (2012)] note that Lesson (1830, *Dict. Class. Hist. Nat.* 14: 598) selected ***Squalus americanus*** "Broussonet" as type species of ***Scymnus*** Cuvier. Genus ***Scimnus*** S.D.W., 1837, no reference, *fide* Fowler, 1969, *Quart. J. Taiwan Mus.* 22(1–2): 68; cited by Whitley, 1955, *Proc. Roy. Soc. New S. Wales*, 1953–4: 44–57, 8 figs. Genus ***Scymnium*** Valenciennes *in* Cuvier, 1838, *Reg. Anim.*, ed. 3, *Poiss.*: legend to pl. 115, fig. 5, as "***Scymnium niciense*** Cuv.". ***Scymnus*** was used consistently elsewhere in the text (*ibid*, p. 367) and in the plate legend as "S.–Genre des Leiches. ***Scymnus***. Cuv." (*loc. cit.*), suggesting that ***Scymnium nicense*** (= ***Squalus nicaensis*** Risso, 1810) is a mispelling for ***Scymnus nicense***. Cited by Fowler, 1969, *Quart. J. Taiwan Mus.* 22(1–2): 68. Genus ***Dalatius*** Agassiz, 1845, *Nomencl. Zool.*, pisc., 21. Emendation for ***Dalatias*** Rafinesque, 1810. Genus ***Scymnorhinus*** Bonaparte, 1846, *Cat. Metod. Pesc. Europa*: 16. Type species: ***Scymnorhinus licha*** Bonaparte, 1846, by monotypy, equals ***Squalus licha*** Bonnaterre, 1788. Proposed as a replacement for ***Scymnus*** Cuvier, 1816. Genus ***Borborodes*** Gistel, 1848, *Naturg. Thier. Schul.*: x. Genus ***Pseudoscymnus*** Herre, 1935, *Copeia* 1935 (3): 124. Type species: ***Pseudoscymnus boshuensis*** Herre, 1935, by original designation, a junior synonym of ***Squalus licha*** Bonnaterre, 1788. Genus ***Scymnorhynus*** Nobre, 1935, *Faun. Mar. Portugal* 1: Vert: 410. Erroneous spelling of ***Scymnorhinus*** Bonaparte, 1846. Genus ***Barborodes*** (Gistel) Bigelow and Schroeder, 1948, *Mem. Sears Fnd. Mar. Res.* (1), 1: 501. Erroneous spelling of ***Borborodes*** Gistel, 1848.

Field Marks: See species.

Diagnostic Features: Anterior nasal flaps short, not expanded into barbels; snout broadly conical, rounded, and short, length much less than distance from mouth to pectoral–fin origins and about 1/4 of head length; gill openings moderately broad and about equally wide; lips very thick, fringed or pleated, not suctorial; teeth very different in upper and lower jaws, uppers small, with narrow, hooked, needle–shaped cusps and no cusplets, lowers very large, bladelike, interlocked, with broad, erect, triangular cusps, small distal blades, and serrated edges; tooth row counts 16 to 21 upper jaw, 17 to 20 lower jaw. Both dorsal fins without spines; first dorsal–fin origin somewhat behind free rear tips of pectoral fins, first dorsal–fin insertion well anterior to pelvic–fin origins, closer to pectoral–fin bases than pelvic fins; second dorsal–fin origin about over middle of pelvic–fin bases; second dorsal fin only slightly larger than first, its base less than 1.5 times first dorsal–fin base; pectoral fins with short, broadly rounded free rear tips, not broadly lobate or acute and elongated; caudal fin asymmetrical, not paddle–shaped, upper lobe long, lower lobe very short or virtually absent, subterminal notch well–developed. No precaudal pits or lateral keels on caudal peduncle. Dermal denticles with low flat, ridged, unicuspid crowns, not pedicellate. Cloaca is without a luminous gland. Vertebral counts: total vertebral counts 78 to 85, precaudal vertebral counts 47 to 55. **Colour:** greyish to black or blackish brown, sometimes violet with black spots.

Local Names: Kitefin sharks, Black sharks, Seal sharks.

Dalatias licha (Bonnaterre, 1788)

Squalus licha Bonnaterre, 1788, *Tabl. Encyclop. Method. Trois Reg. Nat., Ichthyol.*, Paris: 12. Holotype: Lost, from "Le cap Bretan".

Synonyms: ***Squalus americanus*** Gmelin, *in* Linnaeus and Gmelin, 1788, *Syst. Nat.*, ed. 13, Pisces 1(3): 1503. Holotype: Same as for ***S. licha***, lost, from "Le cap Bretan". ?***Dalatias sparophagus*** Rafinesque, 1810, *Caratt. gen. sp. anim. piant. Sicilia, Palermo*, pt. 1: 10, pl. 13, fig. 2. No type material, Sicily. ***Squalus nicaensis*** Risso, 1810, Ichthyol. Nice, Paris: 43, pl. 4, fig. 6. No type material(?), Nice, France. ***Scymnus vulgaris*** Cloquet, 1822 (1823), *Dict. Sci. Nat.* 25: 433. European seas, general. ***Scymnus scymnus*** Voigt, *in* Cuvier, 1832, Tierreich 2: 512. Replacement name for ***Squalus lichia*** Bonnaterre, 1788. ?***Scymnus aquitanensis*** de la Pylaie, 1835, *Rech. France Poiss.*, 1832–1833, *Congr. Sci. France Poitiers*, 1834: 527. *Fide* Jordan, 1919, *Stanford U. Pub., U. Ser., Gen. Fish.*(2): 182. Possible replacement name for ***Squalus lichia*** Bonnaterre, 1788. ***Scymnus lichia*** Bonaparte, 1836, *Iconog. Fauna Italica*, 3, *Pesci, fasx.* 16, pta. 85, 4 p., 1 pl. Emended spelling. ***Scymnorhinus phillippsi*** Whitley, 1931, *Australian Zool.* 6(4): 310. New name for ***Scymnorhinus licha*** of McCulloch, 1914 (*Zool. Resul. Fish. Exper. F.I.S. "Endeavour"*, 2: 81, text–fig. 1, pl. 14, fig. 1.). Holotype as designated by Whitley is an 1140 mm male, probably adult, illustrated by McCulloch, 1914, one of nine specimens from the Great Australian Bight, localities given as 127–128° long., 293–366 m and 128–129° long., 366–549 m. Possibly in Australian Museum, Sydney? ***Pseudoscymnus boshuensis*** Herre, 1935, *Copeia* 1935 (3): 124, fig. 2. Holotype: Division of Systematic Biology, Stanford University, SU–29535, 337 mm TL immature female, Boshu, Sagami Bay, Japan. ***Scymnorhinus brevipinnis*** Smith, 1936, *Trans. Roy. Soc. S. Africa*, 24(1): 1, fig. 1–2. Types: Three specimens mentioned, 770–1100 mm, of which the holotype is in the Albany Museum, Grahamstown, Eastern Cape, collected at 34°32'S, 25°42'E, 35 mi. (56 km) S. of Cape Recife, Eastern Cape, South Africa, 201–275 m. ***Dalatias tachiensis*** Shen and Ting, 1972, *Bull. Inst. Zool., Acad. Sinica, Taiwan*, 11(1): 18, fig. 3. Holotype: National Taiwan University, NTU 7234001, 480 mm TL immature male, 24°56.5'N, 121°53.0'E, 3 km. off Ta–chi coast, N.E. Taiwan, 183 to 220 m.

Other combinations: None.

FAO Names: En – Kitefin shark; **Fr** – Squale liche; **Sp** – Carocho.

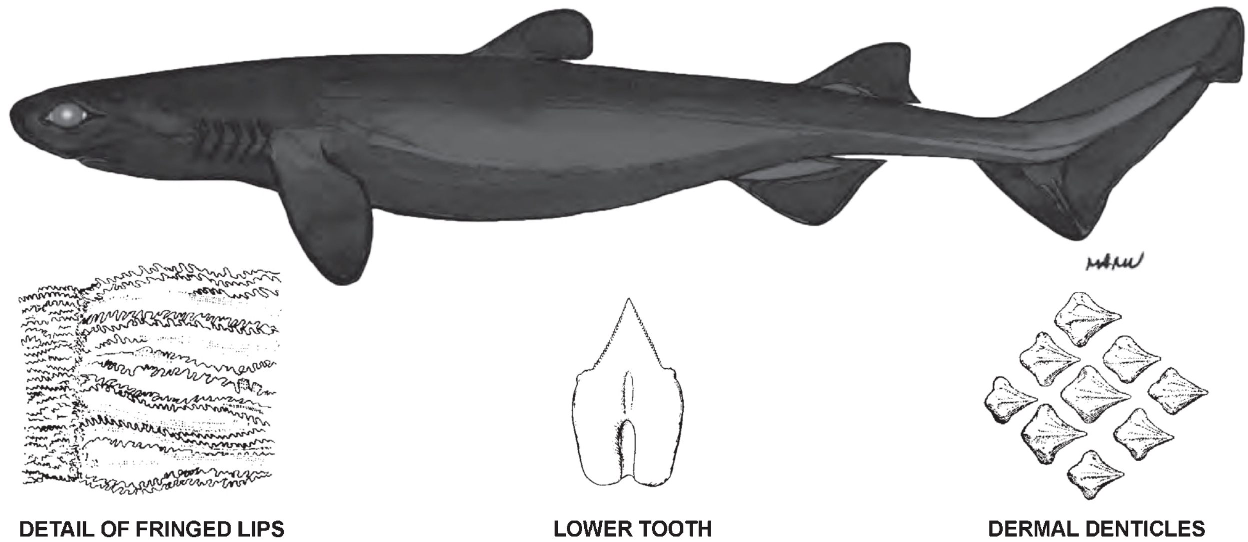


Fig. 148 ***Dalatias licha***

Field Marks: A moderate–sized, short– and blunt–snouted shark with two almost equal–sized spineless dorsal fins, no anal fin, papillose thick lips, small slender–cusped upper teeth and very large lower teeth with erect triangular serrated cusps and distal blades, first dorsal fin on back with its origin behind the pectoral–fin rear tips and its base closer to the pectoral–fin base than the pelvic fins, and caudal fin with the ventral lobe not expanded.

Diagnostic Features: See genus account above.

Distribution: Indian Ocean: South Africa (Eastern Cape and KwaZulu–Natal Provinces), Mozambique, and southern Madagascar Ridge, Australia (Western and South Australia, Victoria, and Tasmania), and southern Indonesia. It possibly extends further north to Malaysia. Elsewhere, occurs in the Atlantic, central and western Pacific oceans.

Habitat: A common but sporadically distributed deepwater, warm–temperate and tropical shark of the outer continental and insular shelves and slopes from 37 to at least 1800 m depth, commonest below 200 m. It occurs most frequently on or near the bottom but readily ranges well off the substrate. Its large oily liver allows it to attain neutral buoyancy, so it can move or hover above the bottom without the necessity of utilizing dynamic lift from fins and body.

Biology: Development is yolk–sac viviparous, with litters of 3 to 16 young, but nothing is known about its reproductive cycle or age at maturity.

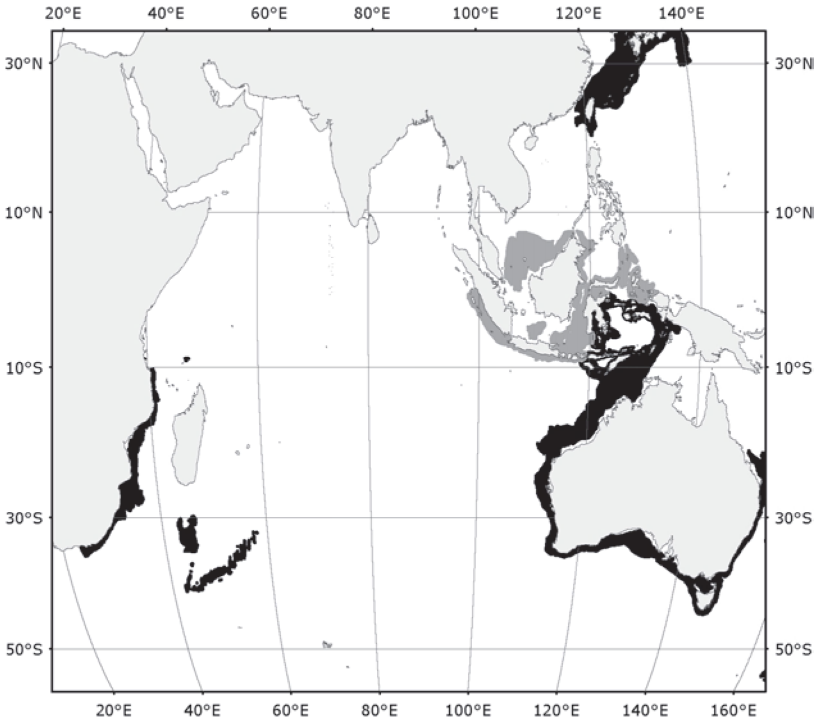


Fig. 149 *Dalatias licha*

Known distribution Possible distribution

A powerful and versatile deep–sea predator, ***D. licha*** is equipped with huge serrated teeth and compact, heavy jaws of enormous power. It feeds primarily on deepwater bony fishes, including deepwater smelt (Argentinidae), viperfishes, scaly dragonfishes, barracudinas, greeneyes, lanternfishes, gonostomatids, cod, ling, whiting and other gadids, hake, grenadiers, deepwater scorpionfishes, bonito, gempylids, epigonids, and chaunacid anglers, but also skates, catsharks (***Galeus***), spiny dogfish (***Squalus***, ***Etmopterus***, ***Deania*** and ***Centrophorus***), squid, octopi, amphipods, isopods, shrimp and lobsters, and even polychaetes and siphonophores. The recorded diet is fairly representative of the bottom and midwater fauna where it occurs, but the presence of fast–swimming epipelagic fishes such as bonito may indicate either scavenging or some means of ambushing or otherwise overcoming such prey. Often chunks of large fish are found in the stomach of this shark, as well as small whole fish, suggesting that it may take chunks out of live fish prey in “cookie–cutter” fashion as in ***Isistius*** species and ***Centroscymnus coelolepis***, though to date bite–sized chunks of cetacean have not been found in this shark. In the western Mediterranean bony fishes are a staple primary fare throughout the year. Sharks are consumed more commonly as secondary prey in spring and winter, but crustaceans become more important in the summer and cephalopods in the fall. Adult sharks eat more crustaceans and sharks and less cephalopods than young. Male ***Dalatias*** for some reason are found to have full stomachs more commonly than females.

Size: Maximum total length to at least 159 cm, possibly to 182 cm; males mature at about 100 cm and females mature at about 120 cm. Size at birth about 30 to 40 cm.

Interest to Fisheries and Human Impact: Of little to no commercial value throughout most of the Indian Ocean, but a directed fishery for this species in the eastern Atlantic collapsed after nearly 30 years of fishing pressure, thus highlighting the potential vulnerability of this species to intensive fishing pressure. These sharks are caught with longline gear, demersal and pelagic trawls, and fixed bottom gillnets. They are used for human consumption dried–salted or fresh, or as fish meal, leather, and their livers, which are extremely large, oily, and have a high squalene content.

The conservation status is Near Threatened globally.

Local Names: Black shark, Black jack, Seal shark, Robhaai (South Africa).

Literature: Bigelow and Schroeder (1948, 1957); Bass, D’Aubrey and Kistnasamy (1976); Matallanas (1982); Compagno (1984a); Compagno, Ebert and Smale (1989); Last and Stevens (1994, 2009); Compagno, Dando and Fowler (2005); Blasdale *et al*. (2006); Capapé *et al*. (2008); Gibson *et al*. (2008); Blasdale *et al.* (2009); Dunn *et al.* (2010); Kyne and Simpfendorfer (2010); Ebert and Compagno (In press); D.A. Ebert (unpubl. data).

Euprotomicrus Gill, 1865

Genus: *Euprotomicrus* Gill, 1865 (listed 1864), *Proc. Acad. Nat. Sci. Philadelphia*: 264, ftn. 4.

Type species: *Scymnus labordii* “Müller and Henle”, 1839, by monotypy, equals ***Scymnus bispinatus*** Quoy and Gaimard, 1824.

Number of Recognized Deep–sea Indian Ocean Species: 1.

Synonyms: None.

Field Marks: See species.

Diagnostic Features: Anterior nasal flaps very short, not expanded into barbels. Snout moderately long, bulbously conical, length about 2/5 of head length and less than distance from mouth to pectoral–fin origins. Gill openings very small, uniformly broad. Lips thin, not fringed, pleated or suctorial. Teeth strongly different in upper and lower jaws, uppers small, with narrow, acute, erect cusps and no cusplets, not bladelike, lowers much larger, bladelike, interlocked, with a high, broad, nearly erect cusp and distal blade, edges not serrated; tooth rows 19 to 21 upper jaw, 19 to 23 lower jaw. Both dorsal fins spineless; first dorsal–fin origin far behind free rear tips of pectoral fins, insertion well ahead of pelvic–fin origins but much closer to pelvic–fin bases than pectoral fins; second dorsal fin much larger than first, with its base about 4 times as long as base of tiny first dorsal. Origin of second dorsal fin over rear end of pelvic–fin bases. Pectoral fins with short, broadly rounded free rear tips and inner margins, not expanded and acute or lobate. Caudal fin nearly symmetrical, paddle–shaped, with short, strong upper lobe and long lower lobe, subterminal notch well–developed. No precaudal pits but with low lateral keels on caudal peduncle, no midventral keel. Dermal denticles flat and block–like, not pedicellate, no posterior cusps on flat, depressed crowns. Cloaca normal, not expanded as a luminous gland. Vertebral counts: total vertebral counts 60 to 70, monospondylous vertebral counts 31 to 32, precaudal diplospondylous vertebral counts 15 to 20, total precaudal vertebral counts 46 to 52, caudal vertebral counts 11 to 19. Intestinal valve turn counts 12 to 13. **Colour:** blackish with conspicuously light–edged fins.

Local Names: Pygmy sharks.

Euprotomicrus bispinatus (Quoy and Gaimard, 1824)

Scymnus bispinatus Quoy and Gaimard, 1824, *Zoologie, Poissons*, *in* L. de Freycinet, Voyage aut. monde corv. S.M. *l'Uranie* et *La Physicienne*, 1817–1820: 197, pl. 44, figs. 1, 2. Holotype: Museum National d'Histoire Naturelle, Paris, MNHN–1216, 196 mm male, Mauritius, Indian Ocean.

Synonyms: ***Scymnus mauritianus*** Quoy and Gaimard, 1830, *Dict. Class. Hist. Nat. Atlas* 11: 114, fig. 2; Quoy and Gaimard, 1830, *ibid.*, pl. 22. Type material? Mauritius. ***Scymnus (Laemargus) labordii*** Quoy and Gaimard, *in* Müller and Henle, 1839, *Syst. Beschr. Plagiost.*, pt. 2: 94. "Isle de France, Isle de Bourbon", three specimens in Museum National d'Histoire Naturelle, Paris.

Other combinations: None.

FAO Names: En – Pygmy shark; **Fr** – Squale pygmée; **Sp** – Tollo pigmeo.

Fig. 150 ***Euprotomicrus bispinatus***

Field Marks: Small size, bulbous snout, cylindrical body, no dorsal–fin spines, tiny flag–like first dorsal fin, this over abdomen and closer to pelvic fins than pectoral fins and well behind pectoral fins, second dorsal–fin base about four times larger than first, no anal fin, blackish colour with conspicuous light–edged fins.

Diagnostic Features: See genus.

Distribution: Oceanic and amphitemperate, scattered throughout most ocean basins. Southern Indian Ocean: Madagascar to Western Australia.

Habitat: The pygmy shark is an epipelagic, mesopelagic, and perhaps bathypelagic inhabitant of the central water masses of the North and South Pacific, South Atlantic, and southern Indian Ocean, at water depths from 1829 to 9938 m. It occurs at or near the surface at night and apparently descends to at least midwater depths, to probably well below 300 m during the day; sand grains in the stomach of one specimen suggests that it may have been feeding on the bottom, presumably below 1800 m depth. All known specimens have been caught at the surface at night while none have been taken in midwater trawls at night or during the day. This also suggests that the diel vertical migrations of this little shark are enormous, at least 1500 m or more each way to put it below the normal range of midwater trawl hauls in the day. In human terms this would be roughly equivalent to someone climbing at least 11 km up and down each day.

Biology: Development viviparous with a yolk sac and with 8 young per litter. This shark eats deepwater squid and bony fishes, including hatchetfishes, lanternfishes, and lightfishes, with some crustaceans, but apparently does not take prey as relatively large as the squid taken by ***Isistius brasiliensis***. Its jaws are moderately strong but far weaker than those of ***Isistius*** and ***Dalatias***, and there is no evidence that the pygmy shark cuts plugs of flesh from fishes and other animals. Its lips are apparently not suctorial.

Size: Maximum total length 27 cm; males maturing between 17 to 19 cm and reaching 22 cm, females maturing between 22 and 23 cm and reaching 27 cm. Size at birth greater than 6 cm and less than or about 10 cm.

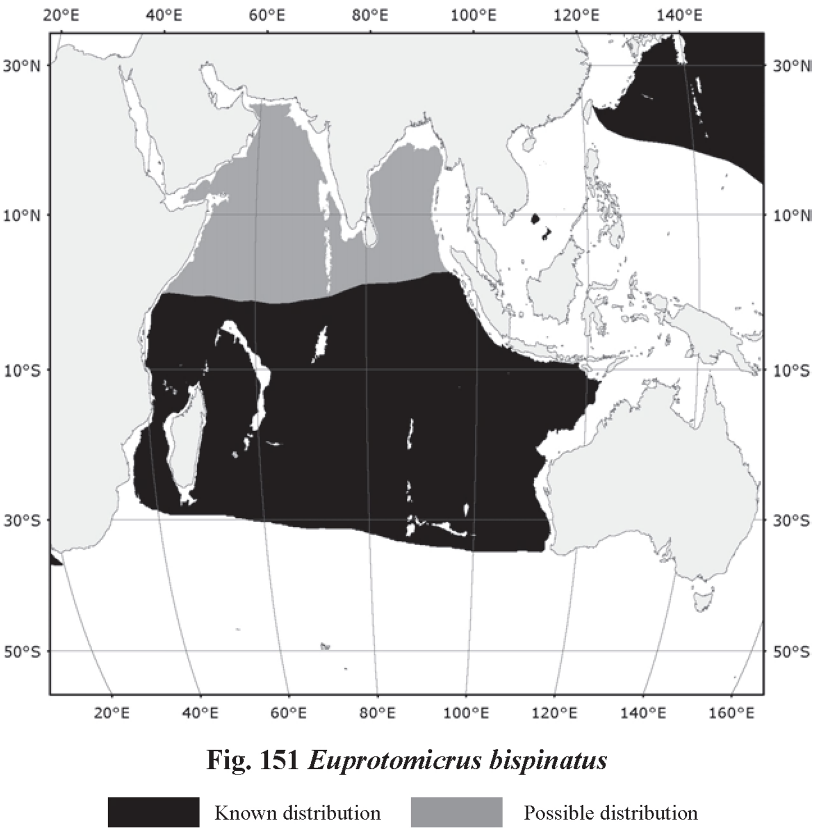


Fig. 151 ***Euprotomicrus bispinatus***

Interest to Fisheries and Human Impact: Interest to fisheries none.

The conservation status of this shark is Data Deficient.

Local Names: Leiche, Slime shark, Pygmy shark, Dwerghaai (South Africa).

Remarks: Pygmy sharks possess luminescent organs on their ventral surfaces that may serve to camouflage them from predators when they are at the surface. These organs may also play an important role in feeding and social recognition.

Literature: Hubbs and McHugh (1951); Bigelow and Schroeder (1957); Hubbs, Iwai and Matsubara (1967); Bass, D'Aubrey and Kistnasamy (1976); Seigel (1978); Cadenat and Blache (1981); Compagno (1984a); Last and Stevens (1994, 2009); Suda *et al.* (1999); Ebert (2003); Burgess (2006a); Last and Stevens (2009); Ebert and Compagno (In press).

Heteroscymnoides Fowler, 1934

Genus: ***Heteroscymnoides*** Fowler, 1934, *Proc. Acad. Nat. Sci. Philadelphia*, 85: 239.

Type species: ***Heteroscymnoides marleyi*** Fowler, 1934, by original designation.

Number of Recognized Deep–sea Indian Ocean Species: 1.

Synonyms: Genus ***Heteroscymnodes*** Fowler, 1969, *Quart. J. Taiwan Mus.* 22(1–2): 70. Apparent typographical error for ***Heteroscymnoides***.

Field Marks: See species.

Diagnostic Features: Anterior nasal flaps very short, not expanded into barbels. Snout very long, bulbously conical, length almost half head length and about equal to distance from mouth to pectoral–fin origins. Gill openings very small, uniformly wide. Lips thin, not fringed, pleated or suctorial. Teeth strongly different in upper and lower jaws, uppers small, with narrow, acute, erect cusps and no cusplets, not bladelike, lowers much larger, bladelike, interlocked, with a high, moderately broad, semi–erect cusp and distal blade, edges not serrated; tooth rows 22 upper jaw, 23 lower jaw. Both dorsal fins spineless. First dorsal–fin well forward, origin over pectoral–fin bases, insertion far ahead of pelvic–fin origins and much closer to pectoral–fin bases than pelvic fins. Second dorsal fin slightly larger than first but with base about equal to first dorsal–fin base. Origin of second dorsal fin over midbase of pelvic fins. Pectoral fins with short, narrowly rounded free rear tips and inner margins, not expanded and acute or lobate. Caudal fin semi–symmetrical, almost paddle–shaped, with moderately long upper lobe and well–developed lower lobe, subterminal notch strong. No precaudal pits, lateral or midventral keels on caudal peduncle. Dermal denticles flat but with pedicels, with lanceolate, ridged, wedge–shaped, monocuspidate crowns. Cloaca normal, not expanded as a luminous gland. Vertebral counts: total vertebral counts 70, precaudal vertebral count 52. **Colour:** brown with conspicuous light and dark banded fin margins.

Local Names: Longnose pygmy sharks.

Heteroscymnoides marleyi Fowler, 1934

Heteroscymnoides marleyi Fowler, 1934, *Proc. Acad. Nat. Sci. Philadelphia*, 85: 240, fig. 4. Holotype: Academy of Natural Sciences, Philadelphia, ANSP–53046, 128 mm newborn female, Durban coast at Point Ocean Beach, Natal.

Synonyms: None.

Other combinations: None.

FAO Names: En – Longnose pygmy shark; **Fr** – Squale mignon; **Sp** – Tollo pigmeo trompudo.

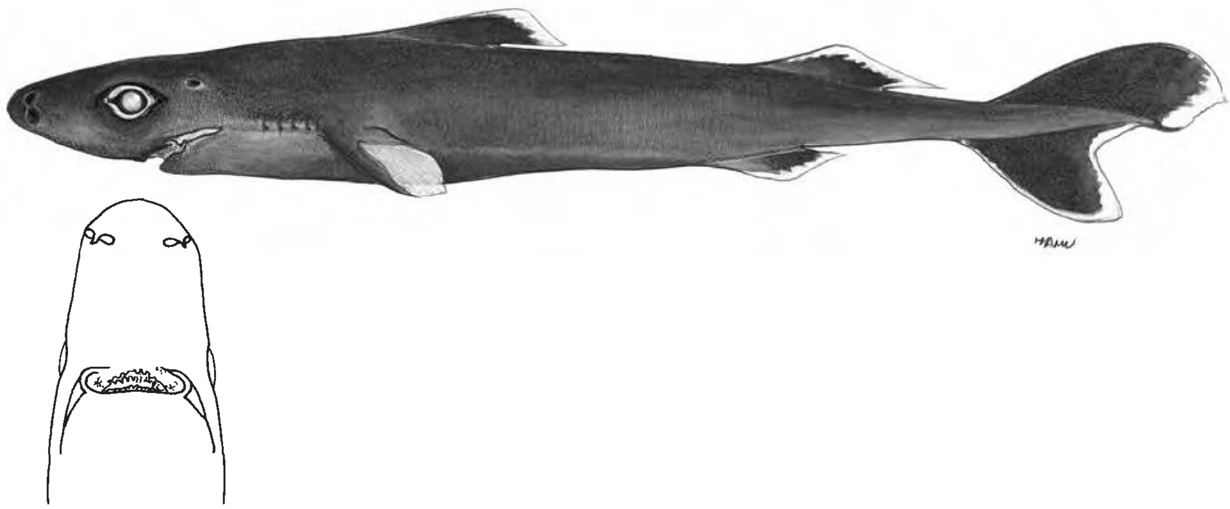


Fig. 152 ***Heteroscymnoides marleyi***

Field Marks: Small size, bulbous elongated snout, no dorsal–fin spines; first dorsal fin far forward, with origin over pectoral–fin bases, second dorsal fin only slightly larger than first, no anal fin, dark brown colour with light–edged fins.

Diagnostic Features: See genus.

Distribution: Possibly circumglobal in cold subantarctic waters of the Southern Hemisphere (Stehmann *et al.*, 1999), but currently only known from six specimens from four widely dispersed locations. Southwestern Indian Ocean: South Africa (Durban, KwaZulu–Natal). Eastern South Atlantic: near the Walvis Ridge (30°4.0'S, 5°22.0'E, 0 to 502 m in water over 4000 m deep) and over the Walvis Ridge (35°53 to 51'S, 2°32 to 35'E at 280 to 300 m in water over 830 m deep). Eastern South Pacific: in the open ocean about 450 km WNW of Alexander Selkirk Island, Chile (32°35.7'S, 85°25.2'W, 45 to 60 m) in water over 4000 m deep.

Habitat: A dwarf oceanic shark. The holotype was found on a beach in a subtropical area (KwaZulu–Natal, South Africa), but additional specimens have been collected in the open ocean in the epipelagic zone in cold southern waters, in the South Atlantic and eastern South Pacific between the surface and 502 m in water over 830 to over 4000 m deep (Krefft, 1980; Stehmann, Kukuev and Konovalenko, 1999). The Walvis Ridge and Selkirk Island specimens were found in cold current systems (Benguela and Humboldt Currents respectively).

Biology: A rare species (known from six individuals), with biology poorly known. Mode of reproduction unknown but almost certainly yolk–sac viviparous and possibly with few young as suggested by the large size of a presumably neonate female (12.8 cm) compared with an adult female (33.3 cm). Food habits unknown, but presumably pelagic fish and invertebrates.

Size: Maximum total length 36.5 cm. Adult males (2) were 36.0 and 36.5 cm. Of the two larger females reported, Krefft's (1980) 28.5 cm female was not examined for maturity but Stehmann *et al.* (1999) indicated that a 33.3 cm female was an adult. The 12.8 cm female holotype was immature and had an umbilical scar, indicating it was close to the size at birth.

Interest to Fisheries and Human Impact: Interest to fisheries none; catches by fisheries unknown at present.

Conservation status of this poorly known species is Least Concern.

Local Names: Longnose pygmy shark.

Literature: Fowler (1934, 1941); Bigelow and Schroeder (1948, 1957); Bass, D'Aubrey and Kistnasamy (1976); Krefft (1980); Compagno (1984a); Stehmann, Kukuev and Konovalenko (1999); Burgess (2006b); Ebert and Compagno (In press).

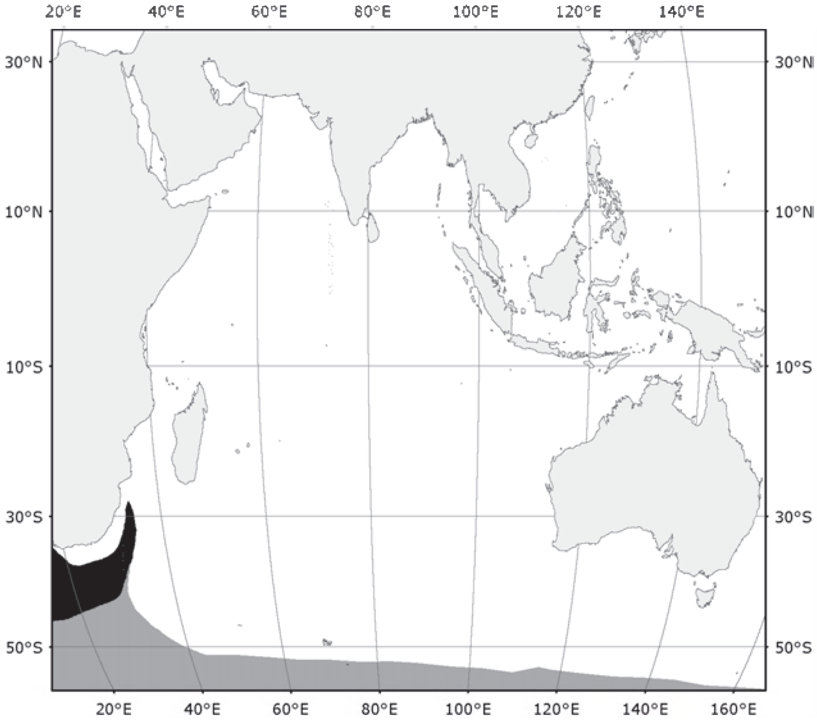


Fig. 153 *Heteroscymnoides marleyi*

Isistius Gill, 1865

Genus: *Isistius* Gill, 1865 (listed 1864), *Proc. Acad. Nat. Sci. Philadelphia*: 264, ftn. *2.

Type species: *Scymnus brasiliensis* "Müller and Henle, 1839", by monotypy, equals ***Scymnus brasiliensis*** Quoy and Gaimard, 1824. Published Nov. 22, 1864 according to Garman, 1899, *Mem. Mus. Comp. Zool. Harvard*, 24: 33; listed as 1865 according to Dean, 1916, *Bibliogr. Fish.*, 1: 460 and Eschmeyer (2012).

Number of Recognized Deep–sea Indian Ocean Species: 1.

Synonyms: Genus ***Leius*** Kner, 1864, *Anz. Akad. Wiss. Wien*, 1: 186; Kner, 1864, *Ann. Mag. Nat. Hist.*, 3, ser. 15: 185–187; Kner, 1865, *Denkschr. Akad. Wiss. Wien, Math.–nat. Kl.*, 24: 9, pl. 4, figs. 2–2a. Type species: ***Leius ferox*** Kner, 1865, by original designation? The latter was published Nov. 10, 1864 according to Garman, 1899, *Mem. Mus. Comp. Zool. Harvard*, 24: 33; 1865, according to Dean, 1916, *Bibliogr. Fish.*, 1: 695. See also Eschmeyer, 2012, *Cat. Gen. Fish.*, who indicates type by monotypy.

Field Marks: Small size, cigar–shaped body with long abdomen and short tail, small, spineless, nearly equal–sized dorsal fins far posterior on back, no anal fin, large to huge, triangular–cusped lower teeth without blades, suctorial lips, short, bulbous snout, caudal fin with short to long ventral lobe.

Diagnostic Features: Anterior nasal flaps very short, not expanded into barbels. Snout short, bulbously conical, length less than 2/5 of head length and much less than distance from mouth to pectoral–fin origins. Gill openings small, uniformly broad. Lips expanded, fleshy, suctorial, allowing the shark to attach to its prey like a lamprey. Teeth strongly different in upper and lower jaws; uppers small, with narrow, acute, erect cusps and no cusplets, not bladelike, lowers very large, bladelike, interlocked, with a high broad, erect cusp but no blade, edges not serrated; tooth row counts 29 to 43 upper jaw, 17 to 31 lower jaw. Both dorsal fins spineless; first dorsal fin far posterior, origin far behind pectoral fins and somewhat anterior to pelvic–fin origins, insertion over pelvic–fin bases. Second dorsal fin slightly larger than first but with base about equal to first dorsal–fin base; origin of second dorsal fin about over pelvic–fin rear tips. Pectoral fins with short, narrowly to broadly rounded free rear tips and inner margins, not expanded and acute or lobate. Caudal fin varying from asymmetrical to nearly symmetrical, paddle–shaped or not, with a short upper lobe, short to long lower lobe, and a strong subterminal notch. No precaudal pits but with low lateral keels on caudal peduncle, no midventral keel. Dermal denticles flat and block–like, not pedicellate, no posterior cusps on flat, depressed crowns. Cloaca normal, not expanded as a luminous gland. Vertebral counts: total vertebral counts 81 to 92, precaudal vertebral counts 60 to 66, caudal vertebral counts 20 to 27. Intestinal valve turn counts 8 to 10. Small sharks with a maximum length of about 50 cm. **Colour:** medium grey or grey–brown with light–edged fins; usually with a dark collar–like band around the gill region.

Local Names: Cookiecutter sharks.

Remarks: The arrangement of this genus follows Garrick and Springer (1964).

Isistius brasiliensis (Cuvier, *In* Quoy and Gaimard, 1824)

Scymnus brasiliensis Cuvier, *in* Quoy and Gaimard, 1824, *Zoologie, Poissons*, *in* L. de Freycinet, Voyage aut. monde corv. S.M. l'Uranie et La Physicienne, 1817–1820: 198. Holotype: Museum National d'Histoire Naturelle, Paris, MNHN–A.7787, 140 mm total length, female, off Brazil.

Synonyms: ***Scymnus torquatus*** Valenciennes, *in* Müller and Henle, 1839, *Syst. Beschr. Plagiost.*, pt. 2: 93. Listed as a variety of ***Scymnus*** (***Scymnus***) ***brasiliensis***, = ***Isistius brasiliensis***. Type material, possibly in Museum National d'Histoire Naturelle, Paris(?), locality not mentioned but probably considered the typical variety, and possibly from off Rio de Janeiro and St. Jago. ?***Scymnus unicolor*** Valenciennes, *in* Müller and Henle, 1839, *Syst. Beschr. Plagiost.*, pt. 2: 93. Listed as a variety of ***Scymnus*** (***Scymnus brasiliensis***, = ***Isistius brasiliensis***. Holotype: Museum National d'Histoire Naturelle, Paris, approximately 376 mm TL (13" 11"', 27 mm German inch), "Ein Exemplar in Paris von Isle de France". Not ***Spinax unicolor*** Engelhardt, 1912, = ***Etmopterus unicolor***. ***Squalus fulgens*** Bennett, 1840, *Narr. Whaling Voy.* 2: 255. Types: ?, from 2.5°S, 163° W near Christmas Island, also possibly from 55°S (originally given as 55°N, which is erroneous, being inland in Canada), 110°W, west of Cape Horn. ?***Leius ferox*** Kner, 1864, *Denkschr. Akad. Wiss. Wien, Math.–nat. Kl.*, 24: 10, pl. 4, figs. 2–2a. Types: Possibly in Naturhistorisches Museum, Vienna, from Australia (see discussion under ***Isistius labialis***).

Other combinations: None.

FAO Names: En – Cookiecutter shark; **Fr** – Squalelet féroce; **Sp** – Tollo cigarro.

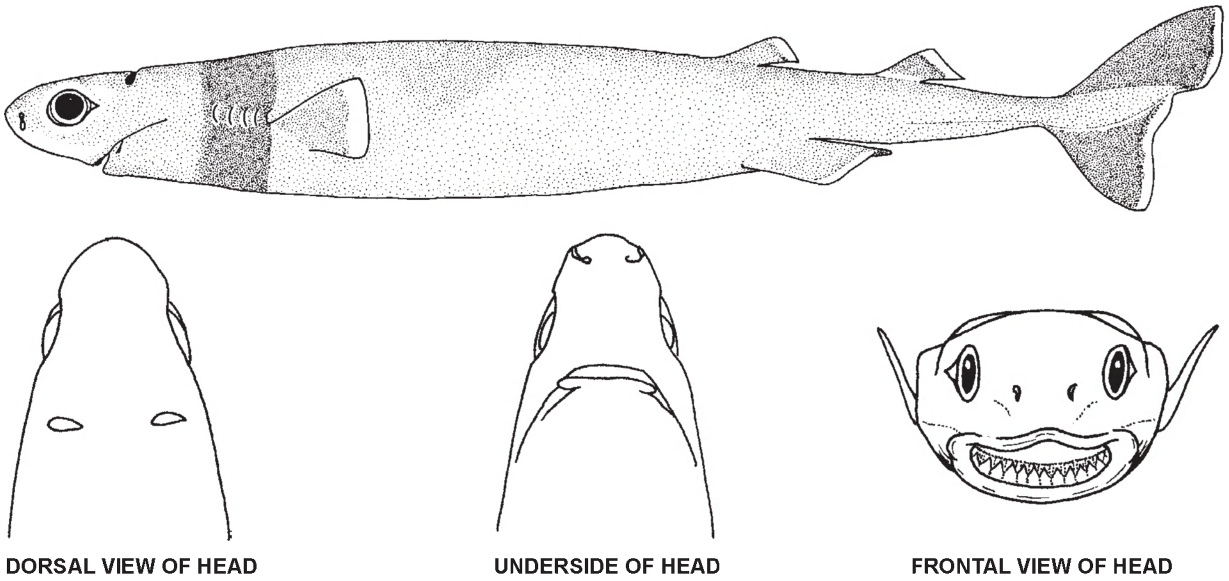


Fig. 154 *Isistius brasiliensis*

Field Marks: Small size, cigar–shaped body, small, spineless dorsal fins far posterior on back, no anal fin, triangular–cusped lower teeth without blades and in 25 to 31 rows, suctorial lips, short, bulbous snout, nearly symmetrical caudal fin with long ventral lobe and a prominent dark collar–marking over branchial region.

Diagnostic Features: Snout moderately short, about length of eye. Eyes anterior on head but sufficiently far back to lack an extensive anterior binocular field. Teeth in upper jaw 30 to 37, lower jaw 25 to 31; lowers moderately large. Interdorsal space over twice first dorsal–fin base, space between second dorsal–fin insertion and upper caudal–fin origin over twice second dorsal–fin base. Pectoral fins subquadrate, pelvic fins larger than dorsal fins. Second dorsal–fin height about equal to first. Caudal fin large and nearly symmetrical, with a long ventral caudal–fin lobe over 2/3 length of dorsal caudal–fin margin. Vertebral counts: total vertebral counts 81 to 89, precaudal vertebral counts 60 to 66, caudal vertebral counts 20 to 24. Intestinal valve turn counts 8 to 10. A small shark with a maximum total length of about 56 cm. **Colour:** pale brown above, becoming lighter below, with a conspicuous dark collar–like marking around the gill region; fins dark, but with pale to translucent edges.

Distribution: Widespread oceanic in temperate and tropical regions. Southern Indian Ocean: Mauritius to New Guinea and Western Australia. Elsewhere, known from scattered records throughout the Indian, Atlantic and Pacific oceans.

Habitat: A wide–ranging tropical oceanic shark, epipelagic to bathypelagic in distribution. It is caught at night, sometimes at the surface, but usually below it at depths between 85 to 3500 m, however its preferred depth range and maximum depth are uncertain. Apart from those captured at the surface specimens are generally taken in midwater nets fished over a wide depth range, and it is difficult to tell at what depth these sharks were captured. This shark is thought to be a vertical migrator on a diel cycle, coming to the surface and to the level of midwater trawl hauls at night and presumably dropping below this during the daytime as few if any of these sharks have been taken during the daytime. This implies a long vertical distance travelled, in excess of 2000–3000 m up and down in the ocean basins. These sharks are often caught near islands; this may imply an inshore pupping ground or merely the distribution of large potential victims. The cookiecutter shark may be capable of living in water of lower oxygen content than ***Euprotomicrus bispinatus*** or ***Squaliolus*** spp., but this is hypothetical.

Biology: Viviparous with a yolk sac, 6 or 12 large eggs have been found in ovaries and a 46.5 cm pregnant female had nine near–term foetuses, but little else is known about their reproductive biology.

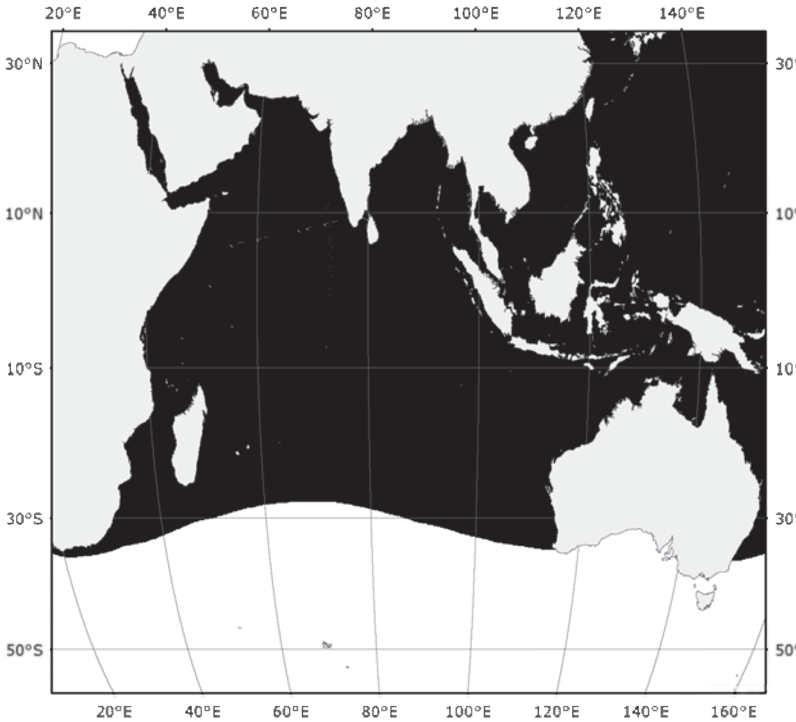


Fig. 155 *Isistius brasiliensis*

Known distribution

This shark has very powerful jaws and large teeth. It feeds on free–living deepwater prey, including squid with bodies almost as large as itself, gonostomatid fishes, and crustaceans, but is also a facultative ectoparasite on larger marine organisms. It has highly specialized suctorial lips and a strongly modified pharynx that allows it to attach to the sides of large bony fishes such as marlin, tuna, albacore, wahoo, and dolphinfish, as well as phocid seals, dolphins and other cetaceans (including the melon–headed whale, ***Peponocephala electra***) and even the megamouth shark (***Megachasma***), deep–sea stingray (***Plesiobatis daviesi***) and sixgill stingray (***Hexatrygon***). Off Brazil in the Santos area ***Isistius*** spp. (including this spp. and ***I. plutodus***) bit swordfish (***Xiphias***), snake mackerel (***Ruvettus*** and ***Lepidocybium***), marlin and sailfish (***Tetrapturus*** and ***Istiophorus***), yellowfin tuna and albacore (***Thunnus albacares*** and ***T. alalunga***), dolphinfish (***Coryphaena hippurus***), bramids (***Brama brama***) and bigeye thresher (***Alopias superciliosus***). The shark drives its razor–sharp saw–like lower dentition into the skin and flesh of its victim, twists about to cut out a conical plug of flesh, then pulls free with the plug cradled by its scoop–like lower jaw and held by the hook–like upper teeth. This method of feeding leaves `crater wounds' on victims, which were long thought to be caused by bacteria or invertebrate parasites, until Jones (1971) connected them to the cookiecutter or cigar shark. It has been hypothesized that the strong luminescence shown by this shark may serve to lure in other predators to attack it, with the result that the shark attacks or parasitizes them instead. It has been suggested (Widder, 1998) that the dark collar marking of this shark, banded by luminescent areas on the head and abdomen, specifically serves as a lure to attract upward–looking pelagic predators, which are killed and eaten or 'cored'. Incomplete crater wounds often show that the cookiecutter shark attacked its victim's head on, perhaps after they attacked it. Aggregations of these sharks may appear as schools of prey fishes to large pelagic fishes such as tuna or swordfish, which prove to be an unwelcome surprise as the fishes are in turn bitten by the cookiecutters.

The small paired fins, long body cavity and enormous, oily liver of this shark point to its being neutrally buoyant and not dependent on forward motion and its fins for dynamic lift. The liver and body cavity is proportionately much larger than in ***Euprotomicrus bispinatus*** or ***Squaliolus*** spp., and much more oil is present in its body cavity and gut. This may be an adaptation for greater depths than those attained by the other species, but may also compensate for its more highly calcified skeleton, which in turn may be necessary for supporting its activities in taking larger prey and gouging flesh from large animals. It can be quite quick and active when caught and can nip its captors if they are unwary.

This shark has luminous organs that cover the entire lower surface of its trunk with the exception of its fins and the dark collar marking. It is reported as glowing a bright, ghastly green.

An unusual habit of this shark, perhaps related to maintaining sufficient calcium levels in its body for its relatively well–calcified skeleton and replacing its massive dentition, is swallowing and possibly digesting its own lower teeth as they are replaced and become loose in entire series.

Size: Maximum total length about 56 cm; males maturing at about 31 to 37 cm and reaching at least 42 cm, females maturing between 38 and 44 cm and reaching at least 56 cm. Size at birth between 14 to 15 cm.

Interest to Fisheries and Human Impact: Of little interest to fisheries because of its small size and low abundance, but reportedly captured by bottom trawls and used for fishmeal in the eastern Atlantic. It has been also caught in experimental pelagic gillnets targeting pelagic ommastrephid squid in the North Pacific. ***Isistius brasiliensis*** might be of slight negative interest to fisheries because the species gouges plugs of flesh from commercially important fishes, which may increase their mortality rate, but this is uncertain. Also, extensively damaged or scarred fishes are of less valuable than undamaged ones. Unusual non–edible and non–living victims of this shark include nuclear submarines of the U.S. Navy, which have had rubber sonar domes bitten by ***I. brasiliensis***. Despite its rather vampire–like mode of feeding, it is not of much concern to people because of its small size and oceanic habitat preferences. The chances of it biting a swimmer or diver are remote though possible. There is at least one confirmed attack by this shark on an open ocean swimmer off the Hawaiian Island of Maui. The attack occurred at night while an open ocean swimmer was attempting to cross 30–mile Alenuihaha Channel from the Big Island to Maui. There are other anecdotal accounts of swimmers, including a swimmer off a ship in mid–ocean, being nipped by dwarf sharks.

Conservation status is Least Concern, but may be of some concern regionally due to its presence as bycatch in fisheries targeting large bony fishes and squid.

Local Names: Cigar shark, Collared dogfish.

Literature: Bigelow and Schroeder (1948, 1957); Strasburg (1963); Garrick and Springer (1964); Parin (1966);Hubbs, Iwai and Matsubara (1967); Jones (1971); Cadenat and Blache (1981); Compagno (1984a); Jahn and Haedrich (1987); Last and Stevens (1994, 2009); Gasparini and Sazima (1996); Widder (1998); Gadig and Gomes (2002); Ebert (2003); Stevens (2003b); Papastamatiou *et al*. (2010); Honebrink *et al*. (2011); Ebert and Compagno (In press).

Squaliolus Smith and Radcliffe, 1912

Genus: ***Squaliolus*** Smith and Radcliffe, *in* Smith, 1912, *Proc. U.S. Nat. Mus.* 41(1877): 683.

Type species: ***Squaliolus laticaudus*** Smith and Radcliffe, *in* Smith, 1912, by original designation.

Number of Recognized Deep–sea Indian Ocean Species: 2.

Synonyms: ***Euprotomicrus laticaudus*** Garman, 1913, Plagiostoma. *Mem. Mus. Comp. Zool. Harvard*, 36: 235–236.

Field Marks: The only sharks with a fin spine on their first dorsal fins but not on their second, very small size, spindle–shaped body, snout long, bulbously conical and pointed, second dorsal fin with base about twice as long as that of first, first dorsal fin with origin opposite to inner margins or rear tips of pectoral fins, no anal fin, dark colour with conspicuously light–margined fins.

Diagnostic Features: Head cylindrical, snout very long, bulbously conical but slightly pointed, length about half head length and about equal to distance from mouth to pectoral fins. Eye variably small to large depending on species; upper margin of orbit nearly straight to broadly arched or angular and chevron shaped. Anterior nasal flaps very short, not expanded into barbels. Gill openings very small, uniformly wide. Lips thin, not fringed, pleated or suctorial, upper lip with or without paired lateral papillae. Teeth strongly different in upper and lower jaws, uppers small, with narrow, acute, erect cusps and no cusplets, not bladelike, lowers much larger, bladelike, interlocked, with a high, moderately broad, nearly erect cusp and distal blade, edges not serrated; tooth row counts 21 to 23 upper jaw, 16 to 21 lower jaw. Lateral dermal denticles flat, block–like, not pedicellate, with no posterior cusps on flat, depressed crowns. First dorsal fin with a spine, covered by skin or not, but second dorsal fin without a spine; first dorsal fin well anterior, origin about opposite to inner margins or free rear tips of pectoral fins, insertion well anterior to pelvic–fin origins and closer to pectoral–fin bases than pelvic fins; second dorsal fin much larger than first, base about twice as long as first dorsal–fin base; origin of second dorsal fin over from half of pelvic–fin bases; pectoral fins with short, narrowly rounded free rear tips and inner margins, not expanded and acute or lobate; cloaca normal, not expanded as a luminous gland. No precaudal pits or midventral keels, but with low lateral keels on caudal peduncle. Caudal fin nearly symmetrical, paddle–shaped, with a short upper and long lower lobe and a strong subterminal notch. Vertebral counts: total vertebral counts 55 to 62, precaudal vertebral counts 44 to 48, monospondylous vertebral counts 27 to 32, diplospondylous vertebral counts 26 to 32. Spiral valve turn counts 13. These are among the smallest known of living shark species. **Colour:** blackish to blackish–brown with conspicuously light–margined fins.

Local Names: Spined pygmy sharks.

Remarks: Regan (1912) recognized this genus but Garman (1913), Fowler (1941) and Bigelow and Schroeder (1948) considered it to be a synonym of ***Euprotomicrus***. It is clearly distinct as demonstrated by Hubbs and McHugh (1951) and has been recognized by subsequent authors (Bigelow and Schroeder, 1957; Seigel *et al*., 1977; Seigel, 1978; Compagno, 1984a; Sasaki and Uyeno, 1987; Shirai, 1992a, Ebert and Compagno, In press).

The present arrangement of this genus follows Sasaki and Uyeno (1987) and includes two valid species, ***Squaliolus aliae*** confined to the western Pacific and eastern Indian Ocean, and ***S. laticaudus***, a near circumglobal species that occurs in the western Indian Ocean. A third species, ***Squaliolus sarmenti***, described from off Madeira is recognized by some authors, but Seigel *et al*. (1977) and Seigel (1978) demonstrated that ***S. sarmenti*** is a junior synonym of ***S. laticaudus***.

Key to Deep–sea Indian Ocean Species:

1a. Eye smaller, eye length 46 to 70% of interorbital width and 43 to 66% of preorbital snout length. Upper margin of orbit angular, chevron–shaped (Fig. 156). Upper lip with a pair of lateral papillae that partially cover teeth . . . . ***Squaliolus aliae***

Fig. 156 ***Squaliolus aliae***

1b. Eye larger, eye length 73 to 86% of interorbital width and 61 to 82% of preorbital snout length. Upper margin of orbit nearly straight and broadly arched (Fig. 157). Upper lip without a pair of lateral papillae (or with these weakly developed) . . . . . ***Squaliolus laticaudus***

Fig. 157 ***Squaliolus laticaudus***

Squaliolus aliae Teng, 1959

Squaliolus alii Teng, 1959, *Taiwan Fish. Res. Inst. Lab. Fish. Biol. Rep.* (9): 1, pl. 1. Holotype: Taiwan Fisheries Research Institute no. 3837, 187 mm female, off Tung–Kang, Taiwan (Povince of China), on bottom at about 330 m depth. Name corrected to ***aliae*** by Sasaki and Uyeno (1987, *Japanese J. Ichthyol.* 34(3): 373), because this species was named after the describer's wife.

Synonyms: None.

Other combinations: None.

FAO Names: En – Smalleye pigmy shark; **Fr** – Squalelet de Chine; **Sp** – Tollo pigmeo ojuelo.

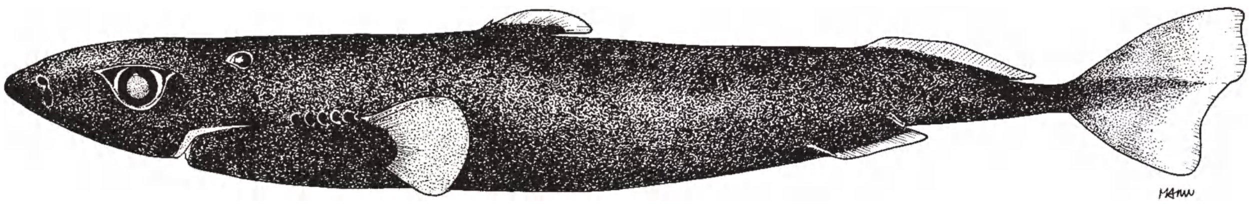


Fig. 158 ***Squaliolus aliae***

Field Marks: A small spindle–shaped shark, with a long bulbous, conical snout, and a small fin spine preceding the first dorsal fin, but lacking a fin–spine on the second dorsal fin, eye diameter smaller, 46 to 70% of interorbital width, than eye diameter of ***Squaliolus laticaudus***, upper eyelid angular, and colour uniformly dark brown to black with lighter fin margins.

Diagnostic Features: Head cylindrical, snout very long, bulbously conical but slightly pointed, length about half head length and about equal to distance from mouth to pectoral fins. Eye small, diameter 46 to 70% of interorbital width and 43 to 66% (mostly less than 60%) of preorbital snout length; upper margin of orbit angular, chevron shaped. Anterior nasal flaps very short, not expanded into barbels. Gill openings very small, uniformly wide; lips thin, not fringed, pleated or suctorial, upper lip with a pair of lateral papillae that partially cover teeth. Teeth strongly different in upper and lower jaws, uppers small, with narrow, acute, erect cusps and no cusplets, not bladelike, lowers much larger, bladelike, interlocked, with a high, moderately broad, nearly erect cusp and distal blade, edges not serrated; tooth rows 21 to 23 upper jaw, 20 to 21 lower jaw. Dermal denticles flat and block–like, not pedicellate, no posterior cusps on flat, depressed crowns. First dorsal fin with a spine, covered by skin or not, but second dorsal fin without a spine; first dorsal fin well anterior, origin about opposite to inner margins or free rear tips of pectoral fins, insertion well anterior to pelvic–fin origins and closer to pectoral–fin bases than pelvic fins; second dorsal fin much larger than first, base about twice as long as first dorsal–fin base; origin of second dorsal fin over from half of pelvic–fin bases; pectoral fins with short, narrowly rounded free rear tips and inner margins, not expanded and acute or lobate. Cloaca normal, not expanded as a luminous gland. No precaudal pits or midventral keels, but with low lateral keels on caudal peduncle. Caudal fin nearly symmetrical, paddle–shaped, with a short upper and long lower lobe and a strong subterminal notch. Vertebral counts not available for this species. One of the smallest known sharks, to at least 22 cm total length. **Colour:** uniformly black to blackish–brown with conspicuously light–margined fins.

Distribution: Eastern Indian Ocean and western Pacific: Japan, Taiwan (Province of China), Philippines, and Australia (northwestern Australia, Queensland, and New South Wales).

Habitat: This species appears to overlap the distribution of its congener (***S. laticaudus***), but may occur closer to continental landmasses. It has an epipelagic or mesopelagic habitat ranging over waters from 200 to 2000 m, although it is also caught near or on the bottom by trawls.

Biology: Viviparous with a yolk sac, but little else known about its reproductive biology. The diet consists of small midwater fishes (Myctophidae), cephalopods, and small crustaceans including shrimps. This species has numerous photophores on the ventral surface of its body that serve to counter–illuminate it, in other words provide camouflage in the midwater so that it can hunt for prey and hide from predators in a pelagic habitat.

Size: One of the smallest living sharks reaching a maximum total length of 22 cm; males mature at about 15 cm in length. Birth size uncertain, but likely less than 10 cm as smallest free swimming individuals measured were 9.1 and 9.8 cm long.

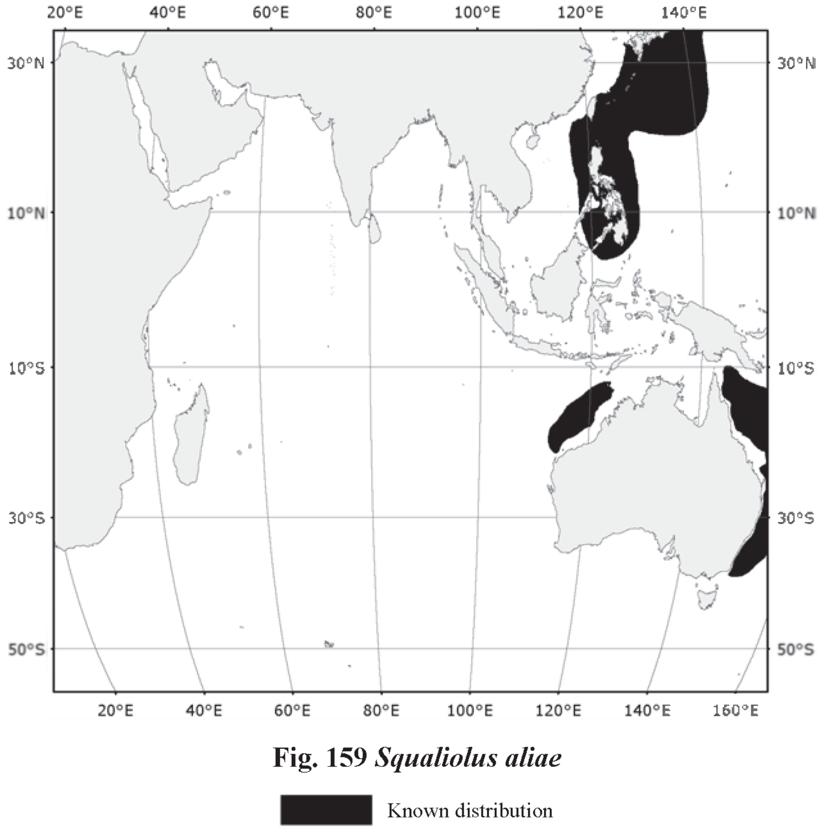


Fig. 159 *Squaliolus aliae*

Interest to Fisheries and Human Impact: Occasionally caught as bycatch, but not utilized.

The conservation status of this species is Least Concern due to its small size which likely precludes capture by most fishing gear and lack of commercial value.

Local Names: None.

Remarks: Compagno (1984a) following Seigel *et al.* (1977) and Seigel (1978) considered this genus to be monotypic, but a re–evaluation of this species with ***Squaliolus laticaudus*** by Sasaki and Uyeno (1987) identified several characteristics, including eye diameter to snout length and to interorbital width, that revealed that these two species are indeed separate species.

Literature: Teng (1959b); Seigel *et al.* (1977); Seigel (1978); Compagno (1984a in part); Sasaki and Uyeno (1987); Last and Stevens (1994, 2009); Heupel (2003b); Claes, Ho and Mallefet (2012); Ebert and Compagno (In press); D.A. Ebert (unpubl. data).

2.3 Order PRISTIOPHORIFORMES – Sawsharks

Order: Order Pristiophoriformes White 1936, emendation of Order Squalea, Suborder Squalida, Super family Pristiophoridea White, 1936, *Amer. Mus. Novit.* (837): 5; White, 1937, *Bull. Amer. Mus. Nat. Hist.* 74: 37, tab. 1.

Number of Recognized Deep–sea Indian Ocean Families: 1.

Synonyms: Part 1 Squali, Abtheilung 3: Müller and Henle, 1839, *Syst. Besch. Plagiost.* (2): 83. Ordo Plagiostomi, Subordo Squalini, Sectio Aproctopterides: Bleeker, 1859, *Acta Soc. Sci. Indo–Neerl.* 6: xii. Order Squali, Suborder Squali: Gill, 1862, *Ann. Lyc. Nat. Hist. N. Y.* 7: 367, 394, 396. Order Squali, Suborder Galei: Gill, 1872 *Smithsonian Misc. Colln.* (247): 23, 24. Suborder Plagiostomi Tectospondyli, Group 1 Squalorajae: Hasse, 1879, *Nat. Syst. Elasmobr.* (1): 44. Order Selachii, Suborder Tectospondyli: Woodward, 1889, *Cat. fossil fish.* BM(NH) (1): 30. Order Asterospondyli: Gill, 1893, *Natn. Acad. Sci.* (U.S.) Mem. 6, 6: 130 (pristiophorids placed with 'galeoid' sharks). Order Euselachii, Suborder Pleurotremata, Division Squaloidei: Regan, 1906a, *Proc. Zool. Soc. London* (1906): 723. Order Selachii, Group 2, Division B, Subdivision 2, Suborder Squaliformes: Goodrich, 1909, *In* R. Lankester, *ed.*, *A treatise on Zoology* (9), Vertebrata Craniata: 151. Order Pleurotremata, Suborder Squaloidei: Engelhardt, 1913, *Abh. math.–phys. Klasse K. Bayer. Akad. Wiss., Suppl., Beitr. Naturg. Ostasiens*, 4: 100. Order Squatinae: Fowler, 1941, *Bull. U. S. Natn. Mus.* (100) 13: 4, 279. Order Plagiostoma, Suborder Antacea, "Group" Squaloidei: Garman, 1913, *Mem. Mus. Comp. Zool. Harvard* 36: 11, 13. Order Euselachii, Suborder Galei, Series Galeoidei: Jordan, 1923, *Stanford Univ. Publ., Univ. Ser., Biol. Sci.*, 3: 100, 101. Order Euselachii, Suborder Squaliformes: Bertin, 1939, *Bull. Inst. Oceanogr. Monaco* (775): 10. Order Squaliformes, Suborder Squaloidei: Berg, 1940, *Trudy Zool. Inst. Akad. Nauk SSSR*, 5(2): 138; Arambourg and Bertin, 1958, *In* P.–P. Grasse, *ed.*, *Traité de Zoologie*, 13: 2010–2067; Nelson, 1976, Fishes of the world: 38. Order Pristiophori, Superfamily Pristiophoroidea: Whitley, 1940, *Fishes Australia. Part I. Aust. Zool. Handbook*: 69. Order Selachii, Suborder Squaloidea: Romer, 1945, *Vert. Paleont.* (ed. 2): 577; Romer, 1966, *Vert. Paleont.* (ed. 3): 350. Order Selachii, Suborder Pristiophoroidea: Bigelow and Schroeder, 1948, *Mem. Sears Fnd. Mar. Res.* (1) 1: 77, 532. Order Squaloidea, Suborder Squaloidea: Schultz and Stern, 1948, ways of fishes: 225. Order Pristiophorae: Smith, 1949, *Sea fishes Southern Africa*: 37, 61. Order Pristiophoriformes: Berg and Svetovidov, 1955, *Trudy Zool. Inst. Akad. Nauk SSSR*, 20: 70; Patterson, 1967, *in* W.B. Harland *et al.*, *Geol. Soc. London, Spec. Pub.* 2: 672; Lindberg, 1971, *Fishes of the world* (trans. 1974): 8, 260; Rass and Lindberg, 1971, *J. Ichthyol.* (trans. *Voprosy Ikhtiologii*) 11(3): 304; Compagno, 1973a, *J. Linn. Soc.(Zool.)*, 53 suppl. 1: 26; Applegate, 1974, *J. Mar. Biol. Ass. India*, 14(2): 743; Chu and Meng, 1979, *Monogr. Fish. China, Sci. Tech. Press, Shanghai*: 114, tab. 2; Compagno, 1984a, *FAO Fish. Synops.* (125) 4(1): 130; Pfeil, 1983, *Palaeo Ichthyologica*, 1: 24; Cappetta, 1987, *Handb. Paleoichthyol.* 3B: 26, 64; Eschmeyer, 1990, *Cat. gen. Recent fish.*: 437; Shirai, 1992a, *Squalean phylogeny, Hokkaido U. Press, Sapporo*, 122; Nelson, 1994, *Fishes of the world*, ed. 3: 57; de Carvalho, 1996, *in* Stiassny *et al.*, *Interrelationships fishes*: 55; Shirai, 1996, *in* Stiassny *et al.*, *Interrelationships fishes*: 34. Order Lamnida, Suborder Pristiophorina: Matsubara, 1955, *Fish morphology hierarchy*, (1): 1–789. Order Pleurotremata, Suborder Squaloidea: Norman, 1966, draft syn. *Recent fishes*: 24. Order Squatiniformes, Suborder Pristiophoroidei: Glikman, 1967, *in* Y.A. Orlov, *ed.*, *Fundamentals Paleontology*, 11: 217. Order Euselachii, Suborder Squaloidei: Blot, 1969, *in* J. Piveteau, *ed. Traité de Paleontologie*. 2: 702–776. Order Pristiophorida, Suborder Pristiophorina, Superfamily Pristiophoricae: Fowler, 1969, *Q. J. Taiwan Mus.* 22(1–2): 80. Order Pleurotremata, Suborder Squaliformes: Budker and Whitehead, 1971, *Life of sharks*: 6, tab. 2. Order Pristiophoriformes, Suborder Pristiophoroidea: Chu and Meng, 1979, *Monogr. Fish. China, Sci. Tech. Press, Shanghai*: 114, tab. 2. Order Squaliformes, Suborder Pristiophoroidei: Nelson, 1984, *Fishes of the world*, ed. 2: 58. Order Squalomorpha, Suborder Squaloidea: Carroll, 1988, *Vertebrate paleont. evolut.*: 599.

