

Deep-water Fish and Fisheries in the Northeastern Atlantic and Mediterranean: an overview of the EC FAIR Deep Fisheries Project.

by

John D.M. Gordon

Scottish Association for Marine Science, Dunstaffnage Marine Laboratory,
PO Box 3, Oban, PA34 4AD, United Kingdom.¹

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ABSTRACT

Some deep-water fisheries such as the longline fishery for *Aphanopus carbo* (black scabbardfish) off Madeira and the semi-pelagic trawl fisheries for *Micromesistius poutassou* (blue whiting) and *Argentina silus* (argentine) of the Rockall Trough are well established. In the late 1980s new deep-water bottom trawl fisheries for species such as *Coryphaenoides rupestris* (roundnose grenadier) and *Hoplostethus atlanticus* (orange roughy) began to develop. In some instances the increase in the landings of these and other 'new' species represents the development of markets for the bycatch of existing deep-water fisheries, such as for *Molva dypterygia* (blue ling) in the Atlantic and the red shrimps *Aristeus antennatus* and *Aristaeomorpha foliacea* in the Mediterranean.

In an effort to learn more about these new fish and their fisheries, the European Commission supported workshops in 1993 and 1994 and ICES set up the Study Group on the Biology and Assessment of Deep-Sea Fisheries Resources in 1994. It was against this background that the proposal for an EC FAIR Deep Fisheries Project was developed. The project, whose full title is *Developing deep-water fisheries: data for their assessment and for understanding their interaction with and impact on a fragile environment*, was funded and began in December 1995. There are 13 partners from 10 European countries extending from Iceland to Greece.

In this paper, the objectives of the five main tasks will be described and some of the results will be highlighted. Other presentations and posters in this Theme Session will deal with specific sub-Tasks in more detail.

INTRODUCTION

Some deep-water fisheries such as the longline fishery for *Aphanopus carbo* (black scabbardfish) off Madeira and the semi-pelagic trawl fisheries for *Micromesistius poutassou* (blue whiting) and *Argentina silus* (argentine) of the Rockall Trough are well established and at present levels of exploitation, appear to be sustainable. In the 1960s a Russian and East European fishery for

Coryphaenoides rupestris (roundnose grenadier) developed in the western North Atlantic and gradually spread eastwards to the northern sector of the Reykjanes Ridge, the northern Mid-Atlantic Ridge and the Hatton Bank area. These fisheries peaked in the 1970s and thereafter declined (Atkinson, 1995).

The next development in the eastern Atlantic was a bottom trawl fishery for *Molva dypterygia* (blue ling). This began in the early 1970s with the exploitation of spawning aggregations around some of the banks in the northern Rockall Trough by German trawlers. In the late 1970s the German fishery declined and was replaced by a French trawl fishery that also exploited aggregations but, more significantly for the development of other deep-water fisheries, began a year-round trawl fishery on the continental slopes. This fishery was an extension of the long-established French trawl fishery for outer shelf species such as *Gadus morhua* (cod), *Molva molva* (ling) and *Pollachius virens* (saithe) (Charuau et al., 1995). In 1989 French trawlers began to land deep-water species such as *Coryphaenoides rupestris*, *Aphanopus carbo* and some deep-water sharks. The sharks were termed 'siki' and consisted of a mixture of two species, *Centroscymnus coelolepis* (Portuguese dogfish) and *Centrophorus squamosus* (leafscale gulper shark). In 1992 French trawlers began to land *Hoplostethus atlanticus* (orange roughy). *Hoplostethus atlanticus* is a valuable and readily marketable species and it was probably the landings of this species that led to a wider interest in the potential of deep-water fisheries.

The European Commission (DGXIV) began to take an interest in these and other developing deep-water fisheries and in December 1992, the Council of Fisheries Ministers made the following declaration: "The Council and the Commission note that fisheries of diverse nature have recently developed on deepwater resources. Given that deepwater fish are likely to be very vulnerable to overexploitation; the Commission will initiate a study on the state of knowledge on these fisheries, particularly aimed at the possibility of implementing a management system and will report to council on the results of the study by October 1993".

