Faroese Fisheries Laboratory
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FO-110 Tórshavn
Faroe Islands

Workshop on mesopelagic fish

Tórshavn, Faroe Island
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EXECUTIVE SUMMARY

Eight participants attended the workshop on mesopelagic fish, which was held in Tórshavn, Faroe Islands in February 7 – 8 2004.

The first part of the workshop was to share knowledge on investigations made by each country that participated in the workshop.

The second part was to discuss future research from the shared knowledge between, Iceland, Faroe Island, Norway, and Russia.

The last part was to establish a Nordic project, and it was decided that the joint research on mesopelagic fish and krill should be divided into three groups; (i) Gear and technology; (ii) Historic data and literature; and (iii) Future surveys.

MEETING AGENDA AND APPOINTMENT OF A REPPORTEUR

Hjalti í Jákupsstovu (chairperson) opened the meeting and Súni Lamhauge from The Faroese Fishery Laboratory was appointed as rapporteur.

The agenda was as follows:
Introduction, Hjalti Í Jákupsstovu
Icelandic investigations, Thorsteinn Sigurdsson
Norwegian Investigations, John Willy Valdemarsen
Faroese Investigations, Súni Lamhauge and Bjarti Thomsen
Russian investigations, Anatoly Filin
Catch technology, John Willy Valdemarsen
Discussion on future research and recommendation, Hjalti Í Jákupsstovu
Planning of a Nordic project, Hjalti í Jákupsstovu

INTRODUCTION

Hjalti í Jákupsstovu, the Faroese Fishery Laboratory, Tórshavn.

Mesopelagic fish is one of the greatest marine resources that still are underutilized. With the growing aquaculture industry there is an increasing demand for fish protein and fish oil for this industry. The objectives of the workshop are to explore the present knowledge about these fish in the North Atlantic, and to co-ordinate and initiate further investigations on these resources. Iceland has in the last few years collected information on mesopelagic fish in the Irminger Sea during their investigations on redfish. They have also done some exploratory fishing trials. In Faroese waters Russian trawlers fishing for blue whiting have occasionally reported significant by-catches of mesopelagic fish, and the Faroese Fisheries Laboratory has also done some exploratory fishing, but so far without any success. However, we feel that there is a lot more to be done describing the biology and distribution of mesopelagic fish in the North Atlantic.

ICELANDIC INVESTIGATIONS

Thorsteinn Sigurdsson, Marine Research Institute Reykjavík.

Results obtained over the Reykjanes Ridge and in the Irminger Sea during pelagic redfish cruises from 1996-2001, results from the 2003 survey (Icelandic contribution to the MAR-ECO project), and trials with a commercial vessel in 2002 were reviewed.

For mesopelagic fish, the aim during the pelagic redfish cruises in the years 1996-2001, was to identify and measure different species, to map the distribution of the deep scattering layer (DSL), and to map the distribution pattern of selected species within the DSL.

Acoustic results were that using data from ICES coordinated trawl-acoustic survey in 2001, relative abundance can not be converted to biomass, due to unknown species composition and unknown TS in the DSL.

Trawl catches consisted of 99 fish species from 43 families, and 4 of these families accounted for 35% of the species. These families were Myctophidae (11 species), Stomiidae (9 species), Platytroctidae (8 species), and Sternoptychidae (7 species).
25% of the species occurred in more than 10% of all tows.

In summary there was continuous distribution of mesopelagic fish throughout the survey area, although the catches in each tow were low. The most common families were Myctophidae, 11 species - 90% of stations, 44% of total number caught, Bathylagidae 3 sp., 86% of stations, 21% of the number caught, and Stomidae 9 sp. 94% of stations, 13% of number caught.
There was probably an underestimation of smallest fish due to too large mesh size. The Myctophidae *Protomyctophum arcticum* was common in "small mesh size" trawl in the northern part of the investigation area (Magnússon, 1996), but were only identified from one tow in these experiments.

