Iranian Journal of Fisheries Sciences 4(2) 101-110 (2005)

Biomass Distribution and Pattern of Myctophids in the Oman Sea

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Abstract: In conformity with programming to harvest from virgin resources of Myctophids (*Benthosema pterotum*) in the Oman Sea (Iranian waters), a series of research cruises and trial fishings were carried out from 1992 to 1998. Assessment of *B. pterotum* stocks was carried out using the data obtained from a series of seven cruises conducted by R/V Ferdows1 in the Iranian waters using modern scientific echo sounder of EK500 system in 1993-94, with complementary monitoring surveys in the following years. The biomass estimates ranged from 1 to 4 million tones with an average of 2.3 million tons. A number of fishing operations using mid-water trawls were also performed in 1994-1998 using the same vessel. Distribution of *B. pterotum* was found to be all around the Oman Sea. The dense schools of this species were found in the northwest areas of the Iranian waters. Also the F/V Jahad Fanoos was applied during 1994-95 to do some trial fishings and its maximum catch was 50 t /h.

Key words: Myctophids, *Benthosema pterotum*, Biomass, Distribution, Oman Sea, Iran

Introduction

The Oman Sea is relatively rich in fisheries resources with considerable quantities of mesopelagic fish occurring on, and seaward, of the continental slope and through the deep zone of the Oman Sea waters.

The importance of lanternfishes in the Oman Sea was indicated by studies on eggs and larvae collected by R/V Anton Bruun during 1959-1965. A series of surveys conducted by R/V Dr. Fridtjof Nansen were carried out in 1975-1981 and 1983-84; Gunnar *et al.*, 1999 in the Arabian Sea and Oman Sea (both Iranian and Omani sides). During 1989–1990 in order to determine the distribution of Myctophids and undertake stock assessment of these resources, the Korean R/V

Jeng Bang san and Norwegian R/V Rastrelliger were used to cover Iranian and Omani sides, respectively.

Because of the limited coverage of areas of the past surveys, more accurate and precise information was needed and therefore the R/V Ferdows 1 was used to cover all the area of the Iranian side of Oman Sea (1992-93) with the main objectives of : 1) To estimate the biomass of Myctophids and 2) to determine the fishing season and fishing grounds (distribution pattern) of Myctophids. A number of monitoring surveys and trial fishing were also performed by this research vessel. In addition to the above mentioned studies, more information was needed before starting any commercial fishery in the region. Hence, the F/V Jahad Fanoos was used during 1994-1995 to carry out continuous commercial fishing on Myctophids in the Oman Sea

Material and Methods

R/V Ferdows 1 was used to carry out research cruises. This vessel is a 673 GRT stern trawler with 45.4m length overall for acoustic surveys. Simrad EK500 dual frequency 38/120 kHz scientific sounder system was installed on the vessel along with two color graphic printers.

The vessel was equipped with a pelagic trawl with small codend mesh size (10mm). Fishing operations were performed in different depths, up to 400 meters, for species confirmation, to collect information on trawl performance and to collect data that could be used in later biomass – backscattering cross section analysis. The studied area covered by the survey was determined by the median line between Iran and Oman and the border line with Pakistan and approximately the 100m isobaths on the Iranian continental shelf spreading from 57° 00` E to 61° 25` E (Fig. 1).