A meeting of experts was held in Brussels in June 1993 to review the fishery and make recommendations for management. The report (Anon., 1993a) described what little was known of the fish and the fisheries at that time and outlined some of the possible future management options. Throughout the report, the possible vulnerability of the stocks to over-exploitation was stressed. One of the conclusions was that "At present, biological information on stocks of deep-water species is limited. However, the information currently available indicates that a precautionary approach should be taken in the development of new fisheries or the enhancement of many of the existing fisheries".

ICES also recognised the growing importance of these new fisheries and in 1993 two of its Working Groups were asked to comment on the status of these fisheries (Anon., 1993 b,c). This led to the convening of an ICES Study Group on the 'Biology and Assessment of Deep-Sea Fisheries Resources' which held its first meeting at ICES Headquarters in August 1994. This Study Group has produced five reports (Anon., 1995a, 1995b, 1996a, 1997, 1998) which in turn have been reviewed by the ICES Advisory Committee on Fishery Management (ACFM). The advice from ACFM has consistently been that "a cautious approach should be adopted" and that "fishing effort should be kept at a low level until sufficient information is gathered from existing fisheries to enable scientifically-based management decisions" (Anon., 1995c). ACFM also recommended that "a comprehensive data collection system should be urgently initiated and that research on the stocks should be increased to provide the data necessary for assessment". The current ACFM advice on management is a recommendation for an "immediate reduction in fisheries that cannot be shown to be sustainable. All remaining fishing activity should be

conducted in the context of effective management which emphasises documentation of fishing activity, and which can react appropriately to biological characteristics of the populations."

In 1994 an Advanced Research Workshop, sponsored by NATO and the European Commission was organised by the UK Sea Fish Industry Authority and the Scottish Association for Marine Science (Hopper, 1995). The detailed conclusions and recommendations of the workshop all focused on the shortage of adequate data that could provide a rational basis for management decisions. Nevertheless, there was a general concern by the delegates that these resources must be treated with extreme caution.

In the UK the House of Lords Select Committee on Fish Stock Conservation and Management collected evidence and gave opinions on deep-water fishing. One of the conclusions of their report was that "Ideally we would recommend an interim suspension of all deep-sea fishing, but we recognise that it could not be enforced at present. **We accordingly recommend that research should be carried out as a matter of urgency into the likely sustainable catch levels, technical measures to minimise damage to non-target and juvenile deep-water fish and the importance of deep-water fish in the food chains to other marine organisms. International collaboration should be sought on research (which is highly expensive in deep-water fisheries), suitable management strategies, including the possibility of licensing schemes, and enforcement**" (Anon., 1996b).

In 1997 Greenpeace published a report entitled "Is Deepwater a Dead-End?" in which they put forward the case for closure of these fisheries in the waters to the west of the British Isles (Greenpeace, 1997). They stated that "waiting for definitive 'scientific' proof of irreversible damage is not good enough--".

Despite all these warnings, it is quite clear that deep-water fishing will continue to increase as the fishing industry continually looks for new opportunities, as the stocks of quota species come under ever-increasing pressure. At the present time the management of deep-water species in the EU Atlantic sector is restricted to limitation of effort. Enforcement of these regulations is difficult because of lack of knowledge of the nature of the fisheries, problems with the identification of the catch and the fact that most fall into the category of 'highly migratory and straddling stocks'.

It was against this background that a proposal for research on deep-water fish and fisheries was developed and subsequently funded by the European Commission DGXIV FAIR Programme. Although many of the above meetings and reports concerned only the Atlantic, it was recognised that deep-water fishing was also increasing in importance in the Mediterranean. The fisheries in the two areas are somewhat different, but it was considered that their joint study would yield new insights into this poorly known ecosystem. The three-year project began in December 1995.

The Project is entitled *Developing deep-water fisheries: data for their assessment and for understanding their interaction with and impact on a fragile environment* (EC FAIR CT 95/655) and has the following objectives:

- (1) To describe in detail the deep-water fisheries presently being prosecuted by member states with particular reference to geographic area, depth of occurrence, seasonal distribution, migration patterns, aggregations and other parameters. To record and describe the gears, both mobile and static, which are currently being used for specified fisheries.