The main objectives of the MAR-ECO part of the survey were to;

- examine the organization and trophic structure of the pelagic ecosystem over the Reykjanes Ridge from phytoplankton to fish as apex predators. Target groups are copepods, euphausiids, chaetognaths and fish
- provide an estimate of the biomasses at the various trophic levels and the energy flow through the ecosystem by combining data from stations occupied at different times we will seek to elucidate diel changes in vertical distribution and feeding

A Gloria type pelagic trawl #1024 m circumference with a 9 mm mesh size codend was used. The data from these experiments is not finally analysed; however more than 70 species were caught in the trawl during the whole survey. The 6 most common fish species were *Benthosema glaciale, Protimyctophum articum, Maurolicus muelleri, Arctozenus rissoi, Bathylagus euryops* and *Chauliodus sloani*.
The average catch in each tow was below 50 kg and often below 10 kg in 60 min. tows. When trawling shallower than 500 m, the number of species approx. 5cm in length were more abundant than when trawling deeper than 500 m. There was also a diurnal change in DSL.

During the trials on the Reykjanes Ridge with the commercial vessel Ásgrímur Halldórsson (17-23 April 2002 and 5 – 12 June 2002), they used a Gloria #1280 from Hampidjan, with a codend with 9

mm mesh size. In summary there were low catch rate in most hauls (Maximum 10 tonnes), and the acoustic recordings were low according to the fishermen perception during the trials.

NORWEGIAN INVESTIGATIONS

John Willy Valdemarsen, Institute of Marine Research, Bergen

The Norwegian research on mesopelagic fish has been reviewed by Anne Gro Vea Salvanes, who has written a chapter on mesopelagic fish in a new book (not available yet) entitled the Norwegian Sea Ecosystem. The book reviews the species and their morphological and physiological adaptations, life history, genetic structure and horizontal distributions, vertical migration behaviour, trophic position, and gives a stock sizes estimate on *Maurolicus muelleri* and *Benthosema glaciale* in the Norwegian Sea.

FAROESE INVESTIGATIONS

Súni Lamhauge and Bjarti Thomsen, Faroese Fishery Laboratory, Tórshavn.

Myctophids are distributed in all Faroese waters outside the plateau, and are sometimes caught as bycatch in blue whiting fishery. The Russian bycatch peaks in April – June. It seems like the abundance varies between years, with 2002 as a good year.

It is *Notoscopolus kroeyeri*, *Benthosema glaciale* and *Myctophum punctatum* which are most common in Faroese waters. From salmon stomach analysis it seems like *Benthosema glaciale* and *Myctophum punctatum* are mainly found north of Faroe Island, whereas *Notoscopolus kroeyeri* is located slightly more southerly. The stomach analyses were made during the salmon season Nov.-Dec and Mars-April in 1992 till 1995.

A fishing trial was made with the commercial vessels Christian í Grótinum 1. -6. October 2002. The trawl used was an 1856 m blue whiting trawl from Vónin, where the aft part of the belly and the codend was taken from a capelin trawl. The aft part of the belly was 71 m with mesh size ranging from 400 mm till 35 mm. The codend was 64m and the meshsize was 19,6 mm. It was concluded that the trawl does not catch myctophids efficiently.

Due to limited data, it is uncertain whether spawning is occurring in Faroese waters or not. However, there has occasionally been found 0-group myctophids on Faroe Bank in some years. The species caught were not identified.

RUSSIAN INVESTIGATIONS

Anatoly Filin, Knipovich Polar Research Institute of Marine Fisheries and Oceanography (PINRO), Murmansk

Dr. Filin presented experience and some results from research of mesopelagic fish as a potential commercial fishery resource by PINRO in the North Atlantic in 1982-1989.