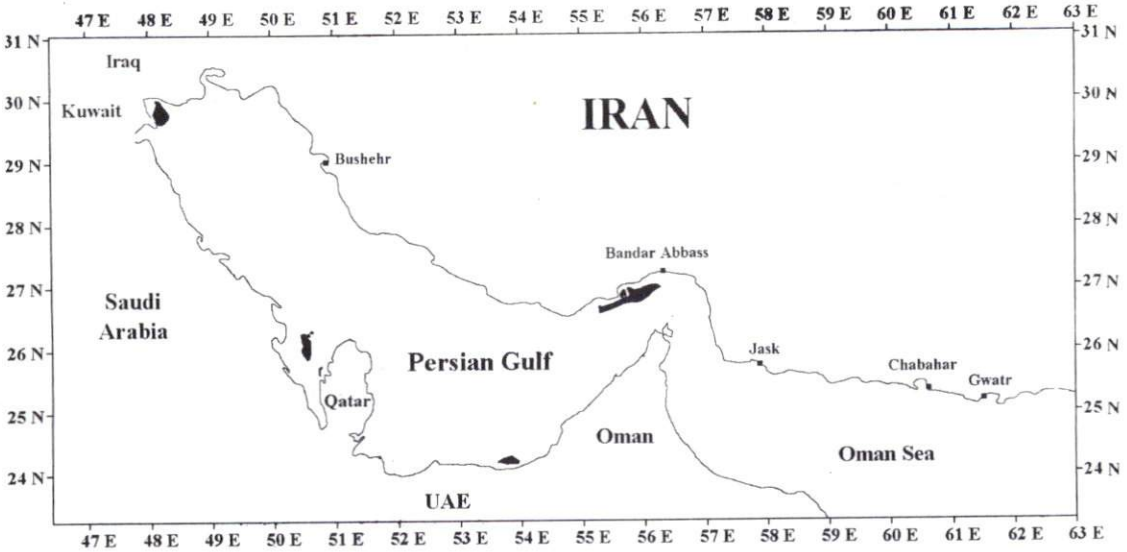

Figure 1: The position of studied area in the Oman Sea

The Simrad system was run continuously during the cruise and in connection with the 38 kHz scientific sounder a detailed set of quantitative acoustic data was obtained. After each EDSU = 2.5nm section a detailed tabular listing of data describing the mean area backscattering cross section values, down to a maximum depth of 450m, was printed.

Since collection of acoustic data should be accompanied with biological data to verify the identification of the species that were sonified, a number of mid-water trawl fishing operations were also performed.

The method of determining the backscattering cross section depends on the fish catch to the integrated echo intensity from the fish caught by the trawl. The fish density can be determined from the volume swept by the trawl, V_s, and the number or fish that were caught (MacLennan & Simmonds, 1991 ; Shotton, 1981) :

$$V_s = 1852\, d_t A_e \qquad (1)$$

Where:

dt = distance towed in nm as measured by the GPS

A_e= mean area of the trawl mouth opening thus the fish density is given by:

$$\rho = \frac{N}{Vs} \qquad (2)$$

Where:

N=number of fish caught in the trawl during a tow

If the weight of the catch is known, then,

$$N = \frac{W_{kg}}{(W_g \times 10^{-3})} \qquad (3)$$

Where:

N=total number of fish caught in the trawl during a tow

W_{kg} = weight of catch in Kg

W_g = mean weight of the fish in grams.

Thus,

$$\rho_w = \frac{W_{kg}}{W_g \times 10^{-3} d_t A_e} \qquad (4)$$

Simrad EK-500 provides an estimate of, SA, the area backscattering cross section for the volume swept by the trawl. Thus the acoustically derived estimate of fish density will be:

$$\rho_{Ek} = \frac{\sum Sa}{V_s \sigma_b} \qquad (5)$$

Where:

$\sum S_a$ = total area backscattering cross section for the pulses covering the trawl interval,

$\bar{\sigma}_b$ = mean backscattering cross section.

Note that Sa is the area backscattering for a single transmission, i.e. the sum of the echo intensity for that transmission then,

$S_v, i = \rho\sigma_b$

Where:

S_v,i = volume scattering coefficient i_{th} sample,

ρ_i = fish density for the i_{th} sample,

Hence, by weighing, or estimating, the total catch, determining the mean weight of the fish by sampling the catch, knowledge of the trawled distance from the GPS and of the effective size of the net opening, the mean fish density can be estimated. The echo intensity from the fish in the swept volume is measured by the EK500 acoustic system by equating equations 4 and 5, then,

$$\frac{W_{kg}}{W_g d_t A_e} = \frac{S_a}{1852^2 \Delta R \sigma_b}$$

$$\sigma = \frac{S_a w_g d_t A_e}{10^3 \Delta R C_{kg}}$$

The biomass was estimated from two different methods. Method A was based on random line transect sampling and collecting the acoustic data; and method B was based on post–survey stratification and contouring of the data.

Results

The results obtained from both methods A & B for estimation of biomass of *Benthosema pterotum* in the Iranian side of the Oman Sea during the course of the present study, with 95% confidence interval, are presented in table 1.

Table 1: Biomass estimation of *Benthosema pterotum* in the Oman Sea (Iranian side) 1993-1998 (numbers in thousands of tons)

Cruise	Method		C.I.
	A	B	± 95%
Feb 1993	2840	2810	14.5
March1993	3130	3280	8.5
April 1993	3790	3750	14.7
May-June 1993	4000	3950	16.1
Oct 1993	1000	970	16.5
Dec 1993	1720	1650	11.0
Feb 1994	2370	2260	25.4
April 1996	2880	-	17.5
Jan 1997	1890	-	16.0
Oct 1998	1240	-	11.5

Considering the systematic surveys carried out on during 1993-94, the mean biomass estimate were 2.3 million tons.