Field Marks: Small (to 150 cm long) slender sharks with long, flat snouts bearing lateral and ventral sawteeth and ventral barbels, 5 or 6 lateral gill openings, two spineless dorsal fins and no anal fin.

Diagnostic Features: Head greatly depressed and somewhat expanded laterally. Snout greatly depressed, laterally expanded, and elongated, with close–set lateral and ventral sawteeth and a pair of long string–like rostral barbels on the ventral surface anterior to the nostrils. Eyes dorsolateral on head, without nictitating lower eyelids, secondary lower eyelids, or subocular pouches; upper eyelids not fused to eyeball. Spiracles large and set just behind at level of eyes. Five or six paired gill openings present on sides of head, with the posteriormost in front of pectoral–fin origins. Nostrils longitudinal on snout, without barbels, nasoral grooves or circumnarial grooves; nostrils separate from mouth, anterior nasal flaps short and not reaching mouth. Mouth small, subterminal, broadly arched and short, extending slightly behind eyes. Labial furrows greatly reduced but present on both jaws. Teeth weakly differentiated along the jaws, without enlarged anterior teeth or enlarged molariform posterior teeth and without a gap or small intermediate teeth between anterior and lateral teeth in the upper jaw; teeth with orthodont histological structure. Trunk cylindrical, not flattened and ray–like. Caudal peduncle with long thick lateral dermal ridges. Dermal denticles covering entire body, not enlarged as thorns or spines. Pectoral fins moderately large, not expanded and ray–like, without triangular anterior lobes that cover the gill openings. Pectoral girdle (scapulocoracoid) high, U–shaped, without a medial joint, and with superscapulae directed posterodorsally and not contacting vertebral column. Pectoral fin skeleton tribasal, with propterygium not excluded from contact with radials and metapterygium without a proximal segment; pectoral fins aplesodic, with radials not extending into fin webs; radial counts 21 to 27 with mostly 2 or 3 segments. Pelvic fins small, with vent continuous with their inner margins. Claspers with siphons in the abdomen at the pelvic–fin bases but without clasper sacs; clasper glans lacking a pseudosiphon but with a cover rhipidion, rhipidion and clasper spine; dorsal and ventral marginals of clasper skeleton strong but not rolled into a tube for the clasper canal. Two spineless dorsal fins present, with origin of first over abdomen and well in front of pelvic–fin bases. Anal fin absent. Caudal fin with a long dorsal lobe and no ventral lobe; vertebral axis slightly elevated into the dorsal caudal–fin lobe (heterocercal caudal fin). Vertebral counts: total vertebral counts 132 to 157, precaudal vertebral counts 90 to 108, monospondylous vertebral counts 42 to 55. Intestinal valve of conicospiral type, with 6 to 10 turns. **Colour:** brown to brownish–grey, light grey, or pale yellow above, lighter below; some species with blotches or stripes on rostrum. Reproductive mode yolk–sac viviparity.

Distribution, Habitat, Biology, Interest to Fisheries and Human Impact: See family Pristiophoridae.

Local Names: Pristiophoriform or Pristiophoroid sharks.

Remarks: The Pristiophoriformes are a highly derived, small group of sharks that are transitional between more conventional sharks and the batoids, but which have many unique characteristics related to their unusual feeding mechanism. It is likely that the pristiophorids are the immediate sister group of batoids (Shirai, 1992a, 1996, de Carvalho, 1996) but should rank as a separate order Pristiophoriformes with the single family Pristiophoridae following Whitley (1940) and many subsequent writers.

2.3.1 Family PRISTIOPHORIDAE

Family: Family Pristiophoroidei Bleeker, 1859, *Act. Soc. Sci. Indo–Neerl.* 6: xii. Type genus: ***Pristiophorus*** Müller and Henle, 1837a.

Type genus: ***Pliotrema*** Regan, 1906.

Number of Recognized Deep–sea Indian Ocean Genera: 2.

Synonyms: Family Pliotremidae Jordan, 1923: 101. Emended as Subfamily Pliotrematinae Fowler, 1947: 13 (Family Pristiophoridae). Probably independently proposed as Family Pliotremidae by Gubanov, Kondyurin, and Myagkov, 1986: 223.

FAO Names: En – Saw sharks; **Fr** – Requins scie; **Sp** – Tiburones sierra.

Field marks: See order.

Diagnostic Features: See order.

Distribution: The sawshark family has a sporadic and disjunct distribution in the western North Atlantic, eastern South Atlantic, Indian Ocean, and the western Pacific.

Habitat: Sawsharks are temperate and tropical benthic and epibenthic inhabitants of the continental and insular shelves and upper slopes from close inshore to about 952 m. Some temperate–water sawsharks occur in shallow bays and estuaries near the intertidal and also on offshore sand and gravel banks down to the upper continental slopes. Tropical species occur on the upper continental and insular slopes.

Some sawsharks are or were common where they occur, and are found in large schools or feeding aggregations. The behavior of sawsharks is poorly known. At least one species shows segregation by depth within populations, with adults in deeper water than young.

Biology: Sawsharks exhibit yolk–sac viviparity, with litters of 7 to 17 young. Apparently sawshark fetuses gain nutrients primarily from their large yolk sacs, which are resorbed just before birth. The large lateral rostral teeth erupt before birth in sawsharks, but to prevent injury to the mother these large teeth lie flat against the rostrum in fetuses until after birth. Smaller teeth either erupt between the large ones after birth (some ***Pristiophorus*** species) or erupt along with the larger teeth before birth but are covered by them (***Pliotrema***).

Food habits of sawsharks are poorly known, but known prey includes small fishes, crustaceans and squid. The long rostral barbels may have taste, touch or other sensors, that these sharks trail along the bottom like those of sturgeons (Acipenseridae) and catfish (Siluriformes) to locate prey, while the long, delicate rostrum has lateral line and ampullal sensors for vibration–sensing and electrolocation, similar to the snout of paddlefish (Polyodontidae). The lateral and ventral rostral teeth, flat snout and head, enlarged occipital condyles, and specialized cervical vertebrae of sawsharks are evident modifications that allow these sharks to use their rostra as feeding devices to kill or capture prey and possibly stir up bottom sediments to rouse prey organisms, and possibly to defend themselves. Unlike the batoid sawfishes (Pristidae), feeding behavior using the rostral saw has not been observed, probably because sawsharks have been seldom kept in captivity and without much success (unlike sawfishes) and have not been studied underwater where they occur. The short jaws, small mouths and long oral and gill cavities of sawsharks suggest that they can suddenly suck prey into their mouths. Unlike sawfishes (Pristidae), sawshark teeth are not strongly anchored in the snout, and are easily pulled out. The needle–pointed, sharp–edged lateral teeth, hooked ventral teeth set at a right angle to the lateral teeth, and the tendency of the rostral teeth to easily snag on various objects suggest that the saw may have a snaring or jigging action with prey. They may be able to hook the arms and tentacles of cephalopods, and the legs and antennae of crustaceans, as well as the bodies of small, soft fishes. ***Pristiophorus*** sawteeth are smooth–edged, but ***Pliotrema*** additionally has mesially directed barbs on its larger sawteeth that enhance adhesion.

Size: Sawsharks are small and slender, little–known sharks with a maximum length of about 137 to 153 cm but with a few species possibly not exceeding 70 cm. Size at birth from 28 to 35 cm in length.

Interest to Fisheries and Human Impact: Sawsharks are harmless to people, unlike large sawfishes (Pristidae) that have occasionally struck and even killed bathers in the shallows and can be a hazard to fishers when caught in nets and on line gear. The rostral teeth of sawsharks are extremely sharp though apparently non–toxic, and should be handled with due care to prevent minor puncture wounds on one's limbs.

Demersal gillnets and trawl fisheries take sawsharks as a relatively small landed bycatch off southern Australia, where they are marketed fresh for human consumption. They are also taken and used in the western North Pacific to some extent, but details are sketchy. Sawsharks are caught in bottom trawl fisheries in the southwestern Indian Ocean off South Africa and southern Mozambique, but are discarded.

The conservation status of sawsharks is mostly Data Deficient or Least Concern where some life history information is available. However, the highly 'adhesive' rostrum of sawsharks suggests that, as with sawfishes, they may be highly vulnerable to net gear (particularly gillnets) because their saws can easily get caught in such gear. Some species have restricted areal and bathymetric distributions, including possible habitat restrictions, and could have problems with intensive fisheries that are operating where they occur. Unfortunately sawsharks are poorly known biologically, and have attracted little attention because of their minor significance or lack of importance to fisheries or other human activities.

Local Names: Sawsharks, Saw sharks (English), Saaghaaie (Afrikaans, South Africa).

Remarks: The family is comprised of two genera and seven species; both genera and four species, two of which inhabit the deep–sea, occur in the western Indian Ocean, while two additional shallow waters species occur in eastern Indian Ocean waters off Australia.

The arrangement of genera and species in this family follows Last and Stevens (2009), Ebert and Cailliet (2011), and Ebert and Compagno (In press).

Literature: Günther (1870); Garman (1913); Fowler (1941, 1969); Springer and Bullis (1960); Last and Stevens (1994, 2009); Ebert and Cailliet (2011); Ebert and Compagno (In press).

List of Deep–sea Species Occurring in the Area:

Pliotrema warreni Regan, 1906
Pristiophorus nancyae Ebert and Cailliet, 2011

Key to Deep–sea Indian Ocean Genera:

1a. Six pairs of gill openings. Larger rostral teeth with posterior barbs (Fig. 160) . . . . ***Pliotrema***

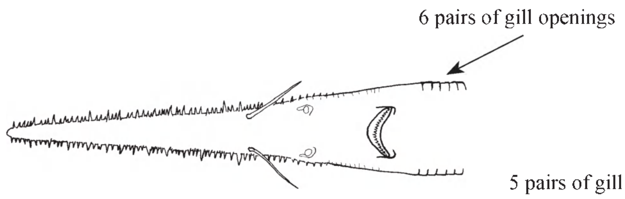


Fig. 160 *Pliotrema*

1b. Five pairs of gill openings. Larger rostral teeth smooth–edged (Fig. 161) . . . . ***Pristiophorus***

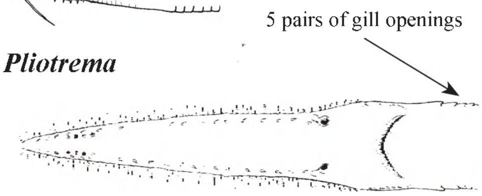


Fig. 161 *Pristiophorus*

Pliotrema Regan, 1906

Genus: ***Pliotrema*** Regan, 1906b, *Ann. Natal Mus.*, 1(1): 1.

Type species: ***Pliotrema warreni*** Regan, 1906b, by monotypy.

Number of Recognized Deep–sea Indian Ocean Species: 1.

Synonyms: Genus ***Poliotrema*** Séret, 1987: 1. Genus ***Piliotrema*** Bass, D'Aubrey and Kistnasamy, 1975c: 58, Tab. 10. Both are typographical errors.

Diagnostic Features: Barbels more posteriorly situated on snout than in ***Pristiophorus***, prebarbel snout 64 to 67% of preoral length. Larger rostral sawteeth with 2 to 8 mesially–directed barbs on their posterior edges. Six paired gill slits. Teeth with transverse ridges on basal ledges. Most teeth with basal ledges notched and with a prominent rounded mesolabial peg. Lateral trunk denticles very widely spaced and only semi–imbricated in large specimens, usually separated by distances greater than their crown lengths. Six gill arches, with hypobranchials 2 to 5 present, hypobranchial 4 enlarged and reflexed distally; basibranchial copula with deep anterior concavities for hypobranchials 4 and 5, with lateral wings for articulation of ceratobranchial 6, and with a joint on its posterior pointed tip. Vertebral counts: total vertebral counts 146 to 157, precaudal vertebral counts 101 to 108, monospondylous vertebral counts 48 to 53. Intestinal valve with 7 to 8 turns. **Colour:** olive brown above, lighter below; no prominent markings.

Local Names: Sixgill sawsharks.

Pliotrema warreni Regan, 1906

Pliotrema warreni Regan, 1906b, *Ann. Natal Mus.*, 1(1): 1, pl. 1. Syntypes: British Museum (Natural History), two specimens each about 750 mm total length, one from "the coast of Natal" (KwaZulu–Natal) at about 73 m depth and apparently received from Dr. E. Warren of the Natal Government Museum (Pietermaritzburg, South Africa); and one from False Bay, Western Cape, South Africa received from Dr. J.D.F. Gilchrist of the University of Cape Town. BMNH–1905.6.8.9 includes one syntype (800 mm long according to Springer and Bullis, 1960, *Bull. Mar. Sci. Gulf Caribb.*, 10(2): 249) or both. Fowler (1941, *Bull. U. S. Natn. Mus.*, (100) 13: 283) and Eschmeyer (2012) list the type locality of the first syntype as "Bird Island, Natal, South Africa". This is questionable as Bird Island in KwaZulu–Natal is inside Lake St. Lucia (where sawfish, not sawsharks, were found). There is also Bird Island in Algoa Bay, Eastern Cape (off which the sixgill sawshark has been collected), which is a more likely locality if the specimen didn't come from KwaZulu–Natal.

Synonyms: None.

Other Combinations: ***Pristiophorus cirratus*** (Latham, 1794).

FAO Names: En – Sixgill sawshark; **Fr** – Requin scie flutien; **Sp** – Tiburón sierra del Cabo.

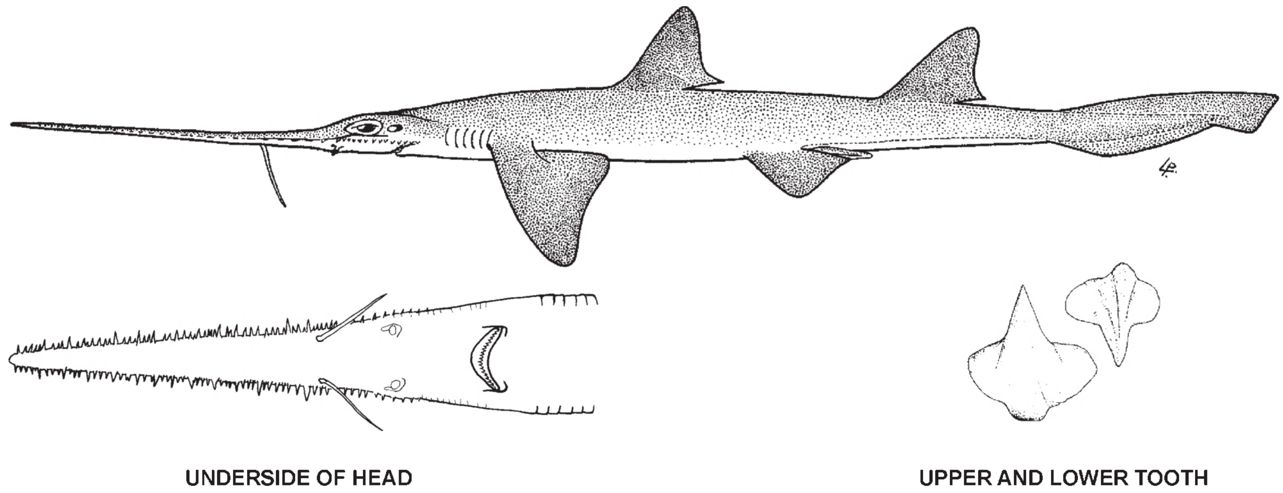


Fig. 162 *Pliotrema warreni*

Field Marks: Small slender sharks with six pairs of gill openings, saw–like snout with barbels and barbed sawteeth, two spineless dorsal fins, and no anal fin.

Diagnostic Features: As for genus.

Distribution: Endemic to South Africa and southern Mozambique, occurring from Table Bay and False Bay (southeastern Atlantic) eastwards to Cape Agulhas (southwestern Indian Ocean), Western Cape Province, to central and northern KwaZulu–Natal, and southern Mozambique and southeastern Madagascar. Intensive trawling by the RV *Africana* during the last three decades between 40 to 500 meters along the west, southwest, and southeast coasts of South Africa suggests that this species normally does not occur along the cold–temperate west coast of South Africa northwards from the Cape Town area, which is influenced by the cold Benguela Current flowing southwards along the coast, but rather the population appears to be concentrated on the Agulhas Bank.

Habitat: A benthic and epibenthic offshore shark, it is mostly found on the Agulhas Bank, but its range extends northwards along the east coast to KwaZulu–Natal, South Africa. It occurs on outer continental shelves and upper slopes in warm–temperate and subtropical waters of southern Africa at depths of 37 to 200 m, but has been recorded to at least 500 m. Distribution off the southern Cape coast of South Africa is bimodal, with most records between 20 to 21° longitude on the outer continental shelf of the Western Cape off Cape Agulhas and Cape Infanta (60 to 160 m, mostly from 70 to 140 m); and between 25 to 27° longitude on the continental shelf and uppermost slope of the Eastern Cape from Algoa Bay to Port Alfred (70 to 290 m, mostly from 80 to 120 m). There are few intermediate records between the two areas, and no records from the deeper slope below 300 m on the Cape coast. The distribution of this shark in Cape waters suggests a restricted habitat (possibly related to feeding?). Off central KwaZulu–Natal it ranges from 73 to 430 m, with most catches below 110 m. It has been taken at 360 m off Delagoa Bay.

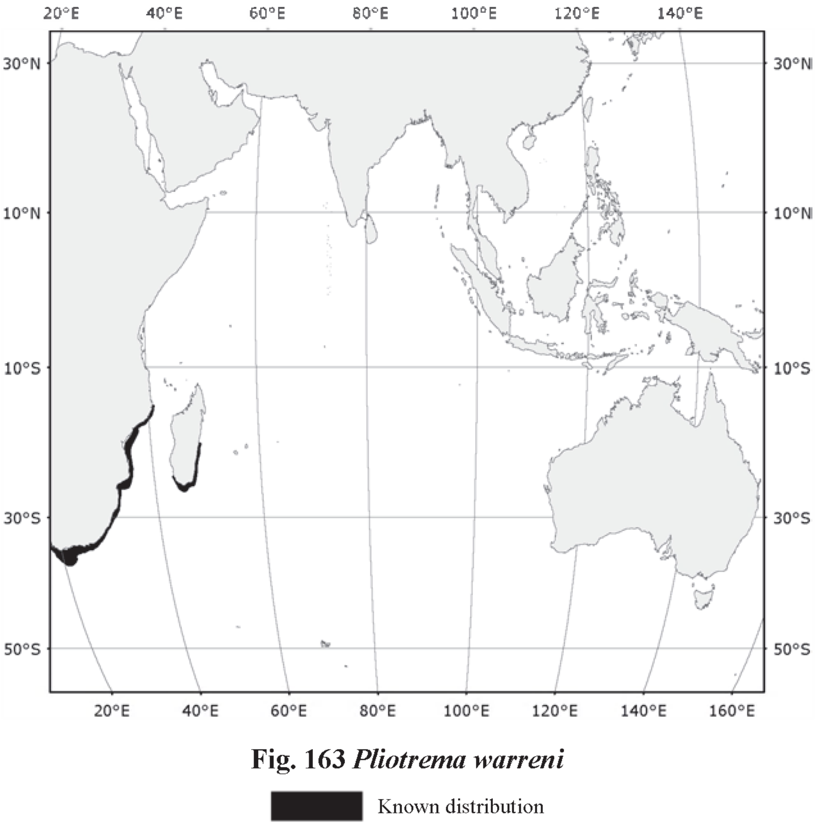


Fig. 163 ***Pliotrema warreni***

Biology: Yolk–sac vivparous, with 5 to 17 young per litter. Adults are partially segregated by depth from young, which occur in shallower water. Females with term fetuses, neonates or small juveniles have been collected in the Eastern Cape (vicinity of Algoa Bay) and off KwaZulu–Natal, suggesting pupping grounds there. Larger individuals including adult males are wider ranging, and have been collected from the Western Cape, South Africa, to southern Mozambique. The behavior of this shark is poorly known.

The sixgill sawshark eats small fish (including ***Champsodon***), crustaceans and squid. Larger individuals may have light parallel cuts and scratches suggestive of combat scars and apparently inflicted by both the oral and rostral teeth of other sawsharks. A live specimen removed from a trawl was observed to swing its head and rostrum violently and quickly from side to side when held just behind the pectoral fins. Predators of the sixgill sawshark are poorly known, but one specimen was found in the stomach of a tiger shark caught off KwaZulu–Natal, South Africa.

Size: Maximum total length at least 136 cm; males maturing at about 83 cm and reaching at least 112 cm; females immature at 68 to 87 cm, maturing at about 110 cm and reaching at least 136 cm. Size at birth between 35 to 37 cm, with free–living specimens at 35 cm and term fetuses up to 37 cm.

Interest to Fisheries and Human Impact: Taken by bottom trawlers as a bycatch of demersal fisheries off South Africa, but not utilized as far as is known and discarded. It probably is not common enough to warrant marketing from bycatch, much less a targeted fishery. It apparently has not been kept in captivity.

The conservation status of the sixgill sawshark is Near Threatened, but should be closely monitored because it is a southern African endemic with a relatively restricted geographic, bathymetric, and habitat range. The sixgill sawshark should be monitored for decreases in abundance as intensive offshore trawl fisheries occur throughout its known range.

Local Names: Sixgill sawshark, Seskief–saaghaai, Saagbek (Afrikaans).

Remarks: Thompson (1914) listed the Australian ***Pristiophorus cirratus*** from Cape Province, South Africa, and noted that Dr. Boulenger of the British Museum (Natural History) had identified a specimen of this species from False Bay. Barnard (1925) thought that the presence of ***P. cirratus*** in South African waters was doubtful, and that Prof. Gilchrist (pers. comm. in Barnard, 1925, p. 53) of the University of Cape Town had suggested that the False Bay specimen possibly was a ***Pliotrema warreni*** of which Boulenger had either overlooked the sixth gill slit or regarded it as an individual aberration. Fowler (1941) listed the South African record of ***P. cirratus*** without comment while Smith (1949) recognized it but noted that it had only been collected once off South Africa. Bass, D'Aubrey and Kistnasamy (1975c) agreed with Gilchrist and Barnard's (1925) opinion on Boulenger's record not being valid. They suggested that as no more records of ***Pristiophorus*** had showed up in southern African waters in fifty years despite extensive collecting it was likely that ***Pristiophorus*** was confined to the central Indo–West Pacific, and that ***Pliotrema warreni*** was the only sawshark in the southwestern Indian Ocean. Bass and Heemstra *in* Smith and Heemstra (1986) noted that Boulenger's False Bay specimen was one of the syntypes of Regan's ***Pliotrema warreni***, and hence confirmed Gilchrist's and Barnard's suggestion. Survey data from the RV *Africana* suggests that the only sawshark normally present in Cape waters between Cape Agulhas and Port Alfred is ***Pliotrema warreni***.

Literature: Regan (1906a, b); Thompson (1914); Barnard (1925); Fowler (1941); Smith (1949); Bass, D'Aubrey and Kistnasamy (1975c); Compagno (1984a); Bass and Heemstra *in* Smith and Heemstra (1986); Compagno, Ebert and Smale (1989); Compagno, Ebert and Cowley (1991); Fowler (2004); Ebert and Cailliet (2011); Ebert and Compagno (In press); J.J. Bizzarro, L.J.V. Compagno, D.A. Ebert, and R. Leslie, *unpublished data*.

Pristiophorus Müller and Henle, 1837

Genus: ***Pristiophorus*** Müller and Henle, 1837a, *Ber. K. preuss. Akad. wiss. Berlin*, 2: 116. Also Müller and Henle, 1837b, *Arch. Naturg.* 3: 399; Müller and Henle, 1838, *Mag. Nat. Hist., n. ser.*, 2: 89 ("***Pristis cirrhatus***, Latham" designated as type species); Müller and Henle, 1838, L'Institut, 6: 65; Müller and Henle, 1839, *Syst. Beschr. Plagiost.*, pt. 2: 97.

Type species: ***Pristis cirratus*** Latham, 1794, by monotypy.

Number of Recognized Deep–sea Indian Ocean Species: 1.

Synonyms: Genus ***Pristidophorus*** Bonaparte, 1838: 206. Emended or erroneous spelling of ***Pristiophorus*** Müller and Henle, 1837a.

Field marks: Small slender sharks with five pairs of gill openings, saw–like snout with barbels and smooth–edged sawteeth, two spineless dorsal fins, and no anal fin.

Diagnostic Features: Barbels more anteriorly situated on snout than in ***Pliotrema***, prebarbel snout 40 to 61% of preoral length and usually less than 60%. Rostral sawteeth without posterior barbs. Five pairs of gill slits. Teeth without prominent transverse ridges, notches, or mesolabial pegs on basal ledges. Lateral trunk denticles imbricated or closely adjacent. Five gill arches, with hypobranchials 2 to 4 present, hypobranchial 4 small and straight; basibranchial copula with shallow concavities for hypobranchial 4 but no lateral wings for articulation of ceratobranchial 5, and without a joint on its posterior pointed tip. Vertebral counts: total vertebral counts 132 to 156, precaudal vertebral counts 90 to 105, monospondylous vertebral counts 42 to 55. Intestinal valve with 6 to 10 turns. **Colour:** brown to brownish grey, light grey or yellowish above, light below.

Local Names: Five–gilled sawsharks, Saw sharks.

Remarks: The present systematic arrangement of ***Pristiophorus*** follows Last and Stevens (2009), Ebert and Cailliet (2011), and Ebert and Compagno (In press) with modifications. Last and Stevens (2009) revised the Australian sawsharks which included a new species, ***P. delicatus*** (formerly ***Pristiophorus*** sp. B of Last and Stevens, 1994) and synonymized ***Pristiophorus*** sp. A with ***P. cirratus***. Ebert and Cailliet (2011) described ***P. nancyae*** (formerly ***Pristiophorus*** sp. D of Compagno, Dando and Fowler, 2005) from the southwestern Indian Ocean. The genus has six nominal species with at least one, possibly two, additional undescribed Indo–West Pacific species.

In the Indian Ocean, only ***P. nancyae*** is considered a deep–sea inhabitant, two other species, ***P. cirratus*** and ***P. nudipinnis***, occur mostly on shallow continental shelf waters off southern and Western Australia.

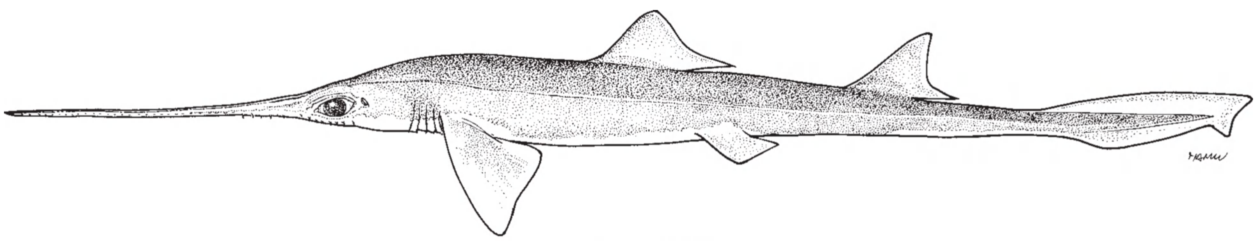
Pristiophorus nancyae Ebert and Cailliet, 2011

Pristiophorus nancyae Ebert and Cailliet, 2011, *Bull. Mar. Sci.* 87(3): 502. Holotype: South African Museum, 61.6 cm TL, mature male, R/V Algoa, Mozambique Scad Survey, bottom trawl, Station C00840 014 037 3074, 22° 07′ S, 35° 45′ E, 500 m, 19 June 1994.

Synonyms: ***Pristiophorus*** sp. D Compagno, Dando and Fowler, 2005: 135, ill., pl. 16.

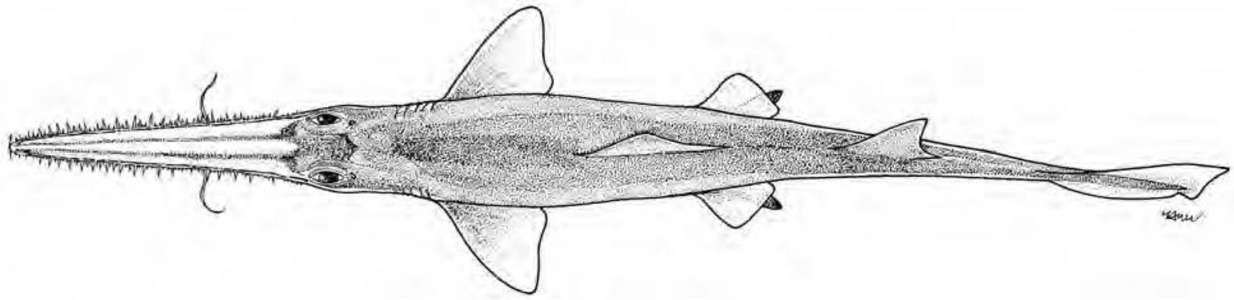
Other Combinations: None.

FAO Names: En – African dwarf sawshark.

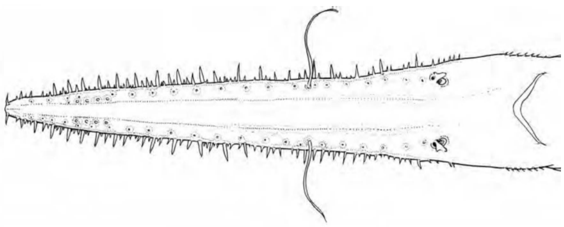


LATERAL VIEW

Fig. 164 ***Pristiophorus nancyae***



DORSAL VIEW



UNDERSIDE OF HEAD

Field Marks: A dwarf five–gilled sawshark with a broad, triangular first dorsal fin with a rear tip that extends behind the pelvic–fin midbases, barbels much closer to mouth than snout tip, two rows of enlarged pits on the underside of the prebarbel rostrum, ridges on the base of its large lateral rostral teeth, mostly tricuspidate, flat, imbricated lateral trunk denticles, and plain colour pattern.

Diagnostic Features: Rostrum long, narrow, and tapering, preoral length 28 to 30% of total length. Sides of rostrum slightly convex from tip to barbels and nearly straight between barbels and nostrils. Ratio of preorbital length to width of rostrum at nostrils 4.1 to 5.0. Two parallel rows of 4 or 5 enlarged pits present on underside of prebarbel snout. Barbels closer to mouth than rostral tip, prebarbel length 58 to 61% of preoral length. Space from barbel to nostril 0.7 to 0.9 times space from nostril to first gill opening. Barbels ending 0.2 to 0.5 of eye length anterior to nostrils in adults, posterior to them by 0.3 to 0.7 of eye length in young. Twenty to thirty-two large lateral rostral sawteeth along sides of snout and head, including 14 to 24 teeth in front of barbels and 6 to 10 teeth behind barbels. Postnarial lateral rostral teeth extending 0.1 to 0.5 times eye length behind eye. Juveniles below 40 cm with 1 to 3 smaller teeth between large lateral rostral sawteeth, adults with up to 4. Prominent longitudinal ridges on bases of lateral and ventral rostral teeth. Thirteen to eighteen ventral rostral teeth in front of barbels and 5 to 7 between barbels and nostril. A ventral rostral tooth in front of nostril but this not enlarged. Spiracles small, width 0.2 to 0.4 of eye length. Nostril excurrent apertures transversely oval, nearly circular. Distance from nostrils to mouth 1.1 to 1.3 times internarial space. Distance from nostrils to barbels 1.1 to 1.4 times distance between nostrils and mouth corners. Mouth extending forward to below posterior third or fourth of eye. Tooth rows 31 to 36 in upper jaw. Body slender in adults. Lateral trunk denticles closely imbricated, with flat mostly tricuspidate crowns. Outer margins of dorsal and pectoral fins densely covered with fine denticles in young and adults. Pectoral–fin anterior margins 32 to 38% of preoral length. First dorsal fin broad and triangular with apex anterior to insertion and posterior margin slanting posteroventrally. First dorsal–fin origin opposite pectoral–fin free rear tips or in front of them by 0.5 eye length or less, insertion over pelvic–fin origins or slightly anterior to them by less than a fourth of fin base, free rear tip extending far posterior and about opposite or slightly in front or behind pelvic–fin insertions and behind pelvic–fin midbases. Second dorsal fin subequal to first, with base shorter but height as great or greater. Second dorsal–fin origin behind pelvic–fin insertions by distance about 0.4 to 1.0 times first dorsal–fin base. Total vertebral counts 132 to 139, monospondylous vertebral counts 42 to 45, precaudal vertebral counts 90 to 93. Intestinal valve with 6 or 7 turns. A very small sawshark, maximum total length of adults about 62 cm. **Colour:** uniform medium brown above, no colour pattern, white below, dark brown stripes on middle of light rostrum and on edges of rostrum, lateral rostral teeth dark–edged, ventral rostral teeth dark and conspicuous against light underside of snout; pectoral and dorsal fins with dark anterior margins, more conspicuous in juveniles than adults, and prominent light posterior margins.

Distribution: A deepwater sawshark from off Mozambique, Somalia, the Arabian Sea, and off Pakistan, but this latter region needs to be confirmed.

Habitat: Occurs in deepwater off central and southern Mozambique at 286 to 500 m, but nothing else known.

Biology: Reproductive mode is yolk–sac viviparity, but nothing else known. Diet unknown, but presumed to include small bottom fishes and crustaceans.

Size: Maximum total length at least 62 cm; males mature at 52 to 62 cm; females mature at about 57 cm. Size at birth uncertain, but smallest free–swimming specimen measured 31 cm in length.

Interest to Fisheries and Human Impact: None at present, but probably caught and discarded as bycatch by offshore shrimp trawlers and other deepwater fisheries operations off Mozambique.

The conservation status of this species has not been assessed.

Local Names: None.

Literature: Compagno, Dando and Fowler (2005); Ebert and Cailliet (2011).

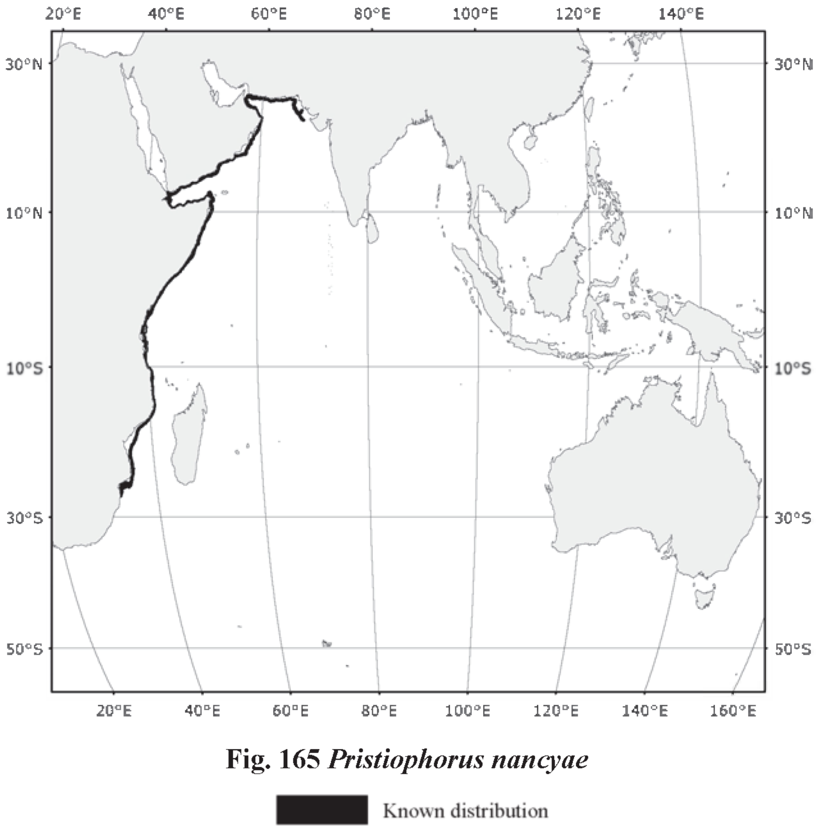


Fig. 165 ***Pristiophorus nancyae***

2.4 Order SQUATINIFORMES – Angel sharks

Order: Tectospondyli, Suborder Squatinoidei: Jordan, 1923, *Stanford Univ. Publ., Univ. Ser., Biol. Sci.*, 3: 102, emended to Order Squatiniformes.

Number of Recognized Deep–sea Indian Ocean Families: 1.

Synonyms: [Part] 1 Squali, Abtheilung [Division] 3: Müller and Henle, 1839: 83. Ordo Plagiostomi, Subordo Squalini, Sectio Aproctopterides: Bleeker, 1859: xii. Order Squali, Suborder Rhinae: Gill, 1862: 395, 397; Gill, 1872: 23. Order Plagiostomi Diplospondyli, Suborder Plagiostomi Tectospondyli, Group 1 Squalorajae: Hasse, 1879: 44. [group] Rhinae Garman, 1885: 30. Order Selachii, Suborder Tectospondyli: Woodward, 1889: 30. Order Asterospondyli, Suborder Rhinae: Gill, 1893: 129. Order Cyclospondyli, Suborder Tectospondyli: Jordan and Evermann, 1896: 53, 58. Order Euselachii, Suborder Pleurotremata, Division Squaloidei: Regan, 1906a: 723. Order Selachii, Group 2, Division B, Subdivision 2, Suborder Rajiformes, Tribe 1: Goodrich, 1909, *In* R. Lankester, *ed.*: 155. Order Pleurotremata, Suborder Squaloidei: Engelhardt, 1913: 100. Order Plagiostoma, Suborder Antacea, “Group” Rhinoidei: Garman, 1913: 11, 13. Order Plagiostomi, Suborder Rhiniformes or Riniformes: Lozano y Rey, 1928: 280. Order Squalea, Suborder Rhinida, Superfamily Rhinoidea: White, 1936: 5; White, 1937: 37, tab. 1. Order Euselachii, Suborder Squatiniformes: Bertin, 1939: 10. Order Squaliformes, Suborder Squatinoidei: Berg, 1940: 138; Berg and Svetovidov, 1955: 68; Arambourg and Bertin, 1958, *In* P.–P. Grasse, *ed.*: 2044; Nelson, 1984: 59. Order Squatinoidei, Superfamily Squatinoidea: Whitley, 1940: 69. Order Squatinae: Fowler, 1941: 4, 279; Smith, 1949: 37, 60. Order Selachii, Suborder Squaloidea: Romer, 1945: 577; Romer, 1966: 350. Order Selachii, Suborder Squatinoidea: Bigelow and Schroeder, 1948: 77, 532. Order Squaloidea, Suborder Squatinoidea: Schultz and Stern, 1948: 225. Order Lamnida, Suborder Squatinina: Matsubara, 1955: 1–789. Order Pleurotremata, Suborder Squaloidea: Norman, 1966: 24. Order Squatinida, Suborder Squatinoidei: Glikman, 1967, *in* Y. A. Orlov, *ed.*: 217. Order Lamniformes, Suborder Squatinoidei: Patterson, 1967, *in* W. B. Harland *et al.*: 672. Order Euselachii, Suborder Squatinoidei: Blot, 1969, *in* J. Piveteau, *ed*: 702–776. Order Squalida, Suborder Squatinina: Fowler, 1969: 74. Order Pleurotremata, Suborder Squaliformes: Budker and Whitehead, 1971: 6, tab. 2. Order Squaliformes, Suborder Squatinoidei: Lindberg, 1971: 8, 260; Nelson, 1976: 40. Order Squatiniformes: Rass and Lindberg, 1971: 304; Compagno, 1973a: 27; Applegate, 1974: 743; Chu and Meng, 1979: 114, tab. 2; Compagno, 1984a: 138; Cappetta, 1987: 26, 68; Eschmeyer, 1990: 437; Shirai, 1992a: 122; Nelson, 1994: 56; de Carvalho, 1996, *in* Stiassny *et al.*: 55; Shirai, 1996, *in* Stiassny *et al.*: 34; Eschmeyer, 2012. Order Squatiniformes, Suborder Squatinoidea: Chu and Meng, 1979: 114, tab. 2. Order Squalomorpha, Suborder Squatinoidea: Carroll, 1988: 599.

Field Marks: Sharks with a flattened batoid–like form but with free anterior pectoral lobes lateral to gills and lower lobe of caudal fin longer than upper lobe.

Diagnostic Features: Head greatly depressed and expanded laterally. Snout extremely short and truncated, without lateral teeth or rostral barbels. Eyes dorsolateral on head, without nictitating lower eyelids, secondary lower eyelids, or subocular pouches; upper eyelids not fused to eyeball. Spiracles large, close behind and at level of eyes. Five pairs of gill openings present on sides of head, with the posteriormost in front of pectoral–fin origins. Nostrils terminal on snout, with barbels on anterior nasal flaps but no nasoral grooves or circumnarial grooves; nostrils separate from mouth but with anterior nasal flaps overlapping mouth. Mouth large, terminal on head, broadly arched and subangular, terminating about opposite or slightly behind eyes. Labial furrows very large and present on both jaws. Teeth moderately differentiated along the jaws, with slightly enlarged anterior teeth, no enlarged molariform posterior teeth, and without a gap or small intermediate teeth between anterior and lateral teeth in the upper jaw; teeth with orthodont histological structure. Trunk greatly depressed and raylike. Caudal peduncle without elongated lateral dermal ridges but with short thick keels at the caudal base. Dermal denticles either covering entire body or absent from lower surface, some denticles more or less enlarged as thorns or spines on head and midline of back. Pectoral fins very large, expanded and raylike, with unique triangular anterior lobes that cover the gill openings. Pectoral girdle (scapulocoracoid) low, wide, C–shaped and depressed, without a medial joint, and with superscapulae directed posterodorsomedially and not contacting vertebral column. Pectoral–fin skeleton tribasal, with propterygium in contact with radials and metapterygium without a proximal segment; pectoral fins semiplesodic, with radials partially extending into fin webs; radial counts 47 to 52 with mostly 4 or 5 but up to 8 segments. Pelvic fins very large, with inner margins lateral to vent. Claspers with siphons in the abdomen below the pelvic–fin bases but without clasper sacs; clasper glans lacking a pseudosiphon or clasper spurs or spines but with a cover rhipidion and rhipidion; dorsal and ventral marginals of clasper skeleton well–developed but not rolled into a tube for the clasper canal. Two spineless dorsal fins present, with origin of first on tail over or behind pelvic–fin free rear tips. Anal fin absent. Caudal fin with a long dorsal lobe and an expanded ventral lobe; vertebral axis depressed into the ventral caudal lobe (hypocercal caudal fin). Vertebral counts: total vertebral counts 119 to 146, monospondylous vertebral counts 43 to 52, diplospondylous vertebral counts 48 to 65, precaudal vertebral counts 90 to 115, caudal vertebral counts 26 to 31. Intestinal valve of conicospiral type, with 7 to 12 turns. Medium sized sharks from just over 100 cm to about 240 cm in length. **Colour:** light grey to brown, reddish brown, or tan above, usually lighter below; most species have some saddles spots, or blotches on dorsal surface.

Distribution, Biology, Size, Interest to Fisheries and Human Impact: See family Squatinidae.

Remarks: The Squatiniformes or angel sharks are a small but bizarre and highly distinctive group of raylike sharks that have usually been recognized as a discrete taxon at the genus, family, and higher level. The order consists of a single family and a monotypic genus, with about 20 valid species recognized worldwide.

2.4.1 Family SQUATINIDAE

Family: Subfamily Squatinini Bonaparte, 1838, *Nuov. Ann. Sci. Nat., Bologna, ser*. 1, 2: 206 (Family Squalidae). Also Subfamily Squatinae Swainson, 1839, *Nat. Hist. Fish. Amphib. Rept., Monocard. Anim*., 2: 321 (Family Raidae Swainson, 1839), and Family Squatinae Müller and Henle, 1841, *Syst. Beschr. Plagiost*., pt. 3: 99.

Type genus: ***Squatina*** Duméril, 1806.

Number of Recognized Deep–sea Indian Ocean Genera: 1.

Synonyms: Family Rhinoidae Gill, 1862: 396, 408; also Family Rhinidae Garman, 1913: 11, 13, 248. Not "Gruppe" Rhinae Müller and Henle, 1841: 110; or Tribe Rhinae Gray, 1851: 91; type genus ***Rhina*** Bloch and Schneider, 1801 (a batoid).

FAO Names: En – Angelsharks, Sand devils; **Fr** – Anges de mer; **Sp** – Angelotes, Peces ángel.

Field Marks: See order.

Diagnostic Features: See order.

Distribution: Angel sharks are found primarily in continental waters, in the eastern North and South Pacific, western North and South Atlantic, eastern Atlantic, extreme southwestern and southeastern Indian Ocean, temperate western North and South Pacific, but are not known from most of the Indian Ocean or in the Central Pacific reaches of Oceania.

Habitat: Angel sharks have a mostly amphitemperate range, with few species being known from tropical equatorial waters, but several occur in warm temperate seas and a few range into cold northern boreal waters. They range in depth from close inshore down to about 1300 m on the continental slopes. They are often found buried in mud and sand on the bottom during the daytime, but are night–active and may swim off the bottom after dusk.

Biology: Most angel shark species are sketchily to poorly known biologically. The reproductive mode is viviparous with a yolk sac and they may have litters from 1 to 25 young, but very little is known of their reproductive cycle. Those species where some information is available appear to have an annual cycle with birth usually occurring in the spring and summer months. Most angel sharks are of moderate size, 120 to 160 cm, but at least one European species may exceed 200 cm. Attempts to age these sharks using vertebral centra have been unsuccessful since it has been shown in at least two species that the banding is not temporal. Angel sharks feed on a variety of small bony fishes, crustaceans, cephalopods, gastropods and bivalves, and use their flexible 'necks' and highly protrusible, trap–like jaws to suddenly raise their heads and snap up prey above or in front of them at high speed.

Interest to Fisheries and Human Impact: Several angel shark species are intensively fished, especially by bottom trawl, line gear and fixed bottom nets, as both targeted catch and bycatch of trawl fisheries for other demersal fishes. World catch of angel sharks averaged approximately 5275 tonnes according to FAO with an increase of 63% in landings from 3375 tonnes in 2000 to 6335 tonnes in 2009, with a high of 6835 tonnes in 2007. The actual landed catch of angel sharks is probably much greater because many countries where angel sharks are caught do not report separate statistics for them. They are used for human consumption, oil, fishmeal, leather and shagreen for woodworking and artistry. Shagreen of certain angel sharks is of use in preparing the bristles of artistic brushes in the Orient.

Angel sharks are harmless to people unless disturbed or provoked, but if aroused they can bite and are capable of causing serious cuts with their small but sharp teeth and strong jaws. Their relatively small size and bottom habitat makes them of little concern to swimmers and bathers, and they primarily pose a minor hazard to fisheries personnel that have to remove live individuals from demersal fishing gear.

The conservation status of angel sharks is Threatened or higher for most species, with some species assessed as Critically Endangered. In those areas where fisheries for angel sharks have occurred, the fishery usually collapses within a few years.

Local Names: Angel sharks, Angelsharks, Angelfish, Monkfishes (English), Engelhaai (South Africa), Anjos (Mozambique), Angeli morskie (Russia), Kasuzame–ka (Japan).

Remarks: A single genus, with about 20 nominal valid species worldwide. Three deep–sea species occur in the Indian Ocean.

Literature: Regan (1908b); Garman (1913); Marini (1936); Fowler (1941, 1969); Compagno (1973a, 1977, 1984a); Capapé and Roux (1980); Vooren and da Silva (1991); Caillet, Holts and Bedford (1992); Cailliet *et al*. (1992); Shirai (1992a, c, 1996); de Carvalho (1996); Walsh and Ebert (2007); Last and Stevens (2009); Walsh, Ebert and Compagno (2011); Ebert and Compagno (In press).

List of Deep–sea Species Occurring in the Area:

Squatina africana Regan, 1908
Squatina pseudocellata Last and White, 2008
Squatina tergocellata McCulloch, 1914

Squatina Duméril, 1806

Genus: ***Squatina*** Duméril, 1806, *Zool. Analyt*.: 102. No species. Genus ***Squatina*** Duméril *in* Risso, 1810, *Ichthyol. Nice, Paris*: 45.

Type species: ***Squatina vulgaris*** Risso, 1810, by subsequent monotypy; a junior synonym of ***Squalus squatina*** Linnaeus, 1758 and unnecessary replacement according to Eschmeyer (1998), who also noted that Duméril applied the species name ***angelus*** to ***Squatina*** in 1806, with ***S. angelus*** an unneeded substitute for ***S. squatina***. If correct this shifts the type allocation from Risso to Duméril. ***Squatina*** was originally proposed by Valmont, 1768, *Dict. Hist. Nat.* 1: 117, without species, but Valmont's names are unavailable by ruling of the International Commission on Zoological Nomenclature (Opinion 89, 1925: 27).

Number of Recognized Deep–sea Indian Ocean Species: 3.

Synonyms: Genus ***Rhina*** Rafinesque, 1810: 14. Type species: "***Squalus squatinus***" Linnaeus, 1758, by original designation. A junior homonym of ***Rhina*** Bloch and Schneider, 1801 (a batoid). Genus ***Squatina*** Blainville, 1816: 121. Type species: ***Squatina angelus*** Blainville, 1816, by monotypy. Genus ***Rhina*** Klein, *in* Gill, 1862: 408. Type species: "***Rhina squatina*** Raf." by designation of Gill, 1862, equals ***Squalus squatina*** Linnaeus, 1758. Also ***Rhina*** Klein, *in* Garman, 1913: 5, 250. Both are revivals of ***Rhina*** Schaeffer, 1760: 20; Klein, 1776: 587; and Walbaum, 1792: 580. Schaeffer's ***Rhina*** had no species, according to Bigelow and Schroeder (1948: 534, ftn. 12). Klein and Walbaum's names are unavailable by rulings of the International Commission on Zoological Nomenclature (Opinion 21, 1910: 51; Opinion 89, 1925: 27.). ***Rhina*** Klein in Gill and Garman are junior homonyms of ***Rhina*** Bloch and Schneider, 1801 (a batoid). Genus ***Squalraia*** de la Pylaie, 1835: 526. Type species: ***Squalraia acephala*** de la Pylaie, 1835, = ***Squalus squatina*** Linnaeus, 1758, by subsequent designation of Jordan (1919: 183).

Field Marks: See order.

Diagnostic Features: See order.

Local Names: Angel sharks, Angelsharks (English), Engelhaai (South Africa), Anjos (Mozambique).

Remarks: The genus is relatively sketchily known in the Indian Ocean.

Key to Deep–sea Indian Ocean Species:

1a. Paired ocelli present on back, tail and pectoral fins (Fig. 166) . . . . ***Squatina tergocellata***

1b. No ocelli on dorsal surface **2**

2a. Nasal barbels strongly bifurcate (Fig. 167) . . . . ***Squatina pseudocellata***

2b. Nasal barbels weakly or not bifurcate (Fig. 168) . . . . ***Squatina africana***

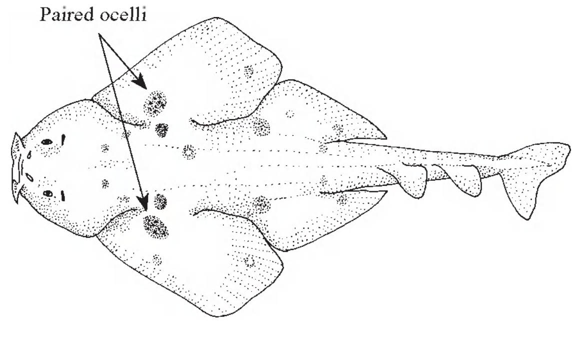


Fig. 166 *Squatina tergocellata*

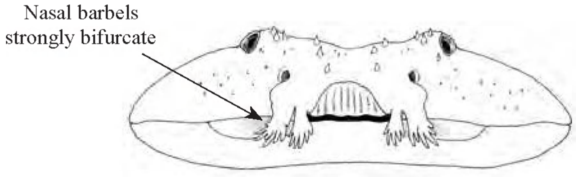


Fig. 167 *Squatina pseudocellata*

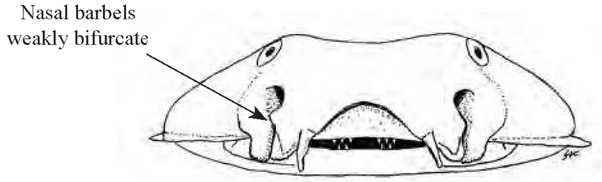


Fig. 168 *Squatina africana*

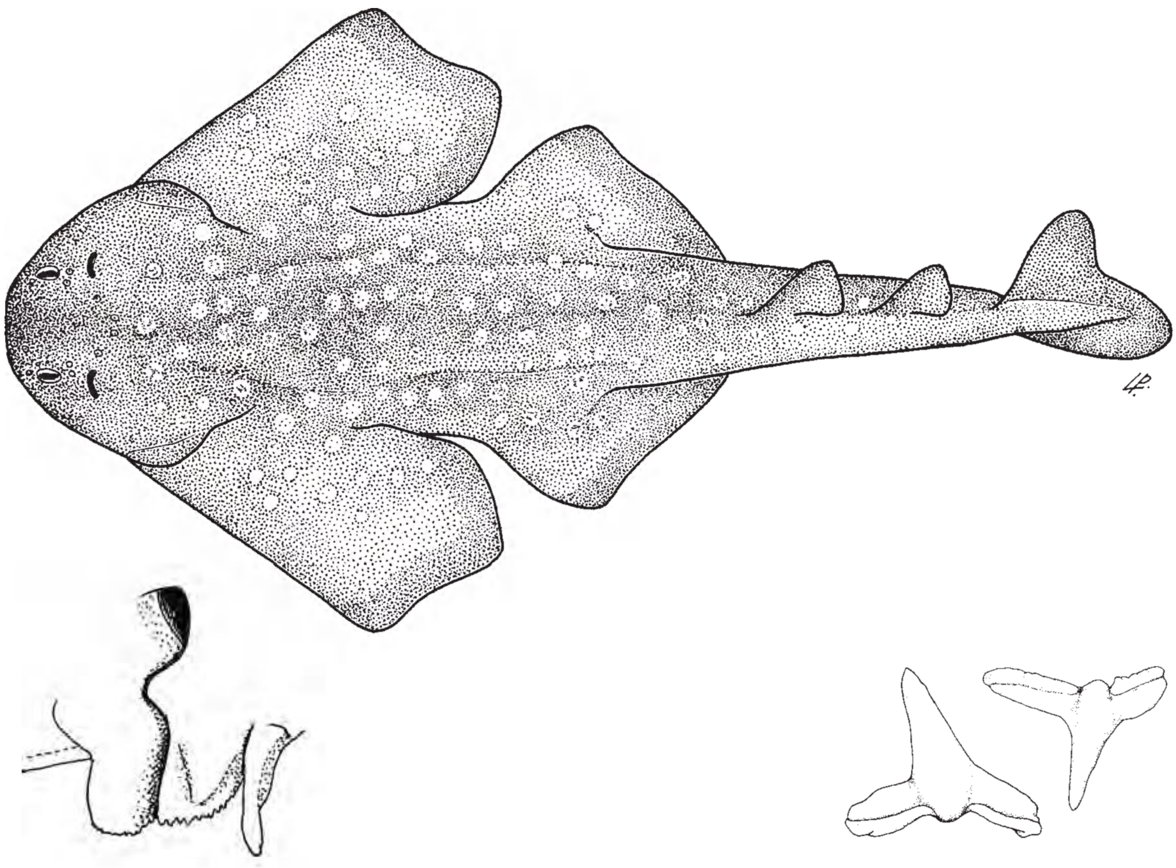
Squatina africana Regan, 1908

Squatina africana Regan, 1908b, *Ann. Natal Gov. Mus.* 1(3): 248, pl. 38. Holotype: British Museum (Natural History), BMNH 1906.11.19.21, 800 mm male, Durban Bay, Natal, South Africa.

Synonyms: None.

Other combinations: ***Rhina africana*** (Regan, 1908b).

FAO Names: En – African angelshark; **Fr** – Ange de mer africain; **Sp** – Angelote africano.



DETAIL OF NOSTRIL **UPPER AND LOWER TOOTH**

Fig. 169 ***Squatina africana***

Field Marks: An angel shark with simple, flat nasal barbels with tapering or spatulate tips, smooth or moderately fringed anterior nasal flaps, lateral dermal flaps without angular lobes, broad, angular high pectoral fins, no enlarged predorsal thorns on back, numerous light and dark spots on the dorsal surface, and often large ocelli with granular centres on body.

Diagnostic: Interorbital space concave. Head width about 3.3 to 4.0 in precaudal length. Head length to notch 3.8 to 4.7 in precaudal length and 1.1 to 1.4 in head width. Lateral head folds low, without triangular lobes. Eye length 3.1 to 4.0 in interorbital space; preorbital length greater than eye length; eye–spiracle space usually less than but sometimes equal to eye length. Spiracle width greater (1.2 to 1.4 times) than eye length; spiracles with 14 pseudobranchial folds. Interspiracular space sometimes subequal to interorbital space but usually slightly less than it (1.1 to 1.3 times in interorbital). Nasal barbels simple, flat, with fairly narrow, tapering or spatulate tips and weakly fringed bases; posterior edges of anterior nasal flaps smooth or moderately fringed; tips of anterior nasal flaps expanded as a simple narrow–based unfringed lobe; posterior nasal flaps greatly enlarged and moderately fringed. Nostril width 3.7 to 4.8 in internarial width. Exposed upper lip between bases of anterior nasal flaps forming a narrow high, rounded or subangular arch in frontal view. Tooth row counts 20 to 22 upper jaw, 18 to 20 lower jaw. Body relatively stocky, width at pectoral–fin insertions about 0.8 to 1.0 times head length to upper notch and 4.7 to 5.3 in precaudal tail. Tail length from pelvic–fin insertions to upper caudal–fin origin 1.0 to 1.1 times trunk length from pectoral–fin origins to pelvic–fin insertions. Moderately large thorns present on snout, on interorbital space above and medial to eyes, and with a pair between spiracles in young but formed as clusters of more numerous large denticles in adults; enlarged predorsal thorns absent from midline of back although denticles there may be slightly enlarged. Dorsal denticles closely spaced but not closely imbricated, forming a rough surface; denticles with a slender (young) to thick, posteriorly hooked cusp (adults) and with 4 ridges and distal scalloping. Adult males with enlarged thorns on anterior dorsal margins of pectoral fins and a few on pelvic fins. Underside of body without denticles except for anterior margins of pectoral fins, apices of pelvic fins, clasper shafts in adult males, and underside of precaudal tail. Angle of pectoral–fin apex narrowly obtuse, usually slightly greater than a right angle. Pectoral–fin anterior margins straight, not forming a distinct anterior shoulder, apices angular to narrowly rounded, posterior margin shallowly concave, rear tips usually broadly rounded or sometimes narrowly rounded, inner margins broadly convex and rounded. Distance from anterior tip of pectoral to insertion about 0.6 of maximum pectoral length from anterior tip to free rear tip; maximum pectoral length about 27.8 to 32.3% of maximum total length to tip of lower caudal lobe. Free rear tip of pectoral fin usually closer to pelvic–fin origin than pelvic–fin apex, sometimes about equidistant. First dorsal–fin origin sometimes about opposite pelvic–fin free rear tips but often somewhat posterior to them; first dorsal–fin base about 1.7 to 2.4 in interdorsal space and 1.7 to 2.4 times in postdorsal space. Postventral caudal margin oblique. Vertebral counts: total vertebral counts 121 to 143, precaudal vertebral counts 93 to 108, monospondylous vertebral counts 43 to 47, diplospondylous precaudal vertebral counts 50 to 58. A moderate sized angel shark, maximum total length about 122 cm. **Colour:** greyish or reddish brown dorsally, white below and sometimes with dark blotches on the pectoral–fin margins; small symmetrical or irregular white spots or flecks without dark edges sparsely scattered on dorsal surface between ocelli; numerous small darker brownish spots scattered more or less regularly on dorsal surface, also larger symmetrical dark blotches and spots on pectoral fins and in transverse bands or irregular saddles on head, back, tail, and below dorsal fins; young with numerous small white ocelli on dorsal surface in symmetrical patterns, with light or dark internal spots, while larger specimens have fewer small ocelli but also have a few large ocelli with dark central reticulations on white backgrounds that resemble mitotic figures; pectoral and pelvic–fin webs with light or boldly white anterior and posterior margins; dorsal fin bases and webs paler than body, with irregular dark brown and white spots; caudal fin with dark base, dorsal and preventral margins, web light and freckled with small dark and light spots, no dense dark spotting, caudal margins conspicuously white.

Distribution: Tropical and warm temperate waters of the western Indian Ocean: Cape coast of South Africa, exceptionally west to Mossel Bay and Knysna, but more regularly from Algoa Bay north to KwaZulu–Natal; also Mozambique, southern Madagascar and Tanzania, and possibly Somalia (Socotra Island). A common shark in the coastal waters of KwaZulu–Natal, but uncommon to rare elsewhere, although this may be an artefact do to the regional remoteness throughout much of its distribution. Intensive bottom trawling between Cape Agulhas and Port Alfred below 30 m depth by the RV *Africana* suggests that the African angelshark seldom occurs offshore in southern Cape waters and usually is found from Algoa Bay and Port Alfred northeastwards. It is apparently rare or absent from the Agulhas Bank east of Cape Agulhas and absent from the Atlantic coast of South Africa west of Cape Agulhas.

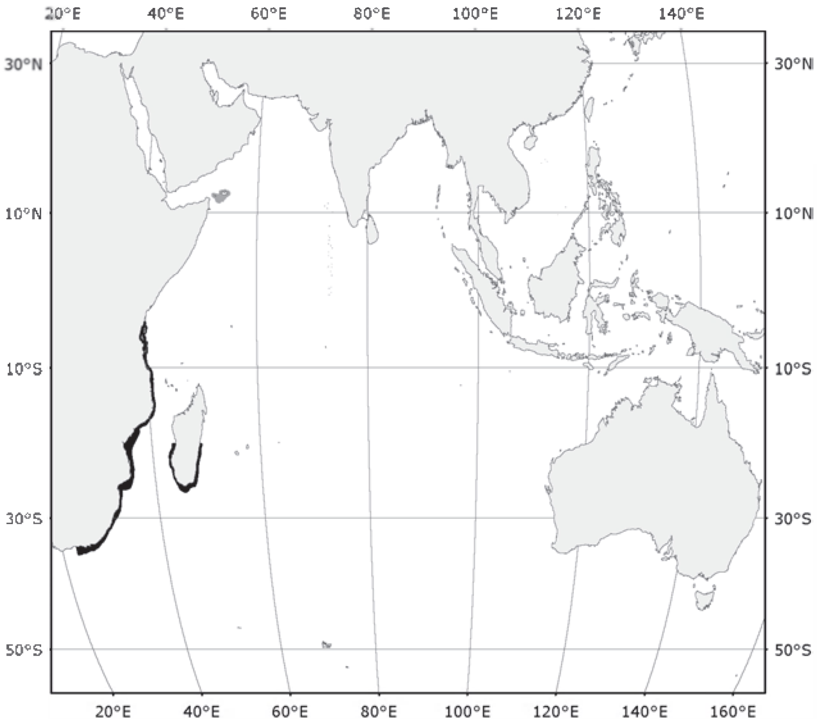


Fig. 170 *Squatina africana*

Known distribution Possible distribution

Habitat: A benthic and epibenthic shark on the continental shelf and uppermost slope, ranging in depth from the surf line close inshore to 494 m depth, with most occurring between 60 to 300 m depth. In KwaZulu–Natal, South Africa, it occurs inshore off open beaches, near river mouths, and on offshore banks, but not in estuaries. It apparently favours sand and muddy bottom where it buries itself in the substrate with eyes and spiracles protruding, and will suddenly lunge to capture prey.

Biology: Development is yolk–sac viviparity, with the number of young per litter ranging from 1 to 12 and an average of 6. Mating appears to take place in February and March, embryos of various sizes are present from April through January, but the largest embryos are typically found in October. Gestation appears to take about 12 months. The Tugela Banks, an offshore region, appears to be a nursery ground for this species as neonates are commonly taken as bycatch in the prawn trawl fishery. Diet consists of small bony fishes (mainly Carangidae, Haemulidae, and Sparidae), squid (***Loligo*** spp.), cuttlefish (***Sepia*** spp.), octopi and large decapod crustaceans (shrimp).

Size: Maximum total length about 122 cm. Males adult at 77 to 95 cm, females adult at 82 to 107 cm and reaching about 122 cm. Size at birth between 28 to 30 cm.

Interest to Fisheries and Human Impact: Interest to fisheries limited, often caught as bycatch by bottom trawlers, and less commonly by surf anglers and by the anti–shark gillnets off the beaches of KwaZulu–Natal, South Africa; between 1980 and 2001 the shark nets averaged 30 individuals per year. Not utilized as far as known, with catches discarded. It is listed by the South African Angling Union as a record fish, but not internationally.

The conservation status is Data Deficient but its abundance should be monitored because of its occurrence in areas subjected to intensive demersal trawling off South Africa and Mozambique.

Local names: African angel shark, Angelshark, Platanner, Afrikaanse engelhaai (South Africa), Anjo africano (Mozambique).

Remarks: Specimens from the East African tropics need to be compared with southern African material to determine if only one species is represented.