- (2) To make an inventory of existing survey data on deep-water resources and ensure that historical data sets are preserved and are accessible. To support the working up of survey data.
- (3) To describe and quantify the bycatch of unwanted species and undersized fish of target species in the fisheries identified in Objective 1.
- (4) To sample at the markets and accurately record the quantities of species landed with particular reference to fishes that are not presently identified to species level.
- (5) To use the information collected by research and commercial surveys and, from market sampling past and present, to provide data on biological parameters of both target and bycatch species, which will be of value for the assessment and management of the resource. Particular importance will be paid to studies on age determination, growth and reproduction. An underlying theme of all these studies will be to (1) consider how the special environmental factors of the deep waters influence the biological parameters of these new resources and (2) understand how the fishery, especially the removal of top level predators and the probable high mortality of escapees from trawls, will effect what is generally considered to be a fragile ecosystem.

These objectives are achieved as a series of Tasks by the following partners, not all of whom participate in all of the Tasks.

Partner 1: Scottish Association for Marine Science, Oban, United Kingdom (SAMS)

Partner 2: (a) IFREMER, Lorient and Boulogne-sur-Mer; (b) the Laboratoire de Biologie Marine du Collège de France, Concarneau, France (IFREMER/LBMCF)

Partner 3: Institut für Seefischerei, Hamburg, Germany (ISH)

Partner 4: Fisheries Research Centre, Dublin, Ireland (FRC)

Partner 5: Università di Bari, Bari, Italy (UBARI)

Partner 6: National Centre for Marine Research, Athens, Greece (NCMR)

Partner 7: Instituto Português de Investigação Marítima, Lisbon, Portugal (IPIMAR)

Partner 8: Fisheries Research Services, Aberdeen, United Kingdom (MARLAB)

Partner 9: Instituto Mediterráneo de Estudios Avanzados, Palma de Mallorca, Spain (CSIC)

Partner 10: Møre Research, Ålesund, Norway (MØRE)

Partner 11: Marine Research Institute, Reykjavik, Iceland (MRI)

Partner 12: Instituto Español de Oceanografía, Vigo, Spain (IEO)

RESULTS

Task 1: Description of deep-water fisheries

This task was undertaken by eight partners and has resulted in valuable descriptions of these new and rapidly-developing fisheries. Scotland (Partners 1 and 8) and France (Partner 2) have described various aspects of the developing deep-water bottom trawl fisheries on the continental slope and offshore banks to the west of the British Isles. The most important species in the mixed trawl fishery are *Molva dypterygia*, *Coryphaenoides rupestris*, *Aphanopus carbo* and *Lophius piscatorius* (anglerfish). There is a targeted fishery for *Hoplostethus atlanticus* in deeper water. Scotland (Partner 8) has shown quite clearly the differences between the species and depths being targeted by the two main fleets. The Scottish fleet targets the upper slope, whereas at least part of the French fleet tends to fish deeper. Because some of the French fleet continues to target shelf species, the calculation of CPUE can be difficult. France (Partner 2) has adopted thresholds in order to be able to compute more reliable CPUE data. Recently a fishery has developed for *Reinhardtius hippoglossoides* (Greenland halibut) in the Faroe-Shetland Channel.

Norway (Partner 10) has described in detail the Norwegian longline fishery for *Molva molva*, *Molva dypterygia* and *Brosme brosme* (tusk). This fishery takes place off Norway, the Shetland Islands, the Faroe Islands, west of Scotland and Ireland, and on the Rockall Plateau. Other deep-water fisheries that have been described are the trawl fishery for *Coryphaenoides rupestris* in the fjords, the trawl, longline and gillnet fishery for *Reinhardtius hippoglossoides* and the vertical longline fishery for *Sebastes* sp. ('giant' redfish).

In Icelandic slope waters and on the Reykjanes Ridge there are deep-water fisheries of varying intensity for *Sebastes mentella* (deep-water redfish), *Reinhardtius hippoglossoides*, *Molva dypterygia*, *Hoplostethus atlanticus* and *Argentina silus*. Detailed information on the distribution of these fisheries in relation to hydrography, gear type, the fleet and landings has been compiled by Iceland (Partner 11).