The main purposes of these studies were to

- detect commercial concentrations of mesopelagic fish in the North Atlantic
- assess stocks of mesopelagic fish, study of distribution of mesopelagic fish and mechanism behind formation of their commercial concentrations
- provide advice on fishing technique for mesopelagic fish

- develop proposals on modification of trawls for fishing on mesopelagic fish
- explore biochemical composition of mesopelagic fish
- develop proposals for processing technology of mesopelagic fish
- study life history of most abundant of mesopelagic fish species and their role in the ecosystem

Main results from the study on mesopelagic fish of the North Atlantic by PINRO in 1982-1989:

- The most promising area for fishing of mesopelagic fish are on the Newfoundland shelf.
- Concentrations of myctophids, which are accessible to commercial fishing, formed on the slopes of Grand Bank in autumn and are represented by 4 species: *Myctophum punctatum, Ceratoscopelus maderensis, Benthosema glaciale* and *Notoscopelus kroeyeri.*
- Maximum daily catch rates were 25-40 tonnes.
- Potential long term yield was estimated to 300 000 tonnes and 50 000 tonnes in the short term.
- The main constrain for development of a fishery of mesopelagic fish in the North Atlantic was the fishing gear. The catch ability of midwater trawl with a codend with double 12 mm mesh size was estimated to 5-15%. He reported that trawl modifications with special devices to concentrate the fish resulted in a catch ability of 20-30%, nevertheless it was considered to be insufficient catch rates.
- Distribution and concentration of mesopelagic fish totally depend on dynamics of water masses.
- Most dense concentrations were found in zones of convergence, currents and different gyres.
- Concentrations of mesopelagic fish are stable as long as the dynamical formation of water masses exists.
- According to estimates, the total allowable catch of short-life species like mesopelagic fish can be as large as 50% of the total stock.
- The Northwest Atlantic myctophids have only a secondary role in diet of commercial fish species.
- Economic benefit from fishing of myctophids in the Northwest Atlantic may be gained by organising it as a mixed fishery with redfish, and by using myctophids partly for consumption.

CATCH TECHNOLOGY

John Willy Valdemarsen, Institute of Marine Research, Bergen

A document on efficient capture and handling of myctophids in Oman, written by Wilfried Thiele (FAO) and John Willy Valdemarsen (then FAO) in 2000 was reviewed. In combination with the presenter's later experience with technology to catch krill, the following key elements were considered as important for efficient capture of small organisms, like krill and mesopelagic fish.

- Large trawls with large meshes in the front part will not herd small fish as myctophids and krill in a similar way as faster swimming fish like blue whiting and herring. Large mesh trawls are thus inefficient for such organisms
- A trawl for efficient myctophids capture should, however, have an opening that is relatively large with a minimum of 20 m vertical opening, moderate (1000mm) mesh sizes in the front part, and less than 30 mm behind the belly section were the diameter is around 8m. The codend should have maximum 10 mm meshsize

- for efficient capture of zooplankton like krill, there is no herding, and the mesh size should therefore not exceed 10-20mm in the part of the trawl that retain such target organisms

DISCUSSIONS ON FUTURE RESEARCH AND RECOMMENDATIONS

Chairperson: Hjalti í Jákupsstovu

An example of a 38 kHz simrad EK500, paper recording that has been interpreted as myctophids was shown. Due to lack of myctophids in the sampling, the question that was raised to begin this discussion was whether it was myctophids or not.

It was mentioned that echo recordings are very difficult to interpret, and therefore catch records are needed to understand the biology of any species and to improve the interpretations of any recordings.

The fishing gears used on most echo surveys are not designed to catch efficiently mesopelagic fish and krill and in the future research; it was recommended that new sampling gear should be designed. Furthermore, the need to establish target strength relationships for mesopelagic fish and krill was stressed.

The possibility of identification of echo recordings from pictures taken by cameras mounted on submarine vehicles or on the sampling gear was discussed. It was noted that video cameras will be used for this purpose on the MAR-ECO cruise 2004.

In conclusion it was decided that we should focus on catching samples by trawls, and that the problem of how to estimate the biomass of myctophids from acoustic surveys has high priority.