Literature: Regan (1908b); Gilchrist and Thompson (1916); Barnard (1925); Belloc (1934); Fowler (1936, 1941); Smith (1949); Bass, D'Aubrey, Kistnasamy (1975c); Compagno (1984a); Bass *in* Smith and Heemstra (1986); Compagno, Ebert and Smale (1989); Timokhin and Usachev (1993); Cliff (2004); Shelmerdine and Cliff (2006); Ebert and Compagno (In press).

2.5 Order HETERODONTIFORMES – Bullhead sharks

Order: [Group] Heterodonti Garman, 1885, *Bull. Mus. Comp. Zool. Harvard*, 21(1): 30, emended to Order Heterodontiformes.

Number of Recognized Deep–sea Indian Ocean Families: 1.

Synonyms: [Part] 1 Squali, Abtheilung [Division] 2: Müller and Henle, 1838: 27; Müller and Henle, 1839: 27; also [Part] 1 Squali, Abtheilung [Division] 2, Unterabtheilung [Subdivision] 3: Müller and Henle, 1839: 66. Ordo Plagiostomi, Subordo Squalini, Sectio Proktopterides, Tribus Dinotopterini: Bleeker, 1859: xi. Order Squali, Suborder Squali: Gill, 1862: 396. Order Squali, Suborder Galei: Gill, 1872: 23. Order Plagiostomi Diplospondyli, Suborder Plagiostomi Asterospondyli, Group 3 Acrodonten: Hasse, 1879: 50. Order Selachii, Suborder Asterospondyli: Woodward, 1889: 157. Order Prosarthri: Gill, 1893: 129. Order Asterospondyli, Suborder Proarthri: Jordan and Evermann, 1896: 19. Order Euselachii, Suborder Pleurotremata, Division Squaloidei: Regan, 1906a: 723. Order Selachii, Group 2, Division A, Suborder Heterodonti: Goodrich, 1909 (in part): 143. Order Plagiostoma, Suborder Antacea, "Group" Centracoidei: Garman, 1913: 11, 13. Order Pleurotremata, Suborder Squaloidei: Engelhardt, 1913: 100. Order Centraciones, Suborder Prosarthri: Jordan, 1923: 95. Order Heterodontea, Suborder Heterodontida, Superfamily Heterodontoidea: White, 1936: 4; White, 1937: 37, tab. 1; Whitley, 1940) 69. Order Euselachii, Suborder Heterodontiformes: Bertin 1939: 9. Order Heterodontiformes: Berg, 1940: 134, 135; Berg and Svetovidov, 1955: 61; Arambourg and Bertin, 1958: 2028; Patternson, 1967: 667; Lindberg, 1971: 8, 256; Rass and Lindberg, 1971: 303; Compagno, 1973a: 28; Applegate, 1974: 743; Nelson, 1976: 32; Chu and Meng, 1979: 114, tab. 2; Compagno, 1984a: 154; Nelson, 1984: 50; Gubanov, Kondyurin and Myagkov, 1986: 3, 42; Cappetta, 1987: 26, 69: Compagno, 1988: 382; Nelson, 1994: 45; Shirai, 1996: 32; Eschmeyer, 1998. Order Heterodontiformes, Suborder Heterodontoidei: Berg, 1940: 134, 135; Berg and Svetovidov, 1955: 61. Order Asterospondyli: Fowler, 1941: 4, 13; Smith, 1949: 37, 39. Order Selachii, Suborder Heterodontoidea: Romer, 1945: 576; Bigelow and Schroeder, 1948: 95; Romer, 1966: 349. Order Heterodontoidea: Schultz and Stern, 1948: 224. Order Pleurotremata, Suborder Heterodontiformes: Budker and Whitehead, 1971: 5, tab. 2. Order Heterodontida, Suborder Heterodontina, Superfamily Heterodonticae: Fowler, 1966: 321, 330, 331. Order Pleurotremata, Suborder Squaloidea: Norman, 1966: 24. Order Hexanchida, Suborder Heterodontoidei: Glikman, 1967: 214. Order Selachii: Blot, 1969: 702–776. Order Heterodontiformes, Suborder Heterodontoidea: Chu and Meng, 1979: 114, tab. 2. Order Galeomorpha, Suborder Heterodontoidea: Carroll, 1988: 598.

FAO Names: En – Bullhead sharks.

Field Marks: The only living sharks with two spined dorsal fins and an anal fin; also a pig–like, small anterior mouth, enlarged molariform teeth in the back of the mouth, supraorbital ridges, rough skin, paddle–like paired fins, and enlarged first gill slits.

Diagnostic Features: Head elevated with crests above eyes, not depressed or expanded laterally. Snout very short, slightly depressed and bluntly rounded, and without lateral teeth or rostral barbels. Eyes dorsolateral on head, without nictitating lower eyelids, secondary lower eyelids, or subocular pouches; upper eyelids not fused to eyeball. Spiracles very small, just behind or about opposite eyes but well below eye level. Five pairs of gill openings present on sides of head, with posteriormost two or three behind pectoral–fin origins. Nostrils diagonal on front of snout, without barbels but with prominent circumnarial grooves around incurrent apertures; nostrils with deep nasoral grooves connecting excurrent apertures to mouth, anterior nasal flaps moderately long and reaching mouth. Mouth small, almost terminal on head, broadly arched and short, ending in front of posterior corners of eyes. Labial furrows large and present on both jaws. Teeth strongly differentiated along the jaws, with small anterolateral teeth and enlarged molariform posterior teeth; no gap or small intermediate teeth between anterior and lateral teeth in upper jaw. Trunk cylindrical, not flattened and ray–like. Caudal peduncle without lateral dermal ridges or keels. Dermal denticles covering entering body, not enlarged as thorns or spines. Pectoral fins moderately large, not expanded and ray–like, without triangular anterior lobes that cover the gill openings. Pelvic fins small, with vent continuous with their inner margins. Claspers with short siphons in the abdomen at the pelvic–fin bases but without clasper sacs. Two spine–bearing dorsal fins present, with origin of first well in front of pelvic–fin bases and over pectoral fins. Anal fin present. Caudal fin with a long dorsal lobe and a short ventral lobe. Vertebral counts: total vertebral counts 103 to 123, precaudal vertebral counts 60 to 81. Intestinal valve of conicospiral type, with 7 turns. Size moderate, most less than 120 cm in length, but a couple species grow to over 150 cm. **Colour:** grey to brown or reddish–brown, many with spots, stripes, or saddle markings. Juvenile coloration may be quite striking and distinctly different from adults. Reproduction oviparous, with unique screw–shaped egg cases.

Distribution: See family account below.

Habitat: See family account below.

Biology: See family account below.

Interest to Fisheries and Human Impact: See family account below.

Remarks: The account above is after Compagno (1984a, 2001).

2.5.1 Family HETERODONTIDAE

Family: Tribe Heterodontina Gray, 1851, *List Fish British Mus., Pt. 1, Chondropterygii, British Mus. (Nat. Hist.)*: 65 (Family Squalidae).

Type genus: ***Heterodontus*** Blainville, 1816. Raised to the rank of Family Heterodontidae by Gill, 1862, *Ann. Lyceum Nat. Hist. New York*, 7(32): 403.

Number of Recognized Deep–sea Indian Ocean Genera: 1.

Synonyms: Subfamily Cestraciontini Bonaparte, 1838: 211 (Family Squalidae). Family Cestraciontes Müller and Henle, 1839: 76. Type genus: ***Cestracion*** Cuvier = Oken, 1817. Family Centraciontidae Garman, 1913: 13, 180. Type genus: ***Centracion*** Gray, 1831, possible error for ***Cestracion*** Cuvier, = Oken, 1817. Family Heterodontidae Bass, D'Aubrey and Kistnasamy, 1975c: 17. Apparent error for Heterodontidae, repeated twice on the same page but correctly spelled elsewhere (title page and table of contents, p. 2).

FAO Names: En – Bullhead sharks, Horn sharks; **Fr** – Requins dormeurs; **Sp** – Dormilones.

Field Marks: See order above.

Diagnostic Features: See order above.

Distribution: Indian Ocean and eastern and western Pacific; absent from the Atlantic Ocean.

Habitat: Warm–temperate and tropical bottom sharks, usually found where the water temperature is above 21°C. Mostly found along continental and insular shelves and uppermost slopes. Most are coastal and found in water depths from the intertidal to less than 100 m, but one species (***Heterodontus ramalheira***) occurs down to at least 275 m. These sharks are most common on rocky bottoms in kelp forests, and on sandy bottoms. Some species prefer rocky crevices and caves. At least one species is known to migrate in coastal waters with adults returning seasonally to the same breeding areas annually.

Biology: Oviparous, producing unique, large, spiral–flanged egg cases. At least two species are known to deposit egg cases in specific egg–laying sites. Egg cases may take five months to hatch after deposition.

Diet primarily consists of benthic invertebrates including sea urchins, crabs, shrimp, other crustaceans, and gastropods.

Interest to Fisheries and Human Impact: Very little interest to fisheries, these sharks are mostly taken as bycatch in bottom trawl and longline fisheries.

The conservation status of these sharks is Data Deficient or Least Concern.

Local Names: Bullhead sharks, Horn sharks (English); Huska k'o, Bulkophaaie (South Africa); Tubarões dorminhocos (Mozambique).

Remarks: Family account is modified from Compagno (1984a, 2001).

Literature: Duméril (1865); Günther (1870); Garman (1913); Fowler (1941, 1966); Smith (1942); Compagno (1984a, 2001); Last and Stevens (2009).

List of Deep–sea Species Occurring in the Area:

Heterodontus ramalheira (Smith, 1949)

Heterodontus Blainville, 1816

Genus: Subgenus ***Heterodontus*** Blainville, 1816 (Genus ***Squalus*** Linnaeus, 1758), *Bull. Sci. Soc. Philomat. Paris*, (8): 121.

Type species: "***Philippi***" = ***Squalus philippi*** Bloch and Schneider, 1801, by monotypy, a junior synonym of ***Squalus portus jacksoni*** Meyer, 1793.

Number of Recognized Deep–sea Indian Ocean Species: 1.

Synonyms: Genus ***Cestracion*** Oken, 1817: 1183. Latinization of "Les Cestracions. Cuv." Cuvier, 1816: 129. Type species: ***Squalus philippi*** Bloch and Schneider, 1801, by monotypy? Genus ***Centracion*** Gray, 1831: 5. Type species: ***Centracion zebra*** Gray, 1831, by monotypy? Error or emendation of ***Cestracion*** Oken, 1817? Genus ***Cestralion*** Müller and Henle, 1838: 85. Probable error for ***Cestracion*** Oken, 1817. Genus ***Heterodontes*** Gill, 1862: 403. Obvious error for ***Heterodontus*** Blainville, 1816, as name is spelled correctly on same page. Genus ***Gyropleurodus*** Gill, 1863: 331. Type species: ***Cestracion francisci*** Girard, 1855, by monotypy (or original designation). Genus ***Tropidopus*** Gill, 1863: 489. Type species: ***Cestracion pantherinus*** Valenciennes, 1846, by original designation. Genus ***Molochophrys*** Whitley, 1931: 310. Type species: ***Cestracion galeatus*** Günther, 1870, by original designation. Subgenus ***Wuia*** Fowler, 1934: 233 (Genus ***Heterodontus*** Blainville, 1816). Type species: ***Centracion zebra*** Gray, 1831, by original designation. Genus ***Tropidodus*** Beebe and Tee–Van, 1941: 118. Apparent error for ***Tropidopus*** Gill, 1863. Genus ***Cestraction*** Fowler, 1941: 17. Apparent error for ***Cestracion*** Oken, 1817. Genus ***Cetracion*** Fowler, 1941: 17. Error ***Cestracion*** Oken, 1817 or ***Centracion*** Gray, 1831.

Field Marks: See species account below.

Diagnostic Features: See family Heterodontidae above.

Local Names: None.

Remarks: Most members of this family are considered to be relatively shallow water inhabitants. The one exception is ***Heterodontus ramalheira***, an endemic deepwater species to the Western Indian Ocean.

Heterodontus ramalheira (Smith, 1949)

Gyropleurodus ramalheira Smith, 1949, *Ann. Mag. Nat. Hist.* (ser. 12), 2(17): 367, fig. 1. Holotype in Natural History Museum, Maputo, Mozambique, 585 mm female, moderately deepwater off Inhambane, Mozambique.

Synonyms: None.

Other Combinations: None.

FAO Names: En – Whitespotted bullhead shark; **Fr** – Requin dormeur chabot; **Sp** – Dormilón boquigrande.

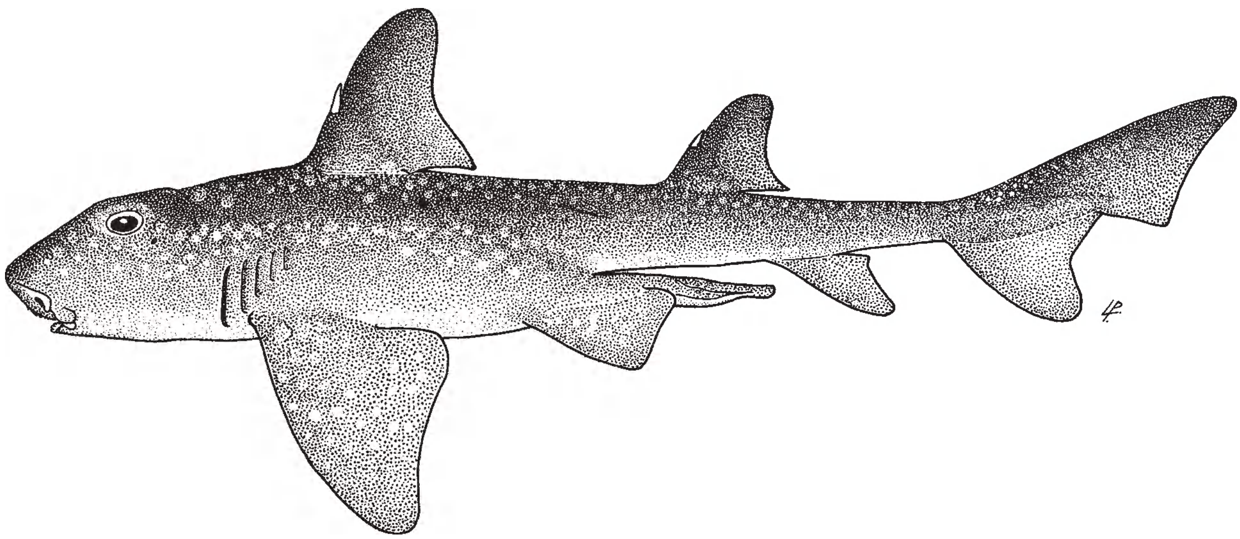


Fig. 171 *Heterodontus ramalheira*

Field Marks: Dorsal fins with spines, anal fin present, colour pattern of white spots on variegated darker background including dark saddles in adults, hatchlings with whorls of dark lines on a light background.

Diagnostic Features: Supraorbital ridges moderately high, abruptly truncated posteriorly; interorbital space moderately concave, depth between ridges about half eye length. Anterior holding teeth with cusp and a pair of cusplets in adults, posterior molariform teeth strongly carinate and not greatly expanded and rounded. Pre–first dorsal–fin length 20 to 26% and anal–caudal space 8 to 10% of total length. Lateral trunk denticles large and rough. First dorsal–fin spine directed somewhat forward in hatchlings and juveniles and vertical in adults; first dorsal–fin origin far anterior to pectoral–fin insertions, just behind or even over pectoral–fin origins and over third to fifth gill openings; first dorsal–fin insertion far anterior to pelvic–fin origins, just behind pectoral–fin insertions; first dorsal–fin free rear tip anterior to or opposite of pelvic–fin origins; first dorsal fin falcate in young and high and semifalcate in adults, first dorsal–fin height 11 to 21% of total length, first dorsal fin much larger than pelvic fins; second dorsal–fin origin over pelvic–fin inner margins and well in front of pelvic–fin rear tips, second dorsal fin falcate and much smaller than first dorsal fin. Anal fin angular and falcate, apex slightly anterior to lower caudal–fin origin when laid back; anal–caudal space slightly less than twice anal–fin base. Vertebral counts: total vertebral counts 104 to 116, monospondylous vertebral counts 32 to 34, diplospondylous precaudal vertebral counts 34 to 40, precaudal vertebral counts 67 to 73, pre–first dorsal–fin spine vertebral counts 10 to 14, and counts from diplospondylous transition to second dorsal–fin spine 7 to 10. A moderately large bullhead shark, maximum total length 83 cm. **Colour:** background colour of dorsal surface dark reddish brown with white spots, lighter in hatchlings, without a dark harness pattern but with darker indistinct saddles; head without light–coloured bar on interorbital surface of head in adults but young with transverse parallel dark lines there, and a series of narrow dark parallel stripes under eye in hatchlings, changing to a dusky patch in larger juveniles and lost in adults; fins without abrupt dark tips and white dorsal–fin apices; hatchlings with a unique and striking pattern of numerous thin curved parallel dark lines in whorls on fins and body, lost with growth and absent in adults.

Distribution: Western and northern Indian Ocean, South Africa (KwaZulu–Natal), south–central Mozambique, Somalia, eastern shore of the Arabian Peninsula and southern Oman.

Habitat: A rare, little–known benthic shark of the outer continental shelf and upper most slope; unusual for the family in being a deep–water species found at 40 to 275 m, with most records below 100 m. Young individuals including a hatchling have been found off southern Mozambique at 110 m. This shark was once recorded on a sandy bottom, but little else known about its habitat preference.

Biology: Oviparous, but egg cases not yet described for this species. Diet includes crabs, but nothing else known.

Size: Maximum total length about 83 cm; males adult at 69 cm, females adult at 75 to 83 cm. Size at birth about 18 cm.

Interest to Fisheries and Human Impact: Interest to fisheries none, although it is occasionally caught as bycatch by bottom trawlers.

Conservation status is Data Deficient.

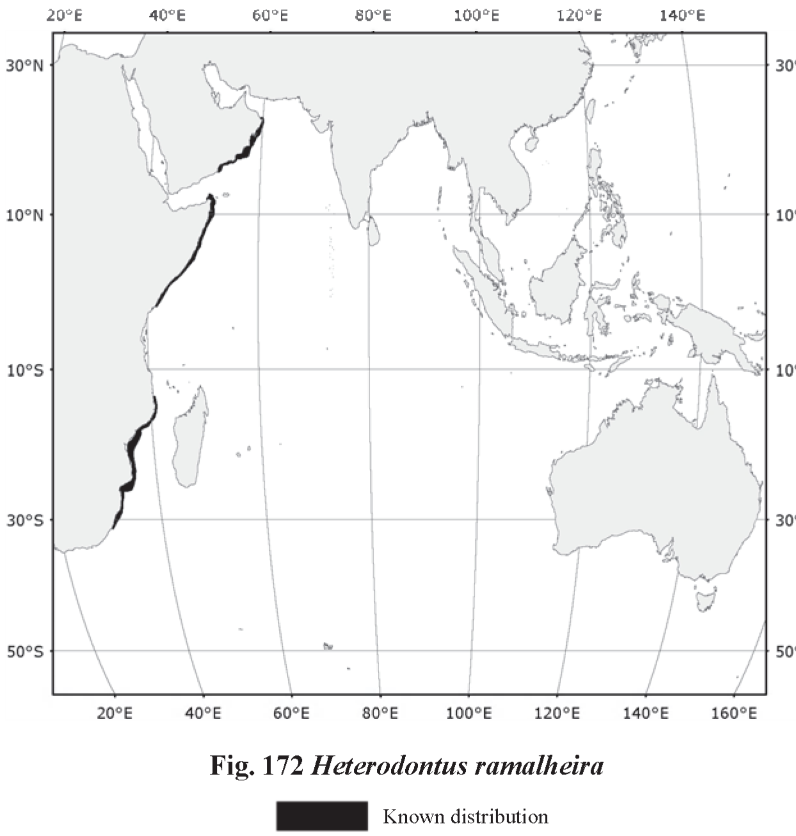


Fig. 172 *Heterodontus ramalheira*

Local Names: Mozambique bullhead shark, Mosambiekse bulkophaai (South Africa); Turbarão dorminhoco de Moçambique (Mozambique).

Remarks: The above account is modified after Compagno (2001).

Literature: Smith (1949); Pinchuk (1969); Bass, D'Aubrey and Kistnasamy (1975c); Compagno (1984a, 2001); Compagno, Ebert and Smale (1989); Ebert (2004a).

2.6 Order ORECTOLOBIFORMES – Carpet sharks

Order: Orectolobiformes Compagno, 1973a, *J. Linn. Soc.* (*Zool.*)*, 53, suppl.* 1: 28; Also Applegate, 1974, *J. Mar. Biol. Ass. India*, 14(2): 743.

Number of Recognized Deep–sea Indian Ocean Families: 1.

Synonyms: [Part] 1 Squali, Abtheilung [Division] 1: Müller and Henle, 1838: 3. [Part] 1 Squali, Abtheilung [Division] 2, Unterabtheilung [Subdivision] 3: Müller and Henle, 1839: 66. Ordo Plagiostomi, Subordo Squalini, section Proktopterides, Tribus Dinotopterini: Bleeker, 1859: xi. Order Squali, Suborder Squali: Gill, 1862: 394, 396. Order Squali, Suborder Galei: Gill, 1872: 22, 23. Order Plagiostomi diplospondyli, Suborder Plagiostomi asterospondyli, Group 1 Scyllia: Hasse, 1879: 52. Order Plagiostomi diplospondyli, Suborder Plagiostomi asterospondyli, Group 2 Scylliolamnidae: Hasse, 1879: 51. Order Selachii, Suborder Asterospondyli: Woodward, 1889: 157. Order Asterospondyli, suborder unnamed: Gill, 1893: 130; Fowler, 1941: 4, 13; Smith, 1849: 37, 39. Order Asterospondyli, Suborder Galei: Jordan and Evermann, 1896: 19, 21. Order Euselachii, Suborder Pleurotremata, Division Galeoidei: Regan, 1906a: 723. Order Selachii, Group 2, Division B, Subdivision 1, Suborder Scylliodei: Goodrich, 1909: 148. Order Pleurotremata, Suborder Galeoidei: Engelhardt, 1913: 97. Order Plagiostoma, Suborder Antacea, “Group” Catuloidei: Garman, 1913: 11, 12. Order Plagiostoma, Suborder Antacea, “Group” Isuroidei: Garman, 1913: 10, 12. Order Euselachii, Suborder Galei, [Series] Scylliodei: Jordan, 1923: 97. Order Plagiostomi, Suborder Galeiformes: Lozano y Rey, 1928: 280. Order Galea, Suborder Isurida, Superfamily Orectoloboidea: White, 1936: 4; White, 1937: 36, tab. 1. Order Euselachii, Suborder Scylliformes: Bertin, 1939: 9. Order Lamniformes, Suborder Lamnoidei: Berg, 1940: 137; Berg and Svetovidov, 1955: 65; Patterson, 1967: 670. Lindberg, 1971: 8, 257; Nelson, 1976: 33; Nelson, 1984: 51; Nelson, 2006: 54. Order Euselachii, Suborder Galeoidei, Superfamily Orectoloboidea: Whitley, 1940: 68–69. Order Selachii, Suborder Galeoidea: Romer, 1945: 576; Bigelow and Schroeder, 1948: 77, 95; Romer, 1966: 350. Order Lamnoidea, Suborder Galeoidea: Schultz and Stern, 1948: 224. Order Lamnida, Suborder Lamnina: Matsubara, 1955: 1–789. Order Galeiformes, Suborder Isuroidei: Arambourg and Bertin, 1958: 2030. Order Pleurotrema, Suborder Galeoidea: Norman, 1966: 7. Order Carchariida, Suborder Carchariina, Superfamily Orectolobicae: Fowler, 1967a: 89. Order Carchariida, Suborder Carchariina, Superfamily Lamnicae: Fowler, 1967a: 104. Order Squatinida, Suborder Ginglymostomatoidei: Glikman, 1967: 216. Order Euselachii, Suborder Galeoidei: Blot, 1969: 702–776. Order Pleurotremata, Suborder Galeiformes: Budker and Whitehead, 1971: 5, tab. 2. Order Carcharhiniformes: Rass and Lindberg, 1971: 304; Gubanov, Kondyurin and Myagkov, 1986: 3, 61. Order Orectolobiformes: Chu and Meng, 1979: 114, tab. 2; Compagno, 1984a: 165; Cappetta, 1987: 26, 71; Compagno, 1988: 382; Eschmeyer, 1990: 435; Nelson, 1994: 45; de Carvalho, 1996: 55; Shirai, 1996: 32. Order Orectolobiformes, Suborder Orectoloboidei: Applegate, 1974: 74. Order Orectolobiformes, Suborder Parascylloidei: Applegate, 1974: 749; Goto, 2001: 78. Order Orectolobiformes, Suborder Rhincodontoidei: Applegate, 1974: 744; Goto, 2001: 78. Order Orectolobiformes, Suborder Rhincodontoidea: Chu and Meng, 1979: 114, tab. 2. Order Orectolobiformes, Suborder Orectoloboidea: Chu and Meng, 1979: 114, tab. 2. Order Galeomorpha, Suborder Heterodontoidea: Carroll, 1988: 598.

FAO Names: En – Carpet sharks; **Fr** – Requins–tapis; **Sp** – Tiburones tapiceros.

Field Marks: These are moderate to enormous sharks with the combined characteristics of nostrils with barbels (rudimentary in ***Rhincodon typus***), nasoral grooves connecting the nostrils to the mouth, relatively short truncated mouth terminating in front of eyes, no nictitating eye membranes, five pairs of gill openings, two spineless dorsal fins, and an anal fin. Many members of this order have rather striking colour patterns.

Diagnostic Features: Body shape cylindrical, depressed, or somewhat ray–like in the Orectolobidae. Head conical to depressed, relatively short, expanded laterally in some species, but not in others. Snout short to very short, conical, truncated, or flattened, but not elongated or blade–like. Nostrils with barbels (rudimentary in ***Rhincodon***), circumnarial grooves present around incurrent aperture but absent in some taxa; nasoral grooves present and connecting excurrent apertures of nostrils with mouth; anterior nasal flaps short to elongate and reaching mouth. Eyes dorsolateral to lateral on head, and without nictitating membranes. Spiracles small to relatively large, located close behind and about opposite level of eyes. Five paired gill openings present on side of head; length relatively small to very long, but not encircling head; posteriormost two to four above pectoral–fin origins. Mouth small to large, usually subterminal, except in ***Rhincodon*** it is terminal, and arched to nearly transverse and short, and ending in front of eyes. Labial furrows well developed. Teeth weakly to strongly differentiated along the jaws, with or usually without enlarged anterior teeth and without enlarged molariform posterior teeth; without a gap or small intermediate teeth between anterior and lateral teeth in the upper teeth in the upper jaw; tooth counts from 23 to over 300 upper jaw, and 19 to over 300 lower jaw. Caudal peduncle with or without lateral dermal ridges or lateral keels. Dermal denticles covering entire body. Pectoral fins small to large, somewhat expanded and ray–like in some species. Pelvic fins small to large, with vent usually continuous with their inner margins, but may be separate in the Orectolobidae. Dorsal fins spineless, with origin of first dorsal fin varying from anterior to pelvic–fin origins to behind pelvic–fin insertions. Anal fin present. Caudal fin with a long dorsal lobe. Vertebral counts: total vertebral counts 117 to 243, monospondylous vertebral counts 32 to 138, diplospondylous precaudal vertebral counts 38 to 95, precaudal vertebral counts 69 to 138, and caudal vertebral counts 49 to 154. Intestinal valve of conicospiral type, with 6 to 74 turns. Size small to gigantic, to over 10 m in length. **Colour:** colour pattern may be obscure or plain, with very few light or dark spots to rather striking with prominent dark saddles with or without numerous small to large dark or light spots, blotches, rings, or reticulations, and collar markings around the gill region on some species; dark spotting or darker and lighter blotches on some species may vary depending on size and stage of development.

Distribution: Most members of this shark group occur in the Indo–West Pacific where several species are regional endemics. The only exceptions are the wide–ranging whale shark (***Rhincodon typus***) found in most tropical and warm–temperate seas, and the nurse shark (***Ginglymostoma cirratum***) found primarily in the tropical and warm temperate Atlantic and tropical eastern Pacific.

Habitat: These are mostly tropical to warm temperate sharks, many are regional endemics, that occur from the intertidal zone down to about 200 m depth. Most species are bottom dwelling, occurring on coral or rocky reefs, on mud or sandy bottoms, but the whale shark is oceanic, travelling great distances, even crossing ocean basins making long distant migratory movements.

Biology: Reproductive mode depending on the species may be oviparous, viviparous with a yolk sac, or in the genus ***Nebrius*** oophagous, with embryos consuming uterine eggs. Virtually nothing is known about the reproductive cycle, length of gestation, or fecundity of most species. Age and growth parameters are only known for a few species, while most are unknown. The diet, depending on the species, is rather broad ranging from invertebrates, including mostly crustaceans, cephalopods, to teleosts and small chondrichthyans. The whale shark unlike most members of this group feeds on plankton, copepods, invertebrate larvae, and gametes from spawning fishes, pelagic crustaceans, cephalopods, and small fishes on occasion.

Interest to Fisheries and Human Impact: Most of the families in this order are of relatively minimal fisheries importance as they are typically discarded. However, some of the most colourful species are highly valued in the aquarium trade and as such are taken in fisheries targeting them. Some species have been maintained in captivity in public aquaria for years and do quite well. Other species, particularly the whale shark (***Rhincodon typus***) is popular with ecotourist divers in those regions where they occur.

The conservation status of these sharks ranges from Data Deficient for many species to Vulnerable for several species with restricted ranges.

Remarks: The arrangement of this order follows Compagno (1984a, 2001) with some modifications.

2.6.1 Family PARASCYLLIIDAE

Family: Subfamily Parascyllinae Gill, 1862, *Ann. Lyceum Nat. Hist. New York*, 7(32): 407, 408. 412 (Family Scylliorhinidae Gill, 1862). Also as Subfamily Parascylliinae Fowler, 1934, *Proc. Acad. Nat. Sci. Philadelphia*, 85: 238 (Family Orectolobidae).

Type genus: ***Parascyllium*** Gill, 1862.

Number of Recognized Deep–sea Indian Ocean Genera: 1.

Synonyms: Family Parascylliidae Applegate, 1974: 749. Type genus: ***Parascyllium*** Gill, 1862. Independently proposed as a family. Family Cirrhoscylliidae Applegate, 1974: 749; Chu and Meng, 1979: 37, 114, tab. 2 (independently proposed from Applegate, 1974). Type genus: ***Cirrhoscyllium*** Smith and Radcliffe, 1913.

FAO Names: En – Collared carpet sharks; **Fr** – Requins carpetttes; **Sp** – Alfombreras.

Field Marks: Small sharks, superficially similar to members of the family Scyliorhinidae in their slender form, cat–like eyes with subocular pockets, first dorsal–fin origin behind pelvic–fin bases, and fin proportions, but differing in having their mouths entirely in front of eyes and in having narrow nasoral grooves, circumnarial grooves and folds around the nostrils, and medial barbels not derived from the anterior nasal flaps. Their mouth and nostril structures, two spineless dorsal fins and an anal fin, anal–fin origin well ahead of second dorsal–fin origin, and minute spiracles distinguish them from other sharks.

Diagnostic Features: Head narrow and somewhat flattened, without lateral flaps of skin. Snout broadly rounded to slightly pointed. Eyes dorsolaterally situated on head and with strong subocular ridges below them. Eyes with movable upper eyelids and shallow subocular pockets and ridges. Spiracles minute and much smaller than eyes, without raised external rims; spiracles somewhat behind but not below eyes. Gill slits small, fifth gill slit overlapping fourth; internal gill slits without filter screens. Nostrils with short, pointed barbels, circumnarial folds and circumnarial grooves around outer edges of incurrent apertures. Nasoral grooves long and strongly developed. Mouth small, moderately arched, and subterminal on head. Lower lip not trilobate and without lateral orolabial grooves connecting edge of lip with medial ends of lower labial furrows; no symphysial groove on chin. Lower labial furrows ending well lateral to symphysis, not connected medially by a mental groove nor mental groove and flap. Teeth not strongly differentiated in upper and lower jaws, with symphysial teeth not enlarged and fang–like. Tooth row count 23 to 54 upper jaw, 22 to 49 lower jaw. Teeth with a strong medial cusp, a pair of short lateral cusplets, and strong labial root lobes. Body cylindrical or slightly depressed, without ridges on sides.

Precaudal tail about as long as body or slightly longer. Caudal peduncle without lateral keels or precaudal pits. Pectoral fins small, broad and rounded. Pelvic fins about as large as dorsal fins and slightly larger than anal fin, noticeably smaller than pectoral fins and with anterior margins 0.6 to 0.8 of pectoral–fin anterior margins. Dorsal fins equal–sized. First dorsal–fin origin and insertion well behind the pelvic–fin bases. Anal fin somewhat smaller than second dorsal fin, with broad base, angular apex, origin well ahead of second dorsal–fin origin, and insertion separated by a space much greater than its base length from lower caudal–fin origin. Caudal fin horizontally elongated and not crescentic, weakly heterocercal and with its upper lobe hardly elevated above the body axis; dorsal caudal–fin margin less than one–fourth as long as the entire shark. Caudal fin with a strong terminal lobe and subterminal notch but without a ventral lobe, preventral and postventral margins not differentiated but forming a continuous curve. Vertebral counts: total vertebral counts 154 to 199, monospondylous vertebral counts 35 to 48, diplospondylous vertebral counts 72 to 95, diplospondylous caudal vertebral counts 51 to 65, and precaudal vertebral counts 11 to 138. **Colour:** obscure or prominent dark saddles, with or without numerous small to large black or white spots, blotches and collar markings around the branchial region.

Distribution: Western Pacific and eastern Indian Ocean: the genus ***Parascyllium*** is confined to Australian waters, while the genus ***Cirrhoscyllium*** occurs from the South China Sea, Taiwan (Province of China), and Japan.

Habitat: Little known bottom–dwelling sharks mostly found close to shore, but two species occur along the upper continental slope to at least 435 m, and are considered deep–sea inhabitants. These sharks are found on muddy, sandy or rocky bottoms.

Biology: Oviparous, but little else known of their biology. Diet includes small fishes, crustaceans, and other benthic invertebrates.

Interest to Fisheries and Human Impact: Of no importance to fisheries, but may be taken as bycatch in some fisheries.

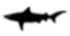
The conservation status is Data Deficient for most species, Least Concern for others.

Local Names: Collared carpet sharks, Australian cat sharks.

Remarks: The family consists of two genera (***Cirrhoscyllium*** and ***Parascyllium***) comprised of about eight species, most occurring on continental shelves, but one genus (***Parascyllium***) and a single deep–sea species occurs within the present area. The family account follows Compagno (1984a, 2001).

Literature: Regan (1908c); Garman (1913); Smith (1913); Whitley (1940); Fowler (1941, 1967a); Applegate (1974); Compagno (1984a, 2001); Dingerkus (1986); Goto and Nakaya (1996); Last and Stevens (2009).

List of Deep–sea Species Occurring in the Area:

 ***Parascyllium sparsimaculatum*** Goto and Last, 2002

Parascyllium Gill, 1862

Genus: ***Parascyllium*** Gill, 1862, *Ann. Lyceum Nat. Hist. New York*, 7(32): 408, 412.

Type species: ***Hemiscyllium variolatum*** Duméril, 1853, by original designation.

Number of Recognized Deep–sea Indian Ocean Species: 1.

Synonyms: Subgenus ***Neoparascyllium*** Whitley, 1939: 227 (Genus ***Parascyllium*** Gill, 1862). Type species: ***Parascyllium multimaculatum*** Scott, 1935, by original designation.

Field Marks: Slender body, lack of throat barbels, very small spiracles, the last two gill openings overlapping, anal fin to lower caudal–fin origin well separated and a dark collar band around the gills or with dense small spots.

Diagnostic Features: Snout relatively short, thick, and broadly rounded, head narrow and cylindrical. No barbels on throat. Eyes more elongated and slit–like. Tooth count 37 to 54 upper jaw, 33 to 49 lower jaw. Pectoral fins thick, muscular, and rather small, their anterior margins much less than head length and than distance between pectoral and pelvic–fin bases. Vertebral counts: total vertebral counts 188 to 199. Size of adults 60 to 91 cm in length. **Colour:** pattern of light or dark spots present, sometimes with dark saddles, black blotches, and collar markings around gills.

Local Names: None.

Remarks: The account above is after Compagno (1984a, 2001).

Parascyllium sparsimaculatum Goto and Last, 2002

Parascyllium sparsimaculatum Goto and Last, 2002, *Ichthyological Research*, 49: 15, figs. 1–5, tab. 1. Holotype: CSIRO H2269.02, 781 mm female, off Cape Leeuwin, Western Australia, 32° 08.51'S, 114° 59'E, depth 204 m, 9 February 1989.

Synonyms: ***Parascyllium*** sp. A Last and Stevens, 1994: 118, fig. 12.1, pl. 16.

Other Combinations: None.

FAO Names: En – Ginger carpet shark; **Fr** – Requin-carpette beige; **Sp** – Alfombrera jengibre.

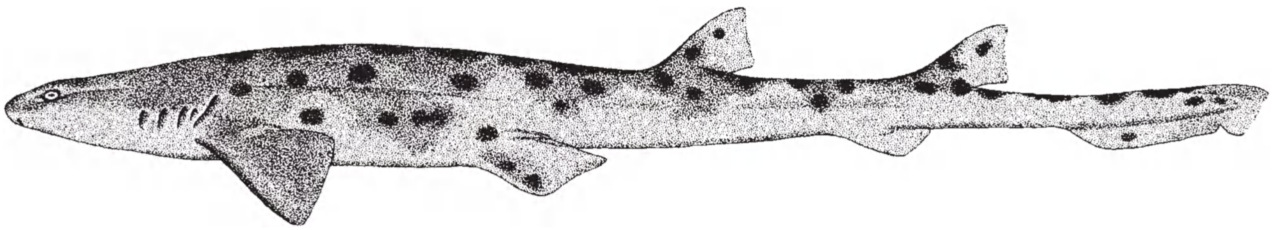


Fig. 173 ***Parascyllium sparsimaculatum***

Field Marks: First dorsal–fin origin behind pelvic fins, anal–fin origin well in front of second dorsal–fin origin, dorsal colour pale brownish to grey, with five to six indistinct saddles on dorsum and caudal fin, an unspotted dusky semi–collar around gill region and spots and blotches sparsely covering the body and fins.

Diagnostic Features: Body slender, head slightly depressed, nasal barbels very short; nasoral and circumnarial grooves present. Tooth counts 43 to 49 upper jaw, not available for lower jaw. Eyes small and located posterior to mouth. Dorsal fins similar in size, first dorsal–fin origin posterior to pelvic–fin bases; second dorsal–fin origin over or slightly anterior to anal–fin insertion. Vertebral counts: monospondylous vertebral counts 45 to 46, diplospondylous precaudal vertebral counts 80 to 83, total precaudal vertebral counts 126 to 128. Spiral valve turn counts not available. Size small, less than 80 cm total length. **Colour:** dorsal surface brownish to grey, with five to six indistinct dark saddles along back and gill region, and with a few smaller, darker spots; faint blotches on body and fins; ventral surface lighter.

Distribution: Eastern Indian Ocean: Western Australia between Fremantle and Cape Leeuwin.

Habitat: Uppermost slope at depths of 205 to 245 m.

Biology: Oviparous, but little else known. Known from only three specimens, all females.

Size: Maximum total length 79 cm; known only from three females specimens, 55.5, 68.4 and 79 cm in length. Unknown if any of these females were mature.

Interest to Fisheries and Human Impact: None, a rarely seen carpet shark; may occasionally be taken in bottom trawls as bycatch.

The conservation status of this shark is Data Deficient.

Local Names: None.

Literature: Goto and Last (2002); Heupel (2003a); Compagno, Dando and Fowler (2005a); Last and Stevens (2009).

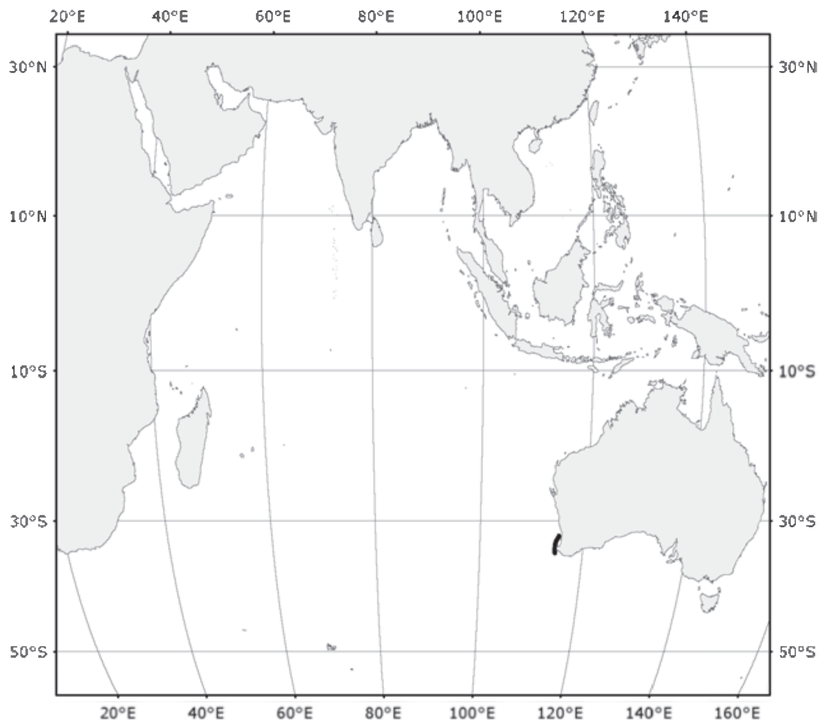


Fig. 174 ***Parascyllium sparsimaculatum***

Known distribution

2.7 Order LAMNIFORMES – Mackerel sharks

Order: Lamniformes Garman, 1885, *Bull. Mus. Comp. Zool. Harvard*, 12(1): 30 (emendation by Compagno 1984a of “group” Lamnae Garman, 1885).

Number of Recognized Deep–sea Indian Ocean Families: 5.

Synonyms: Part 1 Squali, Abtheilung 2: Müller and Henle, 1838: 27; Müller and Henle, 1839: 27. Part 1 Squali, Abtheilung 2, Unterabtheilung 3: Müller and Henle, 1839: 66. Ordo Plagiostomi, Subordo Squalini, Sectio Proktopterides, Tribus Dinotopterini: Bleeker, 1859: xi. Order Squali, Suborder Squali: Gill, 1862: 394, 396. Order Squali, Suborder Galei: Gill, 1872: 22, 23. Order Plagiostomi diplospondyli, Suborder Plagiostomi asterospondyli, Group 2 Scylliolamnidae: Hasse, 1879: 51. Order Selachii, Suborder Asterospondyli: Woodward, 1889: 157. Order Asterospondyli: Gill, 1893: 130; Fowler, 1941: 4, 13; Smith, 1949: 37, 39. Order Asterospondyli, Suborder Galei: Jordan and Evermann, 1896: 19, 21. Order Euselachii, Suborder Pleurotremata, Division Galeoidei: Regan, 1906a: 723. Order Selachii, Group 2, Division B, Subdivision 1, Suborder Scylliodei: Goodrich, 1909: 148. Order Pleurotremata, Suborder Galeoidei: Engelhardt, 1913: 97. Order Plagiostoma, Suborder Antacea, Group Carcharoidei: Garman, 1913: 10, 11. Order Plagiostoma, Suborder Antacea, Group Isuroidei: Garman, 1913: 10, 12. Order Euselachii, Suborder Galei, Series Lamnoidei: Jordan, 1923: 99. Order Plagiostomi, Suborder Galeiformes: Lozano y Rey, 1928: 280. Order Galea, Suborder Isurida, Superfamily Odontaspoidea: White, 1936: 4; White, 1937: 36, tab. 1. Order Galea, Suborder, Isurida, Superfamily Isuroidea: White, 1936: 4; White, 1937: 36, tab. 1. Order Euselachii, Suborder Lamniformes: Berg, 1940: 137; Berg and Svetovidov, 1955: 65; Patterson, 1967: 670; Rass and Lindberg, 1971: 303; Lindberg, 1971: 8, 257; Compagno, 1973a: 28; Applegate, 1974: 743; Nelson, 1976: 33; Compagno, 1984a: 212; Nelson, 1984: 51; Gubanov, Kondyurin and Myagkov, 1986: 3, 49; Cappetta, 1987: 26, 85; Compagno, 1988: 382; Eschmeyer, 1990: 435; Nelson, 1994: 51; de Carvalho, 1996: 55; Shirai, 1996: 32; Eschmeyer, 1998. Order Lamniformes, Suborder Lamnoidei: Berg, 1940: 137; Berg and Svedovidov, 1955: 65; Patterson, 1967: 670; Lindberg, 1971: 8, 257; Nelson, 1976: 33; Nelson, 1984: 51; Nelson, 2006: 57. Order Euselachii, Suborder Galei, Superfamily Odontaspoidea: Whitley, 1940: 68. Order Euselachii, Suborder Galei, Superfamily Isuroidea: Whitley, 1940: 68. Order Selachii, Suborder Galeoidea: Romer, 1945: 576; Bigelow and Schroeder, 1948: 77, 95; Romer, 1966: 350. Order Lamnoidea, Suborder Galeoidea: Schultz and Stern, 1948: 224. Order Lamnida, Suborder Lamnina: Matsubara, 1955: 1–789. Order Galeiformes, Suborder Isuroidea: Arambourg and Bertin, 1958: 2029. Order Pleutrema, Suborder Galeoidea: Norman, 1966: 7. Order Carchariida, Suborder Carchariina, Superfamily Carchariicae: Fowler, 1967a: 92, 140. Order Carchariida, Suborder Carchariina, Superfamily Lamnicae: Fowler, 1967a: 92, 104. Order Squatinida, Suborder Squaloidei: Glikman, 1967: 215. Superorder Lamnae, Order Odontaspidida: Glikman, 1967: 229, 230. Order Odontaspidida, Superfamily Odontaspidoidea: Glikman, 1967: 230. Order Odontaspidida, Superfamily Isuroidea: Glikman, 1967: 232. Order Odontaspidida, Superfamily Scapanorhynchoidea: Glikman, 1967: 233. Order Euselachii, Suborder Galeoidei: Blot, 1969: 702–776. Order Pleurotremata, Suborder Galeiformes: Budker and Whitehead, 1971: 5, tab. 2. Order Carcharhiniformes: Rass and Lindberg, 1971: 303; Gubanov, Kondyurin and Myagkov, 1986: 3, 61. Order Isuriformes: Chu and Meng, 1979: 114, tab. 2. Order Isuriformes, Suborder Carchariodea: Chu and Meng, 1979: 114, tab. 2. Order Isuriformes, Suborder Isuroidea; Chu and Meng, 1979: 114, tab. 2. Order Isuriformes, Suborder Cetorhinoidea: Chu and Meng, 1979: 114, tab. 2. Order Isuriformes, Suborder Alopioidea: Chu and Meng, 1979: 114, tab. 2. Order Galeomorpha, Suborder Lamnoidea: Carroll, 1988: 599.

FAO Names: En – Mackerel sharks.

Field Marks: The external appearance of each of the several members of this group appears to be unique and unrelated, but they share a number of features including a short to moderately long pointed snout, eyes usually lateral on the head (except dorsolateral on ***Carcharias***), eyes without a nictitating membrane, spiracles if present usually very small and located behind the eyes, no nasal barbels, a large to very large mouth extending well behind the eyes, five paired gill openings with the last two in some groups occurring above the pectoral–fin origins, two spineless dorsal fins, and an anal fin. Colour may range from light to dark brown, reddish, yellowish, or even pink above, usually lighter below; some species may have spots or light and dark blotches, and with darker or lighter fin edges.

Diagnostic Features: Body shape cylindrical, fusiform, or somewhat compressed, but not flattened or ray–like; body stout to very slender, and firm or very soft and flabby. Head conical to moderately depressed, relatively short to very long, but not expanded laterally. Snout relatively short to extremely long, flattened and blade–like. Eyes nearly circular, relatively small to very large, located lateral on head, except dorsolateral on ***Carcharias***, without nictitating lower eye membrane. Nostrils without barbels, nasoral or circumnarial grooves, and separated from mouth; anterior nasal flaps short and not reaching mouth. Gill openings numbering five on each side of head; length short to extremely long, nearly encircling the head; posteriormost two gill openings located just anterior to or above pectoral–fin origins. Spiracles, if present, very small and situated behind level to eyes. Mouth very large, broadly rounded and highly protrusible. Labial furrows very small or absent. Teeth weakly to strongly differentiated along jaws, usually with a gap or small intermediate teeth between anterior and lateral teeth of upper jaw; tooth counts number from 19 to over 200 rows in upper jaw, and 20 to over 200 rows in lower jaw. Caudal peduncle with lateral keels, depending on the family, present or absent, if present may number 1 or 2; precaudal pits variably present or absent depending on the group. Dermal denticles covering entire body, small and relatively smooth or enlarged, very rough and thorn–like. Pectoral fins small to very long, and broadly rounded to moderately angular. Pelvic fins small to moderately large. Two spineless dorsal fins; first dorsal fin may be much larger than second dorsal fin, very high, erect, and nearly triangular or small, rounded and similar in size to second; first dorsal fin originating over abdomen, well in front of pelvic–fin origins. Second dorsal fin may be minute, much smaller than first dorsal fin or similar in size. Anal fin present; size may be similar to second dorsal fin or possibly larger depending on species. Caudal fin with long to extremely long upper dorsal lobe and a strong to absent ventral lobe. Vertebral counts: total vertebral counts 107 to 477, precaudal vertebral counts 50 to 126, and caudal vertebral count 55 to 356. Intestinal valve of conicospiral type, with 18 to 55 turns. Size small, from less than 1 m in length, to gigantic, up to 10 m in length. **Colour:** dorsal surface ranges from a pinkish white, bluish, grey, grey–brown, brown or blackish, ventral surface may be similar in colour to dorsal surface or lighter to white; dark spotting or darker and lighter blotches may be present on some species and may vary depending on size and stage of development.

Distribution: Circumglobal from cold temperate to tropical seas, with some species occurring in polar seas.

Habitat: Mackerel sharks occur from close inshore, in shallow bays and estuaries to the outer coast, and the open ocean. They are found over sandy beaches, rocky and coral reefs, and in pelagic waters far from landmasses, and from the surface to over 1600 m deep and over bottom depths of over 5000 m. No mackerel sharks are known to occupy freshwater habitats, such as rivers and lakes.

Biology: Mackerel sharks, with a few exceptions, are highly active, fast swimming, migratory sharks, with most being quite wide–ranging in their geographic distribution. They are viviparous in their reproductive mode, but have uterine cannibalism with the young embryos consuming uterine eggs (oopghagy) or feeding on other embryos (adelphophagy). The reproductive cycle of most species is unknown, although in some species they are known to make long distance migrations to specific nursery areas. The number of young per litter is not well known, but appears to be relatively small, and depending on the species, may only be from 2 to 16 young per cycle. Depending on the species, maturity is attained in 4 to 5 years with a maximum estimated longevity of 20 to 30 years. The diet of these sharks may range from small planktonic organisms to invertebrates, large bony and cartilaginous fishes, and even marine mammals, reptiles, and sea birds.

Interest to Fisheries and Human Impact: Some mackerel shark species are the subject of important target and non–target fisheries worldwide, especially members of the families Alopiidae and Lamnidae. Other groups, Cetorhinidae and Odontaspididae, were the subjects of intense fisheries previously, but they are largely protected in some areas of the world since their populations have declined from previous fisheries exploitation.

Several species, particularly the white shark (***Carcharodon carcharias***), are well known to attack humans engaged in ocean activities including swimming, diving, surfing, kayaking, and boating, among other activities. In temperate waters, the white shark has been implicated in more attacks on people than any other shark species. This is most likely due to its being more easily recognized and a lack of other species, mainly Carcharhinidae species that tend to be more prominent in tropical seas.

In recent years, the white shark and shortfin mako shark, among other lamnoids, have become popular ecotourist attractions for thrill seeking cage divers. The sandtiger shark (***Carcharias taurus***) is another popular species and one that has been maintained in public aquaria for decades. Small white sharks have recently been maintained at the Monterey Bay Aquarium, California (USA), for short time periods, of up to about six months. However, they usually outgrow their surroundings and are released back into the wild.

The conservation status of mackerel sharks have been a concern for several species, but some such as the white shark and basking shark due to their high–profile have received considerable protection through the Convention on International Trade of Endangered Species (CITES) and more regional protective measures. The conservation status of other poorly known species such as the goblin (***Mitsukurina owstoni***), megamouth (***Megachasma pelagios***), and bigeye sand tiger (***Odontaspis noronhai***) sharks are Least Concern or Data Deficient due to a lack of information on their populations and basic biological information.

Local Names: None.

Remarks: The present account is modified from, and follows Compagno (1984a, 1999, 2001) in recognizing seven families; five of which are considered to inhabit the deep–sea. See Compagno (2001) for detailed discussion of the order.

Key to Deep–sea Indian Ocean Families:

1a. Snout extremely elongated, flat, and blade–like (Fig. 175). Precaudal pits and ventral lobe absent . . . . **family Mitsukurinidae**

Fig. 175 *Mitsukurina*

1b. Snout short to moderately, but not greatly elongated or blade–like, and broadly rounded. Precaudal pits and ventral caudal lobe present . . . **2**

2a. Caudal fin about as long as trunk of body (Fig. 176). . . . . **family Alopiidae**

2b. Caudal fin much shorter than trunk of body . . . **3**

3a. Upper precaudal pit present; lower pit and lateral keels absent or weak; caudal fin heterocercal, not crescent shaped **4**

3b. Upper and lower precaudal pits and strong lateral keel present; caudal fin crescent shaped; gill slits extremely large, extending dorsally onto surface of head (Fig. 177a); teeth minute, hook shaped, not bladelike (Fig. 177b) . . . . **family Cetorhinidae**

4a. Eyes very large, body slender; anal fin narrow–based, pivoting; caudal peduncle with both upper and lower precaudal pits and low lateral keels on each side; gill openings extending onto dorsal surface of head (Fig. 178). . . . . **family Pseudocarchariidae**

4b. Eyes relatively small, body stout; anal fin broad–based, not pivoting; caudal peduncle with an upper precaudal pit, but without a lower pit or lateral keels; gill openings not extending onto dorsal surface of head (Fig. 179) . . . . **family Odontaspididae**

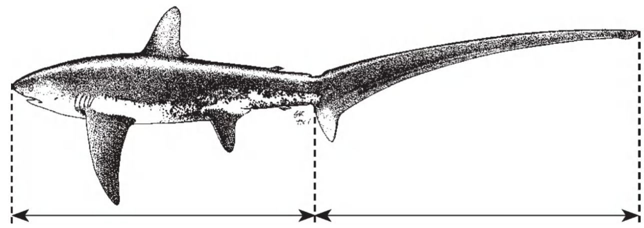


Fig. 176 ***Alopias***

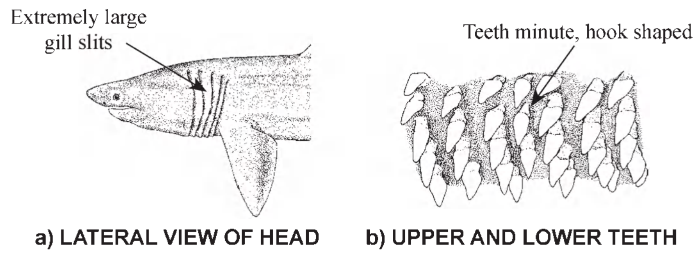


Fig. 177 ***Cetorhinus***

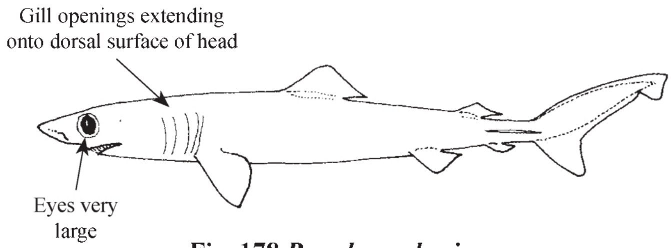


Fig. 178 ***Pseudocarcharias***

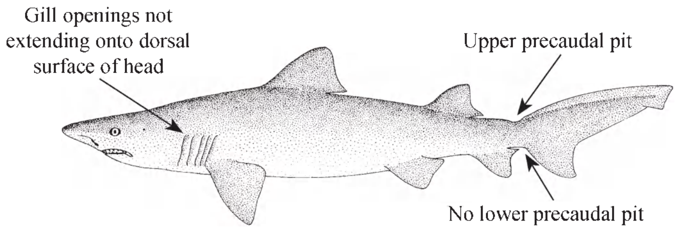


Fig. 179 ***Odontaspis***

2.7.1 Family ODONTASPIDIDAE

Family: Family Odontaspides Müller and Henle, 1839, *Syst. Beschr. Plagiost.*, pt. 2: 73. Emended to Family Odontaspididae Müller and Henle, 1839. The corrected form Odontaspididae was placed on the Official List of Family–Group Names in Zoology (Name no. 385) but Odontaspides was placed on the Official Index of Rejected and Invalid Family–Group Names in Zoology (Name no. 414) by the International Commission on Zoological Nomenclature (1965, Opinion 723, *Bull. Zool. Nomencl.*, 22: 33, 34). Odontaspididae was given special endorsement by the International Commission on Zoological Nomenclature (1987, Opinion 1459.6, *Bull. Zool. Nomencl.*, 44(3): 216) to take precedence over Carchariidae Müller and Henle, 1838 when the two were synonymized.

Type genus: ***Odontaspis*** Agassiz, 1838.

Number of Recognized Deep–sea Indian Ocean Genera: 1.

Synonyms: Subfamily Triglochidini Bonaparte, 1838: 208 (Family Squalidae). Type genus: ***Triglochis*** Müller and Henle, 1837a. Family Carchariae Müller and Henle, 1838: 27. Type genus: ***Carcharias*** Rafinesque, 1810. Rejected by the International Commission on Zoological Nomenclature (1965, Opinion 723: 33) but reinstated by the Commission (1987, Opinion 1459.5: 216) in the corrected form Family Carchariidae Müller and Henle, 1838 on the Official List of Family–Group Names in Zoology, with the special endorsement that it is not to be given precedence over Odontaspididae Müller and Henle, 1839 when considered a synonym of it. This name was widely used by earlier writers for members of the Carcharhinidae, following Müller and Henle's original usage, but Jordan and Gilbert (1883: 27) and many subsequent writers used it for members of the Odontaspididae with the assignment of ***Carcharhias*** to this family. Family Carchariidae Jordan and Gilbert, 1883: 27. Emended spelling for Family Carchariae Müller and Henle, 1838. Type genus: ***Carcharias*** Rafinesque, 1810.

FAO Names: En – Sand tiger sharks; **Fr** – Requins de sable; **Sp** – Solrayos, Toros.

Field Marks: Large fusiform–shaped sharks, with a conical snout, large subterminal mouth, teeth large with slender cusps and lateral cusplets, eyes small to moderately large without nictitating membranes, five moderately long paired gill slits that do not extend onto the dorsal surface of head, two large spineless dorsal fins, an anal fin, upper precaudal pit present, lower precaudal pit absent, caudal fin asymmetrical, upper margin less than one–third total length.

Diagnostic Features: Body fusiform, moderately stout, and firm. Head relatively short to moderately long; snout short to moderately long, conical and pointed, not greatly elongated, or flattened. Eyes are small to moderately large, without nictitating membranes, diameter length 1.4 to 4.1% precaudal length. Spiracles present, but very small. Gill openings relatively long, but not extending onto dorsal surface of head; first gill opening 6.2 to 9.2% precaudal length; fifth gill openings anterior to pectoral–fin bases; no internal gill rakers. Nostrils subterminal, entirely separate from mouth, no nasoral grooves, and anterior margins without barbels. Mouth large, broadly arched, subterminal on head; jaws strongly protrusible. Teeth large, awl–shaped, with lateral cusplets present; 2 to 3 rows of large anterior teeth on each side of jaw followed by 1 to 5 rows of smaller intermediate teeth; tooth counts 34 to 56 upper jaw, 36 to 46 lower jaw. Caudal peduncle not greatly compressed or laterally expanded; upper precaudal pit present, but without lower precaudal pit or precaudal keels. Dermal denticles smooth and moderately large; crowns flattened and with small ridges and cusps; flank denticles posteriorly directed. Pectoral fins broadly angular and moderately long; origin posterior to fifth gill opening. Pelvic fins relatively large, similar in size to first dorsal fin. Dorsal fins large, angular, relatively high and erect; fin spines absent; first dorsal fin originates over or posterior to pectoral–fin free rear tips. Second dorsal and anal fins size similar to or smaller than first dorsal fin; second dorsal and anal fins with broad non–pivoting bases. Caudal fin asymmetrical, upper lobe moderately long, less than one–third length of precaudal length, ventral lobe much shorter. Vertebral counts: total vertebral counts 156 to 183, precaudal vertebral counts 80 to 95, diplospondylous caudal counts 71 to 88. Intestinal valve with 28 to 34 turns. Size large with adults to at least 450 cm total length. **Colour**: light grey, grey–brown, to dark reddish brown or black above; ventral surface lighter or similar to dorsal colour; spots present on some species.

Distribution: Wide–ranging, but patchily distributed, in most warm–temperate and tropical waters.

Habitat: Sand tiger sharks occur mostly in tropical to warm–temperate seas and depending on the species inhabit nearshore coastal areas including bays and harbors, but also offshore, on outer continental shelves, upper slopes, and on seamounts down to 1600 m. The bigeye sand tiger shark (***Odontaspis noronhai***) may be oceanic in the epipelagic and possibly the mesopelagic zone. These are relatively slow moving, but active sharks.

Biology: Viviparous with oophagy, with litters of possibly only two very large young, but little else known about the reproductive biology of this shark family. The diet of sand tiger sharks mostly consists of other elasmobranchs, bony fishes, cephalopods, and crustaceans.

Interest to Fisheries and Human Impact: Most species within this family tend to occur in deeper water and have a very scattered distribution, and as such are generally not important in fisheries other than begin taken on occasion as bycatch. Virtually nothing is known about the population trends for ***Odontaspis ferox*** or ***O. noronhai***. However, ***Carcharias taurus*** is an exception in that it occurs mostly in nearshore waters, may be quite common where it occurs, and has been targeted by commercial and recreational fishers in some areas or has been subjected to eradication programs.

Despite their fearsome, toothy appearance and large size, these sharks are generally not aggressive towards swimmers or divers and in fact ***C. taurus*** and ***O. ferox*** have become the popular subjects for ecotourism by divers in Australia, Mediterranean Sea, South Africa, the east coast of the U.S.A. and in the eastern Pacific off Malpelo Island. There have been a few incidents of people being bitten by ***C. taurus***, but no reported incidents by either of the ***Odontaspis*** species. ***Carcharias taurus*** is also a common and popular species in public aquaria given their hardiness and longevity.

The conservation status for most of these sharks is Vulnerable since some species have experienced declines due to overfishing. However, ***Odontaspis noronhai*** is Data Deficient since very few specimens have ever been observed.

Local Names: Sand tigers, Nurse sharks, and Sand sharks.

Remarks: The family has two genera and three species of which the monotypic genus ***Carcharias*** with a single species, ***C. taurus***, is a nearshore coastal species of warm temperate and tropical seas. The genus ***Odontaspis*** has two species, both of which are deep–sea Indian Ocean inhabitants. The family and genus account is modified after Compagno (2001).

Literature: Garman (1913); Bigelow and Schroeder (1948); Compagno (1973a, 1984a, 2001); Bass, D'Aubrey and Kistnasamy (1975b); Quéro *in* Whitehead *et al*. (1984); Compagno, Ebert and Smale (1989); Ebert (2003); Last and Stevens (2009).

List of Deep–sea Species Occurring in the Area:

 ***Odontaspis ferox*** (Risso, 1810)
Odontaspis noronhai (Maul, 1955)

Odontaspis Agassiz, 1838

Genus: ***Odontaspis*** Agassiz, 1838, *Recher. Poiss. Foss.*, 3: 86, 87. Placed on the Official List of Generic Names in Zoology (name no. 1659) by the International Commission on Zoological Nomenclature (1965, Opinion 723.3c, *Bull. Zool. Nomencl.*, 22(1): 33).

Type species: ***Carcharias ferox*** Risso, 1826, by monotypy, equals ***Squalus ferox*** Risso, 1810. This genus takes precedence over ***Carcharias*** Rafinesque, 1810 when the two are considered synonyms, by special endorsement of the International Commission on Zoological Nomenclature (1987, Opinion 1459.3, *Bull. Zool. Nomencl.*, 44(3): 216).

Number of Recognized Deep–sea Indian Ocean Species: 2.

Synonyms: None.

Field Marks: Large stout–bodied sharks with a conical, bulbous snout, first dorsal fin closer to pectoral fins than to pelvic fins, and much larger than second dorsal and anal fins, caudal peduncle with precaudal pit present, lateral keels absent, and caudal fin asymmetrical but with a strong ventral lobe. Colour greyish brown, dark brown or blackish above, and depending on species ventral surface may be lighter; scattered dark brown to reddish spots may be present on some species.

Diagnostic Features: Body fusiform and stout, with head slightly to strongly depressed. Snout moderately long, conical, preoral length 0.8 to 1.2 times mouth width, 4.4 to 7.8% total length. Eyes small to moderately large, less than 3 to more than 4 times snout length, and about 1.6 to 2.8% total length. Teeth similar in both jaws, awl–shaped, with a long central cusp, flanked by 1 to 3 lateral cusplets. Tooth counts 34 to 56 upper jaw, 36 to 48 lower jaw. First dorsal fin closer to pectoral–fin bases than to pelvic fins. Second dorsal fin about one–half size of first dorsal. Anal fin smaller than second dorsal fin, origin over or posterior to second dorsal–fin origin. Vertebral counts: total vertebral counts 177 to 183, precaudal vertebral counts 95 to 98, caudal vertebral counts 71 to 85. Spiral valve turn count 30 to 34. Large sharks with adults to 450 cm in length. **Colour:** dorsal surface light grey, greyish–brown to dark brown or black; ventral may be lighter or same colour as dorsal surface; depending on species, scattered dark brown or reddish spots may be present and posterior edges of fins may be darker. Iris of eyes dark brown or black with lighter tones.

Local Names: Deepwater sand tigers.

Remarks: The genus consists of two species, the smalltooth sand tiger (***Odontaspis ferox***) and the bigeye sand tiger shark (***Odontaspis noronhai***). The below account is modified after Compagno (2001).