The Spanish Atlantic deep-water fisheries can be divided into three main categories; deep-water bycatch fisheries, deep-water directed fisheries and new deep-water fisheries. The Spanish trawl and longline fleets targeting *Merluccius merluccius* (hake), *Lepidorhombus* spp. (megrim), *Lophius* spp. (anglerfish) and *Nephrops norvegicus* (Norway lobster) land bycatch of deep-water species such as *Phycis blennoides* (greater forkbeard), *Pagellus bogaraveo* (blackspot/red sea bream) and *Helicolenus dactylopterus* (bluemouth). A directed longline fishery for deep-water sharks in ICES sub-Areas VI and VII began in 1991. In addition, in northwest Spain a longline fishery for *Mora moro* (mora) and *Phycis blennoides* takes place in the winter. Other directed fisheries for *Chaceon affinis* (deep-water red crab) and *Pagellus bogaraveo* have also been described by Atlantic Spain (Partner 12). New deep-water fisheries are developing in the Bay of Biscay and on the Hatton Bank.

There are three distinct deep-water fisheries off mainland Portugal. The trawl fishery, which mainly targets high value crustaceans such as *Nephrops norvegicus* and *Parapenaeus longirostris* (rose shrimp), takes place at depths between about 200 and 600 m off the south and southwest coast of Portugal. The fleet, fishing techniques and gear and the bycatch have been described by Portugal (Partner 7). The longline fishery for *Aphanopus carbo* is centred on the port of Sesimbra and takes place at depths of between about 800 and 1200 m. The fleet, method of fishing and the marketing have also been described. In the north of Portugal, there is a targeted longline fishery for *Centrophorus granulosus* (gulper shark).

The deep-water fisheries of Greece are fairly undeveloped and poorly documented. Greece (Partner 6) has provided a detailed overview of the physical and biological characteristics of Greek seas and then described the existing fishery and the fleet.

Task 2: Inventory of survey data and supporting the working up of previous surveys

This task is being undertaken by seven partners. The work content varies between partners. Scotland (Partner 1) has made an inventory of all UK deep-water survey data and has continued to analyse historical data with special emphasis on non-target species. Germany (Partner 3) is compiling survey data from twelve deep-water surveys carried out during the 1970s and 1980s in the northeastern Atlantic. This includes new information previously only held in seagoing logbooks. Iceland (Partner 11) has also screened all survey data from 1975 onwards for information on deep-water species. Others, such as Ireland (Partner 4) and Mediterranean Spain (Partner 9), have developed new unified databases for both historical and new data previously held in a variety of formats. Greece (Partner 6) has compiled and analysed data from three separate surveys in the North Aegean, Thracian and Ionian Seas. Atlantic Spain (Partner 12) is compiling a bibliography and database of 'grey literature' concerning Spanish research and exploratory surveys.

At the first meeting of all the partners it was recognised that data exchange between partners was of considerable importance and it was agreed that a data exchange format was a priority. Scotland (Partners 1 and 8), with input from other partners, has developed an exchange format. It is based on the ICES International Bottom Trawl Survey system but has fields to handle extra parameters such as gear type. New record types have been added to allow for the exchange of biological data such as age and maturity (Coggan and Newton, 1997). The coding of species names caused a problem because no existing system covered the full range of deep-water species. A new system based on NODC codes was developed for use within the project (Newton and Coggan, 1997). In many cases ICES sub-Areas and Divisions are inappropriate for the analysis of deep-water species and new deep-water areas have been defined for use within the project (Coggan, 1997).

Task 3: To describe and quantify the by-catch of unwanted species and undersized fish of target species in the fisheries

One of the major problems with discard studies on deep-water fish is the correct identification of the species being discarded. The use of terms such as 'various sharks' or 'grenadiers' are of only limited value. There is also the problem of secrecy within the fishing industry, especially in developing fisheries. Different partners have addressed the problem in different ways. Some such as France and Scotland (Partners 2 and 8) have had considerable success in sending scientists, who have been trained in the identification of these fish, to sea on commercial vessels. These discard trips, which have all been on bottom trawlers, have also yielded information and biological material for Task 5. In France the emphasis has been on a seasonal study of the discarding of *Coryphaenoides rupestris* from French trawlers operating in ICES sub-Areas VI and VII. Scotland (Partner 8) has placed greater emphasis on the total discards of all species from both French and Scottish vessels working in the same area. Norway (Partner 10) has been investigating the discards from the commercial longliners which target *Molva molva*, *Molva dypterygia* and *Brosme brosme*. In Greece where the deep-water fisheries are not well developed, the likely discards have been estimated from earlier research surveys at three different sites where records and measurements of the total catch have been kept. The composition and quantity of discards depends on the mesh size of the trawl and this is especially important in countries such as Italy and Portugal, where the target species are deep-water crustaceans. In Italy (Partner 5) a

series of seasonal research cruises have been carried out and the discard rates resulting from the use of different mesh sizes are being analysed.