The possibility of using old acoustic data was discussed, and it was concluded, that this would be very time consuming and the outcome dubious as the data probably would not have been systematically recorded. An effort has to be made to encourage systematic in this respect in future acoustic surveys. This question will be taken up on the next ICES planning group on Northeast Atlantic Pelagic Ecosystem Surveys 2004 in Murmansk, Russia 24 – 27 August.

Future surveys targeting mesopelagic fishes alone would be difficult to achieve, and were possibly not advisable. For the immediate future it would be better to integrate studies on krill and mesopelagic fishes in other acoustic surveys e.g. surveys on blue whiting and herring.

The question of localizing the spawning grounds was discussed. From the former Sovjet investigations it is evident that there is spawning of *Notoscopelus kroeyeri* in Newfoundland area and west of Ireland. There are two different population of *Notoscopelus kroeyeri* in the North Atlantic, the western and the eastern. *Benthosema glaciale* is spawning west of Ireland, all over the North Atlantic and there are different populations in the Norwegian fjords. Whether there is spawning in Faroese waters is unknown, however there has been found 0-group Myctophids on Faroe Bank occasional years. The species have not been determined; however it was proposed that it most likely is *Benthosema glaciale*. This has to be looked into.

There was a discussion on where it is most likely to carry out commercially fishery on Myctophids in the North Atlantic. According to available data, this may be in the Newfoundland area in the

Northwest Atlantic. There is however the necessary condition for the formation of dense concentration of mesopelagic fish in the area near the Faroese Plateau, but there has not been conducted as intensive research on Myctophides in this area as in Newfoundland and Labrador area.

In the Northwest Atlantic myctophids only have a secondary role in the diet of commercial species of fish. Although stomach analyses are few in the Icelandic research, myctophids are not likely to be a large part of the diet of commercial fish species. This was also the case in the Faroese stomach analyses, though the majority of the stomach samples were made on the Faroe plateau. The myctophids are, however, a common prey of wild salmon.

There is an ever-growing demand for marine fish protein for fish feed in the aquaculture industry, and it was noted that *Notoscopelus kroeyerii* and *Myctophun punctatum* could be a potential resource in the future.

All the participants agreed upon that further research on mesopelagic fish and krill should have a practical approach with focus on commercial utilization.

All the participants contributed to this discussion.

PLANNING OF NORDIC PROJECT

Hjalti í Jákupsstovu, Faroese Fishery Laboratory, Tórshavn.

From the discussion and recommendations, the following subtasks emerged. The names in boldface are the chairpersons within each task:

	Gear and technology	Historic data and literature	Future surveys
Faroe Island	Bjarti Thomsen Kristian Zachariassen	Súni Lamhauge	**Jan Arge Jacobsen**
Norway	**John Willy Valdemarsen**	Reidar Thoresen	Mikko Heino
Iceland		**Thorsteinn Sigurdsson**	Thorsteinn Sigurdsson Hjalmar Vilhjálmsson
Russia		Anatoly Filin	

Subtask: Gear and technology

Zooplankton and mesopelagic fish are small organisms, which only can be captured with pelagic trawls. Earlier experience indicates that traditional gear designs used for other pelagic resources are unsuitable to catch large quantities of zooplankton like krill and some mesopelagic fish species. Their general small size and thus swimming capability indicates that herding by large meshes will be poor, and trawl designs that rely more on filtering is most likely a better option. A trawl design to catch krill should maximise the filtering volume whereas a trawl for mesopelagics should also utilize the swimming capability of the targeted fish by having larger meshes in the front part of the trawl that will herd the fish into the codend zone.

There are two obvious needs in fishing technology development;

1. Develop a trawl that can measure accurate densities

2. Develop trawl designs and fishing techniques that can result in commercial acceptable catch rates.

The quantitative survey gear should catch all species and sizes from 5mm to 20 cm that are encountered in the trawl mouth. Such a sampling trawl should most likely have a mouth area between 50 and 100 m^2 and designed with small meshes in belly and codend.