Key to Deep–sea Indian Ocean Species:

1a. Teeth mostly with 2 or 3 cusplets on each side of cusp (Fig. 180); colour grey or grey–brown above, lighter below, often with darker spots on sides but without a white–tipped first dorsal fin . . . . ***Odontaspis ferox***

1b. Teeth mostly with only 1 cusplet on each side of cusp (Fig. 181); colour dark reddish brown to blackish brown or black above and below, first dorsal fin often with a white blotch on its tip . . . . ***Odontaspis noronhai***

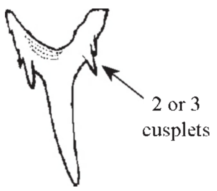


Fig. 180 ***O. ferox***

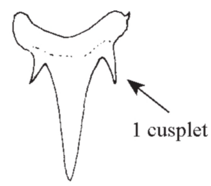


Fig. 181 ***O. noronhai***

Odontaspis ferox (Risso, 1810)

Squalus ferox Risso, 1810, *Ichthyol. Nice, Paris*: 38. Holotype unknown; type locality off Nice, France, in the Mediterranean Sea. Also, ***Carcharias ferox*** Risso, 1826, *Hist. nat. Princip. Prod. Europe Méred., Paris, Poissons*, 3: 122. Description virtually verbatim that of ***Squalus ferox*** Risso, 1810, and quite evidently a generic translocation, not a new species name. Placed on the Official List of Specific Names in Zoology (Name no. 2057) by the International Commission on Zoological Nomenlcature (1965, Opinion 723.4.c: 33).

Synonyms: ***Odontaspis herbsti*** Whitley, 1950: 234, fig. 1, pl. 17, fig. 1. Holotype: Australian Museum, Sydney, AMS–IB.2136, 168 cm immature male, Gabo Island, New South Wales, 137 m depth.

Other Combinations: None.

FAO Names: En – Smalltooth sand tiger; **Fr** – Requin féroce; **Sp** – Solrayo.

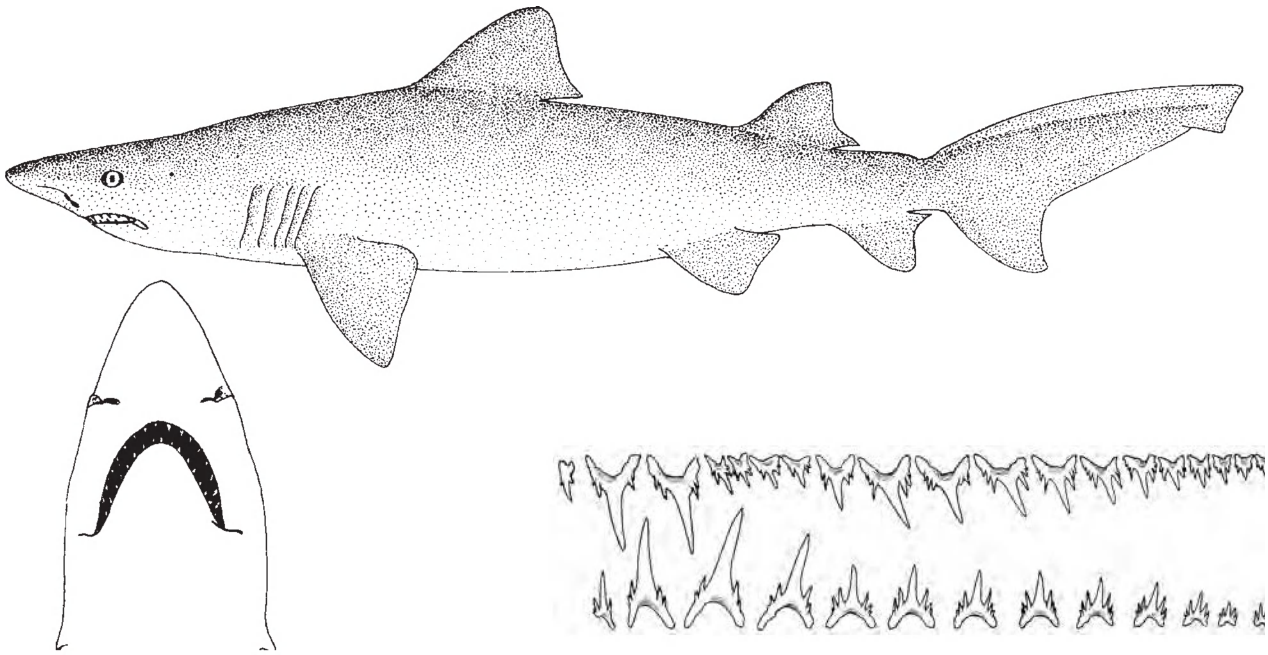


Fig. 182 ***Odontaspis ferox***

Field Marks: A large, stout–bodied shark with a conical to slightly flattened snout, a long mouth extending past the eyes, teeth prominent, long and narrow with a central cusp flanked by two or three smaller cusplets on each side, a first dorsal fin that originates over the pectoral–fin free rear tips, and is much larger than the second dorsal and anal fins, colour grey, brownish grey or olive above, lighter below, some specimens with dark reddish spots scattered over their body.

Diagnostic Features: Head flattened, snout conical and relatively long. Eyes small, without nictitating membrane. Teeth awl–shaped, with long central cusp, flanked by two to three smaller cusplets on each side, similar in both jaws; upper intermediate two to five tooth rows much smaller than anterior or posterior tooth rows; tooth counts 46 to 56 upper jaw, 36 to 48 lower jaw. Dorsal fins subangular, weakly falcate; first dorsal fin much larger than second dorsal and anal fins. Anal–fin posterior margin strongly concave, height 4.6 to 6.0% total length. Caudal fin asymmetrical, with slight bump posterior to upper precaudal pit; ventral caudal lobe short, stout. Vertebral counts: total vertebral counts 177 to 183, precaudal vertebral counts 95 to 98, caudal vertebral counts 71 to 85. Spiral valve turn count 32 to 34. A large shark with adults to 450 cm total length. **Colour:** light grey to grey brown above, lighter below, sometimes with dark reddish or brown spots scattered on the body; fin tips in young juveniles darker with black edges. A piebald coloured specimen has been reported.

Distribution: Circumglobal, but patchily distributed. Indian Ocean: South Africa (KwaZulu–Natal), off northeast and southeast Madagascar in the open ocean, Tanzania, Maldives, open ocean southeast of Sri Lanka, north and south of Sumatra, Java (Indonesia), and northern Australia.

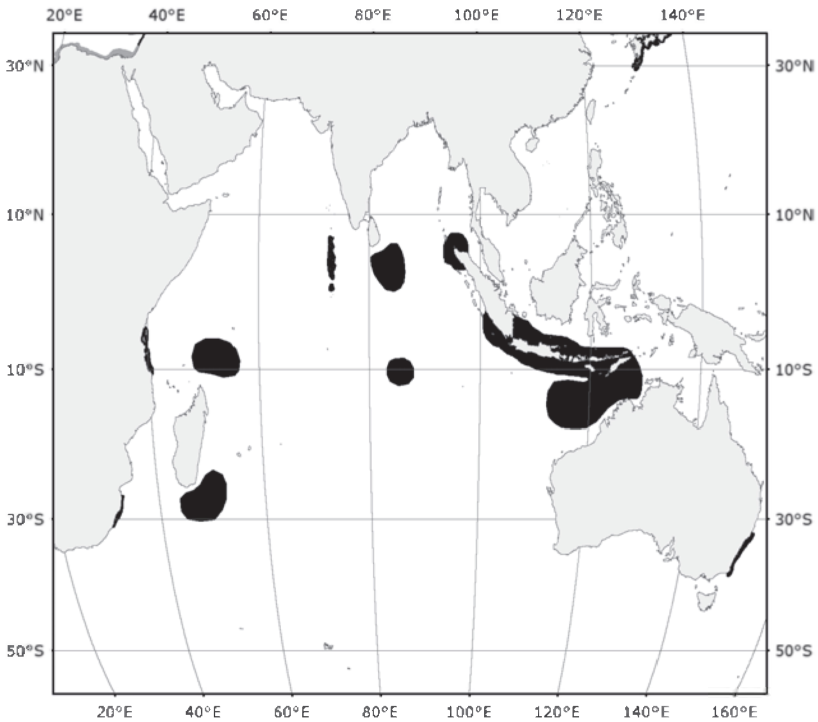


Fig. 183 ***Odontaspis ferox***

Known distribution

Habitat: A large, wide ranging shark found in most warm–temperate and tropical seas on continental and insular shelves and upper slopes. A survey of known records by Fergusson *et al*. (2008) found smalltooth sand tiger sharks range from 10 to 883 m deep, but with most specimens being found at less than 300 m deep. There appears to be some segregation by size and depth as small juveniles, less than about 150 cm total length mostly occur between 300 and 600 m deep, while those over about 350 cm in length also tend to occupy a similar depth range. However, individuals over 150 cm to about 350 cm appear to be more common at shallower depths of less than 150 m. Although usually associated with mud, sand, or rocky reef bottom habitats, smalltooth sand tiger sharks appear to make excursions into the water column as demonstrated by individuals having been caught in midwater trawls within 70 to 500 m of the surface over water depths of 2000 to 4000 m. Water temperature where these sharks have been caught show a broad range from about 6 °C to more than 20 °C.

Biology: Very little is known about their reproductive cycle or litter size, as few mature females have been observed. Their diet includes elasmobranchs, including a 130 cm long ***Dalatias licha*** in a 290 cm individual, teleosts, cephalopods, and crustaceans. There are no known predators on smalltooth sand tiger sharks, but an ***Isistius*** spp. bite wound was observed on one individual caught off the Canary Islands. Nothing is known about the movements of these sharks, but Fergusson *et al*. (2008) speculated that these sharks might move over large distances by following submarine ridges, adjacent island archipelagoes, or seamounts. Support for this comes from captures of these sharks in mid–ocean waters on or adjacent to deep–sea ridges and seamounts.

Size: Maximum total length to 450 cm; males mature at 200 to 250 cm, with a maximum length of 344 cm; females mature at 300 to 350 cm, and have a maximum length of 450 cm. Size at birth about 100 cm.

Interest to Fisheries and Human Impact: Smalltooth sand tiger sharks are taken incidentally in longline and trawl fisheries, but are too patchily distributed to be of interest for directed fisheries. However, with increasing deepwater fishing efforts, these sharks may become more susceptible to fishing pressure than is currently assumed. Currently, there are no estimates as to the numbers of these sharks that may be caught incidentally as bycatch.

Interestingly, in recent years smalltooth sand tiger aggregations in relatively shallow waters off Lebanon in the Mediterranean, Malpelo Island in the Eastern Pacific, and elsewhere have enabled SCUBA divers to regularly encounter these sharks.

The conservation status of this species is Vulnerable due to suspected declines in its population in the Mediterranean and Eastern North Atlantic. However, given the patchy distribution and occurrence of this species, much still remains to be learned about its population structure and status.

Local Names: Bumpytail sandtiger shark, Ragged–tooth shark, Ragged–tooth sandtiger shark, Fierce shark (English); Knopstert–skeurtendhaai (South Africa); Herbsts or Herbst's nurse shark, Small tooth sand tiger shark (Australia).

Remarks: Individuals of this species may or may not have dark scattered spots. This variation has lead some authors to consider those individuals with spots to be a different species, ***Odontaspis herbsti***. However, the presence of spots appears to reflect individual variation within a single species.

Literature: Garman (1913); Maul (1955); Garrick (1974); Bass, D'Aubrey and Kistnasamy (1975b); Compagno (1984a, 2001); Quero *in* Whitehead *et al*. (1984); Compagno, Ebert and Smale (1989); Sheehan (1998); Ebert (2003); Pollard *et al*. (2009); Fergusson, Graham and Compagno (2008); Last and Stevens (2009); Pollard *et al.* (2009).

2.7.2 Family MITSUKURINIDAE

Family: Mitsukurinidae Jordan, 1898, *Proc. Calif. Acad. Sci. ser. 3* (*Zool.*), 1: 201.

Type genus: ***Mitsukurina*** Jordan, 1898.

Number of Recognized Deep–sea Indian Ocean Genera: 1.

Synonyms: Family Scapanorhynchidae White, 1936: 4. Type genus: ***Scapanorhynchus*** Woodward, 1889, a Cretaceous fossil genus.

FAO Names: En – Goblin sharks; **Fr** – Requins lutin; **Sp** – Tiburones duende.

Field Marks: See species account below.

Diagnostic Features: Body compressed, slender, very soft and flabby. Head nearly as long as the body trunk. Snout greatly elongated, flattened, blade–like. Eyes small. Gill openings short, with gill filaments partially exposed; no internal gill rakers; all gill openings anterior to pectoral–fin bases. Mouth large, broadly arched, with highly protrusible jaws. Teeth large, anteriors and laterals very narrow with a single cusp; shape similar in both jaws. Tooth counts 35 to 53 upper jaw, 31 to 62 lower jaw. Caudal peduncle compressed and without keels or precaudal pits. Dermal denticles small, with erect, narrow, spike–like cusps and ridges; cusps of lateral denticles pointing perpendicular to surface of skin making it rough. Pectoral fins small, broadly rounded at apices. Pelvic fins large, larger than dorsal fins. Dorsal fins small, rounded, nearly equal in size, but smaller than pelvic and anal fins. Caudal fin long, dorsal margin elongate but less than one–half body length, ventral lobe absent. Vertebral counts: total vertebral counts 122 to 125, precaudal vertebral counts 53 to 56, monospondylous vertebral count 37, diplospondylous vertebral caudal counts 66 to 69. Intestinal valve of ring type with 18 to 23 turns. Size large, with adults to 550 to 620 cm total length. **Colour:** freshly caught specimens are a uniform pinkish–white above and below, with bluish fins. After preservation this spectacular coloration fades to a uniform brown or grey.

Distribution: Wide–ranging, but patchily distributed in all major oceans. Most specimens have been reported from Japanese and Taiwanese (Province of China) waters.

Habitat: See Species Account.

Biology: See Species Account.

Interest to Fisheries and Human Impact: See Species Account.

Local Names: None.

Remarks: The taxonomic history of this uniquely distinct, monotypic family, its relationship to the fossil genus ***Scapanorhynchus*** and its relationship among the extant lamniform sharks is summarized by Compagno (1984a, 2001). The family has a single genus and species, which occurs in all major oceans.

Literature: Compagno (1984a, 2001); Ebert (2003); Yano, Stevens and Compagno (2007); Last and Stevens (2009).

List of Deep–sea Species Occurring in the Area:

***Mitsukurina owstoni*** Jordan, 1898

Mitsukurina Jordan, 1898

Genus: ***Mitsukurina*** Jordan, 1898, *Proc. Calif. Acad. Sci., ser. 3* (*Zool.*), 1: 199.

Type species: ***Mitsukurina owstoni*** Jordan, 1898, by monotypy.

Number of Recognized Deep–sea Indian Ocean Species: 1.

Synonyms: None.

Field Marks: See species account.

Diagnostic Features: See family Mitsukurinidae above.

Local Names: Goblin sharks.

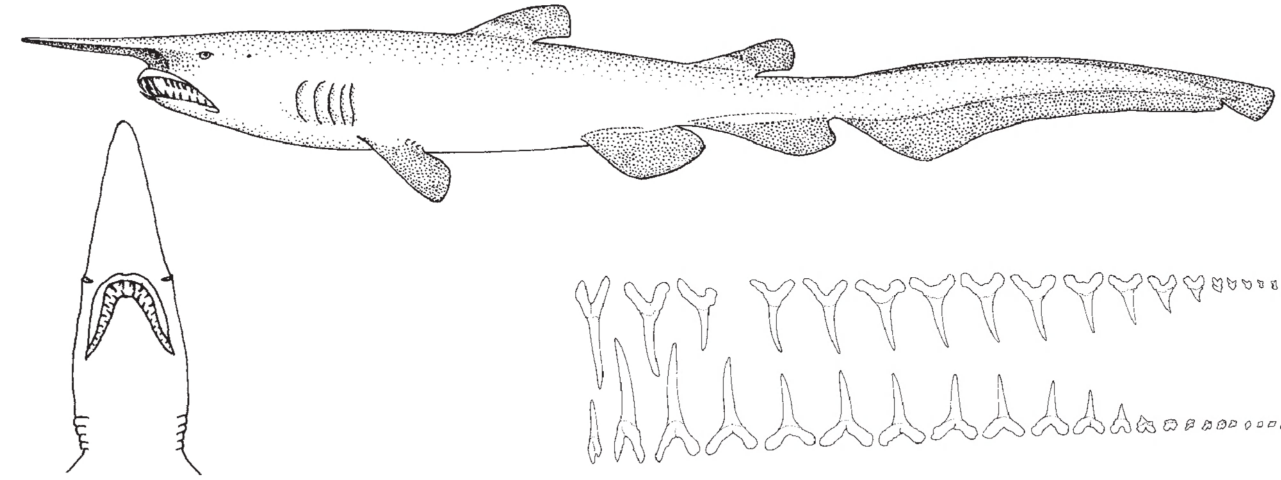
Mitsukurina owstoni Jordan, 1898

Mitsukurina owstoni Jordan, 1898, *Proc. Calif. Acad. Sci. ser. 3 (Zool.),* 1: 200, pls. 11–12. Holotype: Zoological Museum, University of Tokyo, 107 cm immature male, near Yokohama, Japan, in deep water. Holotype lost according to Eschmeyer (2012).

Synonyms: ***Odontaspis nasutus*** de Bragança, 1904: 49, 104, pl 1, figs. 1–1c. Type locality, Mare de Sezimbra Portugal, 603 m. Types unknown according to Eschmeyer (2012). ***Scapanorhynchus jordani*** Hussakof, 1909: 257, text–figs., pl. 44. Syntypes (2): American Museum of Natural History, AMNH–00004SW, jaws, model on display from 1300 mm female; 1155 mm female, formerly in the Zoological Department at Columbia University. ***Scapanorhynchus dofleini*** Engelhardt, 1912: 644. Holotype: Zoologischen Staatssammlung München, 2100 mm female, Mayegawa, Sagami Sea, Japan. Locality of Holotype unknown according to Eschmeyer (2012). ***Scapanorhynchus mitsukurii*** White, 1937: 29 (error for ***Mitsukurina owstoni*** Jordan, 1898), Japan. ***Mitsukurina nasutus*** Albuquerque, 1954–56, *Port. Acta. Boil., ser. B*, 5: 82–83, fig. 47.

Other Combinations: ***Scapanorhynchus owstoni*** (Jordan, 1898).

FAO Names: En – Goblin shark; **Fr** – Requin lutin; **Sp** – Tiburón duende.



UNDERSIDE OF HEAD

UPPER AND LOWER TEETH

Fig. 184 ***Mitsukurina owstoni***

Field Marks: A distinctive, unmistakable shark with its soft flabby body, elongated, flattened, bladelike snout, relatively small eyes, highly protrusible jaws, long and narrow teeth with a single cusp, two spineless dorsal fins, similar in size and about equal to the large rounded anal fin, second dorsal fin originating posterior to the pelvic fins, colour in life a spectacular pinkish–white to white with bluish fins.

Diagnostic Features: As for Family Mitsukurinidae.

Distribution: Wide–ranging, with records in all major oceans, but patchily distributed. Indian Ocean: South Africa (Eastern Cape Province, KwaZulu–Natal), Mozambique (Mozambique seamounts), and Australia (South Australia).

Habitat: The goblin shark is a poorly known deep–sea shark found on the outer continental shelf and upper slopes down to at least 1300 m, but most records are from between 100 and 960 m deep. Although little is known about the habitat of this rare species, in Japanese waters subadults are most common between 100 and 350 m deep taken in the Tokyo Submarine Canyon. Although considered a deepwater shark, the goblin shark has been taken as shallow as 40 m or less. It has been previously speculated that these sharks may occupy more of a midwater habitat than is generally assumed based on their soft–flabby body, light body colour, and diet that includes midwater fishes and invertebrates. The capture of at least one individual in a midwater drift gill net between 12 and 47 m deep over water between 200 and 2000 m deep tends to support this behaviour.

Biology: Virtually nothing is known about the biology of these sharks, although like all other lamnoids for which information is available, they are assumed to be oophagous and have small litters, but this needs to be confirmed. Nothing is known of the reproductive cycle of this shark. The vertebrae of these sharks, as with other lamnoids have well defined banding patterns that would lend themselves well to ageing, but whether these band pairs are related to age or somatic growth is unknown. Although rare in most places where it occurs, in Japanese waters subadult goblin sharks appear to be most abundant in bottom set gillnets between October and April.

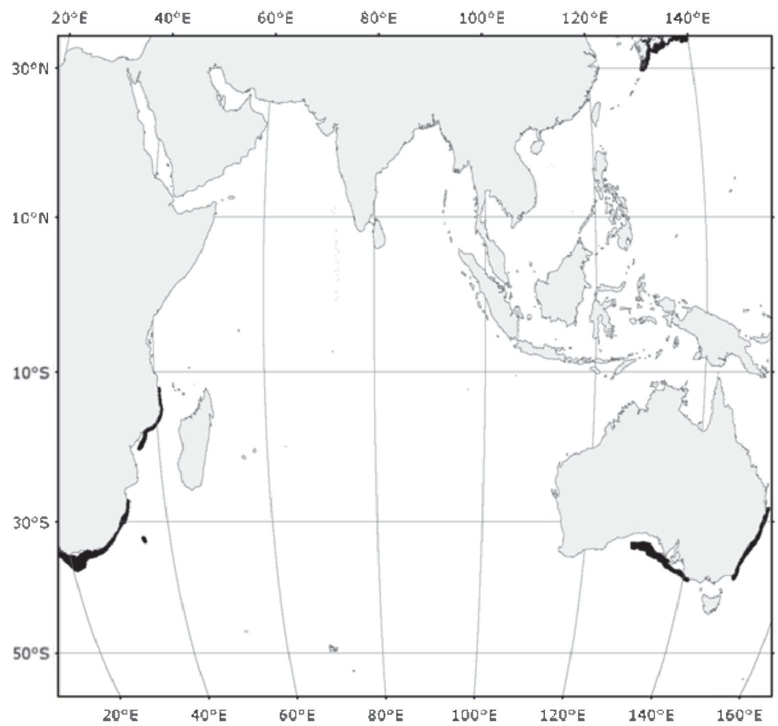


Fig. 185 ***Mitsukurina owstoni***

Known distribution

Goblin sharks feed mostly on bony fishes (Macrouridae, Stomiidae), cephalopods, and crustaceans, including midwater teleosts and crustaceans. Based on the prey items often consumed by these sharks it appears that they may forage off the bottom for food and may in fact occupy more of a midwater habitat than is generally assumed. The goblin shark jaws are highly specialized (similar to some mesopelagic fishes) for rapid projection from the head. The rapid projection of the jaws from the head may allow this apparently sluggish, slow swimming shark to closely approach potential prey items and quickly subdue them. Compagno (2001) provides an overview of the jaw morphology and structure that enables this shark to rapidly project its jaws.

Size: Maximum total length at least 550 to 620 cm. Males possibly adult at 260 to 380 cm, female size at maturity uncertain, but likely at over 400 cm. Size at birth uncertain, but the smallest free–swimming individuals were an 81.7 cm male and a 92.8 cm female.

Interest to Fisheries and Human Impact: Interest to fisheries none, it is usually taken as bycatch of deepwater trawl and longline fisheries. The soft–bodied flesh of this species makes it a relatively undesirable species for human consumption. Where it is consumed it is utilized dried–salted. It jaws are highly sought after by collectors.

The goblin shark has been kept in public aquaria where it was observed that in life this shark swims with its jaws tightly retracted; this as opposed to most illustrations of this shark with its jaws protruded.

The goblin shark has been listed as Least Concern given its global distribution, deepwater habitat, and rarity in most locations where it has been captured. Also, most specimens that have been captured are subadults suggesting that adults occur outside the depth range where most fisheries take place.

Local Names: Kabouterhaai (South Africa).

Remarks: Despite its general rarity, there is one record of these sharks being caught in large numbers (between 100 and 300) over a two–week period in April 2003 by Taiwanese fishers from about 600 m depth. Prior to this apparent anomalous event, goblin sharks had never been reported from Taiwanese waters. The capture of such a large number of goblin sharks, some up to between 350 and 400 cm, followed a strong earthquake centered in the area. Jaws from these sharks were reportedly sold for between 1,500 and 4,000 USD depending on the size and quality of the jaws.

Literature: Jordan (1898); Bean (1905); Garman (1913); Compagno, Ebert and Smale (1989); Duffy (1997); Compagno (2001); Parsons, Ingram and Havard (2002); Ebert (2003); Duffy, Ebert and Stenberg (2004); Yano, Stevens and Compagno (2007); Last and Stevens (2009); D.A. Ebert (unpubl. data).

2.7.3 Family PSEUDOCARCHARIIDAE

Family: Pseudocarchariidae Compagno, 1973a, *J. Linn. Soc. (Zool.)*, 53, suppl. 1: 28.

Type genus: ***Pseudocarcharias*** Cadenat, 1963.

Number of Recognized Deep–sea Indian Ocean Genera: 1.

Synonyms: Family Pseudocarcharinidae Shirai, 1996: 34. Probable error for Pseudocarchariidae.

FAO Names: En – Crocodile sharks; **Fr** – Requins crocodile; **Sp** – Tiburones cocodrilo.

Field Marks: See species account below.

Diagnostic Features: Head much shorter than trunk. Snout moderately long, pointed and bulbously conical, not greatly elongated or flattened and blade–like. Eyes very large, length 3.6 to 4.9% of precaudal length. Gill openings moderately long, length of first 5.4 to 8.2% of precaudal length, extending onto dorsal surface of head; all gill openings in front of pectoral–fin bases; no gill rakers on internal gill slits. Mouth large, parabolic, ventral on head; jaws strongly protrusible to almost opposite snout tip but not greatly distensible laterally. Teeth large, the anteriors narrow and awl–like, the laterals more compressed and blade–like; tooth counts 26 to 29 upper jaw, 21 to 26 lower jaw; two rows of enlarged anterior teeth on each side of upper jaw, the uppers separated from the smaller upper lateral teeth by a row of small intermediate teeth; three rows of lower anteriors on each side, the first two rows enlarged but the third about as large as laterals; symphysials absent. Trunk cylindrical and slender. Caudal peduncle slightly depressed and with low lateral keels and upper and lower crescentic precaudal pits present. Dermal denticles small and smooth, with flat crowns, small ridges and cusps, and with cusps directed posteriorly on lateral denticles. Pectoral fins small, short, and broad, much shorter than head in adults. Pelvic fins large, somewhat smaller than pectoral and first dorsal fins. First dorsal fin small, low, and angular. Second dorsal fin smaller than first, but larger than anal fin; second dorsal fin with a broad non–pivoting base but anal fin pivotable. Caudal fin not lunate, dorsal lobe moderately long but less than half as long as rest of shark, ventral lobe short but strong. Vertebral counts: total vertebral counts 146 to 158, precaudal vertebral counts 80 to 88, caudal vertebral counts 60 to 71. Intestinal valve ring type with 24 to 27 turns. Size small with adults to 122 cm total length. **Colour:** grey to grey–brown above, lighter below, and with lighter fin edges.

Distribution: Wide–ranging in all major tropical and subtropical oceans.

Habitat: See species account.

Biology: See species account.

Interest to Fisheries and Human Impact: See species account.

Local Names: Crocodile sharks, Tubarões crocodilos (Mozambique).

Literature: Compagno (1984a, 2001); Compagno, Dando and Fowler (2005); Last and Stevens (2009).

List of Deep–sea Species Occurring in the Area:

Pseudocarcharias kamoharai (Matsubara, 1936)

Pseudocarcharias Cadenat, 1963

Genus: Subgenus ***Pseudocarcharias*** Cadenat, 1963 (Genus ***Carcharias*** Rafinesque, 1810), *Bull. Inst. Francaise Afrique Noire, ser. A*, 25(2): 526 (proposed as a subgenus of ***Carcharias*** Rafinesque, 1810, but used throughout in generic form).

Type species: ***Pseudocarcharias pelagicus*** Cadenat, 1963, by original designation, a junior synonym of ***Carcharias kamoharai*** Matsubara, 1936.

Number of Recognized Deep–sea Indian Ocean Species: 1.

Synonyms: None.

Field Marks: See species account below.

Diagnostic Features: See family Pseudocarchariidae above.

Local Names: Crocodile sharks.

Pseudocarcharias kamoharai (Matsubara, 1936)

Carcharias kamoharai Matsubara, 1936, *Zool. Mag. Tokyo*, 48(7): 380. Holotype: Imperial Fisheries Institute, Japan, Kyoto University, Department of Fisheries, Faculty of Agriculture, Japan (housed at Maizuru, Japan) FAKU, Fish Spec. 1823, 735 mm male, Koti Fish Market, Koti, Japan, apparently lost according to Eschmeyer (2012).

Synonyms: ***Carcharias yangi*** Teng, 1959: 1, fig. 1. Holotype; Taiwan Fisheries Research Institute, TFRI 2895, 1000 mm total length, adult male, Su–ao fish market, from off Su–ao, Taiwan (Province of China). ***Pseudocarcharias pelagicus*** Cadenat, 1963: 529, figs. 1–5. Holotype: Museum National d'Historie Naturelle, Paris, MNHN 1963–1, 975 mm adult male, off the Guinea coast, West Africa.

Other Combinations: ***Odontaspis kamoharai*** (Matsubara, 1936).

FAO Names: En – Crocodile shark; **Fr** – Requin crocodile; **Sp** – Tiburón cocodrilo.

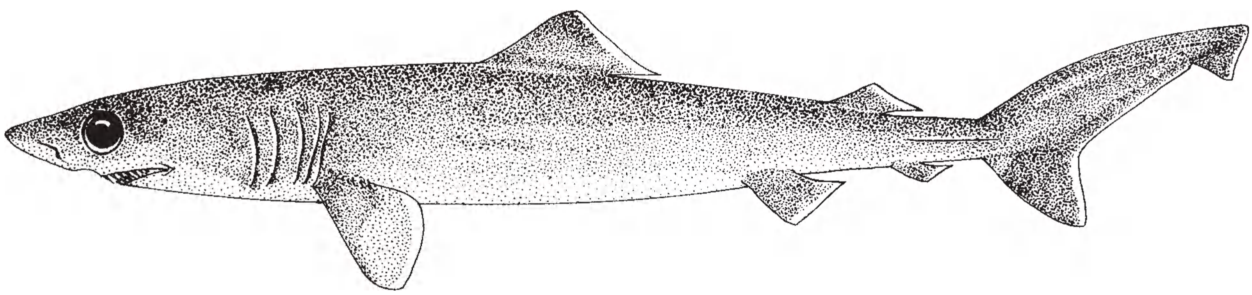
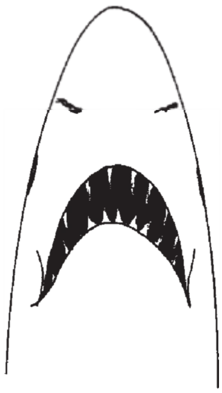


Fig. 186 *Pseudocarcharias kamoharai*



UNDERSIDE OF HEAD

UPPER AND LOWER TEETH

Field Marks: A small, very distinctive oceanic shark, with huge eyes lacking nictitating eyelids, long gill slits, slender, spindle–shaped body, long–cusped prominent teeth in a long angular mouth with highly protrusible jaws, small pectoral fins, two small spineless dorsal fins, an anal fin, weak keels and precaudal pits on the caudal peduncle, an asymmetrical caudal fin with a long ventral lobe, colour a grey to grey–brown above, lighter ventrally, and with light–edged fins; some individuals with a lighter spot on the cheeks.

Diagnostic Features: As for Family Pseudocarchariidae above.

Distribution: Circumtropical. Indian Ocean: Mozambique Channel between southern Madagascar, southern Mozambique and KwaZulu–Natal, South Africa, within Agulhas Current to off Eastern Cape and Western Cape, Bay of Bengal (possibly erroneous), Indonesia, and Australia (to about 35°S off Western Australia).

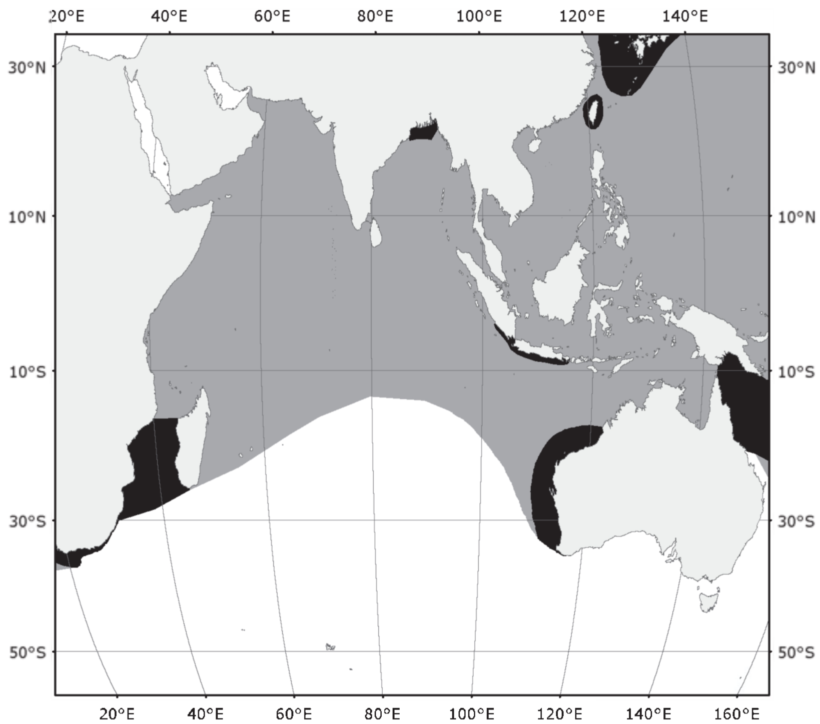


Fig. 187 ***Pseudocarcharias kamoharai***

Known distribution Possible distribution

Habitat: An uncommon to locally abundant oceanic, epipelagic, and possibly mesopelagic shark, usually found offshore and far from land, but sometimes occurs inshore and near the bottom at depths from the surface to at least 590 m. Its bicoloured countershading colour pattern, lack of an expanded iris and prominent green or yellow retinal reflection, and frequent occurrence in pelagic longline catches suggest that it primarily inhabits the epipelagic zone. There are several stranding records in the Cape Town (South Africa) area that suggest upwelling of cold water may stun and possibly kill these sharks on occasion.

Biology: Viviparous with uterine cannibalism; the young have yolk sacs at 3 to 4 cm long, but reabsorb them and subsist on the eggs and possibly smaller embryos. Litter size is usually four, two per uterus with one male and female per uterus; up to nine fertilized eggs per uterus have been recorded. There does not appear to be any seasonality to their reproductive cycle as pregnant females are found year–round.

The diet is not well known, but appears to include midwater bony fishes and cephalopods.

Size: Maximum total length about 122 cm; males adult at 74 to 81 cm, largest male 110 cm; females adult at 87 to 98 cm, largest female 122 cm. Size at birth about 41 cm.

Interest to Fisheries and Human Impact: Interest to fisheries none, it is usually taken as bycatch in longline and trawl fisheries. The small size and poor quality of its flesh makes this a relatively undesirable species for human consumption.

The crocodile shark has been listed as Near Threatened.

Local Names: Grootoog–skeurtandhaai (South Africa).

Remarks: The above account is modified after Compagno (2001).

Literature: Matsubara (1936); Teng (1959a); Cadenat (1963); Chen (1963); D'Aubrey (1964a, b); Merrett (1965); Abe *et al.* (1969); Abe (1973); Compagno (1973a, 1984a, 2001); Bass, D'Aubrey and Kistnasamy (1975b); Fujita (1981); Compagno, Ebert and Smale (1989); Compagno and Musick (2005); Last and Stevens (2009); Oliveira *et al.* (2010); Fricke, Kulbicki and Wantiez (2011); Dai *et al.* (2012).

2.7.4 Family ALOPIIDAE

Family: Subfamily Alopiadini Bonaparte, 1838 (Family Squalidae), *Nuov. Ann. Sci. Nat., Bologna*, ser. 1, 2: 209. Emended to Family Alopiidae Bonaparte, 1838 by Jordan and Gilbert (1883, *Bull., U.S. Nat. Mus.*, 16: 26).

Type genus: ***Alopias*** Rafinesque, 1810.

Number of Recognized Deep–sea Indian Ocean Genera: 1.

Synonyms: Family Alopeciae Müller and Henle, 1839: 74. Type genus: ***Alopecias*** Müller and Henle, 1837a. Family Vulpeculidae Garman, 1913: 12, 30. Type genus: ***Vulpecula*** Garman, 1913.

FAO Names: En – Thresher sharks; **Fr** – Renards; **Sp** – Zorros.

Field Marks: See generic account below.

Diagnostic Features: Body cylindrical, moderately stout, firm and not flabby. Head short, length one–third of total length; snout conical, moderately long, not flattened or blade–like. Eyes moderately large to extremely large, diameter 1.8 to 4.3% of precaudal length; nictitating membrane absent. Spiracles present, but small, pore–like. Gill openings relatively short, first opening 3.1 to 5.2% precaudal length, third to fifth openings over pectoral–fin bases; no gill rakers on internal gill slits. Nostrils small and with nasal flaps, but without barbels or oronasal grooves. Mouth small, broadly arched, below and extending posterior to eyes. Labial furrows variably present or absent. Teeth small, blade–like, with a single erect cusp; depending on species cusplets may or may not be present; tooth counts 19 to 52 upper jaw, 20 to 51 lower jaw. Caudal peduncle moderately compressed laterally, with crescentic shaped upper and lower precaudal pits and no lateral keels. Dermal denticles very small, smooth, with small ridges and cusps pointed posteriorly on lateral flanks. Pectoral fins very long and narrow, anterior margins nearly straight to curved, apices broadly tipped to pointed. Pelvic fins very large, similar in size to first dorsal fin. Dorsal fins noticeably dissimilar on size; first dorsal fin very large, erect, high, and subtriangular. Second dorsal fin minute, low and with pivoting bases; base anterior to anal–fin base. Anal fin very small, similar in size to second dorsal fin. Caudal fin extremely elongated, dorsal lobe length about equal to precaudal length; ventral lobe much shorter. Vertebral counts: total vertebral counts 278 to 477, precaudal vertebral counts 98 to 126, diplospondylous caudal vertebral counts 180 to 356. Intestinal valve with 33 to 45 turns. Size moderately large to very large with adults up to 550 cm long. **Colour:** depending on the species dorsal colour can range from a brilliant dark metallic blue, to a silvery bluish grey or a violet to purplish brown; ventral surface white.

Distribution: Wide ranging in most tropical to temperate seas.

Habitat: Thresher sharks occur from nearshore coastal waters, including bays, to oceanic habitats far from land. They occur from near the surface to depths of at least 723 m, but most are found within 65 m of the surface. Like many other lamnoids for which information is available these sharks are able to maintain their body temperatures above that of the surrounding seawater. The habitats of these shark broadly overlap with each other in some areas, but differences in their spatial distribution and foraging behaviour suggests that they partition the available habitat and preferred prey items.

Biology: Reproductive mode is yolk–sac viviparous with oophagy. Litters are small, ranging from 2 to 7 depending on the species. Gestation is from nine to 12 months with a defined birthing only known for one species (***Alopias vulpinus***), while the other two species do not appear to have a defined birthing season. Thresher sharks feed on a wide variety of schooling fishes and cephalopods. These are the only modern sharks, along with the sawsharks (Pristiophoridae), known to use a structure other than their jaws and teeth to subdue their prey. Thresher sharks use their elongated caudal fins to herd prey species into a tight school and then by rapidly whipping their tails stun and kill their prey before consuming it.

Interest to Fisheries and Human Impact: Worldwide, the thresher sharks are important fisheries because their meat is of high quality for human consumption and the long fins are highly desirable in the shark–fin trade. However, despite their being a common bycatch component in drift gillnets and longline fisheries, they are often reported in mixed catches with little detailed species–specific information.

All members of the genus ***Alopias*** are considered Vulnerable globally due to apparent declining populations.

Local Names: Fox sharks, Threshers, Renards de mer.

Remarks: The genus can be subdivided into two distinct groups; one group consisting of those thresher sharks with relatively small eyes, a thin caudal fin, and no marked grooves on the top of the head. This group includes the common thresher shark (***Alopias vulpinus***) and the pelagic thresher shark (***A. pelagicus***). The other group includes the bigeye thresher shark (***A. superciliosus***) with its extremely large eyes, broad caudal fin, and distinct grooves on the top of the head, running from a central point over the eyes, out and back over the gill region.

The family has a monotypic genus ***Alopias*** with three described species, two (***A. pelagicus*** and ***A. vulpinus***) of which generally occur from nearshore to offshore waters and usually inhabit a more pelagic environment, while one species (***A. superciliosus***) generally occurs in much deeper water than the others. The family, genus, and species accounts are modified and updated from Compagno (1984a, 2001).

Literature: Bigelow and Schroeder (1948); Gruber and Compagno (1981); Compagno (1984a, 2001); Quéro *in* Whitehead *et al*. (1984); Ebert (2003); Gibson *et al*. (2008); Last and Stevens (2009).

List of Deep–sea Species Occurring in the Area:

Alopias superciliosus Lowe, 1841

Alopias Rafinesque, 1810

Genus: ***Alopias*** Rafinesque, 1810, *Caratt. Gen. sp. anim. piant. Sicilia, Palermo*, pt. 1: 13.

Type species: ***Alopias macrourus*** Rafinesque, 1810, by monotypy, a junior synonym of ***Squalus vulpinus*** Bonnaterre, 1788, *Tabl. Encyclop. Method. Trois Reg. Nat. Ichthyol.*, Paris: 9.

Number of Recognized Deep–sea Indian Ocean Species: 1.

Synonyms: Genus ***Vulpecula*** Jarocki, 1822: 454. Probably based on ***Vulpecula marina*** Valmont, 1768 (work not consistently binomial), equivalent to ***Squalus vulpinus*** Bonnaterre, 1788. Genus ***Alopecias*** Müller and Henle, 1837a: 114. Type species: "***Carcharias vulpes*** Cuv[ier]" by original designation, equals ***Squalus*** (***Carcharias***) ***vulpes*** Cuvier, 1816. Genus ***Alopius*** Swainson, 1838: 91 (unjustified emendation of ***Alopias*** Rafinesque, 1810). Genus ***Vulpecula*** Garman, 1913: 3, 30. Type species: ***Vulpecula marina*** Garman, 1913, by monotypy: "Valmont, 1768, gives a description of ***V. marina*** of earlier authors. His species is ***Squalus vulpinus*** Bonn., 1788, the ***Alopias macrourus*** Raf., 1810, ***A. vulpes*** Bonap. 1841. The genus and species are adopted from Valmont" (Garman, 1913: 3). Revival of ***Vulpecula*** Valmont (1768: 740). Valmont's names were rejected as being inconsistently binomial by the International Commission on Zoological Nomenclature (1925, Opinion 89: 27–33).

Field Marks: A distinctive shark group with an extremely long caudal fin that is about as long as the body trunk, very long, narrow pectoral fins, a very large first dorsal fin and comparatively minute second dorsal fin, and large to very large eyes.

Diagnostic Features: See family account above.

Local Names: None.

Alopias superciliosus Lowe, 1841

Alopecias superciliosus Lowe, 1841, (Jan.), *Proc. Zool. Soc. London*, 1840(8): 39. Also Lowe, 1849, *Trans., Zool. Soc. London*, 3(1): 18 (sometimes dated 1839). Holotype unknown (Compagno, 2001), type locality Madeira, Eastern Atlantic.

Synonyms: ***Alopias profundus*** Nakamura, 1935: 2, pl. 1, fig. 1, pl. 2. Syntypes: three large specimens, 332, 352, and 366 cm total length, a large female illustrated and of uncertain size (Nakamura, 1935, pl. 1, fig. 1); also, a 72 cm total length foetus, presumably the same as illustrated (Nakamura, 1935, pl. 2); all specimens from So–au fish market, Taiwan (Province of China). Whereabouts of syntypes unknown according to Compagno (2001); syntypes may possibly have never been accessioned into a research collection.

Other Combinations: None.

FAO Names: En – Bigeye thresher; **Fr** – Renard à gros yeux; **Sp** – Zorro ojón.

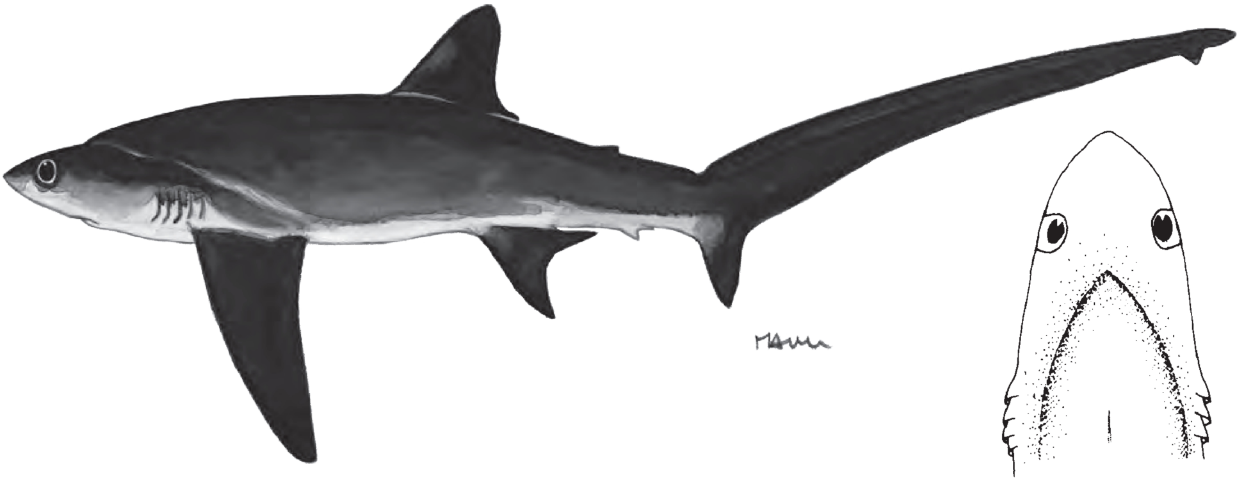


Fig. 188 ***Alopias superciliosus***

Field Marks: A large thresher shark with extremely large eyes extending onto the dorsal head surface, head with distinct lateral grooves extending from above the eyes to behind the gill slits (appearing helmet–like), pectoral fins with curved anterior margin and broadly tipped at the apices, caudal fin extremely long, about same length as precaudal length, broad at fin tip, colour purplish brown to violet above, light below, without white patches extending above pectoral or pelvic fins.

Diagnostic Features: Body stout, cylindrical. Head broad, with deep grooves extending along each side of head from behind eyes to above gill openings. Snout moderately long and bulbous. Eyes huge, extending onto the dorsal head surface; interorbital space nearly flat. Labial furrows absent. Teeth large, with a long slender, smooth–edged cusp, no lateral cusplets, similar in both jaws; no symphysial or intermediate teeth; tooth count 19 to 27 upper jaw, 19 to 24 lower jaw. Pectoral fins falcate with curved anterior margins and broadly tipped apices. Claspers moderately slender, not whip–like. First dorsal midbase closer to pelvic fin bases than to pectoral fin bases. Caudal tip broad with wide terminal lobe. Vertebral counts: total vertebral count 278 to 308, monospondylous vertebral count 66, diplospondylous vertebral count 39, total precaudal vertebral count 98 to 106, caudal vertebral count 175 to 204. Intestinal valve count 43 to 45. Maximum total length about 484 cm. **Colour:** upper body surface violet to purplish–brown, fading to grey or white on sides, becoming lighter ventrally, but not extending over pectoral–fin bases; no white blotches or spots extending onto upper pectoral fin tips.

Distribution: Worldwide in all major oceans. Indian Ocean: South Africa, Madagascar, Arabian Sea, Gulf of Aden, Maldives, Sri Lanka, Indonesia, and northwestern coast of Australia.

Habitat: Bigeye threshers are usually found over continental shelves, but also on the high seas in the open ocean far from land. They may occur at the surface and down to at least 723 m over very deep water. They are usually found in areas where the surface temperature ranges from 16 to 25 °C. This shark appears to exhibit a strong diel movement pattern by remaining at depth, usually between 300 and 500 m where the water temperature is between 6 and 12 °C, during the day, migrating at night to within 10 and 100 m from the surface where the water temperature warms to between 20 and 26 °C.

Biology: Viviparous with a yolk sac, but oophagous, and with litters of 2 to 4, mostly 2. The gestation period may be 12 months, but since there does not appear to be a defined birthing season this has

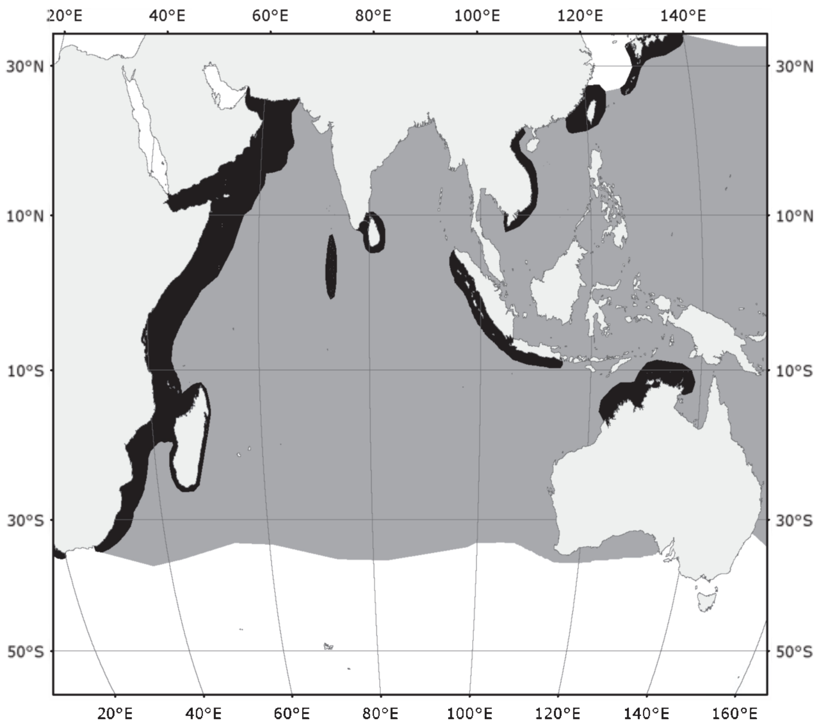


Fig. 189 ***Alopias superciliosus***

Known distribution Possible distribution not been confirmed. Gravid females with embryos in various developmental stages are found year–round. Males mature in about 9 to 10 years and live at least 19 years, while females mature in 12 to 14 years and live about 20 years.

The diet of bigeye threshers consists primarily of benthic and pelagic fishes, cephalopods, and crustaceans. The large eyes are especially well adapted for low light levels, and the expanded orbits allow the eyes to roll upward enabling these sharks to hunt by searching for silhouettes of potential prey items above them.

The bigeye thresher as with the other members of this genus and the family Lamnidae are able to maintain their body temperature several degrees above that of the surrounding water.

Size: Maximum total length about 484 cm; males adult between 270 to 290 cm; females mature 332 to 356 cm. Size at birth 100 to 140 cm.

Interest to Fisheries and Human Impact: The bigeye thresher is taken in drift gillnets and by longline, but very little is known as to how many are typically caught since landings are not generally reported to species.

The conservation status of this thresher shark species is Vulnerable due to apparent declining populations, possibly resulting from a combination of its life history characteristics and high levels of largely unmanaged and unreported mortality from targeted and non-targeted fisheries.

Local Names: Bigeyed thresher.

Literature: Bigelow and Schroeder (1948); Bass, D'Aubrey and Kistnasamy (1975b); Gruber and Compagno (1981); Gilmore (1983, 1993); Compagno (1984a, 2001); Compagno, Ebert and Smale (1989); Chen, Liu and Chan (1997); Liu, Chiang and Chen (1998); Ebert (2003); Weng and Block (2004); Amorim *et al.* (2009); Last and Stevens (2009).

2.7.5 Family CETORHINIDAE

Family: Subfamily Cetorhinidae Gill, 1862, *Ann. Lyceum Nat. Hist. New York*, 7(32): 397–398 (Family Lamnoidae). Emended to Family Cetorhinidae Gill, 1862, by Gill (1872, *Smiths. Misc. Coll.*, [247]: 24).

Type genus: Subgenus ***Cetorhinus*** Blainville, 1816 (Genus ***Squalus*** Linnaeus, 1758).

Number of Recognized Deep–sea Indian Ocean Genera: 1.

Synonyms: Group ***Selachina*** Günther, 1870 (Family Lamnidae): 389, 394. Emended to Family Selachidae Günther, 1870, by Poey, 1875: 85. Also Subfamily ***Selache*** (Family Lamna) Hasse, 1879: tab. 2. Type genus: Subgenus ***Selache*** Cuvier, 1816 (Genus ***Squalus*** Linnaeus, 1758). Family Halsydridae Whitley, 1934: 196. Type genus: ***Halsydrus*** Neill, 1809a, b.

FAO Names: En – Basking sharks; **Fr** – Requins pélerin; **Sp** – Peregrinos.

Field Marks: See species account below.

Diagnostic Features: Body fusiform, stout, and firm, not flabby; body stoutest from about pectoral fins to first dorsal fin, tapering posteriorly to moderately stout dorso–ventrally flattened caudal peduncle. Head moderately long, much shorter than trunk length, and slightly compressed laterally opposite to mouth. Snout short, conical with rounded tip in larger specimens (over 360 cm), but in smaller individuals (less than about 360 cm) snout length much longer, forming a subcylindrical proboscis, becoming oblique, truncated, and terminating in a acutely pointed tip. Eyes nearly circular, relatively small, diameter about 0.8 to 1.3% of precaudal length, located just posterior to front of mouth. Spiracles minute, circular, about opposite to or just posterior to front of mouth. Gill openings enormous, nearly encircling the head; first gill opening largest, each subsequent opening descending in length to the fifth (smallest) opening; all five paired gill openings anterior to pectoral–fin base; internal gill openings with modified gill rakers. Nostrils small, transverse, closer to mouth than to snout tip. Mouth huge, rounded in adults, but variable in young juveniles. Lower labial furrow at mouth corners very short, upper labial furrows absent. Teeth minute, with a single smooth–edged, hook–shaped cusp, similar shaped in both jaws; tooth counts number over 200 rows on upper and lower jaws. Caudal peduncle with strong lateral keels and crescentic shaped upper and lower precaudal pits. Dermal denticles close–set, numerous, varying in size, very rough, erect and thorn–like with strong cusps and ridges; cusps of lateral denticles angled in various directions. Pectoral fins very large and broad, less than head length. Pelvic fins about two–thirds height of first dorsal fin anterior margin. Anal fin similar in size to second dorsal fin; origin below posterior half of second dorsal fin. First dorsal fin very high, erect, nearly triangular; midbase between snout tip and caudal fork. Second dorsal fin anterior margin only about 20% to 25% height of first dorsal fin. Caudal fin crescent–shaped, large, but less than one–third length of shark; dorsal lobe about one–third longer than ventral lobe. Vertebral counts: total vertebral counts 107 to 116, precaudal vertebral counts 50 to 54, diplospondylous caudal vertebral counts 55 to 62. Intestinal valve of ring type with 47 to 51 turns. The second largest fish in the world with adults to about 10 m and possibly to 12 m long. **Colour:** mottled bluish grey to grey or brown above, becoming variably lighter or darker below.

Distribution: Circumglobal, most commonly observed in temperate and boreal waters, but known to occur at depth, usually below 300 m in tropical seas.

Habitat: Coastal and pelagic oceanic, these sharks will dive to several hundred meters and remain at depth as they move through warm temperate to tropical waters migrating between hemispheres. In cooler waters, they are often seen slowly cruising at the surface. These sharks are known to make transoceanic and trans–equatorial migrations.

Biology: See species account below.

Interest to Fisheries and Human Impact: See species account below.

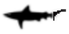
Local Names: None.

Remarks: The family, genus, and species accounts are modified and updated after Compagno (2001) who also provides a detailed account on the history of the spelling and usage of the various scientific names for this shark.

The family has a single genus and species, which occurs in all major oceans.

Literature: Bigelow and Schroeder (1948); Compagno (1984a, 2001); Ebert (2003); Last and Stevens (2009).

List of Deep–sea Species Occurring in the Area:

 ***Cetorhinus maximus*** (Gunnerus, 1765)

Cetorhinus Blainville, 1816

Genus: Subgenus ***Cetorhinus*** Blainville, 1816 (Genus ***Squalus*** Linnaeus, 1758), *Bull. Sci. Soc. Philomat. Paris*, (8): 121.

Type species: Not designated; Blainville included the species "***Gunneri***; ***Peregrinus***; ***Shavianus***; ***Homianus***?" in ***Cetorhinus*** without further comment. Gill (1862, *Ann. Lyceum Nat. Hist. New York*, 7(32): 398), designated ***Squalus maximus*** "Linnaeus" (=Gmelin, 1788) as type of ***Cetorhinus***, but this was not an included species. Jordan and Gilbert (1883, *Bull. U.S. Nat. Mus.*, 16: 31) designated "***Cetorhinus gunneri*** Blainv. = ***S. maximus*** L." (a junior synonym of ***Squalus maximus*** Gunnerus, 1765) as type of ***Cetorhinus***, which may be the earliest valid type designation. Eschmeyer (1998, Cat. Fish.) cited Jordan and Evermann (1896, *Bull. U.S. Natn. Mus.*, (47), pt. 1: 51) as a later, similar type designation.

Number of Recognized Deep–sea Indian Ocean Species: 1.

Synonyms: Subgenus ***Selache*** Cuvier, 1816 (Genus ***Squalus*** Linnaeus, 1758): 129. Type species, "***Sq. maximus*** L." by monotypy (***Squalus maximus*** Gmelin, 1788, a junior synonym of ***Squalus maximus*** Gunnerus, 1765). Genus ***Selanche*** Jarocki, 1822: 452 (error for ***Selanche***, Cuvier, 1816). Genus ***Selanchus*** Minding, 1832: 52 (unjustified emendation of ***Selache*** Cuvier, 1816). Genus ***Polyprosopus*** Couch, 1862: 67.

Field Marks: See species account below.

Diagnostic Features: See family account above.

Local Names: None.

Cetorhinus maximus (Gunnerus, 1765)

Squalus maximus Gunnerus, 1765, *K. Norske Vidensk–selsk. Scr. Trondh.*: 33, pl. 2. Holotype, apparently none. Type Locality: Trondhjem, Norway.

Synonyms: ***Squalus gunnerianus*** Blainville, 1810 (71): 256, pl. 2, fig. 3; Types? ***Squalus homianus*** Blainville, 1810: 257, pl. 2, fig. 1. Types? ***Squalus pelegrinus*** Blainville, 1810: 256, pl. 2, fig. 2. Holotype: Museum National d'Histoire Naturelle, Paris, MNHN 9853. ***Halsydrus pontoppidiani*** Fleming, 1817: 713. Stronsa, Orkney Islands. Holotype: National Museum of Scotland, NMSZ–1979.012. ***Squalus elephas*** Lesueur, 1822: 350, pl. Types: based on a large adult male specimens, about 10 m TL from the New Jersey coast, not saved. ***Squalus rashleighanus*** Couch, 1838: 51. Type locality, Cornwall. Types? ***Polyprosopus macer*** Couch, 1862: 68, pl. 15, fig. 2. Type locality, Startpoint, Cornwall, England. No types. ***Cetorhinus blainvillei*** Capello, 1870: 233, 1 pl. Type locality, Portugal. Types? ***Selachus pennantii*** Cornish, 1885: 351. Type locality: Cornwall. No types.

Other Combinations: ***Halsydrus maximus*** (Gunnerus, 1765), ***Selache maxima***, ***Selache maximus*** or ***Selache maximum*** (Gunnerus, 1765), ***Selache elephas*** (Lesueur, 1822)

FAO Names: En – Basking shark; **Fr** – Pélerin; **Sp** – Peregrino.

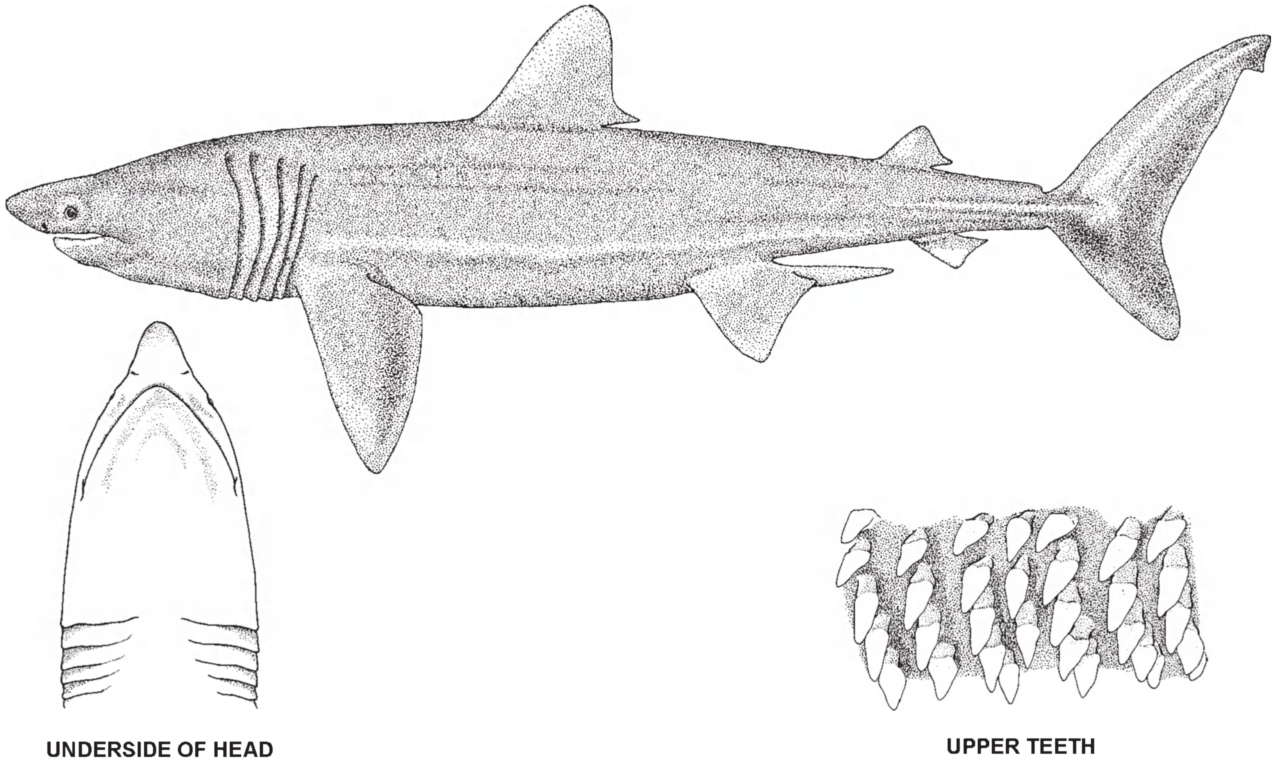


Fig. 190 ***Cetorhinus maximus***

Field Marks: The great size, enormous gill slits that virtually encircle the head, modified gill rakers, pointed snout, huge, subterminal mouth with minute hooked teeth, caudal peduncle with strong lateral keels, and lunate caudal fin distinguish this shark from all others. Colour blackish to grey–brown, grey or blue–grey above and below on body and fins, undersurface sometimes lighter, often with irregular white blotches on the underside of the head and abdomen; flanks sometimes with lighter linear striping and spots.

Diagnostic Features: See family Cetorhinidae above.

Distribution: Circumglobal. Indian Ocean: South Africa and Australia.

Habitat: Basking sharks are coastal pelagic, usually observed at the surface in areas where the water temperature is between 5 and 21 °C. They may be found close inshore, including enclosed bays, from the surfline and over the continental shelf, to well offshore at depths of over 1200 m. This is a very social species and is often seen swimming in small groups of 3 to 10 or in larger groups numbering in the hundreds. At lower latitudes, these sharks will dive to depth and remain between 250 and about 1000 m deep for five months or more without coming to the surface. In warm temperate and tropical

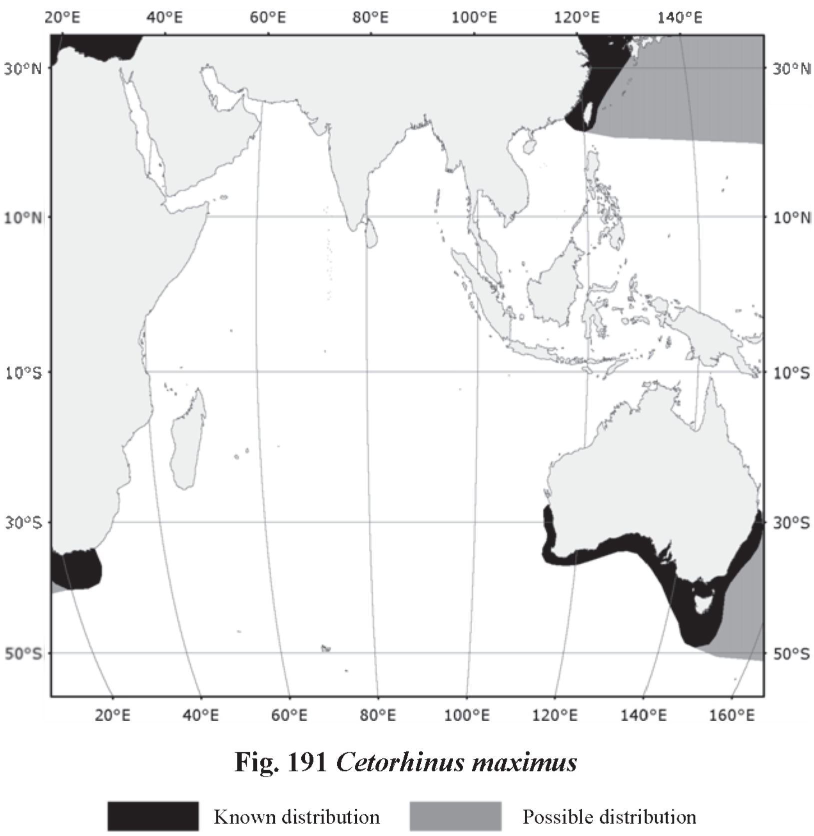


Fig. 191 ***Cetorhinus maximus***

seas, these sharks tend to follow distinct water masses while at depth; one shark was found to follow the 5 °C thermocline at 300 to 400 m deep off Brazil, while another individual followed the 5 °C thermocline at 750 to 1000 m depth off the Bahamas. In the eastern Pacific, one shark tagged off San Diego, California (USA), travelled over 2500 km to just off the northeastern Hawaiian Islands in eight months. The shark remained at depth, mostly below 300 m, following a cooler water thermocline during this time.

Biology: Reproduction oophagous, with 1 to 6 young per litter; reproductive cycle including gestation period unknown. Records of juvenile sharks less than 300 cm for this species are rare, suggesting pupping and nursery grounds are located in planktonic–rich oceanic waters far from populated coastal areas. Previous age estimates for this species are now known to be erroneous as vertebral bands are associated with growth and not age.

These filter–feeding giants consume vast quantities of zooplankton including copepods and planktonic larvae. An individual basking shark may have half a ton of food in its stomach at any time. Adult basking sharks when feeding will cruise at a speed of about two knots per hour and will pass about 2,000 tons of water over their gills per hour. They will close their mouths every 30 to 60 seconds to ingest the filtered plankton that is trapped in their gill rakers. Basking sharks feed along thermal fronts where their food may be especially abundant. They will dive to great depths in warm temperature and tropical seas following thermoclines and will remain at depth for extended periods of time.