Task 4: To sample the commercial landings of deep-water species

Market sampling of the landings of deep-water fish is important because very often they are landed in grouped categories. Many of the species are new to the industry and there is a problem of misidentification. France (Partner 2) has been sampling the landings of *Hoplostethus atlanticus*, *Coryphaenoides rupestris* and deep-water sharks. Sampling of *Hoplostethus atlanticus* was complicated because the landings tend to be grouped into size categories and the size ranges have been adjusted as the new fishery develops. The landings of *Coryphaenoides rupestris* have been sampled at monthly intervals since December 1995. The landings have also been monitored by observers on board French trawlers. The deep-water sharks are collectively known as 'siki' and consist of two species, *Centroscymnus coelolepis* and *Centrophorus squamosus*. Seasonal changes in the proportion, sex and size composition of the two species have been recorded. Some of the French vessels land their catches in Scottish ports from where they are despatched by road to French markets. Scotland (Partner 8) has been sampling these landings and has concentrated on measuring and collecting otoliths samples from a range of deep-water species. In Iceland selected deep-water species have been added to a list of commercially important species that are routinely sampled by the Marine Research Institute at several locations around Iceland. Problems have arisen with sampling species such as *Hoplostethus atlanticus*, which are only landed occasionally and can be missed by routine market sampling on fixed dates.

The Portuguese longline fishery is primarily directed to *Aphanopus carbo*, but sharks are an important bycatch and in some areas are the target species. Four species, *Centrophorus squamosus*, *Centrophorus granulosus*, *Centroscymnus coelolepis* and *Dalatias licha* (kitefin shark) account for most of the landings and they in turn account for 70% of the total shark catch by Portugal. A routine shark-sampling programme was initiated and the identification of the landings were scientifically verified.

Market sampling in the Mediterranean can be difficult because of the artisanal nature of the fisheries and because the catches tend to be landed at a larger number of smaller ports. Attempts by Greece (Partner 6) to sample the landings of *Polyprion americanum* (wreckfish) were unsuccessful because the landings were too spasmodic. A new programme of sending observers to sea is being initiated.

Task 5: Biological parameters of deep-water species

All partners are contributing to Objective 5. The topics being studied are wide ranging but there is considerable emphasis on age estimation and reproduction, both of which are essential for assessment purposes.

Partner 1: Scottish Association for Marine Science, United Kingdom (SAMS)

This partner has a long time-series of data from deep-water surveys in the Rockall Trough and the Porcupine Seabight. In these areas multi-species bottom trawl fisheries are the most important and many non-commercial species are discarded. All discards are dead when returned to the sea and it is probable that a high proportion of the escapees of small fish suffer a high mortality. In order to understand the impact of deep-water fishing on the ecosystem, it is important to understand the biology of the non-target species. Investigations have been completed on the

biology of the notacanthid fishes (Coggan et al., 1997, 1998a), the macrourid, *Nezumia aequalis* (smooth grenadier) (Coggan et al., 1998b; in press) and deep-water sharks (Gordon and Swan, 1997). Age estimation in deep-water fish is difficult and the estimates have seldom been validated. Earlier work on age validation of *Coryphaenoides rupestris* (Gordon and Swan, 1996) has been extended to other macrourid species.

Partner 2: IFREMER and Collège de France, France (IFREMER/LBMCF)

This partner has concentrated on the biological parameters of *Hoplostethus atlanticus*, *Coryphaenoides rupestris* and the deep-water sharks. Age estimation in *Hoplostethus atlanticus* continues to be controversial and this partner is attempting to validate age estimation by *in situ* marking of trapped fish and an analysis of otolith microstructure. In the absence of age estimates, catch statistics and length data have been analysed. Detailed studies of the reproduction of *Hoplostethus atlanticus* have been undertaken. The growth and reproduction of *Coryphaenoides rupestris* has been investigated using material collected from discard surveys and market sampling. The reproductive biology of the deep-water sharks, *Centrophorus squamosus* and *Centroscymnus coelolepis*, has been investigated. Data from French exploratory cruises in the 1960s and 1970s, together with new data from a cruise in 1996, is being used to investigate the possible impact of deep-water fishing on the ecosystem.