Regarding estimation of sample variance, it should be mentioned that the use of a random survey design was recommended by Jolly & Hampton (1990) as the estimation of precision is simple and the appropriate variance model requires no assumption about the nature of distribution of sample values, e.g. absence of trend or auto-correlation.

The great differences in the seasonal variation in abundance is apparent from Figure.2; these appear to be a four – fold variation in abundance during and about May–June.

Myctophids (*B. pterotum*) are found throughout the Oman Sea wherever the depth is greater than the end of the depth of continental shelf and the beginning of continental slope region. During daytime, *B. pterotum* form a distribution pattern characterized by two layers (D_1 & D_2); the upper D_1-layer occurs at 4 depth of 80-130m in which it is characterized as dense layer and the lower Ð2-layer occurs at a depth of 250-450m and is a thick layer with more biomass but scattered schools. Then during night time after migrating towards the surface they form N_1 – layer as a mixed layer of D_1 and D_2 layers.

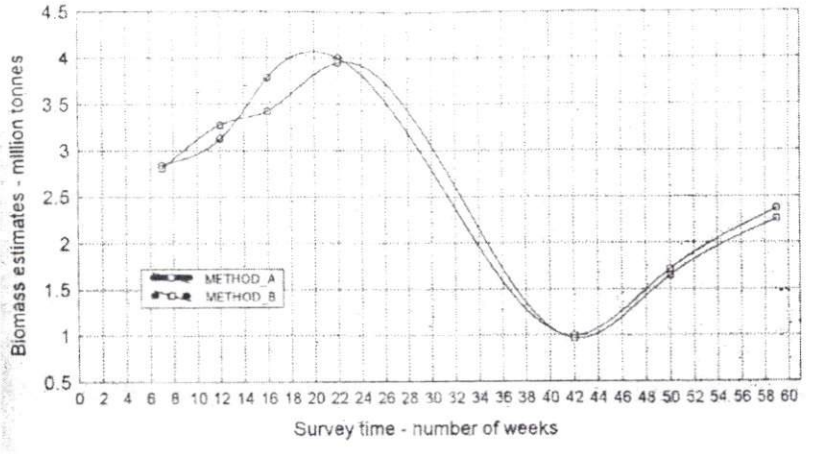

Figure 2: Fluctuation in estimated stock biomass of *Benthosema pterotum* during a part of study period (1993-1994)

Also, the distribution pattern of this species shows that Myctophids are found all over the Oman Sea (both Iranian & Omani sides) and at depth of 100m isobaths up to offshore region. The main portion of Myctophids biomass with high density was found along the south-west of Oman Sea in the Omani waters and north – west of the region in the Iranian waters (Fig. 3).

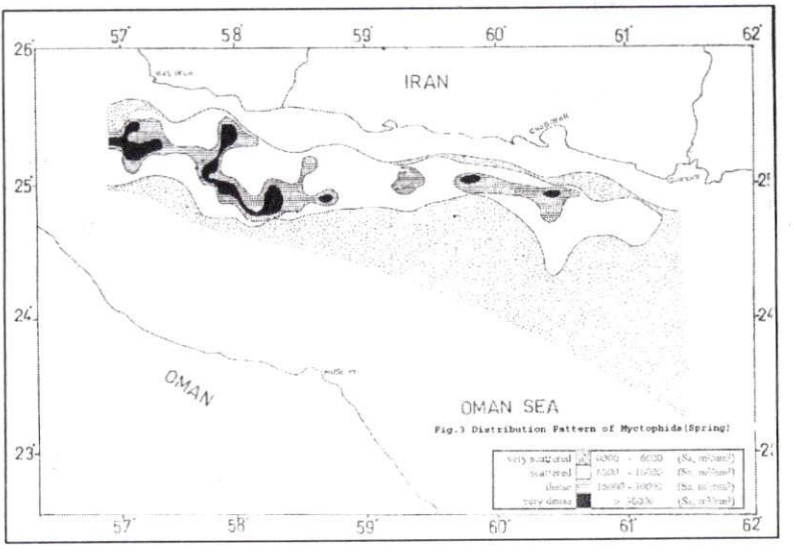

Figure 3: Distribution pattern of Myctophids (*Benthosema pterotum*) in the Oman Sea

Discussion

Fish meal is one of the most important fisheries products, which is imported to Iran, about 130000 tons per year (Plan & Programming Dept). On the other hand, *B. pterotum* is the main resource (with very large biomass) that can be considered as a raw material suitable for production of fish meal. This species with its virgin (unexploited) and considerable biomass is distributed all around the Oman Sea (Gjosaeter & Tilseth,1983). It is obvious that before harvesting from a virgin stock, it would be necessary to estimate the amount of biomass and determine the positions of the dense layers and schools to be introduced as fishing grounds for further commercial harvest.