Basking sharks appear to have few natural predators, although white sharks (***Carcharodon carcharias***), killer whales (***Orcinus orca***), and sperm whales (***Physeter macrocephalus***) are known predators; a 2.5 m juvenile was once found in a sperm whale stomach in the Azores.

Basking sharks are now known to make extensive transoceanic and trans–equatorial movements in the Atlantic and Pacific often moving thousands of kilometres. The North Atlantic population may be contiguous with evidence of movements between the eastern and western North Atlantic. Also, some sharks tagged off southern New England, U.S.A., were found to move southwards to the Caribbean and as far as Brazil, South America. Similarly, a shark tagged off California travelled 2500 km to just off the Hawaiian Islands, suggesting that these sharks may utilize entire ocean basins during their life cycle. Information on this species in the Indian Ocean is scant, as it does not appear to be very common, with very few confirmed records.

Size: Maximum total length about 10 to 12 m; males mature at about 4 to 5 m and females at about 8 to 9 m TL. Size at birth about 1.5 to 2 m total length; smallest free–swimming individual measured 1.7 m in length.

Interest to Fisheries and Human Impact: Of little importance in the Indian Ocean as this species does not appear to be very common. Elsewhere, these sharks have been fished historically in the North Atlantic since at least the seventeenth and eighteenth centuries primarily for their liver oil for vitamin A, and lamp oil, skin for leather, and flesh for human consumption. In recent years, their fins have become quite valuable in the shark–fin trade industry. Since 2003, basking sharks have been largely protected by most nation states with only bycatch landings allowed for in some regions.

The basking shark is quite docile allowing boats and ecotourist divers to approach them. Although considered harmless, divers approaching these sharks should take care as the extremely rough dermal denticles on its skin can cause severe abrasions and lacerations to uncovered human skin.

It has been estimated that the global population of these sharks may be quite low, which raises concerns over its conservation status. It is considered Vulnerable globally. In 2002, the basking shark was listed by the Convention on International Trade in Endangered Species (CITES) on Appendix II.

Local Names: None.

Literature: Matthews (1950, 1962); Matthews and Parker (1950a, b); Parker and Stott (1965); Compagno (1984a, 2001); Compagno, Ebert and Smale (1989); Izawa and Shibata (1993); Harvey–Clark *et al*. (1999); Ebert (2003); Skomal, Wood and Caloyianis (2004); Fowler (2005); Southall *et al*. (2005); Hoelzel *et al*. (2006); Gore *et al*. (2008); Natanson *et al*. (2008); Last and Stevens (2009); Skomal *et al*. (2009).

2.8 Order CARCHARHINIFORMES – Ground Sharks

Order: Carcharhiniformes Compagno, 1973a, *J. Linn. Soc.* (*Zool.*) London, 53, suppl. 1.

Number of Recognized Deep–sea Indian Ocean Families: 5.

Synonyms: [Part] 1 Squali, Abtheilung [Division] 1: Müller and Henle, 1838, *Syst. Besch. Plagiost.* (1): 3 (division 1 equivalent to suborder for scyliorhinids and most orectoloboids, Squali equivalent to order for all living sharks). [Part] 1 Squali, Abtheilung [Division] 2: Müller and Henle, 1838 (in part), *Syst. Besch. Plagiost.* (1): 27; Müller and Henle, 1839 (in part), *Syst. Besch. Plagiost.* (2): 27 (division 2 equivalent to suborder for most carcharhinoids, all lamnoids, heterodontoids, and the family Rhincodontidae, Squali equivalent to order for all living sharks). [Part] 1 Squali, Abtheilung [Division] 2, Unterabtheilung [Subdivision] 1: Müller and Henle, 1838 (in part), *Syst. Besch. Plagiost.* (1): 27; Müller and Henle, 1839 (in part), *Syst. Besch. Plagiost.* (2): 27 (subdivision 1 equivalent to superfamily for carcharhinids and sphyrnids). [Part] 1 Squali, Abtheilung [Division] 2, Unterabtheilung [Subdivision] 2: Müller and Henle, 1839, *Syst. Besch. Plagiost.* (2): 57 (subdivision 2 equivalent to superfamily for some carcharhinids and triakids). Ordo Plagiostomi, Subordo Squalini, Sectio Proktopterides, Tribus Dinotopterini: Bleeker, 1859, *Acta Soc. Sci. Indo–Neerl.* 6: xi (tribus and sectio of equivalent rank to superfamily and infraorder, tribe for heterodontoids, lamnoids, carcharhinoids, orectoloboids, and hybodonts, section for all sharks with anal fins, suborder for all sharks, order for all elasmobranchs). Order Squali, Suborder Squali: Gill, 1862 (in part), *Ann. Lyc. Nat. Hist. N. Y.* 7: 394, 396 (suborder for all sharks except squatinids, order for all sharks). Order Squali, Suborder Galei: Gill, 1872 (in part), *Smithsonian Misc. Colln.* (247): 22, 23 (order for all sharks, suborder for all sharks except squatinids). Order Plagiostomi diplospondyli, Suborder Plagiostomi asterospondyli, Group 1 Scyllia: Hasse, 1879 (in part), *Nat. Syst. Elasmobr.* (1): 52 (suborder for 'galeoid' sharks and heterodontoids, group ranked as infraorder or superfamily and including most carcharhinoids and family 'Cheiloscyllium' = Hemiscylliidae). Order Selachii, Suborder Asterospondyli: Woodward, 1889 (in part), *Cat. fossil fish.* BM(NH) (1): 157 (suborder for hexanchoids, cochliodonts, heterodontoids, hybodonts, palaeospinacids, lamnoids, orectoloboids, and carcharhinoids, order for other living elasmobranchs, psammodonts, petalodonts, and pristodonts). Order Asterospondyli: Gill, 1893 (in part), *Natn. Acad. Sci. (U. S.) Mem.* 6, 6: 130 (carcharhinoids in unnamed suborder [Galei?] with other 'galeoid' sharks and pristiophorids in apposition to suborder for squatinoids); Fowler, 1941 (in part), *Bull. U. S. Natn. Mus.* (100) 13: 4, 13 (group for heterodontoids and 'galeoids'); Smith, 1949 (in part), *Sea fishes Southern Africa*: 37, 39 (group for "typical sharks" including heterodontoids and 'galeoids'). Order Asterospondyli, Suborder Galei: Jordan and Evermann, 1896 (in part), *Bull. US Nat. Mus.* 47(1): 19, 21 (order for heterodontoids and 'galeoid' sharks, suborder for 'galeoids'). Order Euselachii, Suborder Pleurotremata, Division Galeoidei Regan, 1906a (in part), *Proc. Zool. Soc. London* (1906): 723 (division ranking as infraorder or superfamily for all 'galeoid' sharks including lamnoids, orectoloboids, and carcharhinoids). Order Selachii, Group 2, Division B, Subdivision 1, Suborder Scylliodei Goodrich, 1909 (in part), *In* R. Lankester, *ed.*, *A treatise on Zoology* (9), Vertebrata Craniata: 148 (subdivision and suborder for 'galeoid' sharks). Order Pleurotremata, Suborder Galeoidei: Engelhardt, 1913 (in part), *Abh. math.–phys. Klasse K. Bayer. Akad. Wiss., Suppl., Beitr. Naturg. Ostasiens*, 4: 97 (suborder for 'galeoid' sharks: carcharhinoids, lamnoids, and orectoloboids). Order Plagiostoma, Suborder Antacea, "Group" Carcharinoidei: Garman, 1913 (in part), *Mem. Mus. Comp. Zool. Harvard* 36: 11, 12 (group corresponding to infraorder or superfamily, and including the carcharhinoid families Carcharinidae [= Carcharhinidae in large part], Cestracionidae [= Sphyrnidae] and Galeorhinidae [= Triakidae in large part]). Order Plagiostoma, Suborder Antacea, "Group" Catuloidei: Garman, 1913 (in part), *Mem. Mus. Comp. Zool. Harvard* 36: 11, 12 (group corresponding to infraorder or superfamily, and including the carcharhinoid families and including the carcharhinoid families Catulidae [= Scyliorhinidae] and Pseudotriakidae as well as all orectoloboids except the whale shark). Order Euselachii, Suborder Galei, [Series] Scyllioidei: Jordan, 1923 (in part), *Stanford Univ. Publ., Univ. Ser., Biol. Sci.*, 3: 97 (group for scyliorhinids and orectoloboids). Order Euselachii, Suborder Galei, Series Galeoidei: Jordan, 1923 (in part), *Stanford Univ. Publ., Univ. Ser., Biol. Sci.*, 3: 100, 101 (group for triakids, higher carcharhinids, and pristiophoroids). Order Plagiostomi, Suborder Galeiformes: Lozano y Rey, 1928 (in part), Fauna Iberica. Peces. Vol. 1: 280 (suborder for 'galeoid' sharks: lamnoids, orectoloboids, and carcharhinoids). Order Galea, Suborder Carcharinida, Superfamily Catuloidea: White, 1936, *Amer. Mus. Novit.* (837): 4; White, 1937, *Bull. Amer. Mus. Nat. Hist.* 74: 37, tab. 1 (superfamily includes scyliorhinids, proscylliids and pseudotriakids, suborder all carcharhinoids, and order for all 'galeoid' sharks). Order Galea, Suborder Carcharinida, Superfamily Carcharinoidea: White, 1936, *Amer. Mus. Novit.* (837): 4; White, 1937, *Bull. Amer. Mus. Nat. Hist.* 74: 37, tab. 1 (superfamily includes triakids, hemigaleids, carcharhinids and sphyrnids, suborder all carcharhinoids, and order for all 'galeoid' sharks). Order Euselachii, Suborder Lamniformes: Bertin, 1939 (in part), *Bull. Inst. Oceanogr. Monaco* (775): 9 (suborder for lamnoids + pseudotriakids, order for all living elasmobranchs). Order Euselachii, Suborder Scylliformes: Bertin, 1939 (in part), *Bull. Inst. Oceanogr. Monaco* (775): 9 (suborder for scyliorhinids, proscylliids and orectoloboids, order for all living elasmobranchs). Order Euselachii, Suborder Musteliformes: Bertin, 1939 (in part), *Bull. Inst. Oceanogr. Monaco* (775): 9 (suborder for triakids, hemigaleids, proscylliids, carcharhinids, and sphyrnids, order for all living elasmobranchs). Order Lamniformes, Suborder Scyliorhinoidei: Berg, 1940, *Trudy Zool. Inst. Akad. Nauk SSSR*, 5(2): 137 (suborder exclusively for carcharhinoids, order also for lamnoids and orectoloboids); Berg and Svedovidov, 1955 (in part), *Trudy Zool. Inst. Akad. Nauk SSSR*, 20: 66; Patterson, 1967, *in* W. B. Harland *et al.*, *Geol. Soc. London, Spec. Pub.* 2: 671 (suborder exclusively for carcharhinoids, order also includes squaloids, squatinoids, lamnoids, orectoloboids, squalicoracids, protospinacids, and orthacodontids); Lindberg, 1971, *Fishes of the world* (trans. 1974): 8, 258 (suborder exclusively for carcharhinoids, order also for lamnoids and orectoloboids); Nelson, 1976 (in part), *Fishes of the world*: 33 (suborder exclusively for carcharhinoids, order for 'galeoid' sharks including lamnoids and orectoloboids); Nelson, 1984, *Fishes of the world*, ed. 2: 53. Order Euselachii, Suborder Galei, Superfamily Scyllioidea: Whitley, 1940, *Fishes Australia. Part I. Aust. Zool. Handbook*: 68 (scyliorhinids). Order Euselachii, Suborder

Galei, Superfamily Galeoidei: Whitley, 1940, *Fishes Australia. Part I. Aust. Zool. Handbook*: 68 (triakids and higher carcharhinoids). Order Selachii, Suborder Galeoidea: Romer, 1945 (in part), *Vert. Paleont*. (ed. 2): 576 (suborder for lamnoids, orectoloboids, and carcharhinoids, order for all living sharks and protospinacids, hybodonts, coronodonts, and edestoids); Bigelow and Schroeder, 1948 (in part), *Mem. Sears Fnd. Mar. Res*. (1) 1: 77, 95 (suborder for lamnoids, orectoloboids, and carcharhinoids, order for all living sharks); Romer, 1966 (in part), *Vert. Paleont*. (ed. 3): 350 (suborder for lamnoids, orectoloboids, carcharhinoids, and orthacodonts, order for all living sharks and protospinacids, ptychodonts, hybodonts, coronodonts, and edestoids). Order Lamnoidea, Suborder Scyliorhinoidea: Schultz and Stern, 1948 (in part), *Ways of Fishes*: 224 (suborder exclusively for carcharhinoids, order also including lamnoids and orectoloboids). Order Lamnida, Suborder Lamnina: Matsubara, 1955 (in part), *Fish morphology hierarchy*, (1): 1–789 (suborder for lamnoids, orectoloboids, and carcharhinoids, order for all living sharks). Order Galeiformes, Suborder Carcharhinoidei: Arambourg and Bertin, 1958, *In* P.–P. Grasse, *ed*, *Traité de Zoologie*, 13: 2037 (suborder exclusively for carcharhinoids, order also for orectoloboids and lamnoids). Order Pleurotrema, Suborder Galeoidea: Norman, 1966 (in part), *draft syn. Recent fishes*: 7 (suborder for lamnoids, orectoloboids, and carcharhinoids, order for all living sharks). Order Carcharhinida: Glikman, 1967 (in part), *in* Y. A. Orlov, *ed*., *Fundamentals Paleontology*, 11: 222 (for carcharhinoids and palaeospinacids). Order Carchariida, Suborder Galeorhinina, Superfamily Galeorhinicae: Fowler, 1967b, *Q. J. Taiwan Mus*. 20(3–4): 342, 360 (superfamily for triakids, hemigaleids and proscylliids, suborder for all carcharhinoids, order for 'galeoids'). Order Carchariida, Suborder Galeorhinina, Superfamily Scyliorhinicae: Fowler, 1967b, *Q. J. Taiwan Mus*. 20(3–4): 343 (superfamily for scyliorhinids). Order Carchariida, Suborder Galeorhinina, Superfamily Pseudotriakicae: Fowler, 1968, *Q. J. Taiwan Mus*. 21(3–4): 197 (superfamily for pseudotriakids). Order Carchariida, Suborder Galeorhinina, Superfamily Sphyrnicae: Fowler, 1968, *Q. J. Taiwan Mus*. 21(3–4): 197 (superfamily for sphyrnids). Order Euselachii, Suborder Galeoidei: Blot, 1969 (in part), *in* J. Piveteau, *ed*. Traité de Paleontologie. 2: 702–776 (suborder for lamnoids, orectoloboids, and carcharhinoids, order for all living sharks except hexanchoids and heterodontoids). Order Pleurotremata, Suborder Galeiformes: Budker and Whitehead, 1971 (in part), life of sharks: 5, tab. 2 (suborder for lamnoids, orectoloboids and carcharhinoids, order for all living sharks). Order Carcharhiniformes: Rass and Lindberg, 1971 (in part), 1971, *J. Ichthyol*. (Trans. Voprosy Ikhtiologii) 11(3): 304 (includes orectoloboids, carcharhinoids, and the lamnoid family Cetorhinidae); Compagno, 1973a, *J. Linn. Soc. (Zool.) London*, 53, suppl. 1: 28 (exclusively for all carcharhinoids); Applegate, 1974, *J. Mar. Biol. Ass. India*, 14(2): 743 (exclusively for all carcharhinoids); Chu and Meng, 1979, *Monogr. Fish. China, Sci. Tech. Press, Shanghai*: 114, tab. 2 (exclusively for carcharhinoids); Compagno, 1984b, *FAO Fish. Synops*. (125)4(2): 251; Gubanov, Kondyurin and Myagkov, 1986 (in part), *Sharks World Ocean*: 3, 61 (for orectoloboids, carcharhinoids, and the lamnoid families Cetorhinidae and Megachasmidae); Cappetta, 1987, *Handb. Paleoichthyol*. 3B: 27, 111 (exclusively for carcharhinoids); Compagno, 1988, *Sharks Order Carcharhiniformes*: 87 (exclusively for carcharhinoids); Eschmeyer, 1990, *Cat. gen. Recent fish*.: 436 (exclusively for carcharhinoids); Nelson, 1994, *Fishes of the world*, ed. 3: 48; de Carvalho, 1996, *in* Stiassny *et al*., *Interrelationships fishes*: 55 (exclusively for carcharhinoids); Shirai, 1996, *in* Stiassny *et al*., *Interrelationships fishes*: 33 (exclusively for carcharhinoids); Eschmeyer, 1998, *Cat. Fish. Order Carcharhiniformes*, Suborder Carcharhinoidea: Chu and Meng, 1979, *Monogr. Fish. China, Sci. Tech. Press, Shanghai*: 114, tab. 2 (suborder for Family Carcharhinidae). Order Carcharhiniformes, Suborder Scyliorhinoidea: Chu and Meng, 1979, *Monogr. Fish. China, Sci. Tech. Press, Shanghai*: 114, tab. 2 (suborder for Family Scyliorhinidae). Order Carcharhiniformes, Suborder Sphyrnoidea: Chu and Meng, 1979, *Monogr. Fish. China, Sci. Tech. Press, Shanghai*: 114, tab. 2 (suborder for Family Sphyrnidae). Order Carcharhiniformes, Suborder Triakoidea: Chu and Meng, 1979, *Monogr. Fish. China, Sci. Tech. Press, Shanghai*: 114, tab. 2 (suborder for Family Triakidae). Order Galeomorpha, Suborder Carcharhinoidea: Carroll, 1988, *Vertebrate paleont. evolut*.: 599 (suborder exclusively for carcharhinoids, order also for palaeospinacids, hexanchoids, orectoloboids, lamnoids, and heterodontoids).

FAO Names: En – Ground sharks.

Field Marks: These sharks exhibit a wide range in external body morphology, but are generally characterized by having two spineless dorsal fins (except for 1 or 2 species which may have a single dorsal fin), five paired gill openings, a nictitating lower eyelid, a long mouth extending to or behind the eyes, and an anal fin. This group has some of the smallest and largest known shark species.

Diagnosis Features: Trunk cylindrical to slightly compressed or depressed but not raylike. Head conical to depressed and usually not anteriorly expanded, except for the prebranchial head in Sphyrnidae; 5 pairs of gill slits present on sides of head (partly dorsolateral in some Scyliorhinidae), with the last 1 to 3 over pectoral–fin bases; spiracles present in many species, small to large and close behind eyes, or absent; nostrils usually without barbels and nasoral grooves and always without circumnarial grooves, barbels when present developed from anterior nasal flaps rather than from lateral surfaces of flaps, anterior nasal flaps varying from well separated from mouth to overlapping it posteriorly; eyes lateral or dorsolateral on head, with true nictitating lower eyelids; snout varying from very short to moderately long and almost bladelike, but not greatly elongated and not formed as a rostral saw with lateral teeth and barbels; mouth moderately large to very large, arched, and extending behind anterior ends of eyes; labial furrows varying from large and on both jaws to absent; teeth variably differentiated along jaws, but usually without enlarged molariform posterior teeth and with anterior teeth not separated by small intermediate teeth or a gap from the lateral teeth. Two dorsal fins (possibly only one in ***Pentanchus***, family Scyliorhinidae), without spines, the first with origin varying from over the gill slits to behind the pelvic–fin bases; pectoral fins moderate–sized to large but not raylike, without triangular anterior lobes; pelvic fins small to moderately large, with vent continuous with their inner margins; anal fin present; caudal fin with a long dorsal lobe but with ventral lobe varying from long (but considerably shorter than the dorsal lobe) to absent. Vertebral counts: total vertebral counts 100 to 244, monospondylous vertebral counts

23 to 68, diplospondylous vertebral counts 23 to 66, precaudal vertebral counts 41 to 137. Intestinal valve of spiral or scroll type. Size small to very large, maturing at less than 100 cm to over 400 cm in length. **Colour:** depending on the family and genera these sharks are highly variable in colour ranging from rather striking brilliant colour patterns to rather plain without prominent markings.

Distribution: Circumglobal from cold temperate to tropical seas, with representatives of five of eight families inhabiting the Indian Ocean deep–sea.

Habitat: Ground sharks occur in a variety of marine habitats from the intertidal and enclosed bays, estuaries, including freshwater rivers, to the deep sea, and to the open ocean pelagic realm. They occur over sandy and mud bottoms, rocky and coral reefs, and in kelp forests.

Biology: These are very active to sluggish swimming sharks with some species being highly migratory while others having a more limited geographic range. They exhibit a variety of reproductive strategies with some (Scyliorhinidae) being oviparous by depositing egg cases on the bottom while most other groups are live bearing, but exhibit various forms of viviparity, with some providing nutrition by yolk sac and others maternally with the developing embryos being supplied directly by the mother. One family (Pseudotriakidae) exhibits oophagy. There are no known filter feeders in this order, but ground sharks feed on a wide variety of prey items including crustaceans, cephalopods, bony fishes, other chondrichthyans, and even marine mammals in some of the larger species. Many ground sharks are social, with some species occurring in large aggregates or schools, often segregating by sex and life stage.

Interest to Fisheries and Human Impact: Many carcharhinoids are the subject of moderate to major targeted and non–targeted fisheries. Members of the families Carcharhinidae, Sphyrnidae, and Triakidae are the subject of major fisheries globally, while many of the demersal bottom–dwelling species, primarily the Scyliorhinidae, are taken in considerable numbers as by–catch. This group contains some of the most well known species that have been implicated in shark attacks around the world. The bull shark (***Carcharhinus leucas***), oceanic whitetip shark (***Carcharhinus longimanus***), and tiger shark (***Galeocerdo cuvier***) are among the species that have been implicated in shark attacks mostly in tropical and open ocean environments.

Most Indian Ocean deep–sea carcharhinoids are considered Data Deficient or Least Concern since they are very poorly known biologically and taxonomically, but a couple species (***Holohalaelurus favus***, ***H. punctatus***) are listed as Endangered.

Local Names: None.

Remarks: The present account follows Compagno (1984b, 1988, 1999, 2005) and Ebert (In preparation) in recognizing eight families of which five families have representative species occurring in the Indian Ocean deep–sea. See Compagno (1988) for detailed discussion of this order.

Key to Deep–sea Indian Ocean Families:

1a. First dorsal–fin base opposite or behind pelvic–fin bases (Fig. 192) . . . . **family Scyliorhinidae**

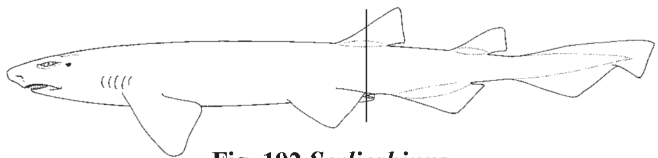


Fig. 192 *Scyliorhinus*

1b. First dorsal–fin base in front of pelvic–fin bases . . . **2**

2a. Precaudal pits present. Dorsal caudal–fin margin undulated (Fig. 193). . . . . . . **family Carcharhinidae**

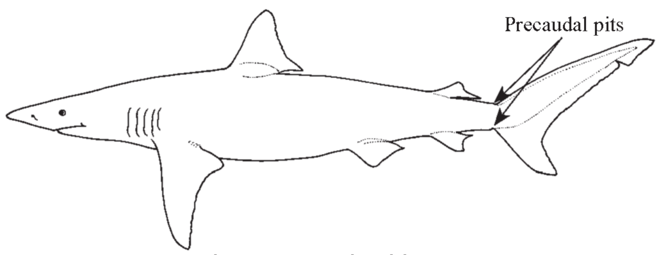


Fig. 193 *Carcharhinus*

2b. Precaudal pits absent. Dorsal caudal–fin margin not undulated **3**

3a. Labial furrows relatively long with uppers extending partway or all the way anterior to level of symphysis (Fig. 194). Posterior teeth on dental bands not comblike . . . . **family Triakidae**

3b. Labial furrows very short or absent, when present confined to mouth corners (Fig. 195). Posterior teeth on dental bands comblike **4**

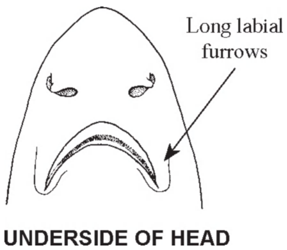


Fig. 194 *Mustelus*

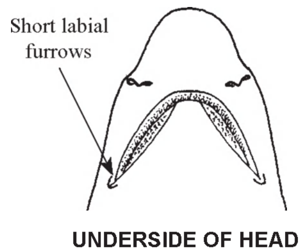


Fig. 195 *Pseudotriakis*

4a. Snout rounded–parabolic or subangular in dorso–ventral profile, without a deep groove in front of eye. Internarial space less than 1.3 times nostril width. Inside of mouth and edges of gill bars with papillae. First dorsal fin short, base closer to pelvic fins than pectoral fins (Fig. 196) . . . . **family Proscylliidae**

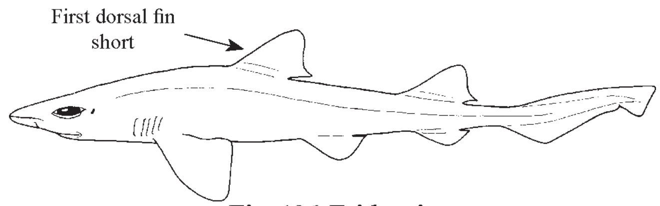


Fig. 196 ***Eridacnis***

4b. Snout bell–shaped in dorso–ventral profile, with a deep groove in front of eye. Internarial space over 1.5 times nostril width. Inside of mouth and edges of gill bars without papillae. First dorsal fin more or less elongated, base closer to pectoral fins than pelvic fins (Fig. 197) . . . . **family Pseudotriakidae**

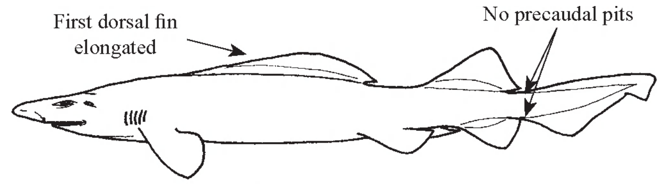


Fig. 197 ***Pseudotriakis***

2.8.1 Family SCYLIORHINIDAE

Family: Scylliorhinoidae Gill, 1862, *Ann. Lyceum Nat. Hist. New York*, 7(32): 393, 396, 406, 412.

Type Genus: "***Scylliorhinus*** Blainville, 1816", unjustified emendation of ***Scyliorhinus*** Blainville, 1816 by Gill, *ibid.*: 407. Emended to family Scyliorhinidae by Jordan and Fowler, 1903, *Proc. U. S. Natn. Mus.* 26: 600.

Number of Recognized Deep–sea Indian Ocean Genera: 7.

Synonyms: Family Scyllia or Scyllium Müller and Henle, 1838a, *Mag. Nat. Hist.*, n. ser., 2: 34; 1838, *Syst. Beschr. Plagiost.*, pt. 1: 3 Type genus: ***Scyllium*** Cuvier, 1816, junior synonym of ***Scyliorhinus*** Blainville, 1816. Subfamily Scyllini Bonaparte, 1838, *Nuov. Ann. Sci. Nat., Bologna*, ser. 1, 2: 130 (Family Squalidae). Type genus: ***Scyllium*** Cuvier, 1816, junior synonym of ***Scyliorhinus*** Blainville, 1816. Family Pentanchidae Smith and Radcliffe, *in* Smith, 1912, *Proc. U.S. Natn. Mus.* 41(1872): 489. Type genus: ***Pentanchus*** Smith and Radcliffe, *in* Smith, 1912. Family Catulidae Garman, 1913, *Mem. Harvard Mus. Comp. Zool.*, 36: 68. Type genus: ***Catulus*** Garman, 1913, equals ***Catulus*** Valmont, 1768, rejected by the International Commission on Zoological Nomenclature (Opinion 89, 1925, *Smithsonian Misc. Colln.* 73: 27); also, ***Catulus*** Smith, 1837, junior synonym of ***Scyliorhinus*** Blainville, 1816 and junior homonym of ***Catulus*** Kniphof, 1759 in Insecta). Subfamily Galeinae Fowler, 1934, *Proc. Acad. Nat. Sci. Philadelphia*, 85: p. 234 (Family Scyliorhinidae). Type genus: ***Galeus*** Rafinesque, 1810. Family Halaeluridae White, 1936, *Amer. Mus. Novit.* (837), 4; White, 1936, *Amer. Mus. Novit.* (879), 18. Type genus: ***Halaelurus*** Gill, 1862. Family Atelomycteridae White, 1936, *Amer. Mus. Novit.* (837), 4; White, 1936, *Amer. Mus. Novit.* (879), 19. Type genus: ***Atelomycterus*** Garman, 1913. Subfamily Cephaloscylliinae Fowler, 1947, *Notul. Nat. Acad. Nat. Sci. Philadelphia* (187): 11 (Family Scyliorhinidae). Type genus: ***Cephaloscyllium*** Gill, 1862. Subfamily Schroederichthyinae Compagno, 1988, *Sharks Order Carcharhiniformes*: 107 (Family Scyliorhinidae). Type genus: ***Schroederichthys*** Springer, 1966.

FAO Names: En – Catsharks; **Fr** – Chiens, Holbiches; **Sp** – Alitanes, Pejegatos.

Field Marks: Usually elongated, catlike eyes with nictitating eyelids, nostrils usually without nasoral grooves but when present these are broad and shallow, mouth long, arched and reaching past anterior ends of eyes, small cuspidate teeth, two small, spineless dorsal fins and an anal fin, the first dorsal–fin base over or behind pelvic–fin bases, no precaudal pits, and the caudal fin without a strong ventral lobe or lateral undulations on its dorsal margin.

Diagnostic Features: Head without laterally expanded blades. Eyes elongated and fusiform, oval, or slitlike, with lengths over 1.5 times height. Nictitating eyelids rudimentary. Spiracles present and moderately large. Anterior nasal flaps variably formed, but not barbel–like, except for one genus (***Poroderma***) with a barbel formed from a separate ridge on each anterior nasal flap. Internarial width about 0.6 to 1.3 times nostril width. Labial furrows absent or very short to very long. Teeth small, with acute narrow cusps, often lateral cusplets, and basal ledges, not bladelike and similar in both jaws; posterior teeth comblike or not; tooth rows 36 to 120 upper jaw, 31 to 111 lower jaw. Precaudal pits absent. Pectoral fins with radials confined to bases of fins. First dorsal fin small and not keel–like, much shorter than caudal fin; first dorsal–fin base over or behind pelvic–fin bases, origin either slightly ahead of pelvic–fin origins (***Cephalurus***) or well behind them; midpoint of first dorsal–fin base always posterior to pelvic–fin origins. Ventral caudal–fin lobe absent or very weak; no undulations or ripples in dorsal caudal–fin margin. Vertebral centra with or without strong, wedge–shaped intermedial calcifications. Vertebral counts: total vertebral counts 85 to 163, monospondylous vertebral counts 28 to 48, diplospondylous precaudal vertebral counts 24 to 61, precaudal vertebral counts 65 to 107. Valvular intestine with a spiral valve of 5 to 23 turns. Most catsharks are small, less than 80 cm long, and while some may be mature at about 30 cm, a few may reach about 160 cm. **Colour:** many species with variegated colour patterns, some without them.

Distribution: This is by far the largest family of sharks, with a broad worldwide geographic range in tropical to cold–temperate and arctic waters.

Habitat: Catsharks occur from the intertidal and shore side to the edges of the continental and insular shelves and down the slopes to depths greater than 2000 m. Catsharks are generally found on or near the bottom in coastal waters inshore and offshore; none are oceanic, although some deepwater species may range a considerable distance off the bottom.

Biology: Most catshark species are very poorly known biologically. The reproductive mode for many species is single oviparity, in which only one fertilized egg enters each oviduct and is deposited on the substrate at a time; the large eggs, encapsulated in tough egg–cases with corner tendrils to anchor them, have most of their embryonic development outside the mother shark and may take two years or more to produce a hatchling shark. Others, possibly in areas of intense egg predation, have multiple oviparity, in which several encased eggs remain in the oviducts for an extended period, during which time the embryos develop to advanced stages before the eggs are laid; such eggs may hatch in less than a month. Still other species have eliminated oviparity altogether and are viviparous, retaining the eggs until the young are ready to be born. Catsharks feed chiefly on invertebrates and small fishes, and are harmless to people. Catsharks are generally weak swimmers and do not migrate over great distances; this is shown in their geographic distribution, which is often much more localized than families with strong swimming species. Some inshore species are nocturnal, sleeping often in groups in rocky crevices in the day and dispersing to feed at night.

Interest to Fisheries and Human Impact: A minority of the species in this family is of importance to fisheries, particularly the spotted catsharks (***Scyliorhinus***) of the eastern Atlantic, which are much utilized for human food consumption. Some are rather common and regularly taken as a bycatch in the trawl fisheries worldwide, and may be used for fishmeal and oil. Many are deepwater sharks and are not utilized to any great extent although they may be a minor component of the catch of large, deep–fishing offshore trawlers. Several inshore species are commonly caught by sportsfishers. Many species are hardy and make attractive if somewhat sluggish exhibits in public aquaria; some readily breed in captivity.

Local Names: Catsharks, Cat sharks, Marbled catsharks (English); Skaamoogs, Lazy sharks (South Africa); Patas–roxas (Mozambique).

Remarks: The Scyliorhinidae is the most diverse shark family with 17 genera and nearly 150 species. Of the 17 recognized genera within this family, 12 are considered to be deep–sea, of which 7 genera have representatives in Indian Ocean. The deep–sea genera are mostly the less colourful members of the family. The arrangement of this family follows revisions by Compagno (1988), Last, White and Pogonoski (2008) and the various chapters therein, Last and Stevens (2009), and Ebert (In preparation).

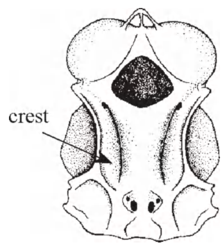
List of Deep–sea Species Occurring in the Area:

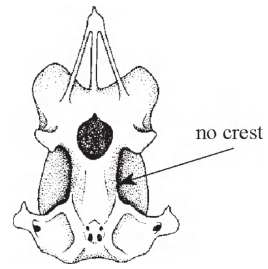
Apristurus ampliceps Sasahara, Sato, and Nakaya, 2008
Apristurus australis Sato, Nakaya, and Yorozu, 2008
Apristurus bucephalus White, Last, and Pogonoski, 2008
Apristurus indicus (Brauer, 1906)
Apristurus investigatoris (Misra, 1962)
Apristurus longicephalus Nakaya, 1975
Apristurus melanoasper Iglésias, Nakaya, and Stehmann, 2004
Apristurus microps (Gilchrist, 1922)
Apristurus pinguis Deng, Xiong, and Zhan, 1983
Apristurus platyrhynchus (Tanaka, 1909)
Apristurus saldanha (Barnard, 1925)
Apristurus sinensis Chu and Hu, 1981
Bythaelurus alcockii (Garman, 1913)
Bythaelurus clevai (Séret, 1987)
Bythaelurus hispidus (Alcock, 1891)
Bythaelurus incanus Last and Stevens, 2008
Bythaelurus lutarius Springer and D'Aubrey, 1972
Cephaloscyllium albipinnum Last, Motomura, and White, 2008
Cephaloscyllium cooki Last, Séret, and White, 2008
Cephaloscyllium hiscosellum White and Ebert, 2008
Cephaloscyllium silasi (Talwar, 1974)
Cephaloscyllium speccum Last, Séret, and White, 2008
Cephaloscyllium sufflans (Regan, 1921)
Figaro boardmani (Whitley, 1928)
Galeus gracilis Compagno and Stevens, 1993
Holohalaelurus favus Human, 2006
Holohalaelurus grennian Human, 2006
Holohalaelurus melanostigma (Norman, 1939)
Holohalaelurus punctatus (Gilchrist, 1914)
Holohalaelurus regani (Gilchrist, 1922)
Scyliorhinus capensis (Smith *in* Müller and Henle, 1838)
Scyliorhinus comoroensis Compagno, 1988

Key to Deep–sea Indian Ocean Genera:

1a. Supraorbital crests present on cranium, above eyes (Fig. 198) **2**

1b. Supraorbital crests absent from cranium (Fig. 199) . **3**





CRANIA (Dorsal view)

Fig. 198 ***Cephaloscyllium*** **Fig. 199** ***Galeus***

2a. Labial furrows absent or rudimentary (Fig. 200) . . . . ***Cephaloscyllium***

2b. Labial furrows present on one or both jaws (Fig. 201). . . . . ***Scyliorhinus***

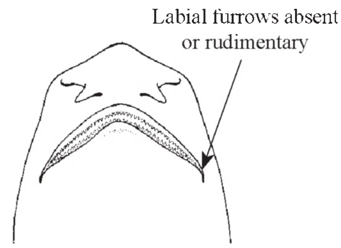


Fig. 200 ***Cephaloscyllium***

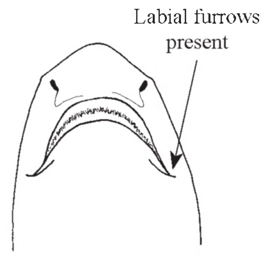


Fig. 201 ***Scyliorhinus***

3a. Head broadly flattened and spatulate, snout elongated and usually greater than mouth width. Labial furrows very long, uppers reaching upper symphysis (Fig. 202) . . . . ***Apristurus***

3b. Head moderately or little–flattened, not spatulate, snout equal or usually less than mouth width. Labial furrows shorter or absent, when present not reaching upper symphysis (Fig. 203) **4**

Fig. 202 ***Apristurus***

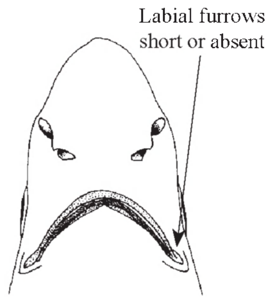


Fig. 203 ***Galeus***

4a. Dorsal caudal–fin margin, and sometimes preventral margin, with a crest of enlarged denticles (Fig. 204 & 205). **5**

4b. No caudal crests of denticles. **6**

5a. Enlarged denticles absent along ventral surface of caudal peduncle (Fig. 204) . . . . ***Galeus***

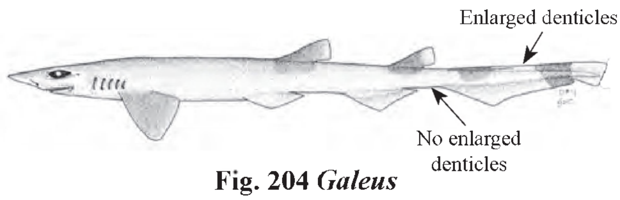


Fig. 204 ***Galeus***

5b. Enlarged denticles present along ventral surface of caudal peduncle (Fig. 205) . . . . ***Figaro***

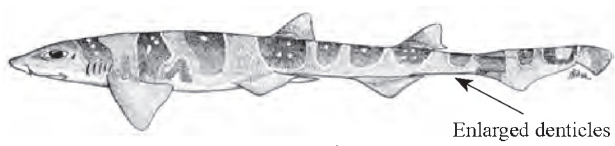


Fig. 205 ***Figaro***

6a. Head very broad. Labial furrows absent. Small black dots on underside of head. . . . . ***Holohalaelurus***

6b. Head narrower. Labial furrows usually present. No small black dots on underside of head . . . . ***Bythaelurus***

Apristurus Garman, 1913

Genus: ***Apristurus*** Garman, 1913, *Mem. Harvard Mus. Comp. Zool.*, 36: 96.

Type Species: ***Scylliorhinus indicus*** Brauer, 1906, by original designation.

Number of Recognized Deep–sea Indian Ocean Species: 12.

Synonyms: Genus ***Apristurius*** Schultz, Kükenthal and Heider, 1926, *Nomencl. animal. gen. subgen., Berlin*, 1: 244. Apparent error for ***Apristurus*** Garman, 1913. Subgenus ***Parapristurus*** Fowler, 1934, *Proc. Acad. Nat. Sci. Philadelphia*, 85: 237 (Genus ***Pentanchus*** Smith and Radcliffe, 1912). Type species: ***Catulus spongiceps*** Gilbert, 1895, by original designation. Subgenus ***Compagnoia*** Springer, 1979, *Nat. Ocean. Atmosp. Admin. Tech. Rept., Nat. Mar. Fish. Serv. Circ.* (422): 102 (Genus ***Parmaturus*** Garman, 1906). Type species: ***Parmaturus*** (***Compagnoia***) ***manis*** Springer, 1979, by original designation. Subgenus ***Campagnoia*** Gubanov, Kondyurin, and Myagkov, 1986, *Sharks World Ocean, Ident. Handbk., Moscow*, Agropromizdat, 116 (Genus ***Parmaturus*** Garman, 1906). Apparently a consistent erroneous spelling of ***Compagnoia*** Springer, 1979.

Field Marks: Scyliorhinids with "the ***Apristurus*** look"– long, laterally expanded snout and head, enlarged nostrils with reduced anterior nasal flaps, very long labial furrows, small rear–sited spineless dorsal fins, very large, elongated anal fin separated from elongated caudal fin by a notch only, and uniform coloration.

Diagnostic Features: Body not tadpole–shaped, stocky and more or less compressed, increasing in height up to the pectoral and trunk region and tapering posteriorly; body very soft and flabby, with thin skin and weakly calcified dermal denticles; stomach not inflatable. Tail short, length from vent to lower caudal–fin origin about 2/5 to 3/5 of snout–vent length. Head greatly depressed, pointed and wedge–shaped in lateral view; head rather elongated, but usually slightly less than 1/4 of total length in adults. Snout elongated, about equal to mouth width or greater, greatly flattened, narrow and pointed in lateral view; snout expanded laterally, narrowly spade–shaped to broadly spatulate and usually more or less bell–shaped in dorsoventral view. Ampullae pores enlarged and prominent on snout. Nostrils more or less enlarged, with incurrent and excurrent apertures broadly open to exterior; anterior nasal flaps reduced to angular lobes, without barbels, widely separate from each other and falling far anterior to mouth; internarial space 0.8 to 1.7 times nostril width; no nasoral grooves. Eyes dorsolateral on head, broad sub–ocular ridges present below eyes. Mouth angular or broadly arched, with lower symphysis well behind upper so that upper teeth are exposed in ventral view. Labial furrows present along both upper and lower jaws, these long and reaching nearly or quite to level of upper symphysis of mouth. Tooth rows 36 to 102 upper jaw, 31 to 106 lower jaw. Branchial region not greatly enlarged, distance from spiracles to fifth gill slits less than half head length; gill slits lateral on head. Pectoral fins variable in size, their width less to greater than mouth width. Inner margins of pelvic fins not fused over claspers in adult males. Claspers short, thick, and distally pointed, not extending more than 2/3 of their lengths behind the pelvic–fin tips and sometimes not extending past their tips. Two dorsal fins present, equal–sized or with the second dorsal larger than the first. Origin of first dorsal fin varying from over the pelvic–fin midbases to over the pelvic–fin free rear tips. Origin of second dorsal fin about over or slightly behind the anal–fin midbase. Anal fin enlarged and more or less elongated, larger than pelvic and dorsal fins, base length at least twice second dorsal–fin base; origin of anal fin just behind pelvic–fin bases, and insertion separated from lower caudal–fin origin by a narrow notch. Caudal fin more or less elongated, over a fifth, and often over a fourth of total length. A crest of enlarged denticles absent or variably developed on the dorsal caudal–fin margin. Supraorbital crests absent from cranium. Vertebral centra with or without strong, wedge–shaped intermedial calcifications. Vertebral counts: total vertebral counts 104 to 122, monospondylous vertebral counts 28 to 47, diplospondylous precaudal vertebral counts 24 to 44. Valvular intestine with a spiral valve of 6 to 22 turns. **Colour:** uniformly jet black, brownish–black, brown, pinkish or whitish; no distinctive colour patterns.

Local Names: Demon catsharks, Ghost catsharks.

Remarks: This is one of the largest and perhaps least known shark genera, having some 37 valid species, with several additional species of uncertain validity or still remaining to be described. Springer (1966, 1979) and Nakaya and Sato (1999) revised the genus while Nakaya (1975, 1988a, b, 1989, 1991) and others have revised and described new species, most recently from the western South Pacific (Nakaya, Sato, and Iglésias, 2008; Kawauchi *et al.* 2008; Sasahara, Sato, and Nakaya, 2008; White, Last, and Pogonoski, 2008; Sato, Nakaya, and Yorozu, 2008; Iglésias, 2012; Sato, Steward and Nakaya, 2013; Ebert, In preparation). Despite these efforts, several species are still of uncertain validity, with over a third of the species known from the holotypes only, at least four species having the holotypes lost, and less than a third of the species known from a modest to good series of specimens. Judging from the frequency that new species are discovered, the wide geographic range of the genus, and the paucity of knowledge of slope faunas in many areas of the world, the number of new species are likely to increase. At least 12 species occur within the Indian Ocean deep–sea, with several undescribed species.

Key to Deep–sea Indian Ocean Species:

1a. Snout very slender and elongate; length to nostrils greater than 6.4% TL, greater than 1.0 times interorbital width (Fig. 206 & 207) . . . . **2** (***Apristurus longicephalus*–group**)

1b. Snout relatively wide and short; length to nostrils usually less than 6.0% TL, less than 1.0 times interorbital width **3**

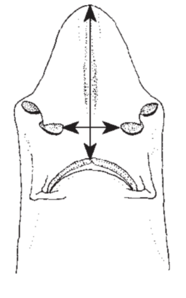


Fig. 206 ***A. longicephalus***

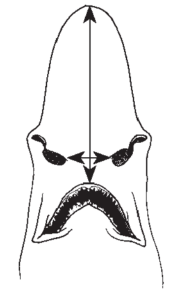


Fig. 207 ***A. australis***

2a. Internostril width into preoral snout length 2.8 times or less (Fig. 206). Upper tooth counts 49 or less; lower tooth counts 44 or less. Spiral valve turn counts 13 or more . . . . ***Apristurus longicephalus***

2b. Internostril width into preoral snout length 2.9 times or more (Fig. 207). Upper tooth counts 47 or more; lower tooth counts 48 or more. Spiral valve turn counts 11 or less . . . . ***Apristurus australis***

3a. Body slender. Upper labial furrows longer than lowers (Fig. 208a). Supraorbital sensory canal discontinuous. Spiral valve turn counts 13 to 22. Egg cases with long, coiled tendrils . . . . . . **4** (***Apristurus brunneus*–group**)

3b. Body stout. Upper labial furrows subequal to or shorter than lowers. Supraorbital sensory canal continuous. Spiral valve turn counts 7 to 12. Egg cases without tendrils . . . . **9** (***Apristurus spongiceps*–group**)

4a. First dorsal fin much smaller than second, about half its area or less, with its origin usually behind pelvic–fin insertions but over last fourth of pelvic–fin bases in some species (Fig. 208b & 209) **5**

4b. First dorsal fin nearly or quite as large as second, two–thirds to equal its area, with its origin usually about opposite pelvic midbases but more posterior and about opposite last third or fourth of pelvic–fin bases in a few species. **6**

5a. Origin of first dorsal fin somewhat in front of pelvic–fin insertions (Fig. 208b) . . . . ***Apristurus sinensis***

5b. Origin of first dorsal fin behind pelvic–fin insertions (Fig. 209) . . . . ***Apristurus platyrhynchus***

6a. Interdorsal space very long, about equal to prespiracular head (Fig. 210) . . . . ***Apristurus saldanha***

6b. Interdorsal space shorter, less than prespiracular head (Fig. 211) **7**

7a. Caudal fin with a crest of enlarged denticles (Fig. 211). . . . . ***Apristurus investigatoris***

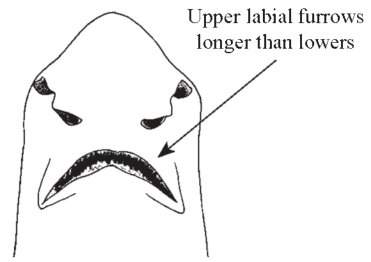
7b. Caudal fin without a crest of enlarged denticles . . . **8**

8a. First dorsal fin lower than the second and extending anteriorly as a long, low ridge (Fig. 212). Mouth very short, hardly expanded . . . . ***Apristurus indicus***

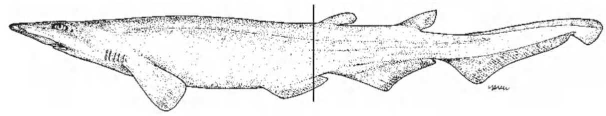
8b. First dorsal fin as high as second and not extending anteriorly as a low ridge (Fig. 213). Mouth longer, somewhat expanded . . . . ***Apristurus melanoasper***

9a. Interdorsal space equal or slightly less than first dorsal–fin base. Pectoral–fin inner margins very short, about a third of pectoral–fin bases (Fig. 214) . . . . ***Apristurus microps***

9b. Interdorsal space greater than first dorsal–fin base (Fig. 215). Pectoral–fin inner margins longer, half to about equal to pectoral–fin bases **10**



a) UNDERSIDE OF HEAD



b) LATERAL VIEW

Fig. 208 ***Apristurus sinensis***

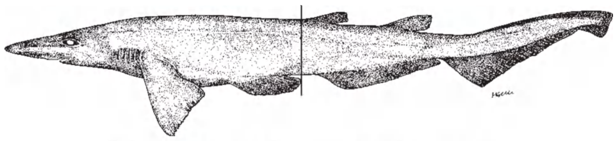


Fig. 209 ***Apristurus platyrhynchus***

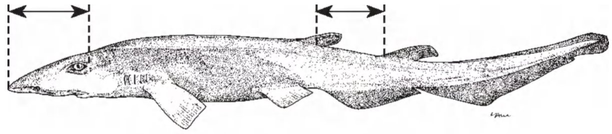


Fig. 210 ***Apristurus saldanha***

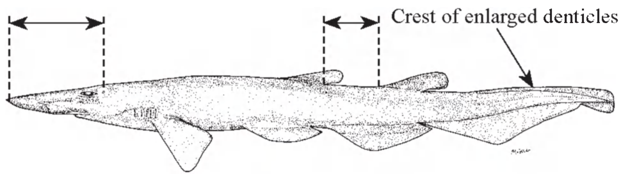


Fig. 211 ***Apristurus investigatoris***

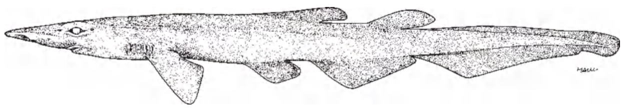


Fig. 212 ***Apristurus indicus***

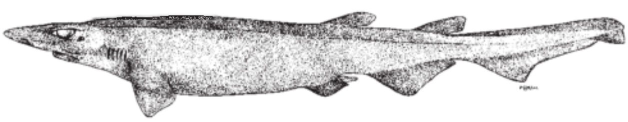


Fig. 213 ***Apristurus melanoasper***

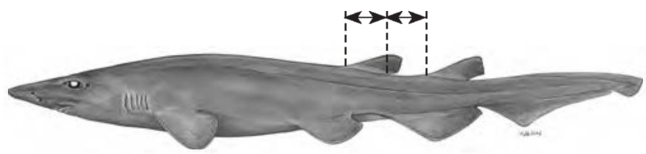


Fig. 214 ***Apristurus microps***

10a. Snout long. Anal fin low, long–based, and broadly rounded in shape (Fig. 215). Dermal denticles on flanks usually with a single cusp . . . . . ***Apristurus ampliceps***

10b. Snout relatively short. Anal fin relatively high, short–based, and subtriangular in shape. Dermal denticles on flanks usually with 3 to 5 cusps. **11**

11a. Head very stout, preoral snout length more than 1.7 times in maximum head width (Fig. 216). . . . . ***Apristurus bucephalus***

11b. Head moderately stout, preoral snout length less than 1.7 times in maximum head width (Fig. 217) . . . . ***Apristurus pinguis***

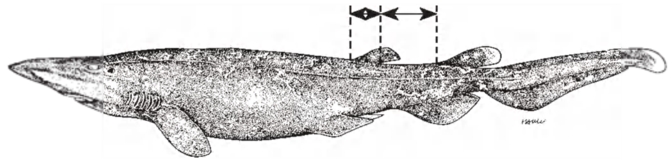


Fig. 215 ***Apristurus ampliceps***

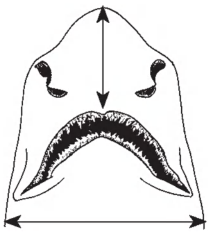


Fig. 216 ***A. bucephalus***

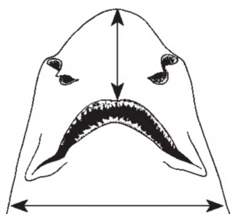


Fig. 217 ***A. pinguis***

Apristurus microps (Gilchrist, 1922)

Scylliorhinus microps Gilchrist, 1922, *Rep. Fish. Mar. Biol. Surv. Un. S. Africa*, (2): 46, pl. 7, fig. 1. Holotype lost, possibly below 30 cm total length, 33°45.8'S, 17°17.1'E, W. of Cape Town, South Africa, 1445 m.

Synonyms: None.

Other Combinations: None.

FAO Names: En – Smalleye catshark; **Fr** – Holbiche porc; **Sp** – Pejegato puerco.

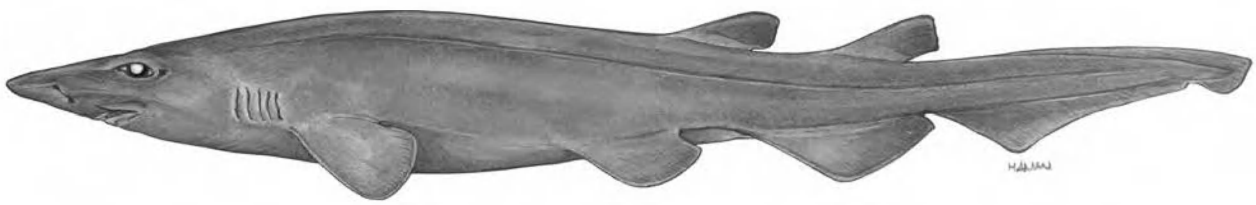


Fig. 218 ***Apristurus microps***

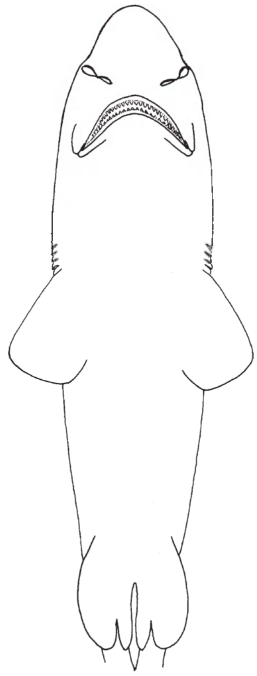
Field Marks: An ***Apristurus*** with an unusually small eye, thick snout, very short interdorsal space, anteriorly projecting mouth, very short pectoral–fin inner margins, and a crest of enlarged denticles on upper caudal–fin margin.

Diagnostic Features: Body relatively stout, especially in subadults, trunk slightly tapering towards head. Snout moderately long, broad, and bell–shaped, preoral snout about 9 to 10% of total length. Gill slits moderately large, somewhat less or equal to eye length; gill septa without projecting medial lobes or pleats, well–incised. Eyes very small, especially in subadults, less than 3% of total length. Nostrils broad, width about 1.2 in internarial space; incurrent and excurrent apertures very narrow and slitlike, anterior nasal flaps very low. Mouth long, large, and broadly arched, with dental bands prominently expanded and with lower ones falling just behind uppers; mouth and labial furrows extending well in front of eyes. Labial folds enlarged, but with lower diagonal to body axis. Lateral trunk denticles of body with crowns erect and not closely imbricate, skin surface with a felt–like or fuzzy texture. Pectoral fins rather small, anterior margins about 9 to 11% of total length; inner margins extremely short, about a third of pectoral–fin bases. Interspace between pectoral and pelvic–fin bases short to moderately long, two–fifths to subequal to prespiracular length and about 6 to 14% of total length in adults. Pelvic fins high and broadly rounded. Interdorsal space equal or slightly less than first dorsal–fin base, one–third to two–fifth of preorbital snout. First dorsal fin about as large or slightly smaller than second, bases about equally long or first slightly shorter than second. Origin of first dorsal fin about opposite last third of pelvic–fin bases. Second dorsal–fin insertion behind anal–fin insertion. Anal fin short, fairly high, and rounded, between three and four times as long as high, base about equal to prespiracular space and 14 to 16% of total length in adults. Caudal fin slender to moderately broad, with a loose crest of enlarged denticles on dorsal caudal–fin margin. Spiral valve counts 9 to 11. Adults large, to 61 cm total length. **Colour:** dusky brown or grey–brown to purplish–black, without conspicuous markings on fins.

Distribution: Southeastern Atlantic and southwestern Indian Ocean along the west and south coast of South Africa.

Habitat: A bottom shark of continental slopes, on or near the bottom at depths of 700 to 2200 m. South African specimens have been collected on soft bottom between 700 to 1200 m deep.

Biology: Oviparous, females appear to deposit egg cases year–round. Egg cases for this ***Apristurus spongiceps***–group catshark are small, 4.7 to 5.2 cm in length, broad and fairly thick, with posterior width about 32 to 37% of case length; case surface with fine, straight, smooth longitudinal striations; both anterior and posterior end without tendrils. Adult males have cuts and scars suggesting bites by conspecifics. The diet of these catsharks includes small midwater bony fishes, shrimp, and squid. One individual was found to have a small unidentified squaloid in its stomach. The presence of prey items that are midwater inhabitants suggests these shark may forage at times far off the bottom.



PARTIAL VENTRAL VIEW

Size: Maximum to 61 cm total length; males mature at about 49 to 51 cm; females mature at 47 to 49 cm. Size at birth unknown, but the smallest free–swimming individual reported to date is a 34.8 cm immature male.

Interest to Fisheries and Human Impact: Interest to fisheries none. Possibly caught as discarded bycatch by deepwater trawl fisheries.

Most fisheries occur shallower than this catshark species and as such its conservation status is Least Concern.

Local Names: Pig catshark.

Remarks: The holotype, of unknown size, was apparently discarded (P. C. Heemstra, *pers. comm.*). Ten specimens in the Institut für Seefischerei, Hamburg, examined and reported by Compagno (1984b) fit this species well in most details, but disagree with Gilchrist's (1922) and Springer's (1979) characterizations in a few particulars, especially in having a somewhat longer abdomen and shorter caudal fin, that may be size–related (assuming that the holotype was small). However, they agree with ***Apristurus microps*** in having exceptionally short pectoral–fin inner margins, thick snouts, thick bodies, broadly rounded fins, equal–sized dorsal fins with the origin of the first over the pelvic–fin bases, unusually short interdorsal spaces, and very small eyes. These specimens are assigned to ***A. microps***, and were taken off the Cape region of South Africa, the eastern North Atlantic between Iceland and Scotland, and on the Newfoundland Bank in the western Atlantic. Specimens of this species should be closely compared between North Atlantic and southern African populations.

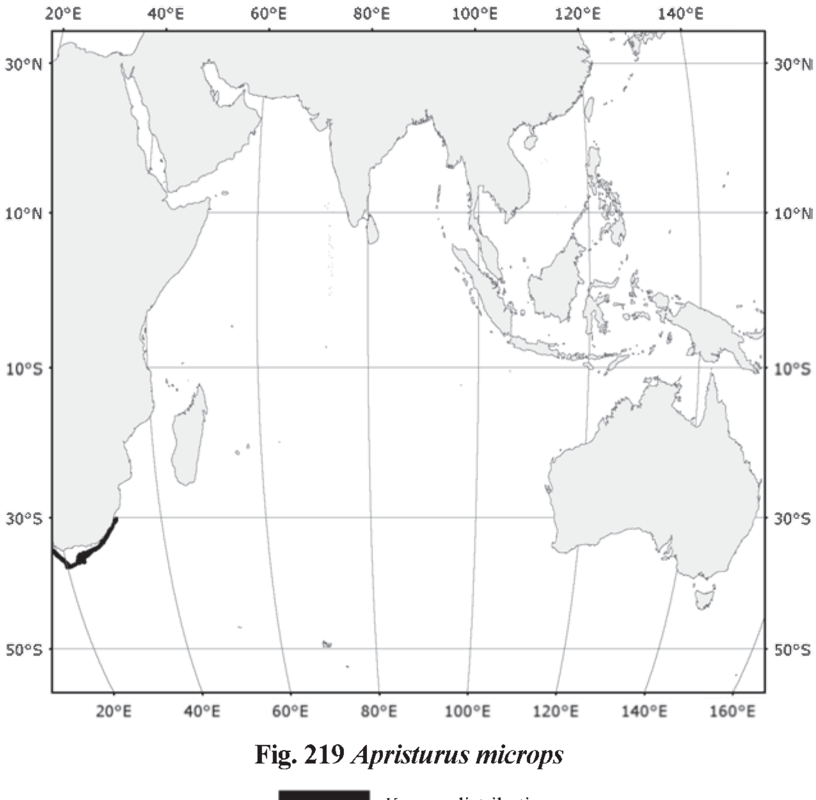


Fig. 219 ***Apristurus microps***

Literature: Gilchrist (1922); Springer (1979); Compagno (1984b, 1988); Ebert Cowley and Compagno (1996); Moore *et al.* (2003); Ebert (2004b); Compagno, Dando and Fowler (2005); Ebert, Compagno and Cowley (2006); Flammang, Ebert and Caillet (2007); Ebert (In preparation).

Bythaelurus Compagno, 1988

Genus: Subgenus ***Bythaelurus*** Compagno, 1988 (Genus ***Halaelurus*** Gill, 1862), Sharks Order Carcharhiniformes: 146.

Type species: ***Scyllium canescens*** Günther, 1878, by original designation.

Number of Recognized Deep–sea Indian Ocean Species: 5.

Synonyms: None.

Field Marks: Scyliorhinids with very short and rounded snouts, no nasoral grooves, anterior nasal flaps small and not reaching mouth, upper and lower labial furrows short, sometimes absent, gills on sides of head opposite mouth, inner margins of pelvic fins not connected, second dorsal fin not greatly smaller than first, caudal fin short, without enlarged denticles on dorsal–fin margin, no supraorbital crests on cranium, colour pattern poorly developed or absent.

Diagnostic Features: Body not tadpole–shaped, slender to moderately stout and cylindrical or fusiform, tapering slightly or moderately to caudal fin; body soft, with dermal denticles well–calcified or weakly so and erect, giving the body a velvety texture; stomach not inflatable. Tail fairly short, length from vent to lower caudal–fin origin about 0.5 to 0.6 of snout–vent length. Head moderately depressed, narrowly rounded in lateral view; head short to moderately long, between 1/4 and 1/5 to less than 1/5 of total length in adults. Snout short to moderately long, less than 4/5 of mouth width, thick, and slightly flattened, bluntly pointed in lateral view; snout not expanded laterally, rounded, parabolic, or somewhat bell–shaped in dorsoventral view but without a knob–like tip. Ampullae pores not greatly enlarged on snout. Nostrils of moderate size, with incurrent and excurrent apertures only partly open to exterior; anterior nasal flaps broadly triangular, narrow and elongated, or reduced and pointed, without barbels, well separate from each other and falling slightly to considerably anterior to mouth; internarial space about 0.6 to 1.1 times nostril width; no nasoral grooves. Eyes dorsolateral on head but not elevated, broad sub–ocular ridges present below eyes. Mouth angular, semiangular, or rounded, short to moderately long, with lower symphysis well behind upper so that upper teeth are exposed in ventral view. Labial furrows present along both upper and lower jaws, these short to moderately long, ending well behind level of upper symphysis of mouth. Branchial region not greatly enlarged, distance from spiracles to fifth gill slits 1/3 to slightly less than 3/5 of head length; gill slits lateral on head. Pectoral fins moderately large, their width subequal or somewhat greater than mouth width. Inner margins of pelvic fins not fused over claspers in adult males. Claspers moderately long, fairly slender to moderately stout, and distally pointed, extending about half of their lengths behind the pelvic–fin tips. Two dorsal fins present, about equal–sized or with second slightly smaller or larger than first. Origin of first dorsal fin varying from slightly in front of the pelvic–fin midbases to slightly in front of their insertions. Origin of second dorsal fin about opposite or in front of the anal–fin midbase. Anal fin moderately large but not greatly elongated, about as large as pelvic fins or slightly smaller or larger, subequal to larger than the dorsal fins; base length subequal to about 1.5 times second dorsal–fin base; origin of anal fin well behind pelvic–fin bases, and insertion separated from lower caudal–fin origin by a narrow notch or a moderately broad space slightly less than the anal–fin base. Caudal fin short and broad to narrow and moderately elongated, between 1/4 and 1/5 of total length in adults. No crests of denticles on the caudal–fin margins. Supraorbital crests absent from cranium. Vertebral counts: monospondylous vertebral counts 35 to 45, diplospondylous vertebral counts 47 to 54, total vertebral counts 120 to 142. **Colour:** light grey or brown to blackish, either plain or with light spots on body and sometimes dark bars on tail but without a prominent pattern of dark spots, saddles and vertical bars.

Local Names: Smoothtail catsharks.

Key to Deep–sea Indian Ocean Species:

1a. Anal–fin base as long or longer than interdorsal space (Fig. 220) . . . . ***Bythaelurus incanus***

1b. Anal–fin base shorter than interdorsal space (Fig. 221–224) 2

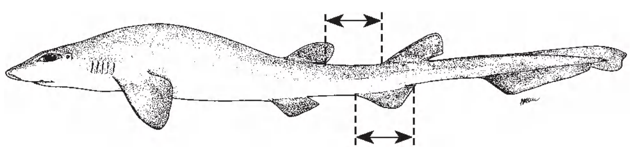


Fig. 220 ***Bythaelurus incanus***

2a. Roof of mouth with numerous small papillae. Eye length less than 14 times in predorsal distance in adults. Adults 24 to 29 cm 3

2b. Roof of mouth without papillae. Eye length 14 or more times in predorsal distance in adults. Adults 30 to 40 cm. 4

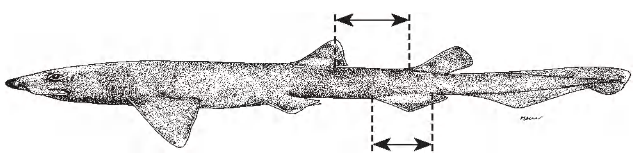


Fig. 221 ***Bythaelurus alcockii***

3a. Snout long and rounded (Fig. 221) . . . . ***Bythaelurus alcockii***

3b. Snout shorter than ***Bythaelurus alcockii*** and rounded (Fig. 222). . . . . ***Bythaelurus hispidus***

4a. Snout long, prenarial snout length 1.4 times greater than internarial space (Fig. 223) . . . ***Bythaelurus clevai***

4b. Snout shorter, prenarial snout length about equal to internarial space (Fig. 224) . . . . ***Bythaelurus lutarius***

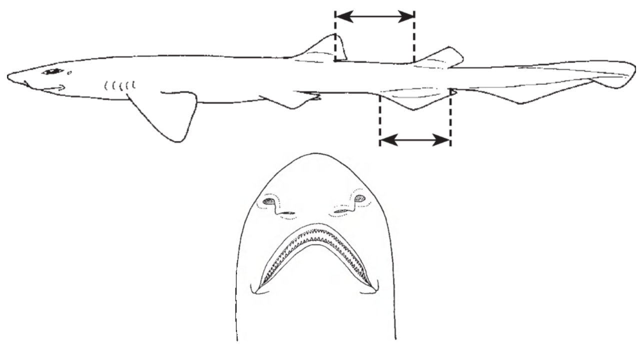


Fig. 222 ***Bythaelurus hispidus***

Fig. 223 ***Bythaelurus clevai***

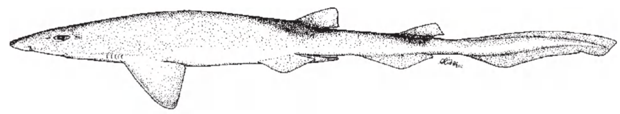


Fig. 224 ***Bythaelurus lutarius***

Bythaelurus hispidus (Alcock, 1891)

Scyllium hispidum Alcock, 1891, *Ann. Mag. Nat. Hist.* (Ser. 6), 8: 21. Holotype: Zoological Survey of India, ZSI–13120, 220 mm adolescent or immature male. Type Locality: Andaman Sea, 344 to 402 m depth.