Partner 3: Institut für Seefischerei, Germany (ISH)

On completion of the analysis and archiving of all the German deep-water survey data, this partner will carry out an analysis of the data in terms of faunal composition, abundance and other parameters by area, depth and season.

Partner 4: Fishery Research Centre, Ireland (FRC)

Studies of the biology of *Coryphaenoides rupestris* (Kelly et al., 1996, 1997); *Helicolenus dactylopterus* and *Phycis blennoides* (Kelly, 1997) have been completed. Investigations are now in progress on the biology of the *Aphanopus carbo*, *Hoplostethus mediterraneus* (silver roughy) and *Alepocephalus bairdii* (smoothhead). Ongoing throughout the project is a PhD study of the biology of the deep-water sharks, *Centroscymnus coelolepis*, *Centrophorus squamosus* and *Deania calceus* (birdbeak dogfish), with the emphasis on age estimation.

Partner 5: University of Bari, Italy (UBARI)

The material for this study has been obtained from a series of eight seasonal deep-water cruises in the north Western Ionian Sea. Data on length-frequency distribution, sex ratio, and maturity stage have been examined for the following species: *Aristeus antennatus*, *Aristaeomorpha foliacea*, *Nephrops norvegicus*, *Merluccius merluccius*, *Micromesistius poutassou*, *Phycis blennoides*, *Helicolenus dactylopterus*, *Hymenocephalus italicus* (Italian grenadier), *Caelorinchus caelorinchus* (hollowsnout/blackspot grenadier), *Nezumia sclerorhynchus* (rougthead grenadier) and *Hoplostethus mediterraneus*. Histological studies on the reproduction of *Aristeus antennatus* and *Aristaeomorpha foliacea* have been completed.

Partner 6: National Centre for Marine Research, Greece (NCMR)

A total of at least 24 species of fish and crustaceans were caught during the deep-water sampling cruises in the south Ionian Sea. For each species data is available on monthly fluctuations by

depth zone, length-frequency distribution, depth distribution by number and weight and mean length distribution in relation to depth. More detailed studies of the biology, especially reproduction, of the deep-water shrimps *Aristeus antennatus*, *Aristaeomorpha foliacea* and *Nephrops norvegicus*, are in progress.

Partner 7: Instituto Português de Investigação Marítima, Lisbon, Portugal (IPIMAR)

The material for this study results from a series of deep-water surveys carried out since 1990 and now integrated with the Project. The distribution and abundance of the following species has been studied: *Helicolenus dactylopterus*, *Phycis blennoides*, *Conger conger* (conger eel), *Hoplostethus mediterraneus*, *Trachyrincus scabrus* (roughsnout grenadier), *Nezumia sclerorhynchus*, *Galeus melastomus* (blackmouth dogfish), *Deania calceus*, *Chimaera monstrosa* (rabbit fish), *Centrophorus granulosus*, *Dalatias licha*, *Nephrops norvegicus*, *Aristeus antennatus*, *Aristaeomorpha foliacea*, *Plesionika martia* (golden shrimp), *Plesiopenaeus edwardsianus* (scarlet shrimp) and *Geryon longipes* (Mediterranean geryon). For each species biological data on length, weight, sex and maturity stage have been recorded. Material for age estimation was also collected. Age estimation has focused on developing techniques for the study of *Hoplostethus mediterraneus*, *Helicolenus dactylopterus*, *Deania calceus* and *Galeus melastomus* (Correia and Figueiredo, 1997).

Partner 8: Fisheries Research Services, Aberdeen, United Kingdom (MARLAB)

The work has focused on age estimation using the otoliths collected during discard trips and from market samples. *Coryphaenoides rupestris* otoliths have been sectioned while the otoliths of *Argentina silus*, *Helicolenus dactylopterus* and *Brosme brosme* are read whole. Monthly length/weight relationships have been calculated for the main commercial species and work is in progress on the less important species.