The commercial trawl for efficient krill capture will be slightly different from the efficient trawl for mesopelagics. Mesh size and tapering of the trawl belly will be critical for the optimal krill trawl design to avoid loosing of targets through the meshes. Possible design features that should be investigated are to use multi-codend concepts. The mesh herding is the critical unknown feature for mesopelagic species. Improved knowledge of such behaviour is a basic requirement to know how long a front belly of larger meshes should be. The longer the large belly the bigger the trawl entrance area can be. The mesh size in the aft belly in front of the codend is another critical design feature of an efficient trawl for mesopelagic fish.

The gear development will have to include behaviour observations in the catching process, and practical testing of various trawl designs including modifications of mesh sizes in various parts of the trawl belly. Such testing has to be carried out on realistic and high concentrations of target organisms.

Organization of the work
Institute of Marine Research in Bergen, Norway will have the lead in the fishing technology development. Ongoing and planned research at IMR will aim to find solution to the described problems. Expertise from the Faroe Island and Iceland will participate in this work, including practical testing and evaluation of various trawl design options.

Subtask: Historic data and literature

In the North-East Atlantic, extensive deep scattering layers of varying intensities have been observed by echosounders throughout vast areas at depths between 0 and 800 m. A great variety of pelagic organisms are found in these layers, but the major components are believed to be fish of several families such as Myctophidae, Stomiidae, Platytroctidae and Sternoptychida, but also jellyfish, cephalopods and euphausiids. The combined biomass of these organisms is believed to be very high, but has not been evaluated because neither the actual species composition in the layers nor their associated acoustic back scattering coefficients are known.

Biological processes of these species are poorly known, but various investigations have been conducted. However, no overview of current knowledge is available and therefore urgently needed. Compilation and evaluation of published and unpublished data on the biology (live cycle, growth, migration etc.) of the species will be an important part of achieving better knowledge of how to utilize the resource in most profitable way. Such knowledge on the most abundant species will help fishermen in localising areas where one could expect fishable concentrations

The main objective of this subtask will therefore be investigation on available literature on the biological aspects of the most abundant species that have been identified in the past. If possible, unpublished information will also be investigated. The goal is to have a better overview of the live

cycles of selected species or groups of species such as where the spawning grounds are, possible migration pattern and other information that are relevant.

Subtask: Future surveys

In order to modify present and future surveys to also include information on mesopelagic species and micronekton at least two options are available:

- Modify existing surveys as to include sampling of mesopelagic fish.
- Plan new surveys dedicated for mesopelagic fish.

New information on mesopelagic species could be obtained from existing surveys by adding comparatively small effort to existing plans. By increasing the frequency of biological sampling, i.e. pelagic trawling, it should be possible to identify the acoustic recordings throughout the water column (at least down to 500 m depth), provided that a suitable gear is used. This task should in any case be practiced in a well planned survey. The crucial point in this process is to use a pelagic trawl designed to catch small mesopelagic species (down to say 3-5 cm). This could be obtained either by using a separate trawl for mesopelagic fish or modify the ordinary sampling trawl to catch small fish.

The second option with new dedicated surveys is more expensive, but is more likely to yield satisfying results. New surveys will be needed because the distribution of mesopelagic fish is likely to be in other areas of common interests for many existing pelagic species like herring, blue whiting and mackerel. This would be in connection with WP "Historic data and literature", dealing with the biology and the distribution pattern.

The ICES Planning Group on Northeast Atlantic Pelagic Ecosystem Surveys (PGNAPES) currently coordinates the pelagic surveys on blue whiting and herring in the Northeast Atlantic. During these surveys mesopelagic species have been reported, but usually in small quantities. With rather small addition of effort and minor changes in their design it should be possible to gather information on mesopelagic fish during these surveys. The modifications would include a standard template on where and when to trawl for the identification of acoustic recordings and which gear to use.

CLOSURE OF MEETING

On behalf of all participants, the chairperson summed up the agenda, and the meeting was then closed.

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