Synonyms: None.

Other Combinations: ***Halaelurus hispidus*** (Alcock, 1891).

FAO Names: En – Bristly catshark; **Fr** – Holbiche mignonne; **Sp** – Pejegato erizado.

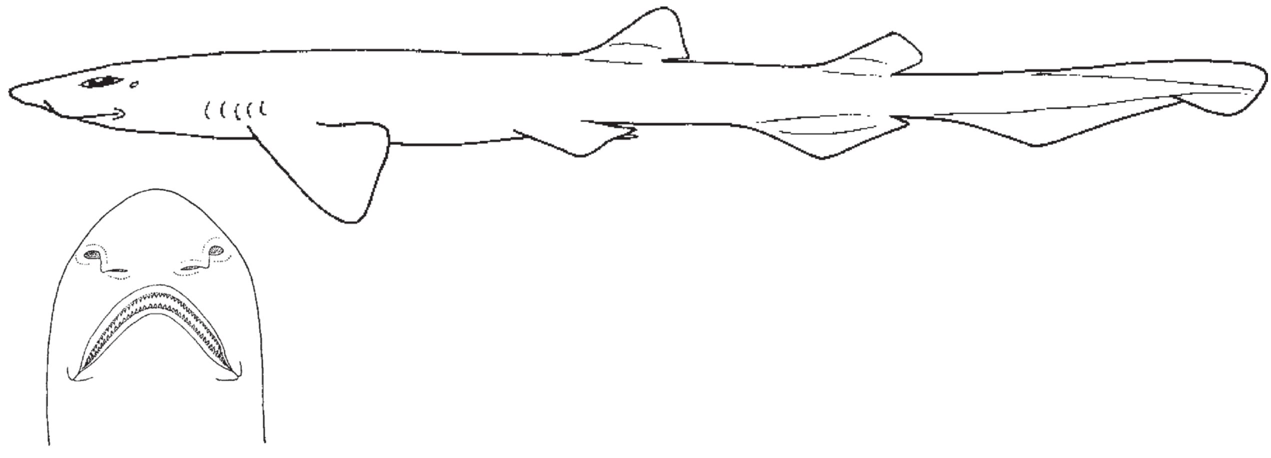


Fig. 225 ***Bythaelurus hispidus***

Field Marks: ***Bythaelurus*** with moderately long abdomen, short anal–fin base, plain light coloration, small size (see **Diagnostic Features**).

Diagnostic Features: Eyes in adults less than 14 times in distance from snout to first dorsal–fin origin. Anterior nasal flaps subtriangular. Oral papillae present in pharynx. Abdomen moderately long in adults, distance between pectoral and pelvic–fin bases 1.3 to 1.4 times pectoral–fin anterior margin. First dorsal–fin origin over last third of pelvic–fin bases. Second dorsal fin slightly smaller than first, origin over or slightly in front of anal–fin midbase. Length of anal–fin base about 1.5 to 1.7 times second dorsal–fin base, slightly shorter than distance between dorsal–fin bases. Vertebral counts: total vertebral counts 123 to 131, monospondylous vertebral counts 35 to 38. Adults very small, 29 cm total length or less. **Colour:** pale brown or whitish, sometimes with obscure grey cross–bands, white spots, or dusky spots.

Distribution: Indian Ocean: southeastern India, Andaman Islands.

Habitat: A common deepwater bottom–dwelling catshark of the upper continental slopes at depths of 293 to 766 m.

Biology: Little known. Eats small fishes, squid and crustaceans.

Size: Maximum 29 cm total length; adult males 24 to 26 cm; adult females about 22 to 29 cm. Size at birth unknown.

Interest to Fisheries and Human Impact: Interest to fisheries none at present.

Conservation status of this poorly known catshark is Data Deficient.

Local Names: None.

Remarks: The holotype of this species is in the Zoological Survey of India in Calcutta, and is not the 237 mm specimen in the British Museum (Natural History) stated to be the holotype by Springer (1979), according to Compagno (1984b).

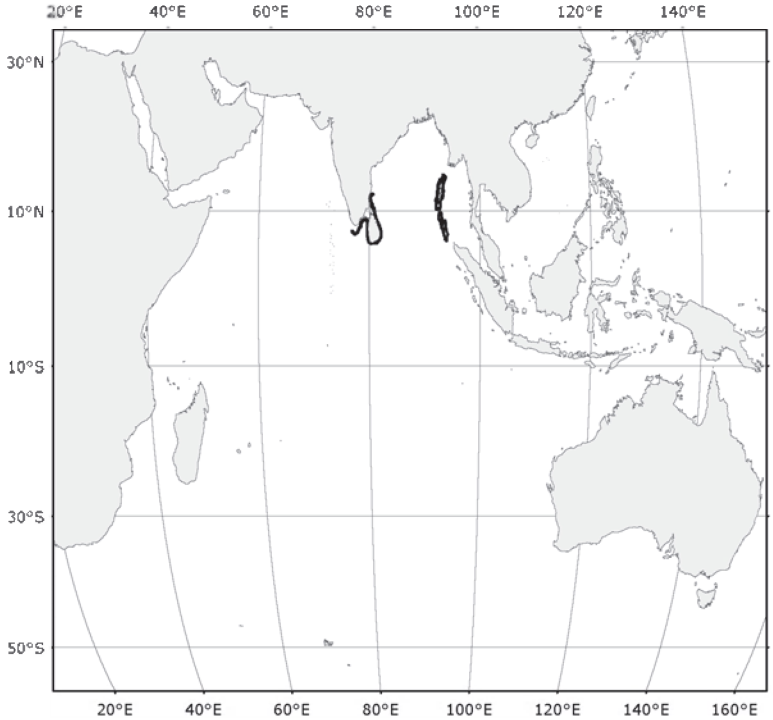


Fig. 226 ***Bythaelurus hispidus***

Known distribution

Literature: Nair and Lal Mohan (1973); Nair and Appukuttan (1973, 1974); Springer (1979); Talwar (1981); Compagno (1984b, 1988); White (2004); Compagno, Dando and Fowler (2005); Ebert (In preparation).

Cephaloscyllium Gill, 1862

Genus: ***Cephaloscyllium*** Gill, 1862, *Ann. Lyceum Nat. Hist. New York*, 7(32): 408, 412.

Type species: ***Scyllium laticeps*** Dumeril, 1853, by original designation.

Number of Recognized Deep–sea Indian Ocean Species: 6.

Synonyms: None.

Field Marks: Stocky, short–tailed scyliorhinids with no labial furrows, an inflatable stomach, and the second dorsal fin much smaller than the first.

Diagnostic Features: Body not tadpole–shaped, very stout and spindle–shaped, tapering considerably to caudal fin; body firm and thick skinned, with well–calcified dermal denticles; stomach inflatable with air or water. Tail short, length from vent to lower caudal–fin origin between 2/5 to slightly less than 1/2 of snout–vent length. Head very depressed and broad, narrowly rounded and not wedge–shaped in lateral view; head fairly short, between 1/4 to 1/5 to less than 1/5 of total length in adults. Snout very short, less than 1/2 of mouth width, thick, and somewhat flattened, bluntly pointed in lateral view; snout not expanded laterally, rounded–parabolic or subangular in dorsoventral view. Ampullal pores not greatly enlarged on snout. Nostrils not enlarged, with incurrent and excurrent apertures only slightly open to exterior; anterior nasal flaps broadly triangular to elongated and lobate, without barbels, falling slightly anterior to mouth or reaching it; internarial space 1.0 to 1.7 times nostril width; nasoral grooves absent. Eyes dorsolateral on head, broad sub–ocular ridges present below eyes. Mouth broadly arched or angular, very large and long, with lower symphysis usually somewhat behind upper so that upper teeth are well–exposed in ventral view (lower jaw covering upper teeth in ***Cephaloscyllium silasi***). Tooth counts 48 to 116 upper jaw, 45 to 110 lower jaw. Labial furrows absent or vestigial. Branchial region not greatly enlarged, distance from spiracles to fifth gill slits 1/2 to 2/5 head length; gills lateral on head. Pectoral fins large, but with their widths varying from less to considerably greater than mouth width. Inner margins of pelvic fins not fused over claspers in adult males. Claspers moderately long and thick to slender and very long, distally rounded, extending 1/2 to 4/5 of its length behind the pelvic–fin tips. Two dorsal fins present, with the second considerably smaller than the first. Origin of first dorsal fin about over anterior halves of pelvic–fin bases. Origin of second dorsal fin over or slightly posterior to the anal–fin origin. Anal fin moderately large but not greatly elongated, subequal to pelvic and first dorsal fins but much larger than second dorsal fin, base length 1.2 to 1.4 times second dorsal–fin base; origin of anal fin well behind pelvic–fin bases, and insertion separated from lower caudal–fin origin by a space 3/5 to 3/4 of anal–fin base. Caudal fin short and broad, between a fourth and a fifth of total length in adults. No crests of denticles on the caudal margins. Supraorbital crests present on cranium. Vertebral counts: total vertebral counts 100 to 129, monospondylous vertebral counts 36 to 48, precaudal vertebral counts 67 to 82. Spiral valve counts 7 to 11. Size moderate to large, adults 30 to 150 cm. **Colour:** varying from uniform grey or brown to variegated with obscure darker saddles and blotches, reticulated dark lines, or numerous dark spots in addition to the saddles and blotches.

Local Names: Swell sharks.

Remarks: This genus has more than doubled in the number of valid species in recent years as 11 new species have been described from the western Indo–Pacific and Australian regions. Seven of eight Australian species have been described since 2008, with one from Indonesia and two additional new species from Taiwan (Province of China). Furthermore, this genus may expand in the future as there are possibly two or three additional undescribed species from the western Indo–Pacific region currently under study.

The below **Key to Deep–sea Species** should be used with caution as many of the species are poorly known, and with only adults or juveniles being described. The colour patterns for many of these species change ontogenetically with growth and can appear quite different depending on the stage of development.

Key to Deep–sea Indian Ocean Species:

1a. A strongly variegated colour pattern of close–set dark saddles and blotches, numerous dark spots and occasional light spots on a lighter background (Fig. 227). Large species, mostly over 70 cm TL . . . . *Cephaloscyllium speccum*

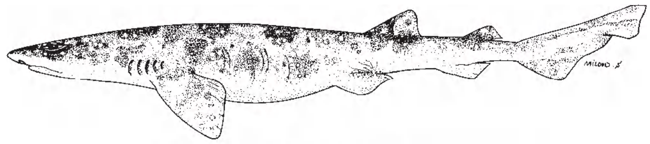


Fig. 227 *Cephaloscyllium speccum*

1b. Colour pattern not strongly variegated, usually simple broad dusky saddles on a light background, no dark or light spots. Most species smaller, less than 70 cm TL (except ***Cephaloscyllium albipinnum***, ***C. sufflans***, ***C. umbratile***) **2**

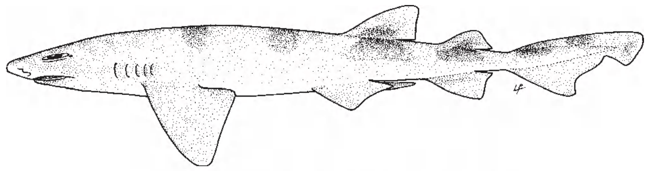


Fig. 228 *Cephaloscyllium sufflans*

2a. Dorsal body coloration pattern of relatively few broad dark saddles or bands. Large species, more than 75 cm TL. **3**

2b. Dorsal body coloration pattern of narrow, sometimes numerous, dark saddles or transverse bands. Generally smaller species, less than 75 cm TL. **4**

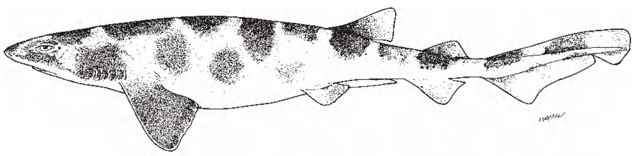


Fig. 229 *Cephaloscyllium albipinnum*

3a. Total number of dorsal saddles 7; 3 predorsal saddles (Fig. 228) . . . . *Cephaloscyllium sufflans*

3b. Total number of dorsal saddles 10 or 11; 5 predorsal saddles (southern Australia) (Fig. 229) . . . . *Cephaloscyllium albipinnum*

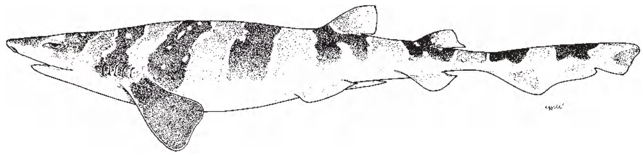


Fig. 230 *Cephaloscyllium cooki*

4a. Dorsal body coloration dark, with very dark, well defined saddles outlined in white. (eastern Indonesia, northwestern Australia) (Fig. 230) . . . . *Cephaloscyllium cooki*

4b. Dorsal body coloration light, with a pattern of broad to narrow saddles or transverse lines **5**

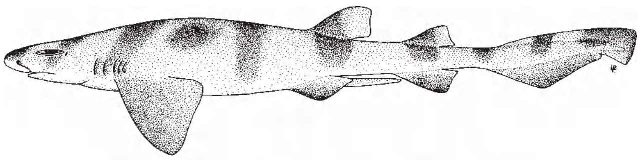


Fig. 231 *Cephaloscyllium silasi*

5a. Colour pattern of 7 moderately broad dark brown saddles on a light brown background (north–central Indian Ocean) (Fig. 231) . . . . . *Cephaloscyllium silasi*

5b. Colour pattern of numerous narrow, transverse saddles (Australia) (Fig. 232) . . . . *Cephaloscyllium hiscosellum*

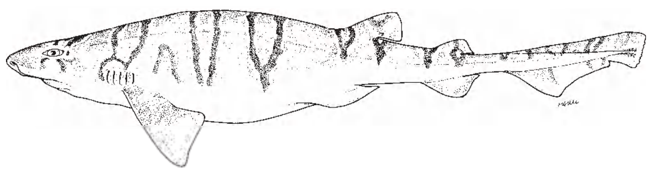


Fig. 232 *Cephaloscyllium hiscosellum*

Cephaloscyllium albipinnum Last, Motomura, and White, 2008

Cephaloscyllium albipinnum Last, Motomura, and White, 2008, *In*: P.R. Last, W.T. White and J.J. Pogonoski (eds). *CSIRO Marine and Atmospheric Research Paper* 022: 147, figs 1, 2, 3a, table 1, 2. Holotype: CSIRO H 5314–11, adult male 1013 mm TL, east of Maria Island, Tasmania, 42°38′ S, 148°26′ E, 445 to 463 m, 01 May 2000.

Synonyms: ***Cephaloscyllium*** sp. A Last and Stevens, 1994, *Sharks and Rays of Australia*: 170, 192, key fig. 44, fig. 26.20, pl. 23. Southern Australia; Compagno, Dando and Fowler, 2005, *Sharks of the World*: 219, 220, pl. 36. ?***Cephaloscyllium isabella laticeps***, forma ***nascione*** Whitley, 1932, *Rec. Australian Mus.* 18(6): 324, fig. 2a. ***Cephaloscyllium laticeps*** forma ***nascione*** Whitley, 1940, *Fish. Australia* (1): 92, fig. 85, no. 2, raised in rank to subspecies. Holotype, Australian Museum, Sydney, AMS–A2829, 255 mm TL immature female, 24 mi NNE of Montague Island, New South Wales. ***Cephaloscyllium nascione*** Gomon, Glover and Kuiter, 1994: 136, 137, figs 104, 105.

Other Combinations: None.

FAO Names: En – Whitefin swellshark; **Fr** – Holbiche de Tazmanie; **Sp** – Pejegato aleta blanca.

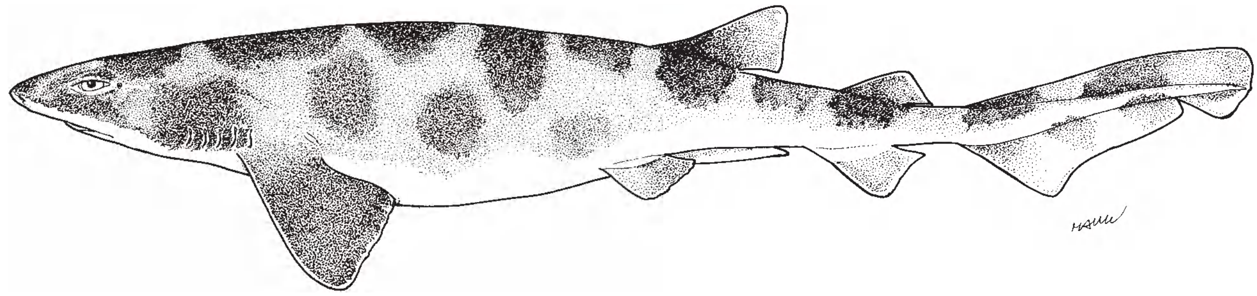


Fig. 233 ***Cephaloscyllium albipinnum***

Field Marks: A large, stout bodied swellshark with a broadly rounded head, the origin of the first dorsal fin located over the anterior half of the pelvic–fin bases, and a dorsal colour pattern of dark brown blotches and saddles dorsal and lateral on body trunk.

Diagnostic Features: Body stout anteriorly, tapering behind first dorsal fin. Head short, very broad, depressed, width 17 to 19% of total length; 3.3 to 3.5 times precaudal length. Snout tip moderately rounded to bluntly pointed. Nostrils large, anterior flap expanded laterally, overlapping outer lobe, but not reaching mouth; posterior margin straight, sometimes weakly fringed; internarial width slightly larger than nostril width. Eyes small, cat–like, horizontal length 3.2 to 4.1% of total length; suborbital groove well–developed. Spiracles very small. Gill openings small, first three subequal in size, fourth and fifth progressively smaller; third opening over origin or slightly anterior of pectoral fin, fourth and fifth openings over pectoral–fin base. Mouth broadly arched, relatively long, its width 2.1 to 2.9 times length; labial furrows absent. Teeth somewhat similar in both jaws, with medial cusp larger than lateral cusplets; sometimes 1 to 2 rudimentary lateral cusplets present; tooth counts 90 to 116 upper jaw, 97 to 110 lower jaw. Dermal denticles on flanks very small, usually weakly tricuspidate, apices broadly pointed, with very strong median ridge; denticles well separated and not overlapping; no enlarged denticles on upper caudal–fin margin. Dorsal fins subequal in size, first noticeably larger than second; first dorsal–fin origin over anterior half of pelvic–fin bases; second dorsal–fin origin well behind anal–fin origin, insertion almost over anal–fin insertion. Pectoral fins moderately large, apex narrowly rounded; free rear tip bluntly angular to narrowly rounded. Pelvic fins small, length 10.1 to 12.1% of total length. Anal fin large, much larger than second dorsal fin; rounded at apex; fin length 1.1 to 1.2 times pelvic–anal space. Claspers robust, elongated, cylindrical, and extending posterior nearly to anal–fin origin; ventral surface covered with denticles. Caudal fin large, ventral lobe very distinct; terminal lobe well developed. Vertebral counts: monospondylous vertebral counts 45 to 48, precaudal vertebral counts 79 to 82, and total vertebral counts 121 to 126. Adults large, to about 110 cm total length. **Colour:** brown to grey dorsally with saddles and blotches on back and lateral surfaces; pre–first dorsal–fin origin with five saddles, followed by 2 to 3 saddles in region of dorsal fins and two additional well developed saddles or bars on the caudal fin; ventral surface pale.

Distribution: Endemic to southern Australia from Batesman Bay, New South Wales to Eucla, Western Australia, and including Tasmania.

Habitat: Occurs along the outer continental shelf and upper slope from 125 to 555 m.

Biology: Egg cases have been described for this species, but little else is known of its biology. Egg cases are relatively large, excluding horns 98 to 116 mm, with long coiled tendrils at both anterior and posterior ends; smooth to the touch, with a glossy appearance, and lacking any transverse or longitudinal striations or ridges; lateral flanges extending along the entire length of egg case; anterior border nearly transverse with relatively short horns curved inwards, posterior border narrower, concave, with horns moderately long, curved strongly inwards and overlapping.

Size: Maximum total length 110 cm; males mature at about 70 cm; females mature by 98 cm. Size at birth unknown.

Interest to Fisheries and Human Impact: A common bycatch species in southern Australia, but of no commercial value.

Conservation status is Near Threatened due to declines of more than 30% in catch rates off New South Wales over a 30 year time period.

Local Names: None.

Remarks: The distribution of this species overlaps that of ***Cephaloscyllium laticeps*** and it is often confused with that species. However, ***C. albipinnum*** tends to occur in deeper water than ***C. laticeps***.

Literature: Last, White and Pogonoski (2008); Last and Stevens (2009); Barratt and Kyne (2011); Ebert (In preparation).

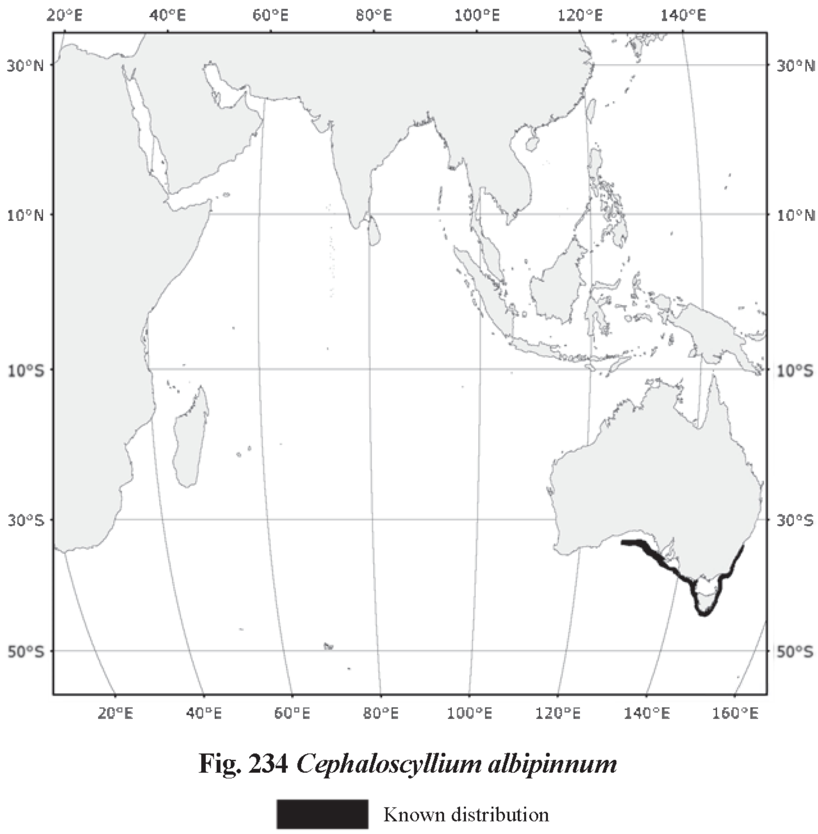


Fig. 234 ***Cephaloscyllium albipinnum***

Figaro Whitley, 1928

Genus: ***Figaro*** (as a subgenus of ***Pristiurus***) Whitley, 1928, *Records of the Australian Museum*, 16: 238.

Type Species: ***Pristiurus*** (***Figaro***) ***boardmani*** Whitley, 1928, by original designation.

Number of Recognized Deep–sea Indian Ocean Species: 1.

Synonyms: None.

Field Marks: Small sawtailed catsharks with a prominent crest of enlarged denticles on the preventral caudal margin, relatively large pectoral, anal, and caudal fins, adult claspers tapering towards anal fin, and a wide anal–caudal fin space. Colour is a grey to brownish–grey with 3 to 16 predorsal saddles and bars.

Diagnostic Features: Body not tadpole–shaped, firm, slender and sub–cylindrical to rather compressed, tapering to caudal fin; body firm and thick skinned, with well–calcified dermal denticles; stomach not inflatable. Head short, slightly depressed, narrowly pointed to rounded in lateral view. Snout broadly to narrowly rounded–parabolic and usually bell–shaped in dorsoventral view, moderately long and subangular. Nostrils moderately sized, with incurrent and excurrent apertures only partly open to exterior; anterior nasal flaps broadly triangular and rather low, without barbels, well separated from each other and falling well anterior to mouth; no nasoral grooves. Eyes dorsolateral on head, with narrow sub–ocular ridges. Mouth fairly large and long, broadly arched; labial furrows moderately long, not confined to mouth corners. Pectoral fins large, their width somewhat less to considerably greater than mouth width. Inner margins of pelvic fins not forming a prominent `apron' over claspers in adult males. Claspers elongate, tapering, distally pointed and twisted, extending from about half of their lengths behind the pelvic–fin tips. Two equal–sized dorsal fins present, origin of first about over pelvic–fin insertions. Origin of second dorsal fin slightly behind the anal–fin midbase. Anal fin elongate, subtriangular, about as large as pelvic fins or larger, and considerably larger than the dorsal fins; origin of anal fin far behind pelvic–fin bases, and insertion separated from lower caudal–fin origin by a long caudal peduncle 3.2 to 3.4 times into anal–fin base. Caudal fin thin, more or less elongated, over 1/4 total length in adults. A well–developed crest of denticles on the dorsal caudal–fin margin, preventral margin and lower edge of caudal peduncle, dorsal crest flat on its upper surface and symmetrical. Vertebral counts: monospondylous vertebral counts 35 to 39, precaudal vertebral counts 85 to 93, total vertebral counts 140 to 149. Size small to moderate, with adults 42 to 61 cm. **Colour:** light grey or brown, with conspicuous pattern of dark saddles and bars.

Local Names: Sawtail catsharks.

Remarks: The subgenus ***Figaro*** was proposed by Whitley (1928) for a new Australian catshark, ***Pristiurus boardmani***, that differed from well–known species of ***Galeus*** by having an additional crest of enlarged denticles on the preventral caudal margin. Whitley (1939) raised the rank of ***Figaro*** to genus, but Fowler (1941) and Bigelow and Schroeder (1948) synonymized it with ***Galeus***. Springer (1966) recognized ***Figaro*** without comment, but later included it in ***Galeus***. Chu *et al.* (1983) revived ***Figaro*** for ***Pristiurus boardmani*** Whitley, 1928, ***Dichichthys melanobranchius*** Chan, 1966, and the new ***Figaro piceus*** Chu, Meng and Liu, 1983 (a possible synonym of ***D. melanobranchius***); they defined the genus primarily by its subcaudal denticle crest. Compagno (1984b, 1988) considered ***Figaro*** to be a subgenus of ***Galeus***. Recently, Gledhill, Last, and White (2008) revisited the issue and raised it back to full generic status.

Two additional closely related catshark species also have subcaudal crests: ***Pristiurus murinus*** Collett, 1904, is usually placed in ***Galeus*** and ***Parmaturus pilosus*** Garman, 1906, the type–species of the genus ***Parmaturus***.

Figaro boardmani (Whitley, 1928)

Pristiurus* (*Figaro*) *boardmani Whitley, 1928, *Rec. Australian Mus.*, 16(4): 238, pl. 18, fig. 3. Holotype: Australian Museum, Sydney, AMS–IA 2483, 542 mm total length adult male, 10 mi NE of Montague Is., New South Wales, 128 to 146 m.

Synonyms: ***Figaro boardmani socius*** Whitley, 1939, *Australian Zool.* 9(3): 230. Holotype: ?, Great Australian Bight, South Australia. ***Galeus boardmani***, Last and Stevens, 1994, *Sharks and Rays of Australia*: 170, 201, key fig. 36, fig. 26.29, pl. 18.

Other Combinations: None.

FAO Names: En – Australian sawtail catshark; **Fr** – Chien égoïne; **Sp** – Pintarroja australiana.

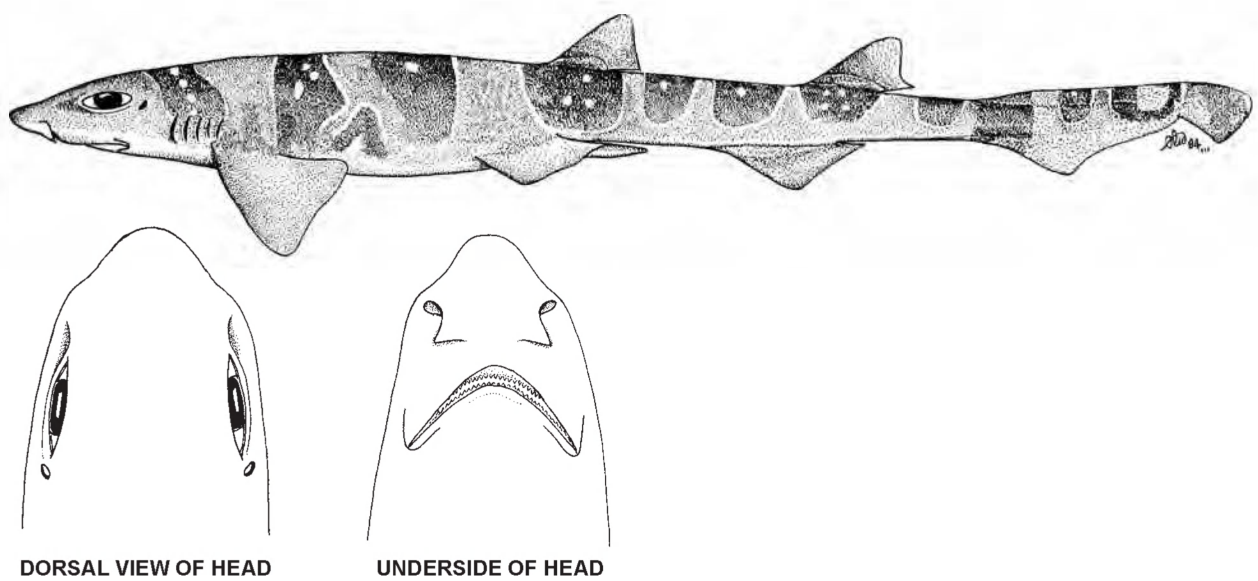


Fig. 235 ***Figaro boardmani***

Field Marks: A sawtailed catshark with three predorsal saddles, a double caudal crest, and prominent saddle markings.

Diagnostic Features: Precaudal tail not compressed at base. Snout moderately long and subangular, preoral length about 3.5 to 6.2% of total length. Eyes dorsolateral on head, with narrow sub–ocular ridges. Mouth fairly large and long, broadly arched, width about 6.4 to 6.8% of total length. Labial furrows moderately long, not confined to mouth corners. Pelvic fins small, low, and angular. Interspace between pelvic and anal–fin bases subequal to anal–fin base. Anal–fin base short, 9 to 11% of total length, less than interdorsal space. A well–developed subcaudal crest of enlarged denticles on preventral caudal–fin margin, extending onto ventral surface of caudal peduncle. Vertebral counts: monospondylous vertebral counts 36 to 39, precaudal vertebral counts 89 to 93. Size moderate, adults to 61 cm total length. **Colour:** pattern of variegated dark, saddle blotches on body and dark bands on caudal fin, saddles well–defined and outlined with whitish; saddle blotches usually present on back and tail and 12 or 13 in number; no additional dark spots on flanks; dorsal fins and caudal tip without black terminal markings; mouth lining light.

Distribution: Eastern Indian Ocean and western South Pacific: southern coasts of Australia from New South Wales, Victoria, Tasmania, South and Western Australia.

Habitat: A little–known but common Australian catshark of temperate and subtropical waters, from the outer continental shelf and upper slope, on or near bottom at depths from 150 to 640 m.

Biology: Little known, its diet includes mainly fish, crustaceans, and cephalopods.

Size: Maximum total length about 61 cm; males mature at 40 cm; females mature at 43 cm. Size at birth unknown.

Interest to Fisheries and Human Impact: Of no commercial value it is occasionally taken as bycatch.

Conservations status is Least Concern.

Local Names: None.

Literature: Whitley (1939, 1940); Fowler (1941); Springer (1979); Kyne and Bennett (2003); Compagno, Dando and Fowler (2005a); Gledhill, Last and White (2008); Last and Stevens (2009); Ebert (In preparation).

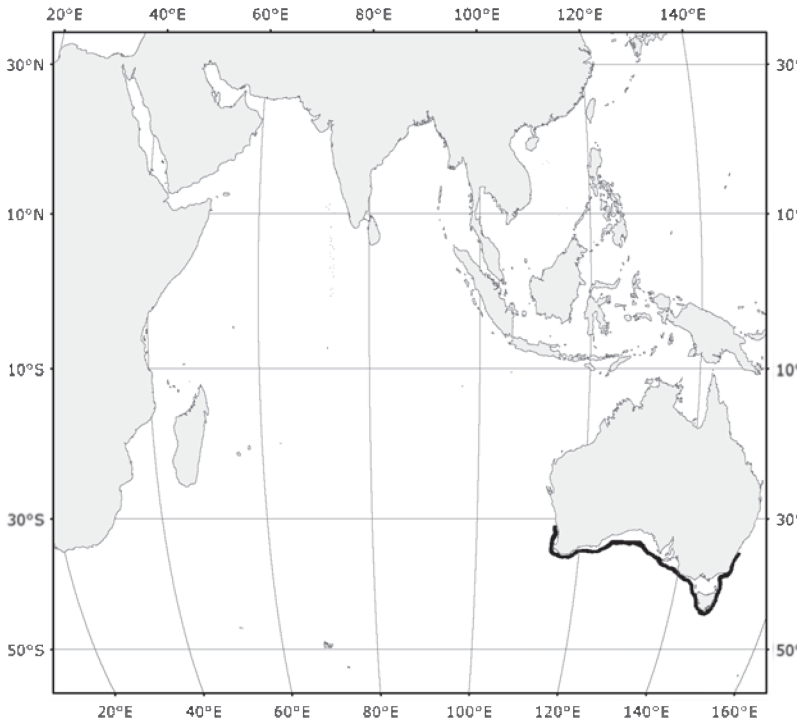


Fig. 236 ***Figaro boardmani***

Known distribution

Galeus Rafinesque, 1810

Genus: ***Galeus*** Rafinesque, 1810, *Caratt. gen. sp. anim. piant. Sicilia, Palermo*, pt. 1: 13.

Type Species: ***Galeus melastomus*** Rafinesque, 1810, by subsequent designation of Fowler, 1908, *Proc. Acad. Nat. Sci. Philadelphia*, 60: 53.

Number of Recognized Deep–sea Indian Ocean Species: 1.

Synonyms: Subgenus ***Pristiurus*** Bonaparte, 1834 (Genus ***Scyllium*** Cuvier, 1816), *Iconog. Fauna Italica, 3, Pesci, liv*. 7, 4th p. Type species: ***Scyllium melanostomum*** Bonaparte, 1834, by monotypy, a junior synonym of ***Galeus melastomus*** Rafinesque, 1810. Genus ***Pristidurus*** Bonaparte, 1838, *Nuov. Ann. Sci. Nat., Bologna, ser*. 1, 2: 213. Type species: ***Scyllium melanostomum*** Bonaparte, 1834, by monotypy, a junior synonym of ***Galeus melastomus*** Rafinesque, 1810. Unjustified emendation of ***Pristiurus*** Bonaparte, 1834. ?Subgenus ***Figaro*** Whitley, 1928 (Genus ***Pristiurus*** Bonaparte, 1834), *Rec. Australian Mus*., 16(4): 238. Type species: ***Pristiurus*** (***Figaro***) ***boardmani*** Whitley, 1928, by original designation.

Field Marks: Usually firm–bodied scyliorhinids with caudal crests of enlarged denticles, usually rather long and wedge–shaped snouts, short labial furrows, sub–ocular ridges virtually obsolete, large pectoral fins, large anal fin, elongated caudal fins, often barred and blotched colour pattern.

Diagnostic Features: Body not tadpole–shaped, slender and sub–cylindrical to rather compressed, tapering slightly to considerably to caudal fin; body firm and thick skinned, with well–calcified dermal denticles; stomach not inflatable. Tail varying from fairly short to moderately long, length from vent to lower caudal–fin origin about 2/5 to 5/6 of snout–vent length. Head slightly depressed, narrowly pointed–rounded in lateral view and somewhat wedge–shaped or not; head short to moderately long, between 1/4 and 1/5 to less than 1/5 of total length in adults. Snout fairly short to moderately elongated, 2/3 to about equal to mouth width, thick to rather thin and flattened, bluntly to almost acutely pointed in lateral view; snout not expanded laterally, broadly to narrowly rounded–parabolic and usually bell–shaped in dorsoventral view. Ampullal pores not greatly enlarged on snout. Nostrils of moderate size, with incurrent and excurrent apertures only partly open to exterior; anterior nasal flaps broadly triangular and rather low, without barbels, well separated from each other and falling well anterior to mouth; internarial space about 0.7 to 1.2 times nostril width; no nasoral grooves. Eyes virtually lateral on head, sub–ocular ridges below eyes narrow or obsolete. Mouth angular or semiangular, moderately long, with lower symphysis well behind upper so that upper teeth are exposed in ventral view. Labial furrows present along both upper and lower jaws, these very short to moderately long but ending well behind level of upper symphysis of mouth. Tooth counts 54 to 70 upper jaw, and 54 to 70 lower jaw. Branchial region not greatly enlarged, distance from spiracles to fifth gill slits 1/3 to 1/2 of head length; gill slits lateral on head. Pectoral fins large, their width somewhat less to considerably greater than mouth width. Inner margins of pelvic fins not fused or variably fused and forming an 'apron' over claspers in adult males. Claspers short to moderately long, fairly thick, and distally pointed and often twisted, extending from less than a fifth to about half of their lengths behind the pelvic–fin tips. Two equal–sized dorsal fins present, origin of first varying from over the first third of the pelvic–fin bases to about over their insertions. Origin of second dorsal fin varies from about over to slightly behind the anal–fin midbase. Anal fin large and more or less elongated, about as large as pelvic fins or larger, and considerably larger than the dorsal fins; base length 1.6 to slightly over 3 times second dorsal–fin base; origin of anal fin close to far behind pelvic–fin bases, and insertion separated from lower caudal–fin origin by a narrow notch to a broad space nearly equal to the anal–fin base. Caudal fin more or less elongated, over or somewhat less than a fourth of total length in adults. A well–developed crest of denticles on the dorsal caudal–fin margin and sometimes the upper edge of the caudal peduncle, and in some species on the preventral margin and lower edge of the caudal peduncle, dorsal crest flat on its upper surface and symmetrical; small median denticles between upper crest denticles usually in less than five rows. Supraorbital crests absent from cranium. Vertebral counts: total vertebral counts 73 to 151, monospondylous vertebral counts 30 to 50, diplospondylous precaudal vertebral counts 36 to 53, precaudal vertebral counts 48 to 97. Spiral valve counts 12 to 14. **Colour:** light grey or brown, with or without a conspicuous pattern of dark saddles and blotches.

Local Names: Sawtail catsharks, Saw tail sharks, Rough cat sharks.

Remarks: The genus has 17 recognized species, with all except ***Galeus sauteri*** being considered deep–sea inhabitants. Only one species though is confirmed as occurring in the Indian Ocean deep–sea.

Galeus gracilis Compagno and Stevens, 1993

Galeus gracilis Compagno and Stevens, 1993, *Rec. Australian Mus.* 45: 174, fig. 1–10, 13E. Holotype: CSIRO H1208.01, 335 mm total length, adult female, Northern Territory, upper slope north of Melville Island, Australia, 9°49'S, 130°15'E, January 1988, 290 m.

Synonyms: ***Galeus*** sp. A Last and Stevens, 1994, *Sharks and Rays of Australia*: 199, fig 26.27, pl 18.

Other Combinations: None.

FAO Names: En – Slender sawtail catshark; **Fr** – Chien gracile; **Sp** – Pintarroja esbelta.

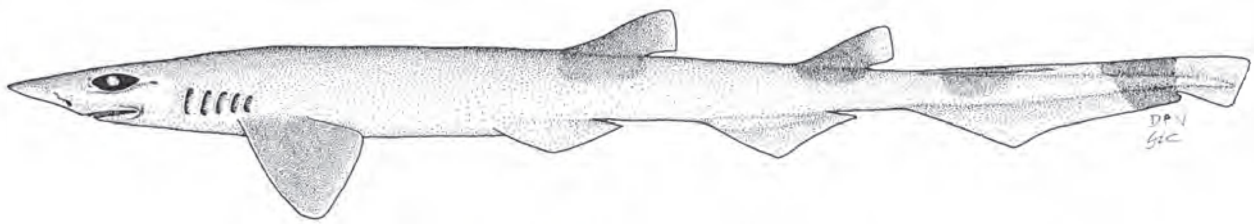


Fig. 237 *Galeus gracilis*

Field Marks: A small, slender ***Galeus*** with a distinct crest of enlarged dermal denticles along the upper caudal–fin margin. Colour is a pale grey with four short dusky saddles, one under each dorsal fin and two on the caudal fin, no predorsal fin markings; ventral surface lighter.

Diagnostic Features: Snout elongated and parabolic in shape, snout tip narrowly rounded. Preoral length about 6.4 to 7.8% of total length and 0.9 to 1.0 times mouth width; prenarial snout 0.9 to 1.3 times eye length. Eyes dorsolateral on head, with narrow but well developed sub–ocular ridges. Eyes small, length 3.2 to 3.3% of total length in adults; eye length 5.7 to 6.7 in head length. Mouth moderately large and long, broadly arched, width 7.0 to 8.1% of total length. Labial furrows moderately long, not confined to mouth corners. Tooth counts 54 to 57 upper jaw, 54 to 62 lower jaw. Body and precaudal tail slender. Caudal peduncle not greatly compressed, width 1.1 to 1.4 in height; peduncle elongated, anal–caudal space 0.5 to 0.7 of anal–fin base. Abdomen long, pectoral–pelvic space 14.3 to 16.0% of total length and 0.7 to 0.9 of head length in adults. Pelvic–anal space long, 0.8 to 1.0 of anal–fin base. Claspers moderately long in adult males, clasper outer length 10.3 to 10.8% of total length, distal tips extending well behind pelvic–fin rear tips but falling just short of anal–fin origin. Claspers tapering rearwards from base, not cylindrical or hourglass–shaped, tips narrow, pointed, not twisted or truncated. Clasper tips with prominent groups of enlarged, anteriorly pointing hooked denticles on their lateral and mesial surfaces. Clasper glans very long, about 0.6 length of clasper from apopyle to tip. Cover rhipidion small but well–developed. Pseudosiphon present and well developed. Exorhipidion large, bulbous, with group of enlarged, anteriorly pointing hooked denticles on outer lateral surface, but without transverse clasper hooks on its mesial edge. Pectoral fin moderately large and broad, anterior margin 9.7 to 11.0 % of total length. Pectoral–fin skeleton with 16 radials; two proximal segments of mesopterygial radials fused together. Pelvic fins small, low, and angular. Anal fin very short, base 10.5 to 11.5 % of total length and 1.1 to 1.2 in interdorsal space;

anal–fin origin under anterior half of interdorsal space; anal–fin height 3.0 to 3.7 in base. No sub–caudal crest of enlarged denticles on preventral caudal fin margin. Vertebral counts: total vertebral counts 130 to 134, monospondylous vertebral counts 33 to 36, diplospondylous vertebral counts 41 to 44, precaudal vertebral counts 74 to 78. Intestinal valve with 6 to 7 turns. Size small, adults of both sexes 31 to 34 cm long. **Colour:** adults light grey above, with well–defined dark saddles on body below first and second dorsal fins, on upper caudal–fin base, and across caudal fin at base of terminal lobe, not highlighted with light lines; dorsal fins dusky with light distal webs; mouth lining blackish.

Distribution: Eastern Indian Ocean: Australia (Western Australia and Northern Territory, Queensland).

Habitat: Occurs on the continental slope of tropical northwestern Australia on the bottom at depths from 290 to 453 m.

Biology: Mode of reproduction unknown at present.

Size: Maximum total length about 34 cm. Males adult at 33 cm; females adult at 32 to 34 cm. Size at birth unknown.

Interest to Fisheries and Human Impact: Interest to fisheries none.

Conservation status is Data Deficient.

Local Names: None.

Literature: Compagno and Stevens (1993); Last and Stevens (1994, 2009); Kyne and Cavanagh (2003); Compagno, Dando and Fowler (2005); Ebert (In preparation).

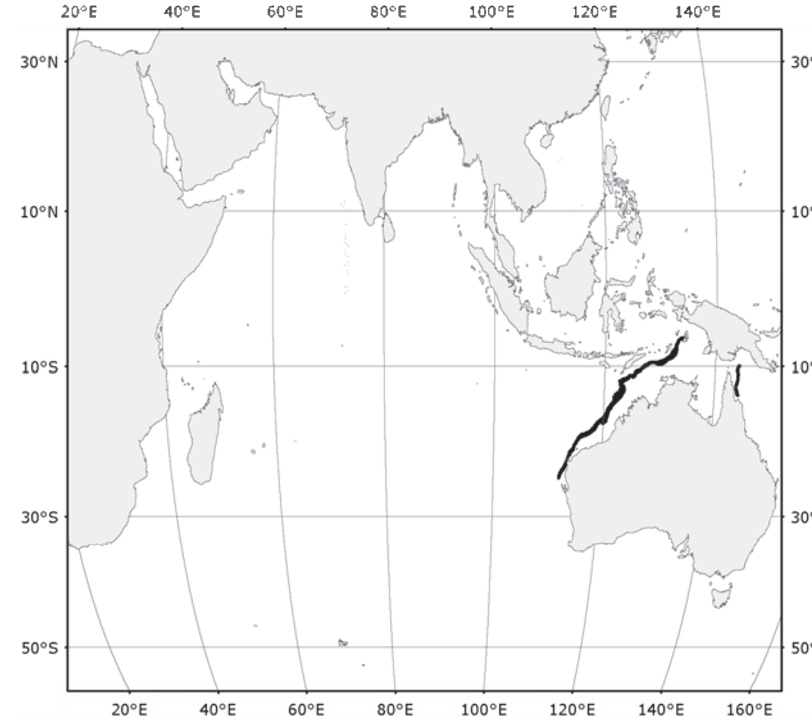


Fig. 238 *Galeus gracilis*

Known distribution

Holohalaelurus Fowler, 1934

Genus: Subgenus ***Holohalaelurus*** Fowler, 1934, *Proc. Acad. Nat. Sci. Philadelphia*, 85: 235 (Genus ***Halaelurus*** Gill, 1862).

Type Species: ***Scylliorhinus regani*** Gilchrist, 1922, by original designation, lost. Neotype: ***Holohalaelurus regani*** (Gilchrist, 1922) by designation SAM 32448, adult male 62.8 cm TL, *R.V. Africana* cruise 079, station A9830 082–3162, southeast of Hondeklip Bay, Northern cape Province, South Africa, 30° 57'S, 17° 46'E, 234 m, 27 January 1990.

Number of Recognized Deep–sea Indian Ocean Species: 5.

Synonyms: None.

Field Marks: Extremely broad–headed short–snouted catsharks without labial furrows, with long mouths and long, low dorsal fins, slender tails, very bold, bright, spotted dorsal colour patterns, and scattered black dots on underside of head.

Diagnostic Features: Body not tadpole–shaped, fairly stout and spindle–shaped, tapering considerably to caudal fin; body firm and thick skinned, with well–calcified dermal denticles; stomach not inflatable. Tail moderately long, length from vent to lower caudal–fin origin over 4/5 of snout–vent length. Head greatly depressed and very broad, narrowly pointed and somewhat wedge–shaped in lateral view; head short, less than 1/5 of total length in adults. Snout rather short, less than 3/5 of mouth width, thin, and very flattened, pointed in lateral view; snout somewhat expanded laterally, rounded–parabolic and slightly bell–shaped in dorsoventral view. Ampullal pores not greatly enlarged on snout. Nostrils fairly large, with incurrent and excurrent apertures only partly open to exterior; anterior nasal flaps broadly triangular, without barbels, well separate from each other but nearly or quite reaching level of mouth; internarial space about 1.0 to 1.3 times nostril width; no nasoral grooves. Eyes dorsolateral on head, very broad sub–ocular ridges present below eyes. Mouth semiangular, very long, with lower symphysis well behind upper so that upper teeth are exposed in ventral view. Labial furrows absent from both jaws. Tooth counts range from 40 to 72 upper jaw, 27 to 78 lower jaw. Branchial region not enlarged, distance from spiracles to fifth gill slits 2/5 of head length; gill slits dorsolateral on head. Pectoral fins moderately large, their width subequal or somewhat less than mouth width. Inner margins of pelvic fins not fused over claspers in adult males. Claspers moderately long, slender, and distally pointed, extending about half of their lengths behind the pelvic–fin tips. Two dorsal fins present, with second slightly larger than first. Origin of first dorsal fin varying from about over the pelvic–fin midbases to slightly in front of their insertions. Origin of second dorsal fin about over the last third of the anal–fin base. Anal fin moderately large and definitely elongated, about as large as pelvic fins or larger, and larger than the dorsal fins; base length 1.5 to 2 times second dorsal–fin base; origin of anal fin well behind pelvic–fin bases, and insertion separated from lower caudal–fin origin by a broad space subequal to the anal–fin base. Caudal fin moderately elongated, between 1/4 to 1/5 of total length in adults. No crests of denticles on the caudal–fin margins. Supraorbital crests absent from cranium. Vertebral counts: total vertebral counts 85 to 132, monospondylous vertebral counts 23 to 33, diplospondylous vertebral counts 35 to 61. Size small, adults up to about 51.5 cm total length. **Colour:** light with a conspicuous pattern of dark spots and blotches on dorsal surface and unique small black dots on underside of head.

Local Names: Izak catsharks.

Remarks: Compagno (1988) clarified the status of this genus relative to the closely related genus ***Halaelurus***. This followed earlier works by Bigelow and Schroeder (1948), Smith (1949), Bass, D'Aubrey and Kistnasamy (1975), Springer (1979), and Compagno (1984b) in recognizing distinct morphological and colour pattern differences between of this genus and ***Halaelurus***. Human (2006, 2007) extensively revised this genus, which previously had two recognized species, ***Holohalaelurus punctatus*** and ***H. regani***, resurrecting a third species (***H. melanostigma***), and described two new species (***H. favus*** and ***H. grennian***) bringing the total number of valid species for this genus to five. A possible sixth species (***H. polystigma***) was found to be a junior synonym of ***H. punctatus***.

Key to Deep–sea Indian Ocean Species:

1a. No enlarged denticles on dorsal midline of body; buccal papillae very prominent; white spot at origin of each dorsal fin (Fig. 239). . . ***Holohalaelurus punctatus***

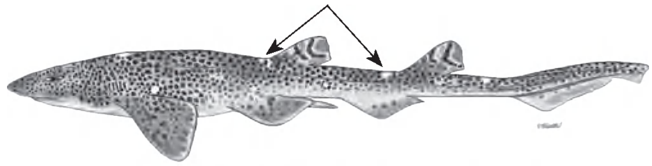


Fig. 239 ***Holohalaelurus punctatus***

1b. Enlarged denticles on dorsal midline of body; buccal papillae not prominent or inconspicuous; white spot variably present at origin of each dorsal fin, but never at both dorsal–fin origins **2**

2a. Anal–fin base length 1.5 times or less than pelvic–fin base length; club–shaped papillae present on distal tip of claspers in adult males; white spots present (Fig. 240). . . . . ***Holohalaelurus grennian***

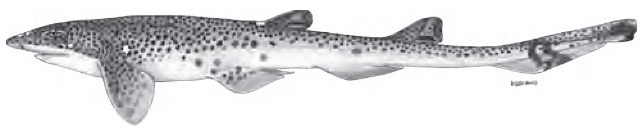


Fig. 240 ***Holohalaelurus grennian***

2b. Anal–fin base length 1.8 times or more than pelvic–fin base length; club–shaped papillae not present on distal tip of claspers in adult males; white spots absent . **3**

3a. Enlarged denticles on dorsal surface of snout absent; "tear line" markings present from origin of orbit to anterior margin of snout; enlarged denticles on dorsal surface of pectoral fins in adults absent (Fig. 241) . . . . ***Holohalaelurus melanostigma***

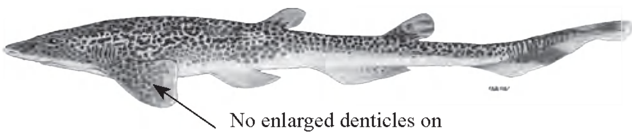


Fig. 241 ***Holohalaelurus melanostigma***

3b. Enlarged denticles on dorsal surface of snout present; no "tear line" markings present from origin of orbit to anterior margin of snout; enlarged denticles on dorsal surface of pectoral fins in adults present **4**

4a. Spot diameter less than eye diameter in adults; not forming "horseshoe" shaped markings (Fig. 242); snout broadly rounded and not coming to a point in adults; never more than one symphyseal tooth in each of the upper and lower jaws . . . . ***Holohalaelurus favus***

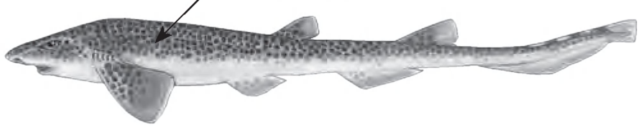


Fig. 242 ***Holohalaelurus favus***

4b. Spot diameter greater than eye diameter in adults; forming "horseshoe" shaped markings (Fig. 243); snout rounded and coming to a point in adults; up to six symphyseal teeth in each of the upper and lower jaws . . . . ***Holohalaelurus regani***

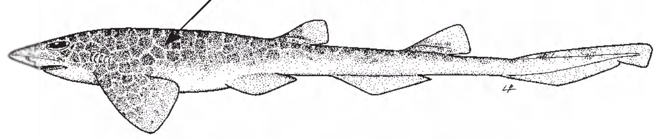


Fig. 243 ***Holohalaelurus regani***

Holohalaelurus favus Human, 2006

Holohalaelurus favus Human, 2006, *Zootaxa*, 1315: 36, figs 11–12, tab. 4. Holotype: RUSI 6139, mature male 525 mm TL, off Durban, KwaZulu–Natal, South Africa, approximately 29° 51'S, 31° 00'E, 5 February 1965.

Synonyms: ***Holohalaelurus regani*** Smith, 1949, *The Sea Fishes of Southern Africa, Central News Agency, South Africa*: 60 (in part); Bass, 1973: 6 (in part); Bass, D'Aubrey and Kistnasamy, 1975a, *South African Assoc. Mar. Biol. Res. Investigational Report no.* 37: 25 (in part); Compagno, 1984b, *FAO Species Catalogue Vol. 4, Sharks of the World, FAO Fisheries Synopsis no.* 125, vol. 4, part 2: 338 (in part); Bass, 1986, *in* Smiths' Sea Fishes: 93 (in part); Compagno, 1988: 152 (in part); Compagno, Ebert and Smale (1989), *Guide to Sharks and Rays of Southern Africa, New Holland*: 54 (in part); Compagno, 1999: 98 (in part); Richardson *et al.*, 2000, *Journal of Fish Biology*: 553 (in part). ***Holohalaelurus regani*** (northeastern subspecies, Compagno, Dando and Fowler, 2005a: 237).

Other Combinations: None.

FAO Names: **En** – Honeycomb Izak; **Fr** – Holbiche criblée; **Sp** – Tiburón gato miel.

Fig. 244 ***Holohalaelurus favus***

Field Marks: A large species of ***Holohalaelurus*** with a broad head, no labial furrows, nostrils separate from each other and mouth and without barbels or nasoral grooves, dorsolateral gill slits, dorsal fins subequal in sized, first dorsal–fin origin about over rear end of pelvic–fin bases, second dorsal–fin base about over anal–fin insertion, dorsal surface background colour brown with a honeycomb pattern of irregular reticulations and spots.

Diagnostic Features: Anal–fin base 3.5 times its height or more, usually shorter than interdorsal space. Second dorsal fin larger than first. Tooth counts 65 to 68 upper jaw, 53 to 70 lower jaw. Vertebral counts: total vertebral counts 104 to 124, monospondylous vertebral counts 28 to 31, diplospondylous vertebral counts 55 to 56. Intestinal valve counts not available. A large Izak catshark, adults to 51.5 cm total length. **Colour:** dorsal pattern honeycomb with numerous irregular shaped spots and reticulations covering a pale brown background; white spots above pectoral fins absent; ventral surface uniformly grey brown. See **Key to Species** for characteristics separating this from other ***Holohalaelurus*** species.

Distribution: Southwestern Indian Ocean: this species appears to be a regional endemic that may have a very limited distributional range of about five degrees of latitude. It is confirmed from off Durban, South Africa, to northeast of Maputo, Mozambique.

Habitat: This species appears to have a preference for water deeper than 200 m, but shallower than 1000 m. Although records are somewhat scarce due to misidentification with other similar looking Izak catshark species, the depth range appears to be approximately 200 to 740 m. Juveniles may occur in deeper water than adults, but this has not been confirmed. If true, this would be the opposite of ***H. regani*** whereby the juveniles occur in shallower water than the adults.

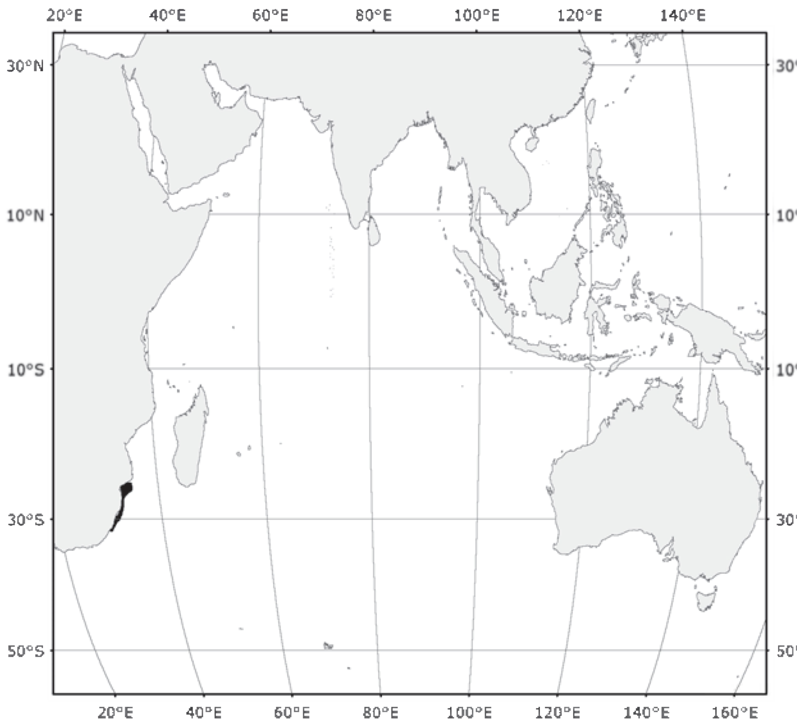


Fig. 245 ***Holohalaelurus favus***

Known distribution

Biology: Nothing known.

Size: Maximum total length to at least 51.5 cm; males mature at 51.5 cm; females mature at 42.3 cm. Size at birth unknown.

Interest to Fisheries and Human Impact: None.

This species was once very common on the trawling grounds from off Durban to southern Mozambique, but no specimens appear to have been collected since the mid–1970s raising concern over the conservation status of this species, which is now considered to be Endangered. This species, like ***H. punctatus***, may have been locally extirpated from some areas of its known range. Unfortunately, small demersal sharks, as with many demersal batoid species, that frequently are taken as bycatch often fall under the radar from fisheries management and conservation efforts due to a lack charisma that some of the larger, oceanic shark species often receive from the media.

Local Names: Honeycomb catshark, Natal Izak catshark.

Remarks: Different ***Holohalaelurus*** species from Kwa–Zulu–Natal were first recognized by Bass, D'Aubrey and Kistnasamy (1975a) who referred to the "Typical" or "Cape" form (referable to ***H. regani***) and to a "Natal" form. Other subsequent authors noted the two forms (Compagno, 1984b, 1988; Bass, 1986; Compagno, Ebert and Smale, 1989; Compagno, Dando and Fowler, 2005) that Human (2006) later clearly showed to be a distinct species, which he named ***H. favus***. Both ***H. favus*** and ***H. regani*** slightly overlap off Durban, but ***H. favus*** appears to have been the more common species at one time. Neither these two species or other ***Holohalaelurus*** species all once considered to be common off KwaZulu–Natal and southern Mozambique are seen in fishery surveys raising concerns about the population status of these species. Human (2006) provides an excellent detailed description and discussion on the taxonomic history of this, and other, members of this genus.

Literature: Human (2006, 2007, 2009a); Ebert (In preparation).

Holohalaelurus punctatus (Gilchrist, 1914)

Scylliorhinus punctatus Gilchrist, 1914, *Un. S. Africa, Prov. Cape of Good Hope, Marine Biol. Rep.* (2): 129, fig. Holotype: 245 mm total length, probably female, apparently lost, listed as from off Cape Point, South Africa, but according to Human (2006) was more likely from off Cape St. Lucia, Kwa–Zulu, Natal, South Africa as Gilchrist at the time was conducting a continuous marine survey aboard the *S.S. Pickle* between Cape Point, Western Province, and Natal, South Africa. It is likely that an error occurred during the on the ship's log during that survey. Furthermore, the holotype was described from a preserved specimen adding support to the notion that the locality data may be erroneous. Regardless, the holotype for this species is lost and a neotype has been designated to help clarify the status of this species. Neotype: RUSI 6128, adult male 298 mm TL, Red Cliff, Bazaruto, Mozambique, 237–256 m, 16 May 1969.

Synonyms: ***Scyliorhinus (Halaelurus) polystigma*** Regan, 1921, *Ann. Mag. Nat. Hist., ser.* 9, 7(41): 413. Holotype: British Museum (Natural History), BMNH 1921.3.1.1, 320 mm adult male, off Umvoti R., Natal, South Africa, 220 to 238 m.

Other Combinations: ***Halaelurus punctatus*** (Gilchrist and Thompson, 1914).

FAO Names: En – African spotted catshark; **Fr** – Holbiche à gorge tachetée; **Sp** – Pejegato moteado.

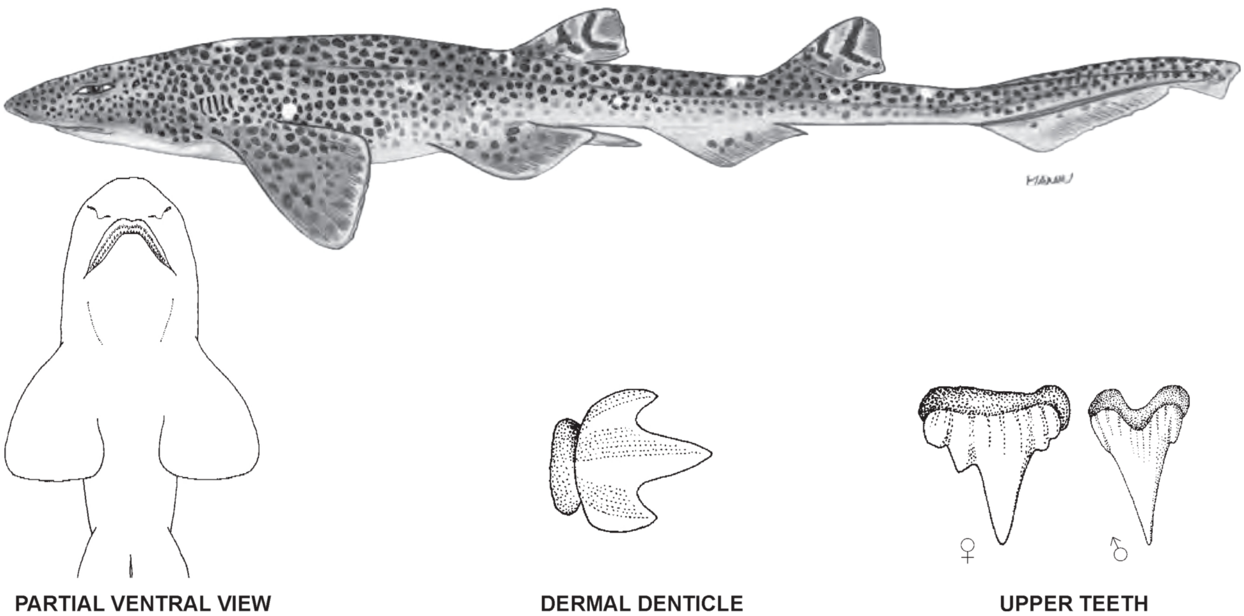


Fig. 246 *Holohalaelurus punctatus*

Field Marks: A dwarf species of ***Holohalaelurus*** with an extremely broad head, no labial furrows, nostrils separate from each other and mouth and without barbels or nasoral grooves, dorsolateral gill slits, dorsal fins equal–sized, first dorsal fin with origin about over rear end of pelvic–fin bases, second dorsal–fin base partly behind anal–fin base, dorsal surface with dense covering of dark brown spots, underside of head with tiny dark dots, conspicuous white spot over pectoral–fin insertion.

Diagnostic Features: Anal–fin base 3.5 times its height or less, usually shorter than interdorsal space. Second dorsal fin about as large as first. Denticles on back and top of head of uniform size. Tooth counts 42 to 52 upper jaw, 40 to 47 lower jaw. Vertebral counts: total vertebral counts 85 to 119, monospondylous vertebral counts 23 to 29, diplospondylous vertebral counts 35 to 57. Intestinal valve counts not available. A dwarf species with a maximum total length of about 33 cm. **Colour:** pattern variable but usually with very small, regular, closely spaced dark brown spots on yellow–brown or orange–brown ground colour of back giving more of a leopard–like appearance; also longitudinal or double–V shaped markings on dorsal fins, lined with white, and white spots on sides of body that are especially prominent above pectoral–fin insertions.

Distribution: Western Indian Ocean: common or formerly common off KwaZulu–Natal, South Africa, Mozambique, and eastward to Madagascar; this is the only ***Holohalaelurus*** known to occur east of the Mozambique Channel. The type specimen was reported to have come from Cape Point, Western Cape Province, South Africa, but this locality is considered erroneous.

Habitat: A small bottom shark of deepish water of the uppermost continental slopes from 220 to 420 m. Off of KwaZulu–Natal females are far outnumbered by males, but not off southern Mozambique, indicating partial sexual segregation.

Biology: Development oviparous, with one egg–case being laid per oviduct at a time. Eats small bony fishes, crustaceans and cephalopods.

Size: Maximum total length 32.6 cm; male adolescent 24 cm, adult males 29 to 33 cm; females immature at 20 cm, adolescent at 23 cm and adult at 24 to 26 cm. Size at birth unknown.