Partner 9: Instituto Mediterráneo de Estudios Avanzados, Palma de Mallorca, Spain (CSIC)

Detailed studies on the distribution, reproduction and age composition of selected deep-water species are being carried out. The study of *Bathypterois mediterraneus* (Mediterranean spiderfish) is complete (Morales-Nin et al., 1996) and work on *Phycis blennoides*, *Mora moro* and *Lepidion eques* is in progress. Two cruises aimed at investigating the distribution of fish and macrofauna in a virgin deep-water area south of Eivissa and Formentera Islands have been carried out. Studies of the fish assemblages and how they are influenced by environmental and biological factors are in progress.

Partner 10: Møre Research, Ålesund, Norway (MØRE)

The main target species of the longline and gillnet fisheries are *Reinhardtius hippoglossoides* and *Sebastes* spp. The so-called 'giant' redfish is morphologically similar to *Sebastes marinus* (redfish) but there are genetic differences between these large specimens and those caught in shallower water. There has been a dramatic decrease in the CPUE between 1996 and 1997. Discards of non-target species have been estimated from exploratory surveys. In the *Reinhardtius hippoglossoides* surveys on the Reykjanes Ridge, the main discard species were *Macrourus berglax* (roughhead grenadier) and *Antimora rostrata* (blue hake). In the horizontal longline survey for *Sebastes* spp. the main discards were *Centroscyllium fabricii* (black dogfish), *Macrourus berglax* and *Antimora rostrata*, whereas in the vertical longline survey the discards were dominated by *Etmopterus princeps* (greater lantern shark). Investigations are being carried

out on the age, growth and reproduction of both target and non-target species on the Mid-Atlantic Ridge.

Partner 11: Marine Research Institute, Iceland (MRI)

Material for these studies has been obtained from the historical data extracted for this project and from a ground fish survey carried out for *Reinhardtius hippoglossoides* and *Sebastes* spp. in 1996 and a dedicated deep-water cruise to the Reykjanes Ridge area in 1997. During the 1996 cruise 38 deep-water species were sampled. 56 hauls were made on the Reykjanes Ridge between depths of 600 and 1800 m and 79 species of fish were recorded. The results of the work on *Argentina silus* has been published (Magnússon, 1996). Detailed studies of other species are in progress.

Partner 12: Instituto Español de Oceanografía, Vigo, Spain (IEO)

The material for these studies was obtained by sending trained observers on commercial vessels and from a deep-water fishing survey in the summer of 1996. The most detailed studies have been on the biology of *Phycis blennoides*. Length frequency data by sex has been obtained for *Deania calceus*, *Galeus melastomus* and *Trachyrincus scabrus*. Length-frequency data for both sexes combined have also been analysed for *Lepidion eques*, *Trachyscorpia cristulata echinata* (spiny scorpion fish) and *Hoplostethus mediterraneus*. Length/weight relationships by sex and area have been computed for sixteen of the more important species.

CONCLUSIONS

In this paper, I have not attempted to describe all the achievements of this project. Instead I have tried to highlight some of the results which either are published or have been described in the first and second progress reports of the project and which reflect the range of work being undertaken. Some of the more recent work is described in separate papers being presented in the Theme Session and which are listed in reference list B.

It is perhaps inevitable that in a project with so many partners, there will be a tendency for each partner to work independently. However the project has been useful in building up a network of expertise in deep-water fish and fisheries. In the Atlantic and ICES context the project has accounted for most of the new information provided to the ICES Study Group on the Biology and Assessment of Deep-Sea Fisheries Resources in 1996 and 1998.

As a part of the project, two workshops have been held. The first was held in Concarneau in 1997 and was devoted to age estimation in deep-water fish species. The second was held in Vigo in 1998 and was divided between age estimation and reproduction.

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(B) Papers and posters contributed to Theme Session O resulting in whole or in part from EC FAIR Project 95/655.

PAPERS

O:04. V. Allain: Reproduction and fecundity of 3 species of deep-sea fish from the north-east Atlantic Ocean.

O:08. B Morales-Nin: Mediterranean deep-water fish age determination and age validation: the state of the art.

O:10. C.G. Piñeiro, M. Casas and R. Bañón: Current situation of the deep water fisheries exploited by Spanish fleets in the North and Northeast Atlantic: A review.

O:11. T. Blasdale and A.W. Newton: Estimates of discards from two deep-water fleets in the Rockall Trough.