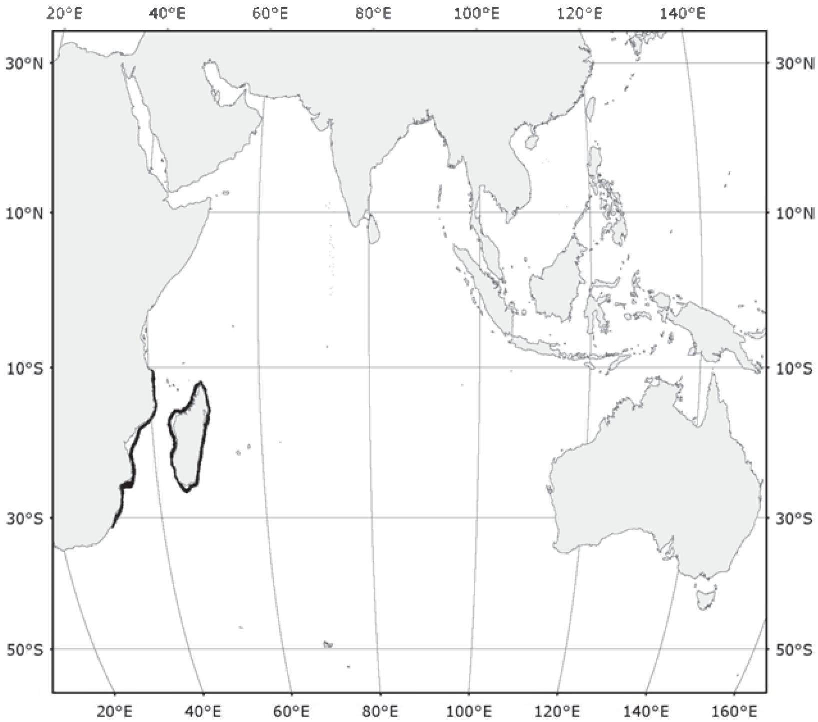


Fig. 247 *Holohalaelurus punctatus*

Known distribution

Interest to Fisheries and Human Impact:
Interest to fisheries none, taken in bottom trawls as discarded bycatch.

Conservation status is Endangered because this shark has been subjected to intense bottom trawl fisheries for deepwater shrimp off of KwaZulu–Natal and Mozambique. Although Bass, D'Aubrey and Kistnasamy (1975a) and Bass (1986) reported it as common on the offshore trawl grounds, not a single specimen has been collected from this area since 1972 despite biodiversity trawl surveys in that region as part of a coelacanth (***Latimeria chalumnae***) project in the early 2000's. Human (2006) investigated records maintained by the Oceanographic Research Institute's from 1964 to 1972 and confirmed that this species was caught with regularity in bottom trawls. Whether the apparent disappearance of this species from KwaZulu–Natal, South Africa and southern Mozambique is due to fishing pressure, habitat loss, pollution, or an as yet unidentified cause remains uncertain.

Local Names: Spotted catshark, Spikkel–kathaai (South Africa), Pata–roxa africana (Mozambique).

Remarks: See Human (2006) for excellent review of the synonymy and distribution, and a detailed description of this species separating it from other ***Holohalaelurus*** species.

Literature: Bass, D'Aubrey and Kistnasamy (1975a); Springer (1979); Compagno (1984b, 1988); Human (2006, 2007, 2009b); Ebert (In preparation).

Scyliorhinus Blainville, 1816

Genus: Subgenus ***Scyliorhinus*** Blainville, 1816 (Genus ***Squalus*** Linnaeus, 1758), *Bull. Sci. Soc. Philomat. Paris*, (8): 121.

Type Species: "***Scylliorhinus canicula*** Blainville", by subsequent designation of Gill, 1862, *Ann. Lyceum Nat. Hist. New York*, 7(32): 407; equals ***Squalus canicula*** Linnaeus, 1758.

Number of Recognized Deep–sea Indian Ocean Species: 2.

Synonyms: Subgenus ***Scyllium*** Cuvier, 1816 (Genus ***Squalus*** Linnaeus, 1758), *Reg. Anim.*, ed. 1, 2: 124 . Type species: ***Squalus canicula*** Linnaeus, 1758, by subsequent designation of Jordan and Evermann, 1917, *Stanford U. Pub., U. Ser., Gen. Fish.* (1): 97. Whitley (1935, *Australian Zool.* 8[2]: 137) and [Eschmeyer (1998), Catalog of Fishes] note that Bory de St. Vincent (1828, *Dict. Class. Hist. Nat.* 14: 708) selected ***Squalus canicula*** Linnaeus, 1758 as type species of ***Scyllium*** Cuvier, (1816, *Le Règne Animal distribué d'après son organisation pour servir de base à l'histoire naturelle des animaux et d'introduction à l'anatomie comparée. Les reptiles, les poissons, les mollusques et les annélides*. Edition 1: 124). Genus ***Scylium*** Eichwald, 1819, *Selachus Aristotelus zoolog. geograph. specimen inaugur., Vilniae*: 65 (not seen). Apparent error for ***Scyllium*** Cuvier, 1816. Genus ***Scyllia*** van Hasselt, 1823, *Algemeene Konst–Letter–Bode*, 1823, I, Deel, (21): 315 (error or emendation for ***Scyllium*** Cuvier, 1816). Subgenus ***Scylliorhinus*** Blainville, 1825 (Genus ***Squalus*** Linnaeus, 1758), *in* Vieillot *et al.*, *Faune Francaise*, liv. 13–14: 68. Unjustified emendation of ***Scyliorhinus*** Blainville, 1816. Subgenus ***Catulus*** Willoughby *in* Smith, 1837 (Genus ***Scyllium*** Cuvier, 1816), *Proc. Zool. Soc. London* 5: 85; also Smith, 1838, *Ann. Nat. Hist. Mag. Zool. Bot. Geol*, 1: 73 (identical account). Smith (1837, 1838) listed three species in the subgenus ***Catulus***: ***Squalus canicula*** Linnaeus, 1758, ***Scyllium marmoratum*** Bennett, 1830, and ***Catulus Edwardsii*** Smith (*nomen nudum*) without a type designation. Type species: ***Squalus canicula*** Linnaeus, 1758 by subsequent designation of Fowler, 1908, *Proc. Acad. Nat. Sci. Philadelphia*, 60: 53. According to Eschmeyer (1998, Cat. Fish.) erroneous type designations for ***Catulus*** Willoughby *in* Smith include: ***Scyllium capense*** Smith, 1838, which was placed in the subgenus ***Scyllium*** by Smith and furthermore is a *nomen nudum*, as given by Jordan (1919: 190); ***Scyllium stellaris*** Linnaeus, 1758 as given by Jordan and Evermann (1896: 23), which Smith cited as ***Catulus stellare*** and placed in the subgenus ***Scyllium***. A junior homonym of ***Catulus*** Kniphof, 1759, in Insecta. Ultimately based on ***Catulus*** Valmont, 1769 (see below). Genus ***Catulus*** Garman, 1913, *Mem. Harvard Mus. Comp. Zool.*, 36: 3, 71. Type species: ***Catulus saxatilis*** Valmont, 1769 by original designation, equals ***Squalus stellaris*** Linnaeus, 1758. A junior homonym of ***Catulus*** Kniphof, 1759 in Insecta. A revival of ***Catulus*** Valmont, 1768, *Dict. Hist. Nat.*, 4: 51; *Ibid.*, 1769, 10:. 114; *Ibid*, 1769, 12: 421. Valmont's names were rejected as being inconsistently binomial by the International Commission on Zoological Nomenclature (Opinion 89, 1925, *Smithsonian Misc. Coll.* 73(3): 27–33). "Pseudogenus" (= Subgenus) ***Alphascyllium*** Leigh–Sharpe, 1926 (Genus ***Scyllium*** Cuvier, 1816), *J. Morph.* 42: 322. Type species: "Scyllium canicula" by original designation, equals ***Squalus canicula*** Linnaeus, 1758. Leigh–Sharpe's "pseudogenera", based on clasper morphology, must be considered the nomenclatural equivalent of subgenera under Article 10e of the Third Edition of the International Code of Zoological Nomenclature (Ride, Sabrowsky, Bernardi, and Melville, eds, 1985, *Intern. Trust. Zool. Nomen.*, London). "Pseudogenus" (= Subgenus) ***Betascyllium*** Leigh–Sharpe, 1926 (Genus ***Scyllium*** Cuvier, 1816), *J. Morph.* 42: 325. Type species: ***Scyllum catulus*** by original designation, equals ***Squalus catulus*** Linnaeus, 1758, a junior synonym of ***S. stellaris*** Linnaeus, 1758. Genus ***Scylliorhynchus*** Nobre, 1935, *Fauna marin. Portugal.* 1. Vertebrados (Mamiferos, Reptis e Peixes), Porto: 409. Probable error for ***Scyliorhinus*** Blainville, 1816. Genus ***Scylliorhynus*** Nobre, 1935, *Fauna marin. Portugal.* 1. Vertebrados (Mamiferos, Reptis e Peixes), Porto: 416. Probable error for ***Scyliorhinus*** Blainville, 1816.

Field Marks: Scyliorhinids without trilobate, barbeled anterior nasal flaps, labial furrows on lower jaw only, second dorsal fin much smaller than first.

Diagnostic Features: Body not tadpole–shaped, moderately stout to slender and cylindrical or spindle–shaped, tapering considerably to caudal fin; body firm and thick skinned, with well–calcified dermal denticles; stomach not inflatable. Tail moderately long, length from vent to lower caudal–fin origin between 3/5 to 3/4 of snout–vent length. Head slightly to moderately depressed, narrowly rounded and not wedge–shaped in lateral view; head short, less than 1/5 of total length in adults. Snout short, less than 3/4 of mouth width, thick, and slightly flattened, bluntly pointed in lateral view; snout not expanded laterally, rounded–parabolic in dorsoventral view. Ampullal pores not greatly enlarged on snout. Nostrils not enlarged to moderately enlarged, with incurrent and excurrent apertures only slightly open to exterior; anterior nasal flaps more or less triangular, sometimes slightly elongated, without a prominent barbel, well separated from each other and ending somewhat anterior to mouth but close together and reaching it in ***Scyliorhinus canicula***; internarial space 0.3 to 0.8 times nostril width; nasoral grooves usually absent, except ***S. canicula*** in which broad grooves are present. Eyes dorsolateral on head, broad sub–ocular ridges present below eyes. Mouth angular or broadly arched, moderately long, with lower symphysis somewhat behind upper so that upper teeth are well–exposed in ventral view (except ***S. canicula***, in which upper teeth are obscured by lower jaw). Labial furrows present along lower jaw only, these short to moderately long; vestigial uppers occasionally present. Tooth counts 40 to 65 upper jaw, 38 to 65 lower jaw. Branchial region not greatly enlarged, distance from spiracles to fifth gill slits 1/2 to 2/5 head length; gill slits lateral on head. Pectoral fins large, their width about as great or considerably greater than mouth width. Inner margins of pelvic fins more or less fused over claspers in adult males, forming a 'apron'. Claspers short, relatively thick, and distally pointed or rounded, extending less than half their lengths behind the pelvic–fin tips. Two dorsal fins present, with the second considerably smaller than the first. Origin of first dorsal fin varying from over last half of pelvic–fin bases to over pelvic–fin free rear tips. Origin of second dorsal fin over last third of anal–fin base to slightly behind anal–fin insertion. Anal fin moderately large but not greatly elongated, subequal to pelvic and first dorsal fins but much larger than second dorsal fin, base length 1.3 to 2.4 times second dorsal–fin base; origin of anal fin well behind pelvic–fin bases, and insertion separated from lower caudal–fin origin by a space varying from half as long to slightly longer than the anal–fin base. Caudal fin short and fairly broad, between 1/4 to 1/5 to less than 1/5 of total length in adults. No crests of denticles on the caudal–fin margins.

Supraorbital crests present on cranium. Vertebral counts: total vertebral counts 114 to 144, monospondylous vertebral counts 30 to 47, precaudal vertebral counts 90 to 95. Spiral valve turns 6 to 11. **Colour:** pattern extremely variable, ranging from simple dark saddles, reticulating dark bars, or large dark spots on a light background to combinations of light and dark spots and saddles.

Local Names: Spotted dogfishes, Roussettes.

Remarks: The arrangement of this genus follows Springer (1966, 1979), Compagno (1984b, 1988), Shirai, Hagiwara and Nakaya (1992), and Ebert (In preparation). Of the 15 currently recognized species within this genus, nine are deep–sea inhabitants and two occur in the Indian Ocean.

Key to Deep–sea Indian Ocean Species:

1a. A large species, adults over 70 cm. Saddles with irregular edges; no conspicuous dark bar under eyes (Fig. 248) . . . . ***Scyliorhinus capensis***

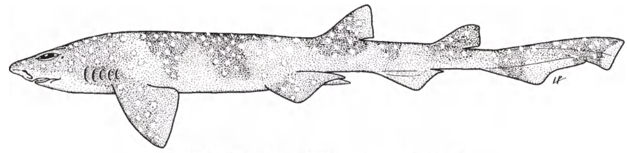


Fig. 248 ***Scyliorhinus capensis***

1b. Medium–sized species, adults mature between 40 to 50 cm. Saddles with sharp edges; a conspicuous dark bar under eye (Fig. 249) . . . . ***Scyliorhinus comoroensis***

Fig. 249 ***Scyliorhinus comoroensis***

Scyliorhinus capensis (Smith *in* Müller and Henle, 1838)

Scyllium capense Smith, 1838, *Proc. Zool. Soc. London* 5: 85 (*nomen nudum*). Smith 1838, *Ann. Mag. Nat. Hist.*, 1(1): 73 (*nomen nudum*). Smith, *in* Müller and Henle, 1838, *Syst. Beschr. Plagiost.*, pt. 1: 11. Syntypes: Rijksmuseum van natuurlijke Historie, Leiden and British Museum (Natural History), "vom Cap." = Cape of Good Hope, South Africa.

Synonyms: None.

Other Combinations: None.

FAO Names: En – Yellowspotted catshark; **Fr** – Roussette à taches jaunes; **Sp** – Alitán de manchas amarillas.

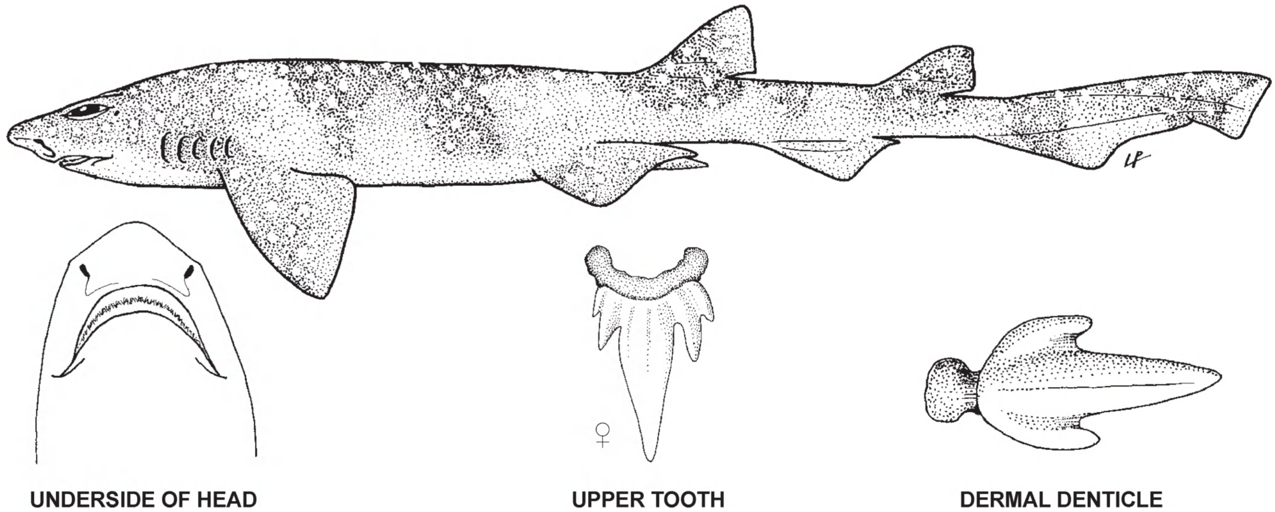


Fig. 250 ***Scyliorhinus capensis***

Field Marks: A fairly large and slender, bright yellow–spotted and grey–saddled catshark with small anterior nasal flaps that don't reach mouth, no nasoral grooves, labial furrows on lower jaw only, second dorsal fin much smaller than first.

Diagnostic Features: Head and body relatively deep, slender and narrow; greatest width of head less than 2/3 of head length. No nasoral grooves; anterior nasal flaps not expanded and falling just short of mouth. Tooth counts 65 to 60 upper jaw, 55 to 65 lower jaw. Denticles fairly large and erect, skin relatively rough. First dorsal–fin origin somewhat behind pelvic–fin insertions. Second dorsal–fin origin over anal–fin insertion. Interdorsal space somewhat greater than anal–fin base. Vertebral counts: total vertebral counts 130 to 144, monospondylous vertebral counts 44 to 46, precaudal vertebral counts 91 to 95. Spiral valve turns 10 to 11. Size large, to 122 cm total length. **Colour:** pattern of numerous small bright yellow spots about size of eye pupil or more; 8 or 9 dusky grey saddle marks on back; no dark spots.

Distribution: Western Indian Ocean and eastern South Atlantic: South Africa (KwaZulu–Natal, eastern, western, and northern Cape Provinces) to Namibia.

Habitat: A common inshore to offshore temperate benthic catshark on the continental shelf and upper slope of South Africa, uncommon to rare northwestwards to KwaZulu–Natal and northeastwards to Namibia. Depths recorded 26 to 530 m, possibly confined to deep water (420 m) off KwaZulu Natal than off the Cape Provinces of South Africa, where it occurs in shallow bays such as False Bay and Table Bay but ranges in depth from 26 to 530 m. This may be an example of tropical submergence in which minimum depth range becomes greater in warmer waters.

Biology: Oviparous, laying one egg per oviduct at a time; egg cases about 8 cm long by 3 cm wide. Few adult females were available for study of their reproduction.

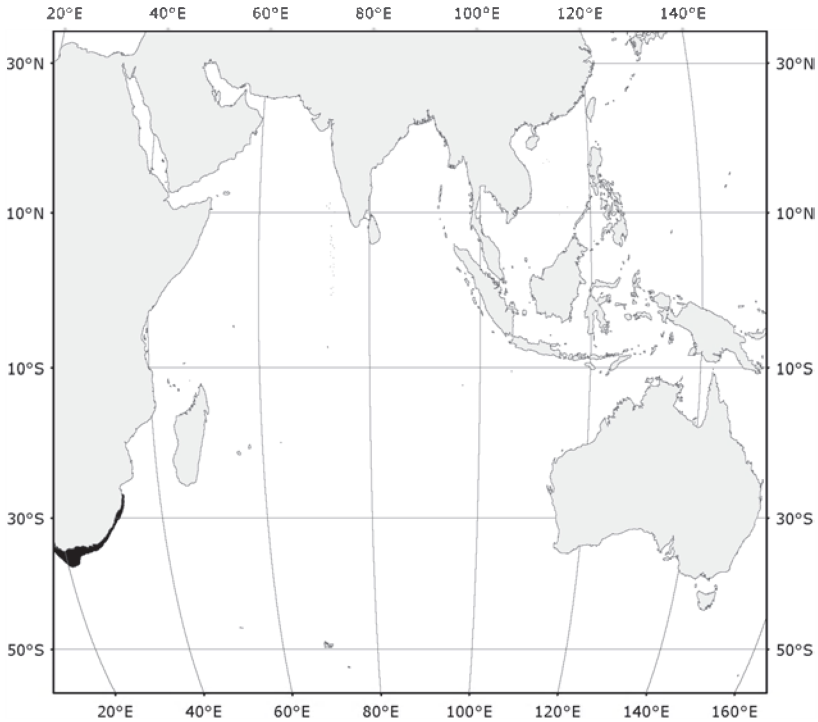


Fig. 251 ***Scyliorhinus capensis***

Known distribution

Feeds on small fishes and various invertebrates, including jack and horse mackerels (***Trachurus***, Carangidae), dragonets (Callionymidae) porcupine fish, horsefish (***Congiopodus***), anchovy, round herring, fish offal (including hake and anchovy heads, with the former apparently scavenged from fishing operations and the latter possibly from squid predation on anchovies), spiny dogfish (***Squalus***), crabs, hermit crabs, shrimps, mantis shrimp, mud shrimp, amphipods, isopods, lobsters, squid, octopus, cuttlefish, and polychaete worms.

Size: Maximum total length 122 cm, but most 100 cm or less. Males adult at 82 cm and reaching at least 102 cm. Females adult at about 75 to 88 cm. Males reach a somewhat larger maximum length than females, 102 cm versus 88 cm, respectively. Size at hatching near 16 to 22 cm (size of smallest free–living individuals).

Interest to Fisheries and Human Impact: Interest to fisheries none, taken occasionally by commercial bottom trawlers off South Africa as discarded bycatch. A handsome species, with slight utilization in the international aquarium trade. Occasionally caught by sports anglers in ski boats.

Conservation status is listed as Near Threatened, but demographic studies have shown its population to be increasing.

Local Names: Yellowspotted catshark, Spotted lazyshark or Lazy shark, Dogfish, White–spotted dog–fish, Geelspikkel–kathaai.

Literature: Fowler (1941); Smith (1949); Bass, D'Aubrey and Kistnasamy (1975a); Springer (1979); Compagno (1984b, 1988); Compagno, Ebert and Smale (1989); Compagno, Ebert and Cowley (1991); Ebert, Cowley and Compagno (1996); Compagno, Krose and Brash (2004); Ebert, Compagno and Cowley (2006); Ebert (In preparation).

2.8.2 Family PROSCYLLIIDAE

Family: Subfamily Proscylliinae Fowler, 1941 (Family Scyliorhinidae), *Bull. U.S. Nat. Mus.*, (100), 13: 25.

Type genus: ***Proscyllium*** Engelhardt, 1912.

Synonyms: None.

Number of Recognized Deep–sea Indian Ocean Genera: 2.

FAO Names: En – Finback catsharks; **Fr** – Requins chat; **Sp** – Tollos coludos.

Field Marks: Elongated, catlike eyes with nictitating eyelids, nostrils without barbels or nasoral grooves, mouth long and angular, arched and reaching past anterior ends of eyes, labial furrows very short or absent, small cuspidate teeth, two small, spineless dorsal fins and an anal fin, the first dorsal–fin base well ahead of pelvic–fin bases, no precaudal pits, and the caudal fin without a strong ventral lobe or lateral undulations on its dorsal margin.

Diagnostic Features: Head narrowly rounded in dorsoventral view, without laterally expanded blades. Eyes elongated and fusiform, oval, or slit–like, with lengths over 2 times height. Eyes without deep groove in front; nictitating eyelids rudimentary, with horizontal edges. Spiracles present, conspicuous, moderately large. Anterior nasal flaps broadly angular, not barbel–like. Internarial width about 0.5 to 1.9 times nostril width. Oral papillae and gill rakers present in mouth. Labial furrows absent or very short. Teeth small, with acute narrow cusps, often lateral cusplets, and strong basal ledges and grooves, not bladelike and similar in both jaws; posterior teeth comblike; tooth rows 46 to 86 upper jaw, 49 to 88 lower jaw. Precaudal pits absent. Pectoral fins with radials confined to bases of fins. First dorsal fin small and not keel–like, much shorter than caudal fin; first dorsal–fin base well ahead of pelvic–fin bases, but usually closer to pelvic–fin bases than pectoral fins; midpoint of first dorsal–fin base always in front of pelvic–fin origins. Ventral caudal–fin lobe absent or very weak; no undulations or ripples in dorsal caudal–fin margin. Vertebral counts: total vertebral counts 113 to 168. Valvular intestine with a spiral valve of 6 to 10 turns. **Colour:** some species with variegated colour patterns, others without them.

Distribution: This is a small family of poorly known deepwater sharks with a disjunct distribution in mostly tropical waters of the western North Atlantic and Indo–West Pacific.

Habitat: The species live on the outer continental and insular shelves and upper slopes on or near the bottom, at depths of 50 to 766 m.

Biology: These are small to dwarf sharks, with adults at 15 to 65 cm total length; one species, ***Eridacnis radcliffei*** is among the smallest of living sharks. Most of the species are viviparous with a yolk sac, except for the oviparous ***Proscyllium*** species. Food of these harmless sharks consists of small fishes and invertebrates.

Interest to Fisheries and Human Impact: Minimal, a few species are taken by commercial bottom trawlers, but the small size of these sharks makes them unsuitable for fisheries utilization other than for fishmeal. They may in some areas be subject to bycatch especially where intensive bottom trawl fisheries for bony fishes and crustaceans occurs.

Conservation status is mostly Least Concern or Data Deficient as these small–sized, dwarf sharks although poorly known biologically as largely too small to be of interest to targeted fisheries.

Local Names: Finback catsharks.

Remarks: The family is comprised of three genera and six species, all of which are poorly known biologically. The genus ***Proscyllium*** is comprised of shelf species, but the genera ***Ctenacis*** and ***Eridacnis*** inhabit mostly the outer continental shelf and upper continental slope.

List of Deep–sea Species Occurring in the Area:

Ctenacis fehlmanni (Springer, 1968)
Eridacnis radcliffei Smith, 1913
Eridacnis sinuans (Smith, 1957)

Key to Deep–sea Indian Ocean Genera:

1a. Caudal fin narrow and ribbon–like. No colour pattern except vertical barring on caudal fin (Fig. 252) . . . . ***Eridacnis***

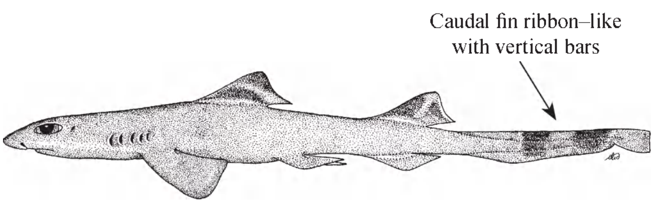


Fig. 252 *Eridacnis*

1b. Caudal fin broad and not ribbonlike. A colour pattern of spots, saddles and bars present on body and fins (Fig. 253) . . . . ***Ctenacis***

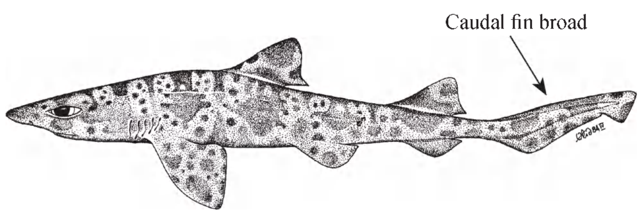


Fig. 253 *Ctenacis*

Ctenacis Compagno, 1973

Genus: *Ctenacis* Compagno, 1973b, *Proc. California Acad. Sci., ser.* 4, 39(14): 258.

Type species: *Triakis fehlmanni* Springer, 1968, by original designation.

Number of Recognized Deep–sea Indian Ocean Species: 1.

Synonyms: None.

Field Marks: See the single species.

Diagnostic Features: Body rather stocky. Head and snout not bell–shaped in dorsoventral view. Preoral snout length about 2/3 of mouth width. Anterior nasal flaps small, with rear edges well in front of mouth; internarial space 1.2 times nostril width. Inside of mouth and edges of gill bars with papillae. Total tooth counts upper jaw 86, lower jaw 88. First dorsal–fin origin slightly anterior to free rear tips of pectoral fins, base closer to pelvic–fin bases than pectoral–fin bases. Anal–fin origin slightly posterior to second dorsal–fin origin. Caudal fin broader, not tape–like, and shorter, dorsal margin about 23% of total length. Spiral valve turns 10. Total vertebral count 136. A small species with a maximum total length of 52 cm. **Colour:** a unique pattern of large, reddish–brown, irregular dorsal saddle blotches on body, interspersed with smaller round spots and vertical bars, as well as spots on fins.

Ctenacis fehlmanni (Springer, 1968)

Triakis fehlmanni Springer, 1968, *Proc. Biol. Soc. Washington*, 81: 614, figs. 1–4. Holotype, U. S. National Museum of National History, USNM 202969, 46 cm (451 mm) TL, adult female, type locality, 11° 24'N, 51° 35'E, southwest of Cape Guardafui, Somalia, 70–170 m depth. Status of holotype confirmed by Howe and Springer (1993, *Smiths. Contr. Zool.* [540]: 7).

Synonyms: None.

Other Combinations: None.

FAO Names: En – Harlequin catshark; **Fr –** Requin chat arlequin; **Sp –** Tollo coludo arlequín.

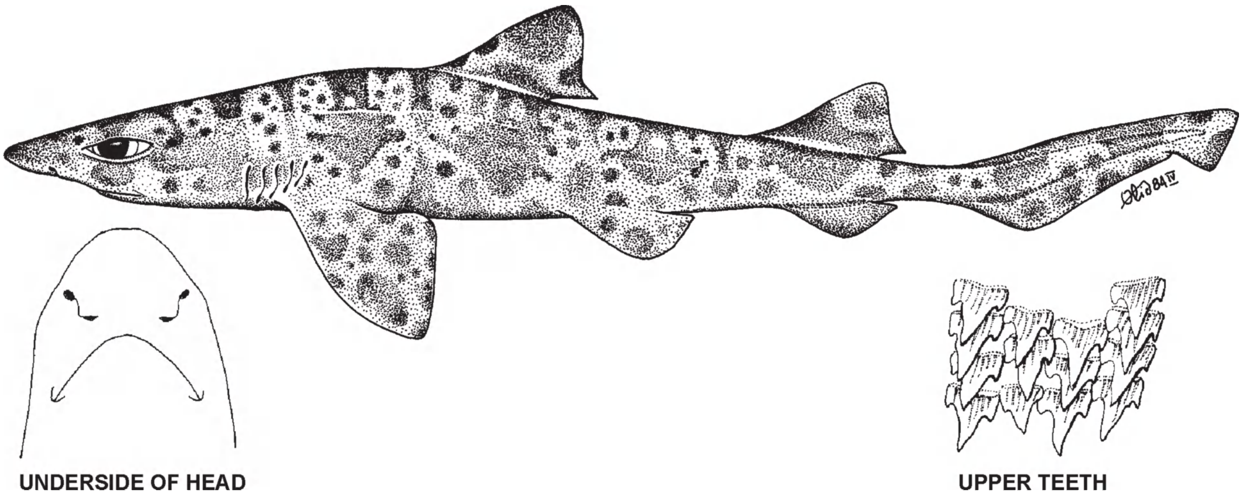


Fig. 254 ***Ctenacis fehlmanni***

Field Marks: The reddish–brown blotched, spotted and barred colour pattern of this shark is unique; also, an anal fin and two equal–sized, spineless dorsal fins, the first over abdomen slightly closer to pelvic fins than pectoral fins, nictitating eyelids, a triangular mouth, very short labial furrows, comblike posterior teeth, short anterior nasal flaps that do not reach mouth, and a stout body and tail.

Diagnostic Features: See genus.

Distribution: Northwestern Indian Ocean: off Somalia and Oman.

Habitat: A poorly known tropical bottom shark from the outer continental shelf off Somalia, known only from the holotype collected during the International Indian Ocean Expedition and from additional specimens collected by Russian research vessels, and from five additional specimens collected off Oman at a depth of over 300 m.

Biology: Mode of reproduction viviparous, with a yolk sac, but little else is known about these sharks; one adult female was found to have a single mid–term developing embryo. An unidentified crustacean was found in the stomach of the holotype, and the describer of this species (S. Springer) speculated that its large mouth, small teeth, and large pharynx with gill raker papillae might allow it to feed on very small invertebrates.

Size: Maximum total length 52 cm (adult female). Females mature at about 44 cm, immature at 37 cm; male size at maturity unknown. Size at birth uncertain, but the smallest free–swimming individual measured 17 cm.

Interest to Fisheries and Human Impact: Interest to fisheries none at present.

The conservations status of this poorly known proscyllid is Data Deficient.

Local Names: None.

Remarks: The species is known from only about six specimens. The holotype, an adult female, had long been the only known specimen, but recently Henderson and Reeve (2011) reported on an additional five specimens from off Oman.

Literature: Springer (1968); Compagno (1973b, 1984b, 1988); Bass, D'Aubrey and Kistnasamy (1975a); Compagno, Dando and Fowler (2005); Cronin (2009); Henderson and Reeve (2011).

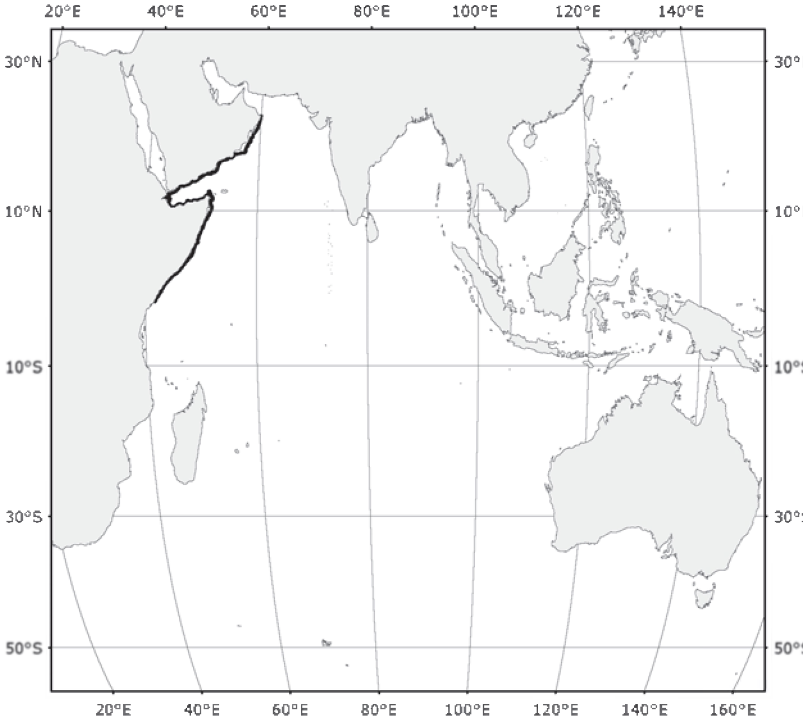


Fig. 255 ***Ctenacis fehlmanni***

Known distribution

Eridacnis Smith, 1913

Genus: ***Eridacnis*** Smith, 1913, *Proc. U.S. Nat. Mus*. 45(2003): 599.

Type species: ***Eridacnis radcliffei*** Smith, 1913, by original designation.

Number of Recognized Deep–sea Indian Ocean Species: 2.

Synonyms: Genus ***Neotriakis*** Smith, 1957, *S. African J. Sci*. 53(10): 262. Type species: ***Neotriakis sinuans*** Smith, 1957, by original designation.

Field Marks: Small, slender bodied sharks, with a narrow, moderately long head, small anterior nasal flaps, with edges falling well anterior to upper symphysis, labial furrows extremely short to vestigial or absent, pectoral fins with straight or convex posterior margins, colour light grey to brown or reddish brown, with distinctive bands on the caudal fin.

Diagnostic Features: Body rather slender. Head and snout not bell–shaped in dorsoventral view. Preoral snout length subequal to about 2/3 of mouth width. Anterior nasal flaps small, with rear edges well in front of mouth; internarial space 0.7 to 1.3 times nostril width. Inside of mouth and edges of gill bars with papillae. Teeth exhibit sexual heterodonty; males have slightly larger, lanceolate teeth. Total tooth counts 55 to 78 upper jaw, 63 to 77 lower jaw. First dorsal–fin origin varying from well anterior to slightly posterior to free rear tips of pectoral fins, base closer to pelvic–fin bases than pectoral–fin bases. Anal–fin origin slightly anterior, under, or slightly posterior to second dorsal–fin origin. Caudal fin very narrow, tape–like, and long, dorsal margin 25 to 30% of total length. Vertebral counts: total vertebral counts 113 to 144. Spiral valve counts 6 to 8. These are among some of the smallest known shark species with a maximum total length of 37 cm. **Colour:** no pattern or other markings except vertical barring on caudal fin.

Local Names: Ribbontail catsharks.

Remarks: Treatment of this genus follows Compagno (1970, 1984b, 1988). Members of this genus had been previously placed in four genera, ***Eridacnis*** (for ***E. radcliffei***), ***Neotriakis*** (for ***E. sinuans***), ***Proscyllium*** (for ***P. alcocki***, a synonym of ***E. radcliffei***), and ***Triakis*** (for ***T. barbouri***) by various writers.

Three species are recognized for this genus, two of which occur in the Indian Ocean.

Key to Deep–sea Indian Ocean Species:

1a. Preoral snout less than 1.5 times mouth length (Fig. 256). Lateral dermal denticles narrow and with narrow, long cusps. . . . . ***Eridacnis radcliffei***

1b. Preoral snout over twice mouth length (Fig. 257). Lateral dermal denticles broad and with short, wide cusps . . . . ***Eridacnis sinuans***

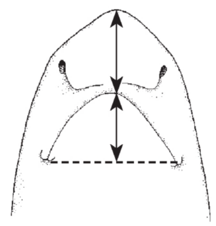


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Fig. 256 ***Eridacnis radcliffei***

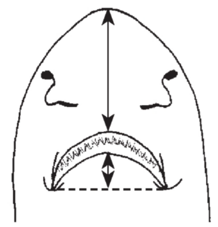

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Fig. 257 ***Eridacnis sinuans***

Eridacnis radcliffei Smith, 1913

Eridacnis radcliffei Smith, 1913, *Proc. U. S. Nat. Mus.*, 45(2003): 599, figs. 1–3. Holotype: U.S. National Museum of Natural History, USNM–74604, 230 mm TL adult (pregnant) female, 6°11.8'N, 121° 08.3'E, off Jolo Light, Jolo Is., Sulu Archipelago, Philippine Islands, 295 m. Status of holotype from Howe and Springer (1993, *Smiths. Contr. Zool.*, 540: 12).

Synonyms: ***Proscyllium alcocki*** Misra, 1950, *J. Zool. Soc. India*, 2: 87, fig. Holotype: Zoological Survey of India, Calcutta, ZSI F 229/1, 208 mm adult male, 13°17'15"N, 93°15'E, Andaman Sea, Bay of Bengal, 339 m. Status of holotype confirmed by examination of specimen (see Compagno, 1984b, 1988).

Other Combinations: None.

FAO Names: En – Pygmy ribbontail catshark; **Fr –** Requin chat pygmée; **Sp –** Tollo coludo pigmeo.

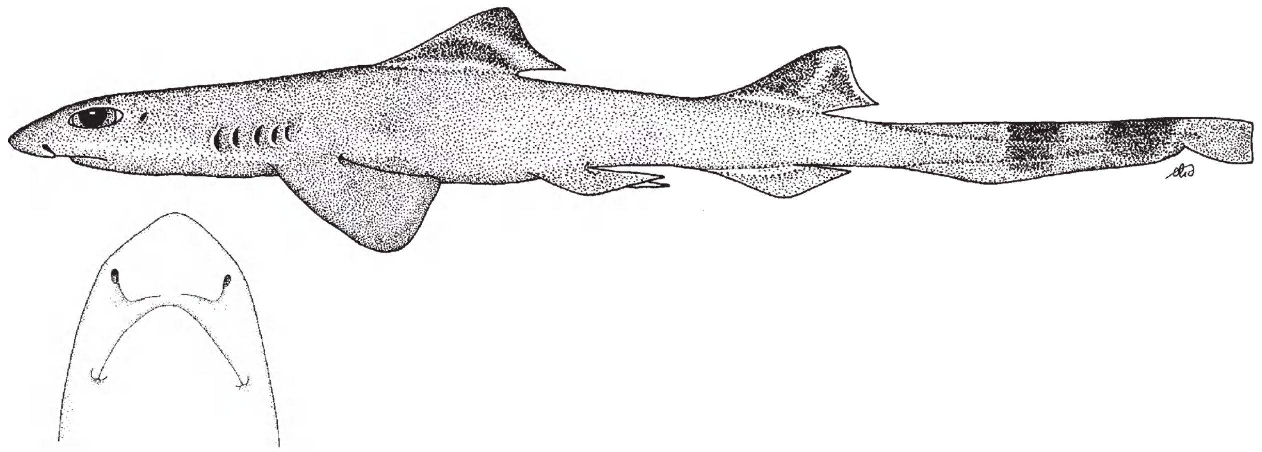

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Fig. 258 ***Eridacnis radcliffei***

Field Marks: One of the smallest living sharks, not exceeding 24 cm, with an anal fin and two equal–sized, spineless dorsal fins, first dorsal fin over abdomen and slightly closer to pelvic fins than pectoral fins, preoral snout less than 1.5 times mouth length, nictitating eyelids, a triangular mouth, labial furrows rudimentary or absent, comblike posterior teeth, short anterior nasal flaps that do not reach mouth, no nasoral grooves or barbels, a long, narrow, ribbon–like caudal fin with prominent dark banding, and brown coloration.

Diagnostic Features: Preoral snout less than 1.5 times mouth length. Labial furrows rudimentary or absent. Lateral trunk denticles narrow–crowned and with long, narrow cusps. Total tooth counts upper jaw 72 to 78, lower jaw 65 to 77. Dorsal fins fairly large and high, with anterior margin of first dorsal fin at a low angle to body axis. Anal–fin height less than half dorsal–fins height. Junction of preventral and postventral caudal–fin margins broadly rounded. Total vertebral counts 113 to 130. Spiral valve counts 6 to 8. One of the smallest known sharks with a maximum total length of 24 cm. **Colour**: brown, with prominent dark banding on tail and dark markings on dorsal fins.

Distribution: Wide–ranging in the Indo–West Pacific, but with spotty records from Tanzania, the Gulf of Aden, India (Gulf of Mannar and Bay of Bengal), the Andaman Islands, Vietnam, the Philippine Islands, and Taiwan (Province of China). The pigmy ribbontail catshark is common in some areas where it occurs (particularly southern India and the Philippine Islands). The immense range of this species is striking compared to the limited ranges of other members of the genus ***Eridacnis***; it is possible that more than one species referred to as ***E. radcliffei*** may occur.

Habitat: A deepwater tropical benthic shark that often occurs on mud bottoms, on the upper continental and insular slopes and the outer shelves at depths from 71 to 766 m.

Biology: Viviparous with a yolk sac, number of young 1 or 2 per litter. Fetuses resorb their yolk sacs and are ready for birth at about 10.1 to 10.7 cm length. This shark is extraordinary in the great size of full–term young compared to their mothers, and the small size of females at maturity. Examination of females in Indian waters show that these may become pregnant at 16.6 cm length or less (large eggs appear at about 15.0 cm). It is possible that females grow considerably while pregnant, as only the larger females above 18.0 cm have large, near or full–term young, while small females below 17.0 cm only have embryos in earlier stages.

This shark feeds primarily on small bony fishes and crustaceans, with squid a lesser component of its diet. In the stomachs of over 300 specimens from Indian waters, bony fishes, particularly lanternfishes but also bristlemouths (Gonostomatidae), small eels and digested fish remains formed about 55% of this shark's diet by volume; crustaceans, primarily deepwater shrimp but also stomatopods and crab larvae occurred at 28% by volume; squid occurred at about 14% by volume, but few other items were recorded (bivalves in one stomach).

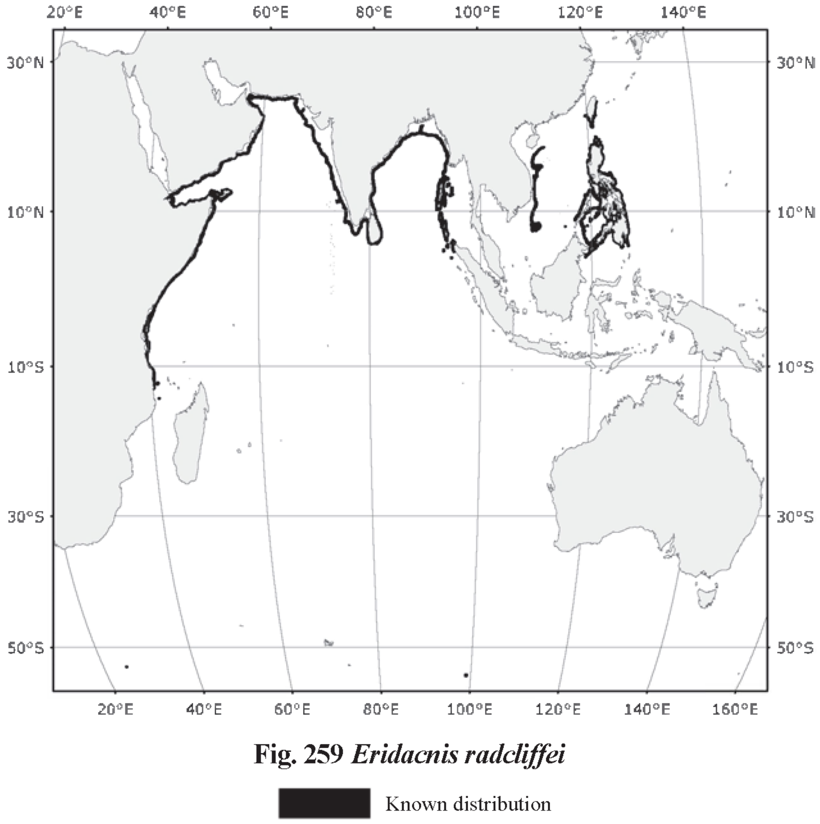


Fig. 259 ***Eridacnis radcliffei***

Size: Maximum total length 24 cm; males mature at 18 to 19 cm or less and reach 23 cm; females mature at about 15 to 16 cm and reach 24 cm. Size at birth about 11 cm.

This is one of the smallest living sharks known at present, and is only rivaled in size by dwarf squaloids, including a few species of ***Etmopterus*** (Etmopteridae) and the dalatiids ***Squaliolus*** and ***Euprotomicrus***.

Interest to Fisheries and Human Impact: Interest to fisheries minimal, taken in commercial bottom trawls in the Philippine Islands, but utilization there is not known.

The conservations status is Least Concern given its small size.

Local Names: None.

Literature: Smith (1913); Norman (1939); Fowler (1941); Misra (1950); Bessednov (1969); Compagno (1970, 1984b, 1988); Nair and Appukuttan (1973, 1974); Nair and Lal Mohan (1973); McCormack *et al.* (2009); Ebert (In preparation).

2.8.3 Family PSEUDOTRIAKIDAE

Family: Subfamily Pseudotriacinae Gill, 1893, *Natn. Acad. Sci.* USA, Mem. 6, 6: 130 (Family Scylliorhinidae). Emended and raised in rank as the family Pseudotriakidae by Jordan and Evermann, 1896, *Bull. U.S. Nat. Mus.* (47), 1: 26.

Type Genus: ***Pseudotriakis*** Capello, 1867, *J. Sci. Math. Phys. Nat. Lisboa, ser.* 2, (4): 321.

Number of Recognized Deep–sea Indian Ocean Genera: 2.

Synonyms: Subfamily Golluminae Compagno, 1988, *Sharks Order Carcharhiniformes*: 192 (Family Proscylliidae). Type genus: ***Gollum*** Compagno, 1973b.

FAO Names: En – False catsharks; **Fr** – Requins à longue dorsale; **Sp** – Musolones.

Field Marks: A distinctive group of small to large sharks with a narrowly rounded head and a more or less elongated bell–shaped snout, a deep groove anterior to elongated, slit–like eyes, very large spiracles, first dorsal fin more or less elongated, with the base closer to the pectoral fins than the pelvic–fin bases, no precaudal pits, a weak or absent ventral lobe on the caudal fin, colour usually plain brown, grey, or black with no distinct markings.

Diagnostic Features: Head narrowly rounded with a more or less elongated bell–shaped snout, a deep groove in front of elongated, slit–like eyes; nictitating eyelids rudimentary. Spiracles very large. Anterior nasal flaps broadly angular, not barbel–like. Internarial space over 1.5 times nostril width. Mouth long, angularly arched, and extending posteriorly to eyes, papillae distinctly present or absent inside mouth and none on edges of gill arches. Labial furrows very short. Teeth small, with acute narrow cusps, lateral cusplets, and strong basal ledges and grooves, not bladelike and similar in both jaws; posterior teeth comblike; tooth rows very numerous, upper jaw 94 to 294, lower jaw 81 to 335. Pectoral fins with radials confined to bases of fins. First dorsal fin more or less elongated, base closer to pectoral–fin bases than to pelvic–fin bases. Precaudal pits absent. Caudal fin with weak ventral lobe or lobe absent; no undulations or ripples in dorsal caudal–fin margin. Vertebral counts: total vertebral counts 140 to 186, monospondylous vertebral counts 44 to 52, diplospondylous vertebral counts 107 to 115, precaudal vertebral counts 94 to 101. Valvular intestine with a spiral valve of 11 to 17 turns. Small to very large sharks with adults ranging from 65 to about 300 cm in length. **Colour:** plain grey to brown or blackish.

Distribution: Wide ranging, but scattered for the large ***Pseudotriakis***, but the smaller ***Gollum*** and ***Planonasus*** species have more restricted ranges around New Zealand and adjacent waters, the Philippines, and the northwestern Indian Ocean, respectively.

Habitat: Poorly known deepwater sharks of the outer continental and insular shelves and slopes, on or near the bottom from 129 to 1890 m.

Biology: Development is a unique form of oophagy as early in development the embryos are nourished by a yolk sac, but as development proceeds oophagy commences. This is the only family of sharks, other than the lamnoids, to exhibit this reproductive mode. The reproductive mode of the recently described ***Planonasus*** is unknown. Diet consists mostly of fishes, cephalopods, and crustaceans.

Interest to Fisheries and Human Impact: A poorly known group of sharks occasionally captured incidentally by fisheries and in fishery surveys, but likely not impacted much by fishing activity.

The conservation status of these poorly known sharks ranges from Data Deficient to Least Concern.

Local Names: Gollumsharks, Keelbacked catsharks (English).

Remarks: Most writers recognize this family for the false catsharks, ***Pseudotriakis***, but Compagno (1988) proposed that the New Zealand ***Gollum*** shark was the closest living relative of ***Pseudotriakis***, and suggested an alternate scheme that included these two genera in a common taxon (Compagno, Dando and Fowler, 2005). The sharks of this genus exhibit a unique form of oophagy that unites them in this family.

A new genus of Pseudotriakidae was recently described by Weigmann *et al.* (2013) as ***Planonasus*** and was captured in the northern Indian Ocean from the Arabian Sea (off Socotra Island), the Maldives, and off southwestern India on continental and insular slopes down to 1120 m (Compagno, Dando and Fowler, 2005). This new species of pygmy false catshark attains maturity between 49 and 56 cm for males (M. Stehmann, pers. comm.). The reproductive mode of the recently described ***Planonasus*** is unknown as of this writing. It arrangement in this family is based on morphological characters presented by Weigmann *et al.* (2013).

Literature: Compagno (1988); Compagno, Dando and Fowler (2005); Musick and Ellis (2005); Last and Gaudiano (2011); Ebert (2013); K.V. Akhilesh, *pers. comm.*).

List of Deep–sea Species Occurring in the Area:

Planonasus parini Weigmann, Stehmann, and Thiel, 2013
Pseudotriakis microdon de Brito Capello, 1868

Key to Deep–sea Indian Ocean Genera:

1a. First dorsal fin low and keel–like, longer than dorsal caudal–fin margin and much lower than second dorsal fin (Fig. 260) . . . . ***Pseudotriakis***

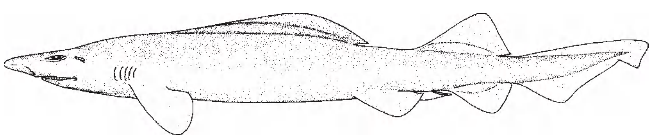


Fig. 260 ***Pseudotriakis microdon***

1b. First dorsal fin not low and keel–like, rather high, about as high as second dorsal fin, and angular, shorter than dorsal caudal–fin margin (Fig. 261) . . . ***Planonasus***

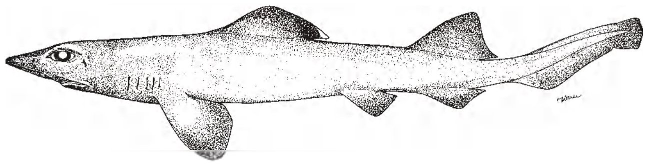


Fig. 261 ***Planonasus parini***

Planonasus Weigmann, Stehmann, and Thiel, 2013

Genus: ***Planonasus*** Weigmann, Stehmann, and Thiel, 2013, *Zootaxa*, 3609 (2): 164.

Type species: ***Planonasus*** Weigmann, Stehmann, and Thiel, 2013 by original designation.

Number of Recognized Deep–sea Indian Ocean Species: 1.

Synonyms: None.

Field Marks: See species account below.

Diagnostic Features: See species account below.

Remarks: This recently described shark genus is closest to the much larger species of the genus ***Pseudotriakis***, although its phylogenetic relationship is unresolved at this time.

Planonasus parini Weigmann, Stehmann, and Thiel, 2013

Planonasus parini Weigmann, Stehmann, and Thiel, 2013, *Zootaxa*, 3609 (2): 166, figs 2 to 20. Holotype (unique): ZMH 25895, female, 534 mm total length, R/V *Vityaz*, cruise 17, station 2565, 12º 22'8"N, 53º 02'2"E to 12º 21'2"N, 53º 01'3"E, off Socotra Islands, 1000 to 1120 m deep, 28 October 1988.

Synonyms: None.

Other Combinations: None.

FAO Names: En – Dwarf false catshark.

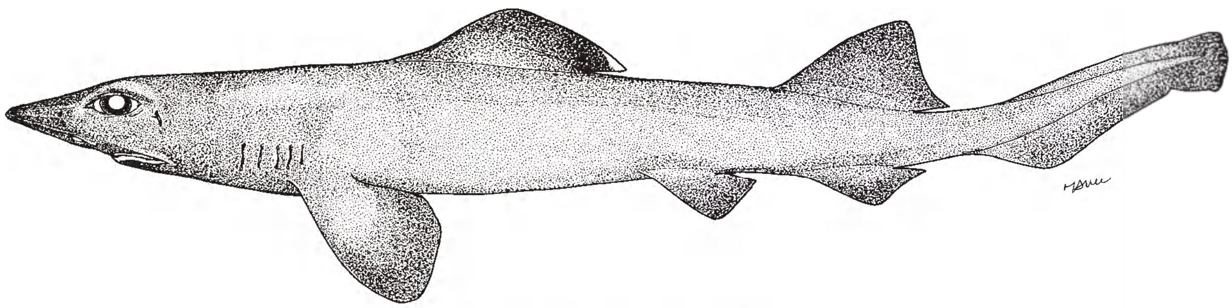


Fig. 262 *Planonasus parini*

Field Marks: A small, rather distinctive shark.

Diagnostic Features: Body soft, stout to rather slender, elongated, with a relatively long head, more than 24% of total length. Snout moderately long, preorbital length 8.3 to 8.5% of total length, bell–shaped and flattened. Eyes moderately long, oval–shaped. Spiracles present, very large. Anterior nasal flaps short; internarial space more than 1.5 times nostril width. Mouth large, angular; labial furrows short, subequal in length; roof of mouth with distinct oral papillae closely set. Teeth dimorphic, very small, numerous, upper jaw with central cusp, flanked by lateral cusplets, lower teeth comb–like; tooth counts about 110 to 115 upper jaw, about 120 lower jaw. First dorsal fin long, low, triangular with narrowly rounded apex; origin about over posterior free–rear tip of pectoral fins. Second dorsal–fin height greater than first dorsal fin, apex narrowly rounded. Interdorsal space without ridge, distance about 1.1 times first dorsal–fin base length. Pectoral fins moderate in size, angular, apices broadly rounded. Pelvic fins narrow, relatively long, anterior margin straight, posterior margin shorter; origin of posterior tips below origin of second dorsal fin. Anal fin long, low, subtriangular; origin slightly posterior to second dorsal–fin origin. Precaudal pits absent. Ventral caudal–fin lobe very weak; no undulations or ripples in dorsal caudal–fin margin. Vertebral counts: total vertebral count about 140, monospondylous vertebral counts 50 to 52, diplospondylous precaudal counts 41, caudal vertebral counts about 24 to 47. Spiral valve turn counts not available. Maximum total length more than 53 cm. **Colour:** uniformly plain dusky greyish–brown with ventral surface of head, lateral flanks, and fin edges darker; first dorsal fin free rear tip with distinct white marking. After preservation colour fades to a plain greyish–brown dorsally, with gill region dusky and ventral head surface darker than the rest of the body.

Distribution: Northwestern Indian Ocean from off Socotra Islands, Maldives and off southwestern India.

Habitat: A little known deep–sea false catshark known only from three specimens caught between 560 and 1120 m deep.

Biology: Reproductive mode is uncertain since the only known specimens were immature.

Size: Maximum total length at least 53.4 cm for an immature female; size at maturity and birth unknown. Known from only three specimens ranging in size from a 33.9 cm immature male to two immature females measuring 37.8 cm and 53.4 cm.

Interest to Fisheries and Human Impact: Of no fisheries interest, although likely taken as bycatch in deep–sea fisheries in the northwestern Indian Ocean.

The conservation status of this species has not been assessed.

Local Names: None.

Remarks: A second species of this recently described genus may occur off the Maldives and India.

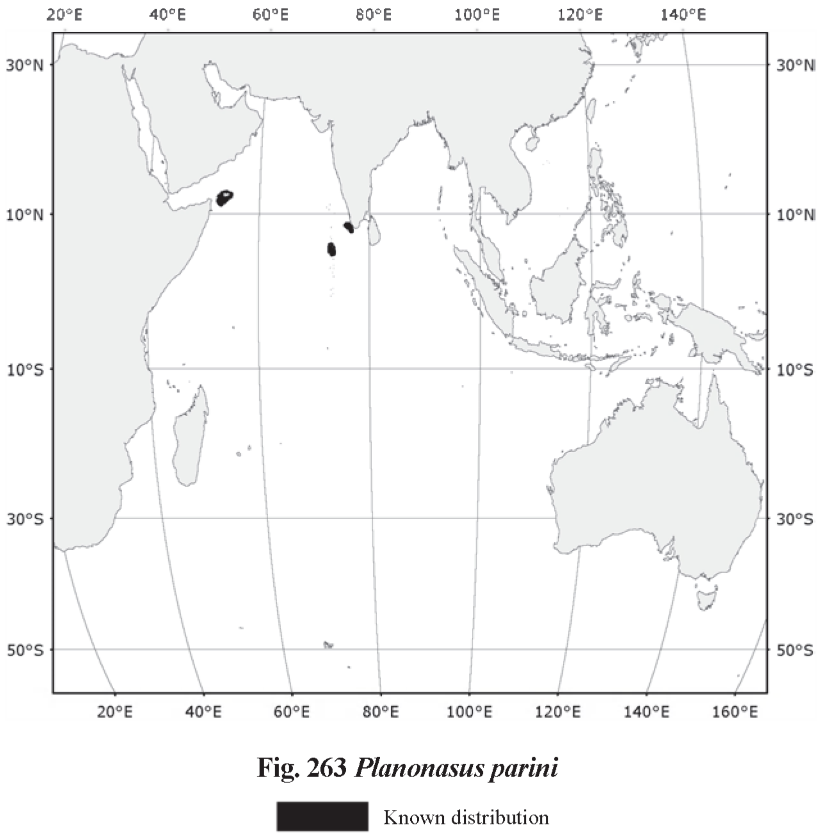


Fig. 263 ***Planonasus parini***

Literature: Compagno, Dando and Fowler (2005); Weigmann, Stehmann and Thiel (2013).

Pseudotriakis de Brito Capello, 1868

Genus: ***Pseudotriakis*** de Brito Capello, 1868, *J. Sci. Math. Phys. Nat. Lisboa*, (2), 1: 321.

Type species: ***Pseudotriakis microdon*** de Brito Capello, 1868, by monotypy.

Number of Recognized Deep–sea Indian Ocean Species: 1.

Synonyms: Genus ***Pseudotriacis*** Günther, 1870, *Cat. Fish. British Mus.* 8: 395. Emended spelling of ***Pseudotriakis*** de Brito Capello, 1868, and therefore taking the same type species, ***P. microdon*** de Brito Capello, 1868.

Field Marks: See species account below.

Diagnostic Features: See species account below.

Remarks: See species account below.

Pseudotriakis microdon de Brito Capello, 1868

Pseudotriakis microdon de Brito Capello, 1868, *J. Sci. Math. Phys. Nat. Lisboa*, (2), 1: 321, pl. 5, fig. 1. Holotype in Museum Bocage, Lisbon, Portugal, 2310 mm adult male, lost in fire that destroyed this museum; collected off Setubal, Portugal.

Synonyms: None.

Other Combinations: None.

FAO Names: En – False catshark; **Fr** – Requin à longue dorsale; **Sp** – Musolón de aleta larga.

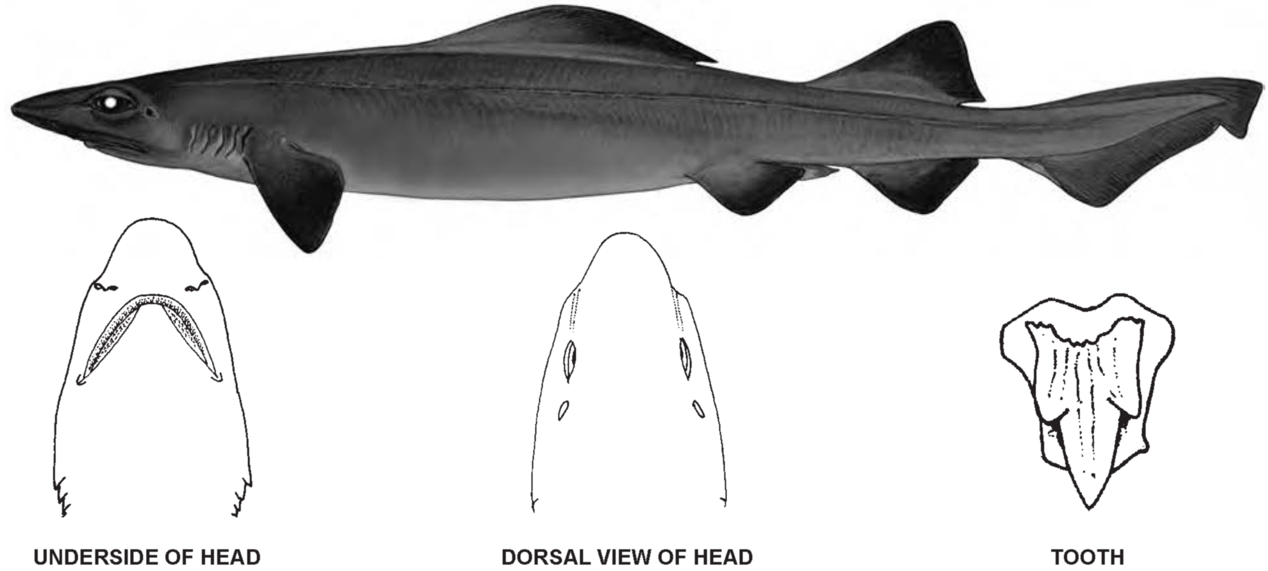


Fig. 264 ***Pseudotriakis microdon***

Field Marks: A large, bulky, dark–brown, soft–bodied shark with elongated, catlike eyes and nictitating eyelids, large spiracles, a huge, wide, angular mouth that reaches behind eyes, very short labial furrows, numerous small cuspidate teeth in 200 or more rows in each jaw, two large spineless dorsal fins and an anal fin, a low, long, keel–like first dorsal fin on back, no precaudal pits, a caudal fin without a strong ventral lobe or lateral undulations on its dorsal margin, colour a uniform dark brown to black without any mottling, spots or other patterns.

Diagnostic Features: Head without laterally expanded blades. Eyes elongated and slit–like, their length over two times the height. Nictitating eyelids are rudimentary. Spiracles are present and very large. Anterior nasal flaps broadly angular, not barbel–like. Internarial width about 2.8 times nostril width. Labial furrows very short. Teeth small, with acute narrow cusps, lateral cusplets, and strong basal ledges and grooves, not bladelike and similar in both jaws; posterior teeth comblike; tooth rows very numerous, upper jaw 202 to 294, lower jaw 258 to 335. Precaudal pits are absent. Pectoral fins with radials confined to bases of fins. First dorsal fin very large, low and formed as a rounded keel, about as long as caudal fin; first dorsal–fin base on back with insertion just opposite pelvic–fin origins and origin about opposite free rear tips of pectoral fins; midpoint of first dorsal–fin base well in front of pelvic–fin origins. Ventral caudal–fin lobe absent or very weak; no undulations or ripples in dorsal caudal–fin margin. Neurocranium with supraorbital crests. Vertebral counts: total vertebral counts 180 to 186. Spiral valve turn count 17. Maximum total length 296 cm. **Colour:** uniform plain dark brown to blackish except for darker fins.

Distribution: Indian Ocean: Madagascar Ridge, southern Indian Ocean, Aldabra Island group, Seychelles, southern Java (Indonesia) and off Cape Leeuwin (Western Australia). Sporadic but wide–ranging in most oceans, except so far not recorded in the South Atlantic or eastern Pacific.

Habitat: A large deepwater bottom shark of the continental and insular slopes at depths from 100 to 1890 m; occasionally wandering onto continental shelves, even in shallow water (possibly abnormally or possibly in situations where submarine canyons extend close to shore). Bottom temperature for one individual capture at 830 m was recorded as 6°C.

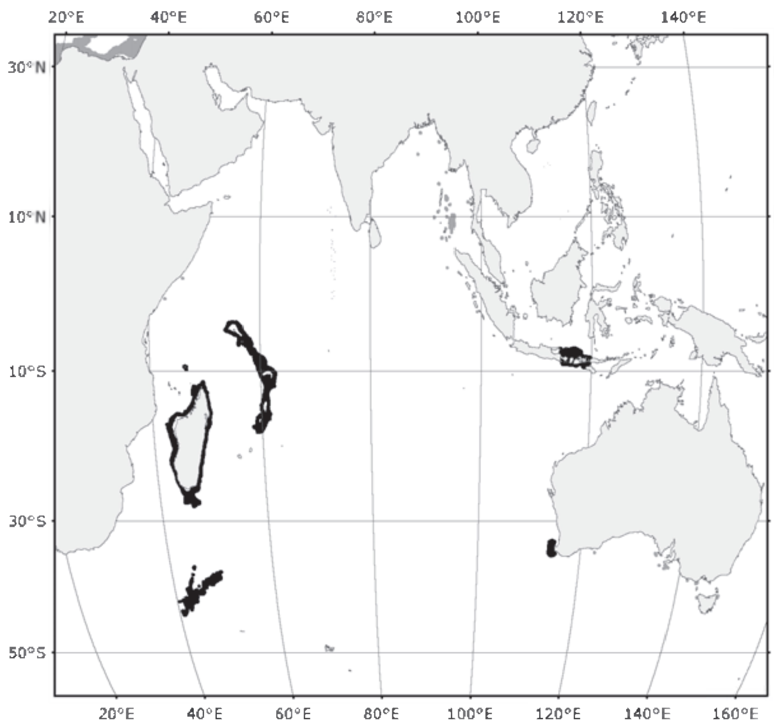


Fig. 265 ***Pseudotriakis microdon***

Known distribution

Biology: Oophagous, with litters of 2, but little else known. The gestation period for this species is unknown, but may last one year or more. Embryos at 8 to 32 cm length have large yolk sacs with abundant yolk, but the considerably larger size attained by term fetuses, the small litter size of this shark, and the immense number of eggs produced by adult females (estimated at 20,000 in one ovary for a 280 cm adult female) led Forster *et al.* (1970) to suggest that this shark may exhibit oophagy or uterine cannibalism as in lamnoid sharks. This hypothesis subsequently was proven correct making it the only non–lamnoid family of sharks to exhibit this reproductive mode.

Feeding habits little known, although it was once photographed in deep water eating a bony fish used as bait on the camera. It has also been photographed from a submersible poking its nose into a trap and eating prawns in its entrance. Probably feeds on a variety of deepwater bony fishes, elasmobranchs and invertebrates. Its teeth are small but sharp cusped, and its mouth is very large, which may allow prey organisms of considerable size to be ingested. Seemingly uncommon or rare wherever it occurs. The large body cavity, soft fins, and soft skin and musculature of this shark suggest that it is relatively inactive and sluggish, and can hover off the bottom at virtually neutral buoyancy.

Size: Maximum total length 296 cm; adult males reported at about 260 cm; adult females at about 265 cm. Size at birth variably between 70 and 85 cm; smallest free–swimming specimen measured 96 cm.

Interest to Fisheries and Human Impact: Interest to fisheries none since it is only taken incidentally by bottom fisheries usually operating at depths below 600 m. Utilization not reported.

The conservation status is Data Deficient due to its rarity, scattered distribution, and a lack of biological and population data.

Local Names: False cat shark, Atlantic false cat shark, Keel–dorsal shark (English).

Remarks: Two species of ***Pseudotriakis*** have been recognized, the Atlantic ***P. microdon*** de Brito Capello, 1868 and the Pacific ***P. acrales*** Jordan and Snyder, 1904, but a detailed comparison by Yano and Musick (1992) confirmed this appears to be a single wide–ranging species. Examination of the holotype of ***P. acrages*** (Stanford University, SU 12903, 1765 mm immature male, from Suruga Gulf, Japan) and comparison of specimens of ***Pseudotriakis*** from the North Sea and from the Hawaiian Islands (Compagno, 1988) revealed no reliable characters to separate Atlantic and Pacific ***Pseudotriakis***, although it was initially thought that the Atlantic species might have a longer snout. The morphological criteria that Jordan and Snyder (1904) and Bigelow and Schroeder (1948) proposed to separate these species do not hold based on the available data at this time. However, recent molecular studies (G.J.P. Naylor, pers. comm.) reveal significant genetic differences between the Atlantic and Pacific populations.

Literature: Capello (1868); Günther (1870); Bean (1883); Goode and Bean (1895); Jordan and Evermann (1896); Garman (1913); Bigelow and Schroeder (1948); Forster *et al.* (1970); Compagno (1984b, 1988); Yano (1992); Yano and Musick (1992); Kyne, Kazunari Yano and White (2004); Last and Stevens (2009); Ebert and Stehmann (2013); P.J. Clerkin (pers. comm.); G.J.P. Naylor (pers. comm.).

2.8.4 Family TRIAKIDAE

Family: Tribe Triakiana Gray, 1851 (Family Squalidae), *List Fish British Mus*., Pt. 1, Chondropterygii: 108.

Type genus: ***Triakis*** Müller and Henle, 1838.

Number of Recognized Deep–sea Indian Ocean Genera: 2.

Synonyms: Subfamily Musteli Bonaparte, 1838 (Family Squalidae), *Nuov. Ann. Sci. Nat., Bologna*, ser. 1, 2: 199. Type genus: ***Mustelus*** Cuvier, 1816, equals ***Mustelus*** Linck, 1790). Preoccupied by the mammalian families Mustelini Fischer, 1817, and Mustelidae Swainson, 1835 (Type genus: ***Mustela*** Linnaeus, 1758). Family Galei Müller and Henle, 1839, p. 57 (Type genus: ***Galeus*** Cuvier, 1816, equals ***Galeorhinus*** Blainville, 1816, not ***Galeus*** Rafinesque, 1809). Family Scylliodontes Müller and Henle, 1839, *Syst. Beschr. Plagiost*., pt. 2: 63 (Not based on a type genus and including only ***Triakis*** Müller and Henle, 1838). Family Galeorhinoidae Gill, 1862, *Ann. Lyceum Nat. Hist. New York*, 7(32): 393. Type genus: ***Galeorhinus*** Blainville, 1816. Family and subfamily Mustelus Hasse, 1879, *Nat. Syst. Elasmobr*. (1): 55, tab. 2. Type genus: ***Mustelus*** Linck, 1790. Subfamily Triacis (Family Mustelus) Hasse, 1879, *Nat. Syst. Elasmobr*. (1): tab. 2. Type genus: ***Triacis*** Gill, 1862. Subfamily Galeus (Family Hemigaleus) Hasse, 1879, *Nat. Syst. Elasmobr*. (1): tab. 2. Type genus: ***Galeus*** Cuvier, 1816. Family Triakidae White, 1936, *Amer. Mus. Novit*. (837): 4. Type genus: ***Triakis*** Müller and Henle, 1838. Family Scylliogaleidae Whitley, 1940, *Fish. Australia* (1): 68. Type genus: ***Scylliogaleus*** Boulenger, 1902. Family Emissolidae Whitley, 1940, *Fish. Australia* (1): 68. Type genus: ***Emissola*** Jarocki, 1822, a junior synonym of ***Mustelus*** Linck, 1790. Family Scylliogaleidae Smith, 1957, *S. Afr. J. Sci*. 53: 353. Type genus: ***Scylliogaleus*** Boulenger, 1902. Apparently proposed independently of Scylliogaleidae Whitley, 1940. Family Eugaleidae Gurr, 1962, *Proc. Geologists' Ass*. (London), 73: 428. Type genus: "***Eugaleus*** Rafinesque, 1810", equals ***Eugaleus*** Gill, 1863, not of Rafinesque, 1810. Tribe Iagini Compagno, 1973a (Family Triakidae), *Zool. J. Linn. Soc., Supp*. 1, 53: 28. Type genus: ***Iago*** Compagno and Springer, 1971.

FAO Names: En – Houndsharks, Smooth–hounds; **Fr** – Émissoles, Requins–hâ; **Sp** – Cazones, Tollos.

Field Marks: Small to moderate–sized sharks with horizontally oval eyes, nictitating eyelids, no nasoral grooves, anterior nasal flaps usually not barbel–like (except in ***Furgaleus***), a long, angular or arched mouth that reaches past anterior ends of eyes, moderate to very long labial furrows, small to moderately large molariform, bladelike or cuspidate teeth, two moderate to large–sized, spineless dorsal fins and an anal fin, the first dorsal–fin base well ahead of pelvic–fin bases, no precaudal pits, and caudal fin without a strong ventral lobe or lateral undulations on its dorsal margin.

Diagnostic Features: Head without laterally expanded blades. Eyes elongated and fusiform, horizontally oval, or slitlike, with lengths over 1.5 to 2.5 times height. Nictitating eyelids external, transitional or internal. Spiracles present and small to moderately large. Anterior nasal flaps varying from elongated to lobular to vestigial, barbel–like in one genus (***Furgaleus***). Internarial width about 0.5 to 3.0 times nostril width. Labial furrows moderately long to very long. Teeth small to moderately large, with acute and narrow to moderately large cusps and lateral cusplets in some species, but with these structures reduced or absent in others; teeth with strong basal ledges and grooves; teeth cuspidate and not bladelike, compressed and bladelike, or thickened and molariform; usually similar in both jaws but differentiated in a few species; posterior teeth not comblike; tooth rows 18 to 42 upper jaw, 27 to 106 lower jaw. Precaudal pits absent. Pectoral fins with radials confined to bases of fins. First dorsal fin moderately large to very large but not keel–like, usually much shorter than caudal fin (except in the genus ***Gogolia***); first dorsal–fin base well ahead of pelvic–fin bases, usually closer to pectoral–fin bases than pelvic fins but sometimes slightly closer to pelvic fins; midpoint of first dorsal–fin base always in front of pelvic–fin origins. Ventral caudal–fin lobe varying from absent to well–developed; no undulations or ripples in dorsal caudal–fin margin. Vertebral counts: total vertebral counts 120 to 193, monospondylous vertebral counts 25 to 52, diplospondylous precaudal vertebral counts 28 to 61, precaudal vertebral counts 65 to 131. Valvular intestine with a spiral valve of 4 to 11 turns. A few houndsharks may reach almost 200 cm total length, but most are smaller. **Colour:** some species with variegated colour patterns, others without them.

Distribution: This is one of the larger families of sharks, with many species found in all warm and temperate coastal seas.

Habitat: Most species occur on the continental and insular waters from the shoreline and intertidal to the outermost shelf, often close to the bottom, but a few deepwater species range down the continental slopes to considerable depths, possibly to over 2000 m (***Iago omanensis***). None of the species are coral reef specialists or are oceanic, but many are found in sandy, muddy and rocky inshore habitats, including enclosed bays. Although a few species have been recorded from up river mouths, none can apparently tolerate fresh water for extended periods.

Biology: Houndsharks are variably viviparous with a yolk sac or placental viviparity without a yolk sac, and with litters of young ranging from 1 or 2 to 52. Some species are relatively fast growing, maturing within 2 to 3 years while others may take more than 10 years to mature. The longevity for this shark group is also variable with some ***Mustelus*** species living only 5 to 9 years and one species (***Galeorhinus galeus***) perhaps living up to 60 years. A few houndsharks may reach almost 200 cm in length, but most are smaller and some mature at about 35 cm.

Houndsharks feed primarily on bottom and midwater invertebrates and bony fishes, with some species taking largely crustaceans, some mainly fishes, and a few primarily cephalopods; none eat mammalian meat or garbage to any extent. They feed on a wide variety of small to medium–sized bony fishes (both demersal and pelagic) and fish eggs, small sharks (including batoids), chimaeroids, crustaceans (including brachyurid crabs, hermit crabs, lobsters, slipper lobsters, mantis shrimp, ghost shrimp, shrimps and prawns, and isopods), king crabs, gastropods, bivalves (whole bivalves and their siphons), cephalopods (squids and octopi), tunicates, cephalochordates, polychaete worms, echiuroid worms, sipunculoid worms, holothurians, coelenterates, and rarely garbage.

These are fairly strong swimmers with most species occurring in small to large schools or singly. Some are very active species, like the tope shark (***Galeorhinus***) may swim more or less continuously, but species of ***Mustelus*** and ***Triakis*** can rest on the bottom; some species are more active at night than the day.

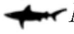
Interest to Fisheries and Human Impact: Genera of especial importance to fisheries include the temperate–water ***Galeorhinus*** (tope, soupfin, school, and vitamin sharks) and the temperate to tropical ***Mustelus*** (smoothhounds and gummy sharks), but members of the genera ***Triakis***, ***Hemitriakis***, ***Furgaleus***, and ***Iago*** are also taken to some extent. All of these sharks are fairly common to very abundant in coastal waters where they occur, are relatively small, and hence are very important to small commercial and artisanal fisheries that are limited in gear and movement, as well as to sports fisheries. These sharks are caught with line gear, bottom and floating gillnets, set bottom nets, bottom trawls, and sports fishing gear. They are primarily utilized for their meat, but also for liver oil, for processing into fishmeal, and for shark–fin soup base. None of the species are dangerous to people.

The conservation status of many species in this family is listed as Least Concern or Data Deficient, but some species are considered Near Threatened or Vulnerable.

Local Names: Houndsharks, Little nurse sharks, Smooth hounds, Smooth dogfishes, Gummy sharks.

Remarks: The arrangement of this family follows the revisions of Compagno (1970, 1973a, 1984b, 1988).

List of Deep–sea Species Occurring in the Area:

Iago garricki Fourmanoir and Rivaton, 1979
 ***Iago omanensis*** (Norman, 1939)
 ***Mustelus stevensi*** White and Last, 2008

Key to Deep–sea Indian Ocean Genera:

1a. Eyes lateral, sub–ocular ridges obsolete. Origin of first dorsal fin far anterior, over pectoral–fin bases (Fig. 266). . . . . ***Iago***

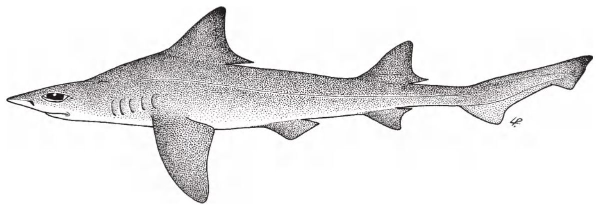


Fig. 266 ***Iago***

1b. Eyes dorsolateral, sub–ocular ridges strong. Origin of first dorsal fin more posterior, over or behind pectoral–fin inner margins (Fig. 267) . . . . . . ***Mustelus***

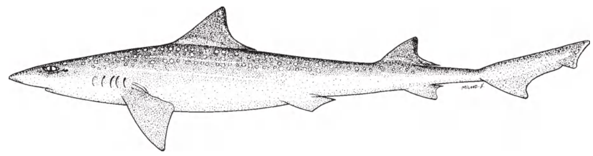


Fig. 267 ***Mustelus***

Iago Compagno and Springer, 1971

Genus: ***Iago*** Compagno and Springer, 1971, *Fish. Bull.* 69: 615.

Type species: ***Eugaleus omanensis*** Norman, 1939, by original designation.

Number of Recognized Deep–sea Indian Ocean Species: 2.

Synonyms: None.

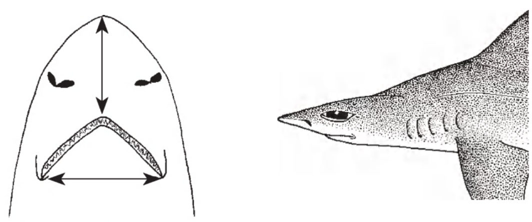
Field Marks: Rather slender houndsharks with lateral eyes and vestigial sub–ocular ridges, angular mouth, first dorsal fin small but with origin far anterior over pectoral–fin bases, second dorsal fin nearly as large as first, and ventral caudal–fin lobe little developed.

Diagnostic Features: Snout moderately long and subangular in dorsoventral view, preoral length 0.7 to 1.4 times mouth width. Eyes horizontally oval and lateral, sub–ocular ridges vestigial. Anterior nasal flaps formed as low, rounded or angular lobes, well separated from each other and mouth; no nasoral grooves. Internarial width about 1.4 to 2.0 times nostril width. Mouth angular and moderately long. Labial furrows moderately long, uppers falling far short or nearly reaching level of upper symphysis. Teeth bladelike, compressed, and cuspidate, hardly differentiated in jaws, anteroposteriors with oblique cusps and cusplets or blades; medial teeth well differentiated from anteroposteriors. First dorsal fin moderately large, base half of dorsal caudal–fin margin or less; origin varying from over pectoral–fin origins to over posteriormost thirds of pectoral–fin bases, midbase closer to pectoral–fin bases than pelvic fins. Second dorsal fin somewhat smaller than first, height 4/5 of first dorsal–fin height or less. Anal fin considerably smaller than second dorsal fin. Ventral caudal–fin lobe hardly developed at all sizes; terminal lobe of caudal fin moderately long and about 2.7 to 3.1 times in dorsal caudal–fin margin. Vertebral counts: total vertebral counts 149 to 160. Small triakids from 58 to 75 cm total length. **Colour:** greyish or brown above, becoming lighter below; dorsal fins with or without conspicuous margins.

Remarks: In addition to ***Iago omanensis*** and ***I. garricki*** there are apparently additional species of ***Iago***, from the Indian Ocean and western Pacific. In the Gulf of Aden and southern India there is a low–finned ***Iago*** that is sympatric with ***I. omanensis*** but readily distinguishable from it, and it may represent a new species. Very small adult male specimens of ***Iago*** from the Bay of Bengal are close to ***I. omanensis*** but may be distinct.

Key to Deep–sea Indian Ocean Species:

1a. Snout rather short, preoral length 0.7 to 0.9 of mouth width (Fig. 268a). Gill region greatly expanded, distance from spiracle to 5th gill slit greater than prespiracular head; width of longest gill slits nearly equal to eye length (Fig. 268b) . . . . . . ***Iago omanensis***



a) UNDERSIDE OF HEAD **b) PARTIAL LATERAL VIEW**

Fig. 268 ***Iago omanensis***

1b. Snout longer, preoral length about 1.1 times mouth width (Fig. 269a). Gill region not greatly expanded, distance from spiracle to 5th gill slit less than prespiracular head; width of longest gill slits much less than eye length (Fig. 269b) . . . . ***Iago garricki***

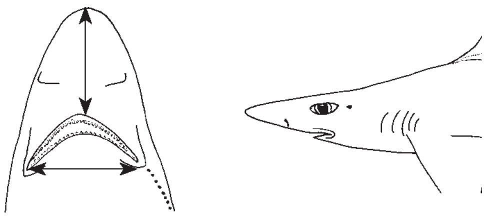


Fig. 269 ***Iago garricki***

Iago omanensis (Norman, 1939)

Eugaleus omanensis Norman, 1939, *John Murray Exped. Sci. Rep.* 7(1): 11, fig. 3. Holotype, British Museum (Natural History), BMNH 1939.5.24.9, 280 mm immature female. Type locality, Gulf of Oman at 210 m depth.

Synonyms: None.

Other Combinations: ***Galeorhinus omanensis*** (Norman, 1939).

FAO Names: En – Bigeye houndshark; **Fr** – Requin–hâ à gros yeux; **Sp** – Cazón ojigrande.

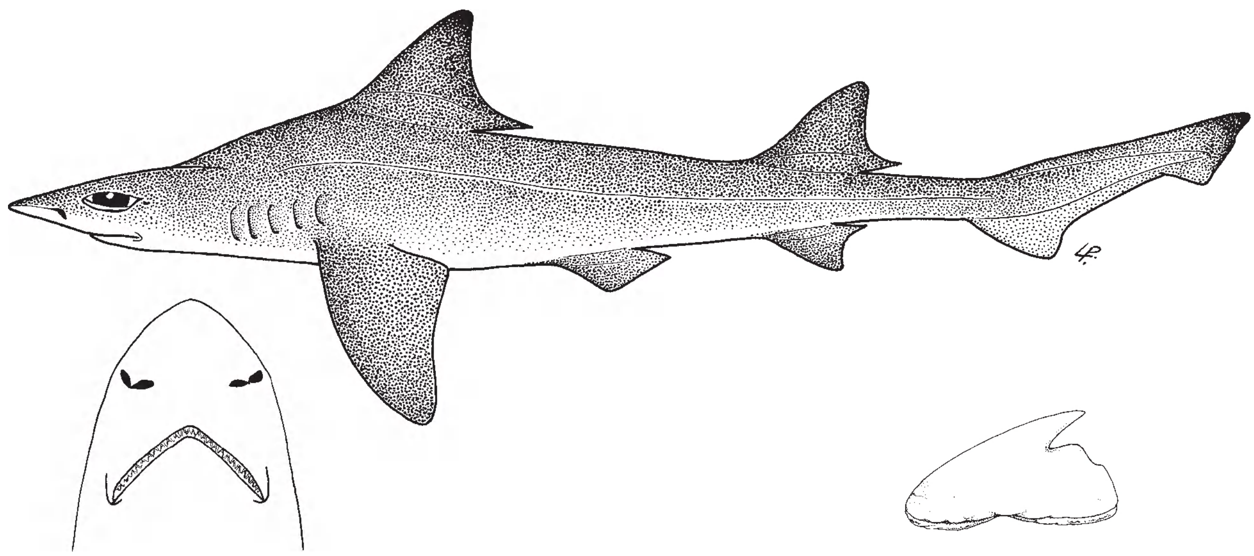


Fig. 270 ***Iago omanensis***

Field Marks: A houndshark with a moderately long snout and long gill area, first dorsal fin small and with its origin far anterior over the pectoral–fin bases, lateral eyes with the sub–ocular ridges obsolete, and ventral caudal–fin lobe hardly developed.

Diagnostic Features: Snout rather short and moderately broad, preoral length about 0.7 to 0.9 times mouth width. Gill region greatly expanded, distance from spiracle to 5th gill slit greater than prespiracular head; width of longest gill slits nearly equal to eye length. Labial furrows short, uppers falling well behind level of lower symphysis. Ventral caudal–fin lobe hardly expanded in adults. **Colour:** brownish or greyish above and lighter below, with no conspicuous markings; margins of dorsal fins often somewhat darker.

Distribution: Red Sea and Gulf of Oman to Pakistan and India. A low–finned, somewhat short–headed ***Iago,*** is largely sympatric with ***I. omanensis*** at least off southwestern India, and in the Bay of Bengal there is a possibly dwarf, ***omanensis***–like ***Iago*** that may or may not be distinct.

Habitat: A small, deepwater tropical shark of the continental shelf and slope from 110 m and probably less depth to at least 1000 m depth and possibly down to 2195 m in the Red Sea, on or near the bottom. This species has been regularly caught in warm water with oxygen levels often at a low level, 16 to 25 °C at 0.2 to 2.4 ml/l (mostly at 0.2 to 0.6 ml/l).

Biology: Viviparous, with a yolk–sac placenta; litter size probably about 2 to 10 young. Definitely known to eat bony fishes and cephalopods. Nair and Appukuttan (1973) noted that bony fishes, particularly lanternfishes, were the most important food item of this species off southern India, followed by deepwater squid, crustaceans (shrimp and larvae of mantis shrimp), bivalves and gastropods; sea grass and mud were found in a few stomachs.

Size: Maximum total length 58 cm; adult males 30 to 37 cm; adult females 40 to 58 cm. Size at birth at least 17 cm.

Sexual dimorphism in size in this species is considerable, with the largest males about 63% as long as the longest female (37 versus 58 cm) and weighing about 1/6 as much (Compagno and Springer, 1971).

Interest to Fisheries and Human Impact: Limited, taken by gillnet fisheries in southern India and also caught by handline fisheries in Israel in the Gulf of Aqaba (Eilat). In India, utilized fresh for human consumption.

Conservation status is Least Concern.

Local Names: None.

Literature: Compagno and Springer (1971); Nair and Lal Mohan (1973); Nair and Appukuttan (1973); Baranes and Ben–Tuvia (1979); Compagno (1984b, 1988); Compagno, Dando and Fowler (2005); Henderson et al. (2006); Baranes and McCormack (2009); Ebert (In preparation).

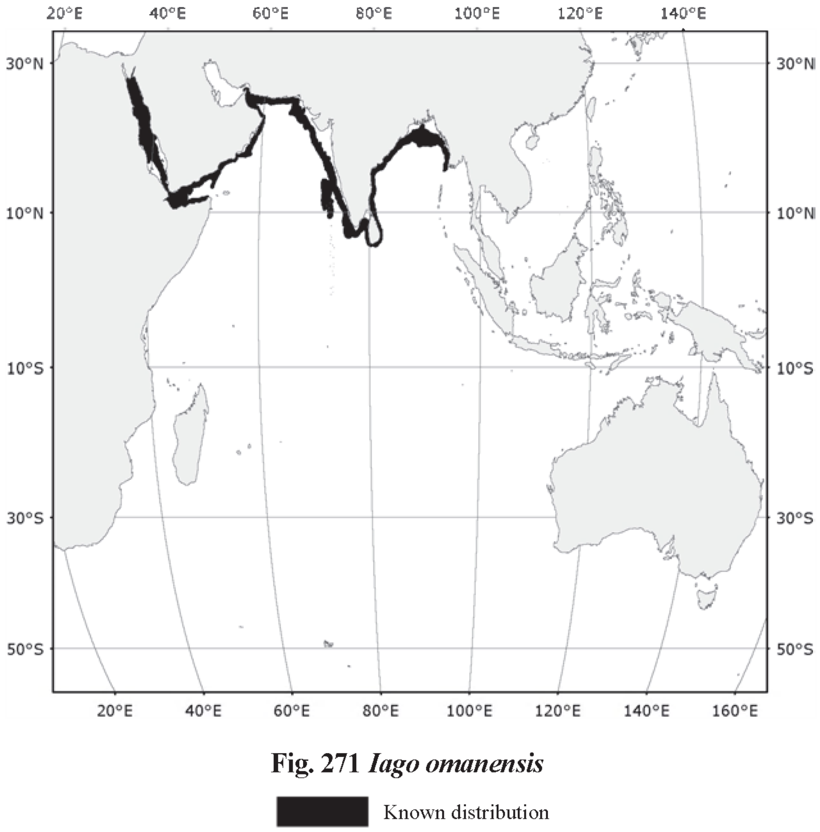


Fig. 271 ***Iago omanensis***

Mustelus Linck, 1790

Genus: ***Mustelus*** Linck, 1790, *Mag. Neue. Phys. Naturg. Gotha* 6: 31.

Type species: ***Squalus mustelus*** Linnaeus, 1758 by suspension of the Rules by the International Commission on Zoological Nomenclature, Opinion 93, 1926.

Number of Recognized Deep–sea Indian Ocean Species: 1.

Synonyms: Genus ***Mustellus*** Fischer, 1813, *Zoognosia, Tab. Synopt. Illustr.* Ed. III. 1: 78. Type species: ***Squalus mustelus*** Linnaeus, 1758 by subsequent designation of Jordan and Evermann, 1917, *Stanford U. Pub., U. Ser., Gen. Fish.* (1): 85. Subgenus ***Mustelus*** Cuvier, 1816 (Genus ***Squalus*** Linnaeus, 1758), *Reg. Anim.*, ed. 1, 2: 28. Type species: ***Squalus mustelus*** Linnaeus, 1758 by monotypy and absolute tautonymy. Genus ***Galeus*** Leach, 1818, *Mem. Wernerian Nat. Hist. Soc. Edinburgh*, 2: 62. Type species: ***Galeus mustelus*** Leach, 1818 by monotypy, equals ***Squalus mustelus*** Linnaeus, 1758. A junior homonym of ***Galeus*** Rafinesque, 1809 (Scyliorhinidae) and ***Galeus*** Cuvier, 1816 (equals ***Galeorhinus*** Blainville, 1816). Genus ***Emissola*** Jarocki, 1822, *Zoologia*. 4: 448. Type species: ***Squalus mustelus*** Linnaeus, 1758 by subsequent designation of Hubbs, 1938, p. 11. Genus ***Myrmillo*** Gistel, 1848, *Naturg. Thierr.*: 10. Substitute name for ***Mustelus*** Cuvier, 1816, and therefore taking the same type species, ***Squalus mustelus*** Linnaeus, 1758. Genus ***Rhinotriacis*** Gill, 1863, *Proc. Acad. Nat. Sci. Philadelphia* 14: 486. Type species: ***Rhinotriacis henlei*** Gill, 1863 by monotypy. Genus ***Pleuracromylon*** Gill, 1864, *Proc. Acad. Nat. Sci. Philadelphia* 16: 148. Type species: ***Mustelus laevis*** Müller and Henle, 1841 by original designation, equals ***Squalus mustelus*** Linnaeus, 1758. Genus ***Cynias*** Gill, 1903, *Proc. U.S. Natn. Mus.* 26: 960. Type species: "***Mustelus canis***" of Jordan and Evermann, 1896, by original designation, a composite of ***Squalus canis*** Mitchill, 1815 and ***Mustelus asterias*** Cloquet, 1821. Genus ***Allomycter*** Guitart, 1972, *Poeyana* (99): 1. Type genus: ***Allomycter dissutus*** Guitart, 1972 by monotypy, probably equals ***Squalus canis*** Mitchill, 1815.

Field Marks: Usually slender houndsharks with long, parabolic–subangular snouts, dorsolateral eyes and strong sub–ocular ridges, angular mouths, teeth formed into a pavement, with cusps and cusplets variably developed but usually obsolete or absent, medial teeth not differentiated from anterolaterals, and second dorsal fin nearly as large as first.

Diagnostic Features: Snout long and parabolic–subangular in dorsoventral view, preoral length less than 1.3 times mouth width. Eyes horizontally elongated or oval and dorsolateral, sub–ocular ridges strong. Anterior nasal flaps rather elongated and lobate, well separated from each other and mouth; no nasoral grooves. Internarial width about 1.0 to 2.0 times nostril width. Mouth angular and moderately long. Labial furrows moderately long, uppers falling well behind level of upper symphysis. Teeth not bladelike and similar in both jaws, varying from somewhat compressed and with short erect cusps and cusplets to rounded, molariform, and without cusps and cusplets; medial teeth not differentiated from anteroposteriors. First dorsal fin moderately large, base less than 3/4 of dorsal caudal–fin margin; origin over pectoral–fin inner margins or slightly behind their free rear tips, midbase about equidistant between pectoral and pelvic–fin bases or closer to pectoral–fin bases. Second dorsal fin nearly as large as first, height about 2/3 to 3/4 as high as first. Anal fin considerably smaller than second dorsal fin. Ventral caudal–fin lobe hardly developed in young but varying from poorly developed to short and strong in adults; terminal lobe of caudal fin moderately long and about 2.3 to 3.0 times in dorsal caudal–fin margin. Vertebral counts: total vertebral counts 109 to 162, monospondylous vertebral counts 25 to 47, diplospondylous precaudal vertebral counts 23 to 66, precaudal vertebral counts 58 to 106. Spiral valve turn counts 7 to 10. Size medium to large, adults 43 to 170 cm. **Colour:** depending on the species, some are relatively plain dorsally, while others have distinctive patterns of lighter or sometimes darker spots; fin edges may be lighter or darker; ventral surface is usually lighter.

Interest to Fisheries and Human Impact: ***Mustelus*** species are abundant temperate to tropical, inshore to offshore bottom sharks of continental and insular shelves and uppermost slopes that figure prominently in artisanal and commercial fisheries.

Local Names: Smoothhounds, Smooth hounds, Smooth dogfish, Gummy sharks, Gummys, Émissoles, Musolas, Tollos, Palombos, Cazones, Dog sharks; Hochizame–zoku (Japan).

Remarks: Members of the genus ***Mustelus*** are unusually difficult to separate from one another, particularly without the use of internal characters. Many of the morphological, morphometric and meristic characters that distinguish species partially overlap, and considerable variation occurs within species.

Most members of the genus are temperate to tropical species, mostly bottom–dwelling sharks of continental and insular shelves, with many coming into enclosed bays and harbors, especially on mud or sandy bottoms, and with most species inhabiting waters less than 200 m deep. A few species however occur along upper continental slopes below 200 m and down to about 800 m. One Indian Ocean species, ***Mustelus stevensi*** (discussed below), is considered a deep–water species.

Mustelus stevensi White and Last, 2008

Mustelus stevensi White and Last, 2008, *CSIRO Marine and Atmospheric Research Paper no.* 22: 189, figs 1–2, 5a, tab 1. Holotype: CSIRO H 1035–13, 611 mm TL, adult male. Type locality: north of Dampier Archipelago, Western Australia, 19°08′ S 116°54′ E, 196 to 198 m, 24 Oct 1986.

Synonyms: ***Mustelus*** sp. B (in part – western form): Last and Stevens, 1994: pp 206, 214, 215, key fig. 16, fig. 27.8, pl. 28; Compagno, Dando and Fowler, 2005: 277, 278, pl. 46; Compagno, 1998: pp 1300, 1301, fig. 14. ***Mustelus manazo***: Gloerfelt–Tarp and Kailola, 1984: p 13.

Other Combinations: None.

FAO Names: En – Western spotted gummy shark.

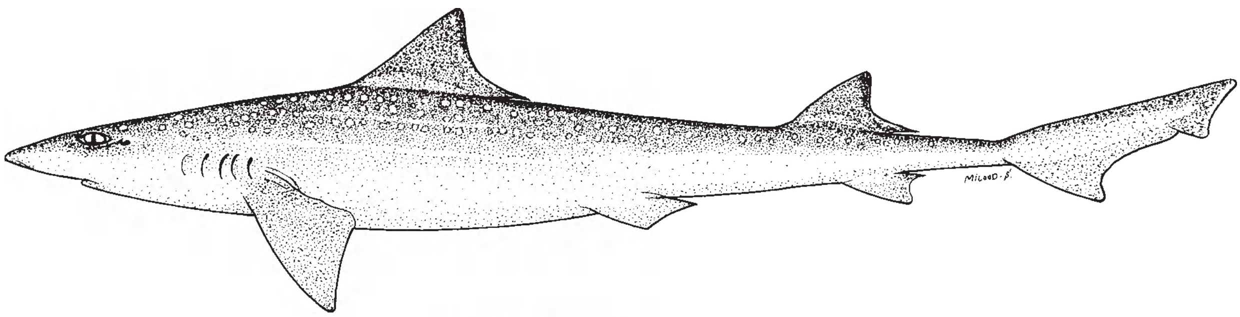


Fig. 272 *Mustelus stevensi*

Field Marks: A slender bodied ***Mustelus*** species uniformly yellowish grey above, with numerous scattered small white spots (spots absent in juveniles); lighter below. Upper labial furrows are shorter than the lowers. Teeth are pavement–like for crushing. Caudal fin is deeply notched. Precaudal centra 76 to 81.

Diagnostic Features: Body slender. Head short, prepectoral length 19.1 to 20.7% of total length. Snout relatively long, and narrowly rounded at tip, preoral length 6.3 to 7.5% of total length, preorbital snout length 7.1 to 8.1% of total length. Internarial space broad, 2.8 to 3.2% of total length. Eyes fairly large, oval shaped, eye length 2.5 to 3.3% of total length. Interorbital space fairly broad, 6.0 to 6.8% of total length. Mouth short, length subequal to eye length and 2.5 to 2.7% of total length. Upper labial furrows longer than lowers and 1.7 to 2.3% of total length. Teeth similar in upper and lower jaws, not blade–like, rather arranged in pavement–like pattern; relatively high cusp; tooth counts 72 upper jaw, 75 lower jaw. Buccopharyngial denticles cover entire palate. Crowns of lateral trunk denticles lanceolate, small and imbricate, variable in size and shape. Pectoral fins large, acutely pointed at anterior margin apex, length of anterior margins 13.2 to 14.4% of total length, width of posterior margin 9.8 to 12.2% of total length. Pelvic–fin anterior margins 6.7 to 7.6% of total length. Interdorsal space 21.3 to 23.3% of total length. Trailing edges of dorsal and caudal fins not frayed. Anal–fin height 3.1 to 3.6% of total length. Anal–caudal space greater than second dorsal–fin height, 6.6 to 7.7% of total length. Caudal peduncle slender, tapering, without precaudal pits or lateral keels. Caudal fin asymmetrical, upper lobe narrow; ventral caudal–fin lobe well developed. Vertebral counts: total vertebral counts 120 to 128, monospondylous precaudal vertebral counts 33 to 35, diplospondylous precaudal vertebral counts 41 to 45, precaudal vertebral counts 76 to 81. Size medium, adults to 103 cm total length. **Colour:** uniform yellowish–grey above, white below, covered with numerous small white spots on adults; juveniles usually plain without spotting; dorsal and caudal fins with dusky or black tips.

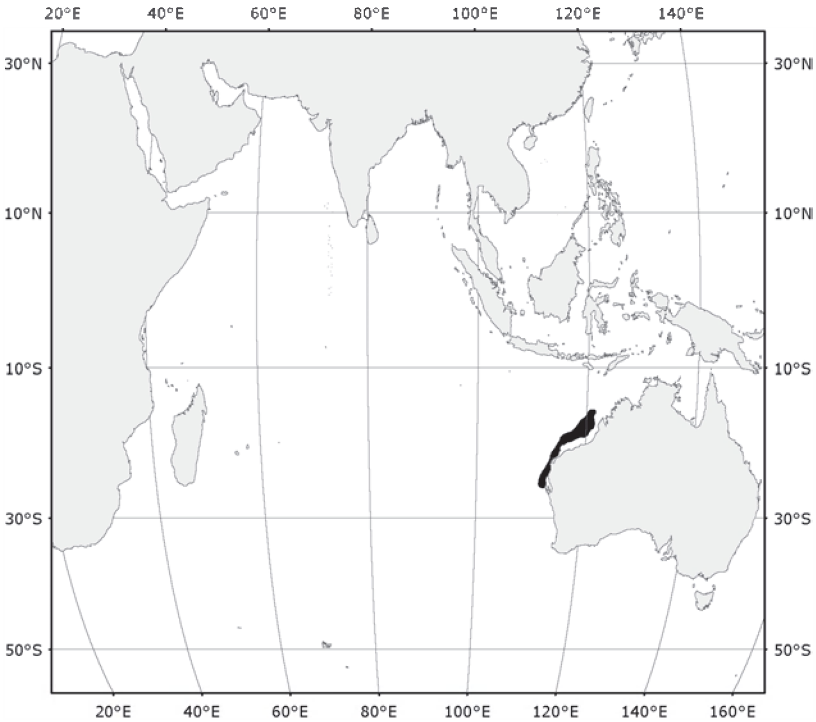


Fig. 273 ***Mustelus stevensi***

Known distribution

Distribution: Eastern Indian Ocean: possibly endemic to tropical Western Australia from Shark Bay to Cape Leveque.

Habitat: A demersal species on outer continental shelf and upper slope from 120 to at least 400 m, and possibly to 735 m.

Biology: Viviparous, but litter size unknown. Diet includes crustaceans, small bony fishes, and cephalopods.

Size: Maximum length to 103 cm total length; males mature at about 58 cm, with a maximum length of 92 cm; females mature at about 60 cm, with a maximum length of 103 cm. Size at birth 25 to 27 cm.

Interest to Fisheries and Human Impact: Nothing is known about possible impact from fisheries.

The conservation status of this species has been assessed as Least Concern.

Local Names: None.

Remarks: This species is very similar to several other spotted gummy sharks.

Literature: White and Last (2008); Last and Stevens (2009); McAuley and Kyne (2011); Ebert (In preparation).

2.8.5 Family CARCHARHINIDAE

Family: Subfamily Carcharhininae Jordan and Evermann, 1896, *Bull. U.S. Nat. Mus.* (47), pt. 1: 28 (Family Galeidae).

Type genus: ***Carcharhinus*** Blainville, 1816.

Number of Recognized Deep–sea Indian Ocean Genera: 1.

Synonyms: Subfamily Triaenodontini Bonaparte, 1838, *Nuov. Ann. Sci. Nat., Bologna*, ser. 1, 2: 200, 212 (Family Squalidae). Type genus: ***Triaenodon*** Müller and Henle, 1837a. Also proposed as Family Triaenodontes by Müller and Henle, 1839, *Syst. Beschr. Plagiost.*, pt. 2: 55; Subfamily Triaenodon (Family Mustelus) Hasse, 1879, *Nat. Syst. Elasmobr.* (1): tab. 2. Family Carchariae Müller and Henle, 1838, *Syst. Beschr. Plagiost.*, pt. 1: 27; also Müller and Henle, 1839, *Syst. Beschr. Plagiost.*, pt. 2: 27. Type genus: ***Carcharias*** Müller and Henle, 1839. Family Nictitantes Owen, 1846, *Lect. comp. anat. physiol. vert. animals* (1), fishes: 51. Not based on a type genus. Family Eulamiidae Fowler, 1928, *Mem. Bernice P. Bishop Mus.*, 101: 19. Type genus: ***Eulamia*** Gill, 1862. Subfamily Galeocerdinae Whitley, 1934, *Mem. Queensland Mus.* 10(4): 185 (Family Galeidae). Type genus: ***Galeocerdo*** Müller and Henle, 1837a. Subfamily Scoliodontinae Whitley, 1934, *Mem. Queensland Mus.* 10(4): 185 (Family Galeidae). Type genus: ***Scoliodon*** Müller and Henle, 1837a. Family Galeolamnidae Romer, 1945, *Vert. Paleont.* ed. 2: 577. Type genus: ***Galeolamna*** Owen, 1853. Tribe Galeocerdonini Steyskal, 1980, *Proc. Biol. Soc. Washington* 93(1): 170, suggested emendation of Galeocerdini because the Latin term *cerdo* is a loanword from the Greek *kerdos* with a stem *cerdon*, for correct orthography. Tribe Rhizoprionodontini Compagno, 1988, *Sharks Order Carcharhiniformes*: 290. Type genus: ***Rhizoprionodon*** Whitley, 1929. Tribe Isogomphodontini Compagno, 1988, *Sharks Order Carcharhiniformes*: 301. Type genus: ***Isogomphodon*** Gill, 1862.

FAO Names: En – Requiem sharks; **Fr** – Requins; **Sp** – Cazones picudos, Tiburones.

Field Marks: Small to large sharks with round to horizontal eyes, internal nictitating eyelids, no nasoral grooves or barbels, usually no spiracles, a long, arched mouth that reaches past anterior ends of eyes, moderately long labial furrows, small to large, more or less bladelike teeth in both jaws, often broader in the upper jaw, two dorsal fins and an anal fin, the first dorsal fin moderate–sized to large and with its base well ahead of pelvic–fin bases, the second dorsal fin usually much smaller than first, precaudal pits present, caudal fin with a strong ventral lobe and lateral undulations on its dorsal margin, intestine with a scroll valve, and usually no striking colour patterns.

Diagnostic Features: Head without laterally expanded blades. Eyes circular, vertically oval, or horizontally oval, with lengths 1.5 times their height or less. Nictitating eyelids internal. Spiracles usually absent (except for ***Galeocerdo***; occasionally present in ***Loxodon***, ***Negaprion*** and ***Triaenodon***). Anterior nasal flaps varying from lobular and tube–shaped (***Triaenodon***) to vestigial, not barbel–like; internarial width usually about 3 to 6 times nostril width (exceptionally 1.5 times it in ***Nasolamia***). Labial furrows varying from moderately long and conspicuous to short and hidden when mouth is closed. Teeth small to large, with acute and narrow to moderately broad cusps, sometimes lateral cusplets, but with basal ledges and grooves low to absent; teeth variably differentiated in upper and lower jaws, uppers often more compressed and bladelike, lowers often more cuspidate and not compressed; posterior teeth not comblike; tooth rows 18 to 60 upper jaw, 18 to 56 lower jaw. Precaudal pits present. Pectoral fins with radials extending into distal web of fins. First dorsal fin moderate–sized to very large but not keel–like, much shorter than caudal fin; first dorsal–fin base ahead of pelvic–fin bases, varying from closer to pectoral–fin bases to closer to pelvic fins; midpoint of first dorsal–fin base always in front of pelvic–fin origins. Second dorsal fin usually smaller than first (***Lamiopsis*** and ***Negaprion*** are exceptions). Ventral caudal–fin lobe strong, undulations or ripples present in dorsal caudal–fin margin. Vertebral centra with strong, wedge–shaped intermedial calcifications. Vertebral counts: total vertebral counts 96 to 244, precaudal vertebral counts 41 to 131. Valvular intestine with a scroll valve. **Colour:** variable, usually no distinctive colour pattern.

Distribution: Requiem sharks are found in all warm and temperate seas, and especially in the tropics.

Habitat: These are the dominant sharks in tropical waters, often both in variety and in abundance and biomass. Most species inhabit tropical continental coastal and offshore waters; several species prefer coral reefs and oceanic islands while a few species, including the blue (***Prionace glauca***), silky (***Carcharhinus falciformis***) and oceanic whitetip (***C. longimanus***) sharks, are truly oceanic and epipelagic, and range far into the great ocean basins. A minority of species range into temperate waters; one of these, the blue shark (***P. glauca***) has one of the greatest geographic ranges of any elasmobranch (rivaled or exceeded only by the white shark and possibly the bluntnose sixgill shark) and any marine vertebrate. Few occur at any great depth and only the bignose (***Carcharhinus altimus***) and night (***Carcharhinus signatus***) sharks occur off the upper continental shelves and slopes down to 600 m.

Biology: This is one of the largest and most important families of sharks, with many common and wide–ranging species. Most requiem sharks are marine, a few occur into freshwater rivers and lakes, usually ranging from close inshore to the outermost shelf edges near the bottom and the epipelagic zone, but none are truly specialized deepwater sharks, unlike many species of Squalidae and Scyliorhinidae. Although species in other families may enter river mouths and ascend rivers for a short distance, a few members of this family, particularly the bull shark (***Carcharhinus leucas***) but possibly also the little–known river sharks (***Glyphis***), apparently are the only living sharks that can live in freshwater for extended periods; the bull shark has a wide range in tropical and temperate rivers and lakes of the world. Requiem sharks are active, strong swimmers, occurring singly or in small to large schools. Some species are continually active, while others are capable of resting motionless for extended periods on the bottom. Many are more active at night or dawn and dusk than the daytime. At least some of the species have been shown to give specialized displays when confronted by divers or other sharks, which may be indicative of aggressive or defensive threat. Some species are relatively small, reaching about a meter long, but most requiem sharks are medium to large–sized, between 100 to 300 cm long, and one species, the tiger shark, is one of the biggest sharks and may reach a length of 740 cm. Except for the tiger shark, which exhibits yolk–sac viviparity, all species are viviparous with a yolk–sac placenta, and have litters of young from 1 or 2 to 135. All are voracious predators, feeding heavily on bony fishes, other sharks, rays, squid, octopi, cuttlefishes, crabs, lobsters, and shrimp, but also sea birds, turtles, sea snakes, marine mammals, gastropods, bivalves, carrion, and garbage. Smaller species tend to select for a narrow range of prey, but certain very large species, especially the tiger shark (***Galeocerdo cuvier***) are virtually omnivorous.

Interest to Fisheries and Human Impact: This is by far one of the most important shark families for fisheries globally, with various species figuring prominently in artisanal, commercial and sports fisheries. Most are utilized for human food, but also for the preparation of various sub–products, including fins for the oriental soup–fin market, oil and Vitamin A from the liver, fishmeal, and leather products. Several species are targeted by sports fishers, and two species, the blue and tiger sharks, are listed as International Game Fish Association record species. This family contains more dangerous species than any other; several of the larger requiem sharks have attacked people and boats while a few species (particularly the bull and tiger sharks), are among the most dangerous living sharks. The danger to divers posed by these sharks is relatively small, however, several species are popular and attractive subjects for viewing underwater. Several species are popular in public aquaria as display animals.

The conservation status ranges from those that are Data Deficient due to a lack of life history information, Least Concern since they have relatively high reproductive rates, to Vulnerable or Critically Endangered from over–exploitation, or from habitat degradation and or modification.

Local Names: Requiem sharks, Gray or Grey sharks, Whaler sharks, Man–eating sharks.

Remarks: The arrangement of this family follows Compagno (1984b, 1988) and Ebert (In preparation). The family has 12 genera and 57 species, but only the bignose shark, ***Carcharhinus altimus***, is considered truly a deepwater shark within this genus. The night shark, ***C. signatus***, is also somewhat of a deepish water shark, occurring down to at least 600 m, but this shark mostly occurs on the outer continental shelf between 50 and 200 m deep.

List of Deep–sea Species Occurring in the Area:

Carcharhinus altimus (Springer, 1950)

Carcharhinus Blainville, 1816

Genus: Subgenus ***Carcharhinus*** Blainville, 1816, *Bull. Sci. Soc. Philomat. Paris*, (8): 121 (Genus ***Squalus*** Linnaeus, 1758).

Type species: ***Carcharias melanopterus*** Quoy and Gaimard, 1824, under suspension of the Rules by the International Commission on Zoological Nomenclature, Opinion 723, 1965, *Bull. Zool. Nomencl.* 22: 32.

Number of Recognized Deep–sea Indian Ocean Species: 1.

Synonyms: Subgenus ***Carcharias*** Cuvier, 1816 (Genus ***Squalus*** Linnaeus, 1758), *Reg. Anim.,* ed. 1, 2: 125, in part. Junior homonym of Genus ***Carcharias*** Rafinesque, 1810 (Odontaspididae), and rejected by the International Commission on Zoological Nomenclature, Option 723, 1965, *Bull. Zool. Nomencl.* 22: 33. Subgenus ***Carcharinus*** Cloquet, 1817 (Genus ***Squalus*** Linnaeus, 1758), *Dict. Sci. Nat.* 7: 7. Incorrect spelling of ***Carcharhinus*** Blainville, 1816 and rejected by the International Commission on Zoological Nomenclature, Opinion 723, 1965, *Bull. Zool. Nomencl.* 22: 33. Subgenus ***Carcharias*** Risso, 1826 (Genus ***Squalus*** Linnaeus, 1758), *Hist. nat. Princip. Prod. Europe Méred., Paris, Poissons*: 119. Genus ***Carcharias*** Müller and Henle, 1839, *Syst. Beschr. Plagiost.*, pt. 2: 27. Subgenus ***Aprion*** Müller and Henle, 1839 (Genus ***Carcharias*** Müller and Henle, 1839), *Syst. Beschr. Plagiost.*, pt. 2: 31). Type species: ***Carcharias*** (***Aprion***) ***isodon*** Valenciennes, in Müller and Henle, 1839 through subsequent restriction by Gill, 1862, *Proc. Acad. Nat. Sci. Philadelphia*, 1861: 59; and Gill, 1862, *Ann. Lyceum Nat. Hist. New York*, 7(32): 401, 411. A junior homonym of ***Aprion*** Cuvier and Valenciennes, 1830 in Osteichthyes. Subgenus ***Hypoprion*** Müller and Henle, 1839 (Genus ***Carcharias*** Müller and Henle, 1839), *Syst. Beschr. Plagiost.*, pt. 2: 34. Type species: ***Carcharias*** (***Hypoprion***) ***macloti*** Müller and Henle, 1839 by subsequent designation of Gill, 1862, *Ann. Lyceum Nat. Hist. New York*, 7(32): 401. Subgenus ***Prionodon*** Müller and Henle, 1839 (Genus ***Carcharias*** Müller and Henle, 1839), *Syst. Beschr. Plagiost.*, pt. 2: 35. Genus ***Carcharius*** Lowe, 1839, *Proc. Zool. Soc. London* 1839 (7): 90. Apparent error for ***Carcharias*** Cuvier, 1816, as name was subsequently used correctly as his ***Carcharias microps*** Lowe, 1840, *Proc. Zool. Soc. London*, 1840 (8): 38. Genus ***Galeolamna*** Owen, 1853, *Descr. cat. osteol. ser. coll. Roy. Coll. Surgeons*: 96. Type species: ***Galeolamna greyi*** Owen, 1853 by monotypy, possibly a junior synonym of ***Squalus obscurus*** Lesueur, 1818 or ***Carcharias*** (***Prionodon***) ***falciformis*** Bibron, 1839. Genus ***Aprionodon*** Gill, 1862, *Proc. Acad. Nat. Sci. Philadelphia*, 1861: 59 (name only); Gill, 1862, *Ann. Lyceum Nat. Hist. New York*, 7(32): 401, 411. Type species: ***Aprionodon punctatus*** Gill, 1862 by monotypy and subsequent designation of Gill, 1862, *Ann. Lyceum Nat. Hist. New York*, 7(32): 401; a junior homonym of ***Carcharias*** (***Aprion***) ***isodon*** Valenciennes, in Müller and Henle, 1839. Genus ***Hypoprionodon*** Gill, 1862, *Ann. Lyceum Nat. Hist. New York*, 7(32): 401, 409. Type species: ***Carcharias*** (***Prionodon***) ***hemiodon*** Valenciennes, in Müller and Henle, 1839 by original designation. Genus ***Eulamia*** Gill, 1862, *Ann. Lyceum Nat. Hist. New York*, 7(32): 401, 410. Type species: ***Eulamia lamia*** Gill, 1862 by original designation, probably equals ***Carcharias*** (***Prionodon***) ***lamia*** Müller and Henle, 1839 and hence a junior synonym of ***Squalus maou*** Lesson, 1830. Genus ***Gymnorrhinus*** Hemprich and Ehrenberg, 1899, *Symbol. Physic. Icones Ined., Zool.*: pl. 7; p. 6 as ***Gymnorhinus*** (a junior homonym of ***Gymnorhinus*** Maximillian, 1841 in Aves), a probable text emendation by Hilgendorf in Hemprich and Ehrenberg. Fowler, 1941, *Bull. U.S. Natn. Mus.*, (100) 13: 148 listed ***Carcharias*** (***Prionodon***) ***menisorrah*** Valenciennes, in Müller and Henle, 1839 as type of ***Gymnorhinus*** (and hence of ***Gymnorrhinus***); this species was synonymized with ***Gymnnorrhinus pharaonis*** Hemprich and Ehrenberg, 1899 by Hilgendorf in Hemprich and Ehrenberg. Hence the type species of ***Gymnorrhinus*** is considered to be ***G. pharaonis*** here. Genus ***Pterolamia*** Springer, 1950, *Amer. Mus. Novit.* (1451): 7. A junior homonym of ***Pterolamia*** Breuning, 1942 in Insecta, and rejected by the International Commission on Zoological Nomenclature, Opinion 723, 1965, *Bull. Zool. Nomencl.* 22: 33. Genus ***Pterolamiops*** Springer, 1951, *Copeia*, 1951 (3): 244. Type species: ***Squalus longimanus*** Poey, 1861 by original designation and as a replacement name for ***Pterolamia*** Springer, 1950.

Field Marks: Requiem sharks with small, wide–spaced nostrils, no spiracles, labial furrows confined to mouth corners, usually serrated upper teeth, no cusplets on lower teeth, no keels on caudal peduncle, transverse crescentic precaudal pits, first dorsal–fin midbase closer to pectoral–fin bases than to pelvic fins or at most about equidistant between them, second dorsal fin less than half the height of first, second dorsal–fin origin usually about opposite to anal–fin origin; anal fin with preanal ridges short to absent and with a deeply notched posterior margin.

Diagnostic Features: Body fairly slender to very stout. Head narrow to broad, flattened but not trowel–shaped; snout varying from narrowly parabolic or subangular to bluntly rounded or nearly truncate in dorsoventral view, very short to long, with preoral length varying from about equal to much greater than internarial space and from much less to considerably greater than mouth width; eyes small to large, without posterior notches; spiracles absent; no papillose gillrakers on internal gill openings; nostrils small, internarial space 3 to 6 times nostril width; anterior nasal flaps short, varying from vestigial to narrowly or broadly triangular, but not tubular; labial furrows short, essentially confined to mouth corners, with uppers about as long as lowers or shorter, ends of uppers falling far behind eyes; teeth highly variable, anteroposteriors similar or strongly differentiated in upper and lower jaws; uppers usually with more or less erect, broad to narrow cusps, variably developed cusplets or blades, and serrations usually present; lowers without cusplets but with variably oblique to erect cusps and with serrations and blades present or absent; cusps of lower teeth no prominently protruding when mouth is closed; tooth counts 24 to 37 upper jaw, 23 to 35 lower jaw. Interdorsal ridge variably absent, present and prominent, or sometimes vestigial; no dermal keels on caudal peduncle; upper precaudal pit transverse and crescentic. First dorsal–fin origin varying from over or slightly anterior to pectoral–fin insertions to slightly behind their rear tips, midbase usually closer to pectoral–fin bases than pelvic fins but sometimes equidistant between them, and free rear tip usually well in front of pelvic fins but occasionally opposite their origins; second dorsal fin much smaller than first, height 2/5 of first dorsal–fin height or less; its origin usually about opposite anal–fin origin but slightly anterior to it in some species and well behind it in others (but usually in front of anal–fin insertion); pectoral fins varying from moderately broad and semifalcate, to narrow and falcate or broad–tipped, their lengths from origin to free rear tip about 1/3 to 2/3 of pectoral–fin anterior margins; pectoral–fin origins varying from about under third to fifth gill slits; anal fin varying from considerably larger than second dorsal fin to about as large, with preanal ridges very short or absent and a deeply notched posterior margin. Vertebral counts: total vertebral counts 96 to 244, precaudal vertebral counts 41 to 131. Small to very large sharks, adults from below 100 to about 400 cm. **Colour:** variably grey, bronze, brownish above, without a colour pattern other than variable light or dark fin markings and lateral light stripes.

Local Names: Gray sharks, Grey sharks, Requiem sharks, Whaler sharks, Ground sharks (English).

Remarks: The genus consists of 33 species worldwide, of which one is considered to inhabit the deep–sea.

Carcharhinus altimus (Springer, 1950)

Eulamia altima Springer, 1950, *Amer. Mus. Novit.* (1451): 9. Holotype: U.S. National Museum of Natural History, USNM–133828, 52" or 1321 mm (1225 mm.) immature female, partly skinned, from off Cosgrove Reef, Florida Keys at 197 m. Confirmation of holotype status and additional data from Howe and Springer (1993, *Smiths. Contr. Zool.* [540): 3).

Synonyms: None.

Other Combinations: None.

FAO Names: En – Bignose shark; **Fr** – Requin babosse; **Sp** – Tiburón baboso.

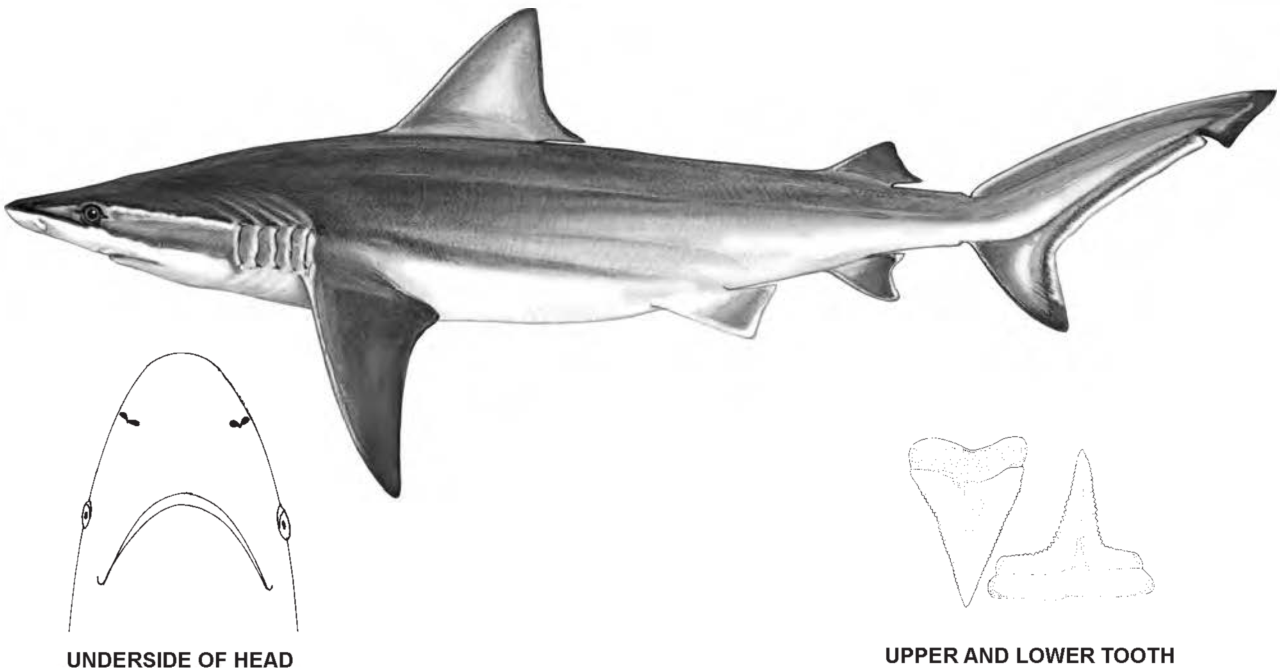


Fig. 274 *Carcharhinus altimus*

Field Marks: A large, deep–benthic grey shark with a long rounded or bluntly pointed snout, prominent anterior nasal flaps, high, triangular, serrated teeth without cusplets in upper jaw, erect narrow–cusped serrated teeth in lower jaw, tooth counts usually 14 to 15 upper jaw and 14 to 15 lower jaw, a high interdorsal ridge, moderately high first dorsal fin, long, nearly straight pectoral fins, a moderately high second dorsal fin with a short rear tip and no conspicuous markings.

Diagnostic Features: Large, fairly slender sharks with snout moderately long and bluntly pointed to rounded, internarial width 1.3 to 1.4 in preoral length. Eyes circular and moderately large, length 1.4 to 2.3% total length. Anterior nasal flaps rather high, triangular, and fairly broad. Upper labial furrows short and inconspicuous. Hyomandibular line of pores just behind mouth corners not conspicuously enlarged. Gill slits moderately long, third slit 3.1 to 3.9% total length and about a third of first dorsal–fin base. Upper teeth with broad, strongly serrated, triangular, erect to slightly oblique, very high cusps that merge into the crown feet, the latter without coarse serrations or cusplets; lower teeth with erect, narrow serrated cusps and transverse roots; tooth counts for anteroposterior teeth varying from 29 to 34 upper jaw, and 29 to 31 lower jaw. A prominent interdorsal ridge present. Pectoral fins large, hardly falcate, with narrowly rounded or pointed narrow apices, length of anterior margins about 20 to 22% total length. First dorsal fin moderately large and falcate, with bluntly pointed apex and posterior margin curving ventrally from fin apex; origin of first dorsal fin over pectoral–fin insertion to about over midlength of pectoral–fin inner margins; inner margin of first dorsal fin moderately long, half dorsal–fin base or slightly less. Second dorsal fin large and high, height 2.8 to 3.4% total length, inner margin short and 1.1 to 1.4 times height; origin of second dorsal fin slightly anterior to anal–fin origin. Vertebral counts: total vertebral counts 194 to 206, precaudal vertebral counts 101 to 110. A large sized ***Carcharhinus*** species with a maximum total length of about 300 cm. **Colour:** light grey above, sometimes bronzy, white below, with dusky fin tips (except for pelvic fins) but no conspicuous markings; white marking on flanks inconspicuous.

Distribution: Occurs in most warm temperate and tropical seas worldwide, but distribution is patchy. Indian Ocean: South Africa, Madagascar, Red Sea, Oman, Maldives, India, possibly Sri Lanka, Indonesia, and Australia (Western Australia).

Habitat: A common, large, offshore, bottom–dwelling warm–temperate and tropical shark usually found in deeper water near the edge of continental and insular shelves and the uppermost slopes, at depths of 80 m or more down to at least 250 to 430 m. The young may occur in shallower water, up to 25 m depth. A large mostly bottom dwelling shark, known to make forays to the surface especially at night. An individual, about 280 cm TL, was once caught in the daytime at the surface in water over 130 m deep by a boat trawling for marlin. This shark species appears to be benthic during the day, but at night actively migrates vertically as individuals have been at or near the surface in water depths of up to 1000 m.

Biology: Viviparous with a yolk–sac placenta; number of young per litter 3 to 15. Mediterranean sharks give birth in August and September, while sharks off Madagascar give birth in September and October. Eats a variety of bony fishes, including lizardfish, croakers, batfish, soles, and other sharks including dogfish (***Squalus***), catsharks (***Holohalaelurus***), stingrays (***Dasyatis***), and cuttlefish.

Size: Maximum total length possibly about 300 cm; mature males at about 190 cm with a maximum length of at least 267 cm; mature females at 225 with a maximum length of at least 282 cm. Size at birth probably between 60 and 90 cm.

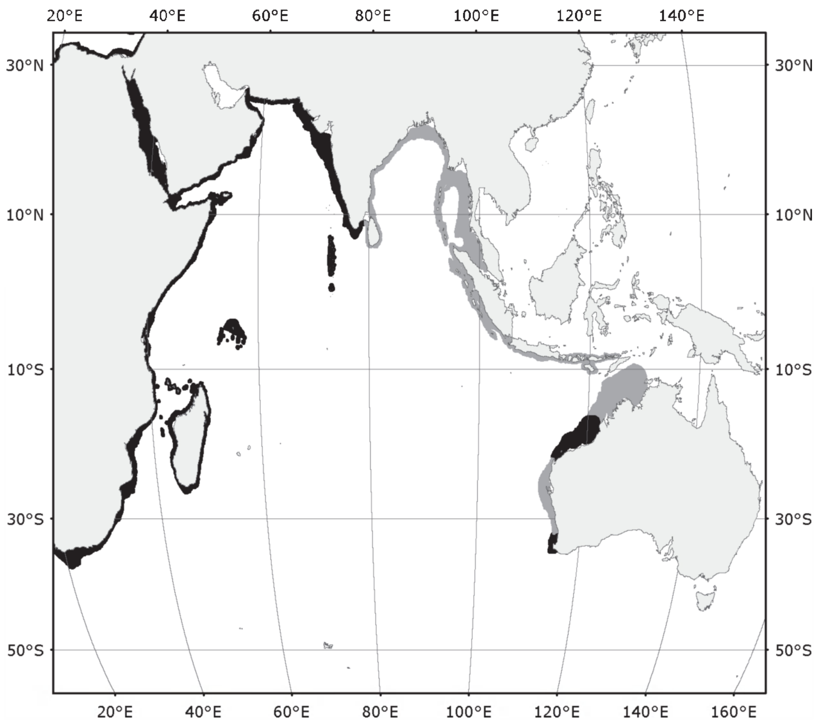


Fig. 275 *Carcharhinus altimus*

A length–weight equation is given by Kohler, Casey and Turner (1995) for fork length (FL): Wt(kg) = $1.0160 \times 10^{-6} x FL^{3.4613}$, n = 38 (both sexes), where FL = 0.8074 x TL + 7.7694, n = 10.

Interest to Fisheries and Human Impact: Interest to fisheries localized. Apparently regularly taken in the Caribbean region on deep–set longlines (especially off Cuba, but also southern Florida), and there utilized for fishmeal, oil and shagreen. In some areas, bignose sharks are often mistaken for sandbar sharks that may have lead to under reporting of catches of this species. Although of large size, this species is probably not dangerous to people because of its deep–water habitat.

The conservation status of this species is Data Deficient due to its not being targeted in fisheries and the lack of biological information on it.

Local Names: Bignose shark, Bignosed shark, Knopp's shark, Réquiem babosse.

Literature: Springer (1950); Fourmanoir (1961); Bass, D'Aubrey and Kistnasamy (1973); Garrick (1982); Compagno (1984b, 1988); Anderson and Stevens (1996); Crow, Lowe and Wetherbee (1996); White (2007); Pillans *et al.* (2008); Last and Stevens (2009); Ebert (In preparation).

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4. INDEX OF SCIENTIFIC AND VERNACULAR NAMES

Explanation of the System

Italics	:	Valid scientific names (double entry by genera and species)
Italics	:	Synonyms and misidentifications (double entry by genera and species)
ROMAN	:	Family names
ROMAN	:	Names of classes, subclasses, cohorts, superorders and orders.
Roman	:	Suborders, subfamilies, tribes, and FAO and local names

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This volume is a comprehensive, fully illustrated Catalogue of the Deep–sea Sharks of the Indian Ocean, encompassing FAO Fishing Areas 51 and 57, and that portion of Area 47 off South Africa from about 18°42'E to 30°00'E. The present volume includes 8 orders, 23 families, 46 genera, and 117 species of shark–like fishes occurring in the Indian Ocean deep–sea. It provides accounts for all orders, families, and genera and all keys to taxa are fully illustrated. A species representative account of each genus is also provided and includes: valid modern names and original citation of the species; synonyms; the English, French, and Spanish FAO names for the species; a lateral view and often other useful illustrations; field marks; diagnostic features; distribution, including a GIS map; habitat; biology; size; interest to fisheries and human impact; local names when available; a remarks sections; and literature. The volume is fully indexed and also includes sections on terminology and measurements for sharks including an extensive glossary, and a dedicated bibliography.