O:19. P. Lorance and H. Dupouy: C.P.U.E. abundance indices of the main target species of the French deep-water fishery in ICES Sub-areas V, VI and VII.

O:20. H. Dupouy, V. Allain and B. Kergoat: The discards of roundnose grenadier in the French fishery in ICES Sub-areas VI and VII.

O:32. J.V. Magnússon: Age, maturity and other biological parameters of two morid species *Lepidion eques* (Günther, 1887) and *Antimora rostrata* Günther, 1878, in Icelandic waters.

O:33. R.A. Coggan, J.D.M. Gordon and N.R. Merrett: Reproduction, age and growth in the grenadier *Nezumia aequalis* (Günther, 1878) (Pisces: Macrouridae) a by-catch species of deep-water fisheries to the west of the British Isles.

O:35. K.B. Jakobsdóttir: Maturity and other biological aspects of two deep water squaloid sharks, *Centrosyllium fabricii* (Reinhardt, 1825) and *Etmopterus princeps* Collett, 1904, in Icelandic waters.

O:39. N.-R. Hareide and G. Garnes: The distribution and abundance of deep water fish along the Mid-Atlantic Ridge from 43° N to 61° N.

O:40. C.J. Kelly, P.L. Connolly and M.W. Clarke: The deep water fisheries of the Rockall Trough; some insights gleaned from Irish survey data.

O:41. M. Clarke, P.L. Connolly and J.J. Bracken: Age estimation of the squaliform shark *Centrophorus squamosus* (Bonnaterre, 1788) using the second dorsal spine.

O:45. G. Petrakis, A. Terrats, A. Plastiras and C. Papaconstantinou: Some aspects on the reproduction of six deep water fish species in west coast of Greece (Ionian Sea).

O:50. G. Petrakis: Catch per unit of effort fluctuations in deep waters in west coast of Greece (Ionian Sea).

POSTERS

- O:09. J.-M. Casas, C.G. Piñeiro and R. Bañón: Results of experimental fishing surveys carried out in Galician deep waters.
- O:38. Ch. Mytilineou, G. Petrakis and A. Fourtouni: Composition of the discarded catches from bottom trawl experimental surveys in Greek waters.
- O:58. J.D.M. Gordon: The EC FAIR Deep Fisheries Project.
- O:59. L. Carvalho and I. Figueiredo: Black scabbardfish fishery. Analysis of a pilot sampling.
- O:60. P. Lorance, H. Dupouy and V. Allain: Assessment of the roundnose grenadier (*Coryphaenoides rupestris*) stock in the Rockall Trough and neighbouring areas (ICES Sub-areas V, VI and VII).
- O:61. H. Dupouy and P. Lorance: Biomass estimate and optimum rate of exploitation for three main species of deep-sea fishes in ICES Divisions VI and VII bc.
- O:65. V. Henriques: Portuguese deepwater fisheries in the continental slope.
- O:66. J. Magnússon: Deep-water fisheries at Iceland.
- O:67. O. Moura, I. Figueiredo, P. Bordalo Machado and V. Henriques: Research on deep-water species off the Portuguese continental coast.
- O:68. M.J. Figueiredo, I. Figueiredo and P.B. Machado: Deep-water crustaceans off the Portuguese continental slope: Will they be an alternative to the future?
- O:69. P.B. Machado, R. Martins, I. Figueiredo and L. Gordo: Some notes on the biology of the black scabbardfish.
- O:70. I. Figueiredo and A. Moreira: Biological aspects of bluemouth off the Portuguese continental slope.
- O:72. O. Moura: Species density estimates by kriging and stratified random sampling estimators.
- O:73. P. Lorance, M.-H. Dubuit and C. Berrehar: Orange roughy fishery in the North East Atlantic.
- O:74. P. Lorance: Comparison of the deep demersal fish assemblage structure sampled before and after fishery exploitation.
- O:85. C. Papaconstantinou, C. Boutsoulis and G. Petrakis: Biological aspects of black-bellied angler (*Lophius budegassa*, Spinola, 1807) in the Aegean Sea (Mediterranean Sea).
- O:86. M. Girard and M.-H. Du Buit: Particularities of the reproductive cycle in two species of deep-water sharks; *Centrophorus squamosus* and *Centroscymnus coelolepis*.