During almost one decade of studies, it has been tried to evaluate this resource and collect all basic data from points of biomass and distribution views as the first step to start experimental harvesting from lantern fishes.

The biomass estimates reported by previous investigations are higher than our estimates here, namely 2.3 million tons. The first study conducted by R/V Dr. Fridtjof Nansen in 1975 was a systematic survey in the Arabian Sea and Oman Sea. All of the Oman Sea (Both Iranian and Omani sides) were covered again in 1979 and 1981 and the area was also studied in 1983 (Anon, 1983). The abundance of this mesopelagic fish ranged from 7 to 20 million tons (Table 2) in the Oman Sea, during 1975-86 (Gjosaeter, 1984).

Table2: Abundance estimation of Myctophids in the Oman Sea(10^6 metric tons)

Year / Area	Spring 1975	Autum 1975	Spring 1976	Summer 1976	Autumn 1976	Summer 1979	Winter 1981	Winter 1983
Gulf of Oman	20	8	13	11	15	8	11	7

During 1989-1990, the biomass of Myctophiods, in the Iranian side of the Oman Sea, was estimated to be about 2000,000 tons in the area up to 90nm from the coastline (Valinassab, 1998).

In 1990, the amount of biomass in the Oman waters was estimated at about 4 million tons (Johannesson, 1991). All the previous studies neither had covered all

the Oman Sea nor all over the year. Therefore, to start investing on fisheries of a new resource, it was clear that systematic surveys should be designed and implemented.

According to the studies conducted by R/V Ferdows-1, the amount of biomass was estimated from 1,000,000 to 4,000,000 tons with an average of 2.3 million tons. The results of biomass estimates bring out a highly investing and important trend of seasonal fluctuations in the resource abundance, the highest biomass was estimated from mid winter up to the end of spring and can be considered as the main fishing season.

These results showed that Myctophids (*B. pterotum)* are found throughout the Oman Sea wherever the depth is greater than the end of the continental shelf depth and the beginning of continental slope region.

The horizontal distribution of biomass depends on production of at lower trophic levels (Paxton, 1979).

During daytime the *B. pterotum* forms a distribution pattern characterized by two layers (D1 & D2) in depths of 80-130 m and 250-450 m. During night time, however, they migrate towards the surface where they normally extend from the surface down to depths varying between 40 and 100m, depending on the existing biomass level in the survey area.

According to all studies carried out so far, the most dense schools of *B. pterotum* are found in the northwest of the Oman Sea (Iranian waters), which would, therefore, be particularly suitable for future commercial exploitation.

References

Anon, E. , 1983. Fisheries resources survey Iran, 23 Sept- 1 Oct 1983. Reports on Surveys with the R/V Fridtjof Nansen, IMR, Bergen. 166P.

Gjosaeter, J. , 1981. Abundance and production of lantern fish (Myctophidae) in the western and northern Arabian Sea. Repots on Norwegian Fishery and Marine Investigation, Bergen. Vol.17, No 6.

Gjosaeter, J. and Tilseth, S. , 1983. Survey on Mesopelagic fish resources in the Gulf of Oman. Institute of Marine Research Bergen. 27P.

Gunnar, S. ; Bianchi, G. and Stromme, T. , 1999. The Dr. Fridtjof Nansen Programme 1975-1993. FAO Fisheries Technical Paper, 391P.

Johannesson, K. and Valinassab, T. , 1994. Survey of mesopelagic fish resources within the Iranian exclusive economic zone of the Oman Sea. Final report (Govt/FAO project: UTF-IRA-020/IRA). 85P.

Johannesson, K. , 1991. Stock assessment of myctophid resources in the Sultanate of Oman waters of the Oman Sea. Final report. 213P.

Jolly, G.M. and Hampton. I. , 1990. A stratified random transect design for acoustic surveys of fish stocks. Can .J. Fish. Aquat. Sci., **47**:1282-1291.

MacLennan, D.N. and Simmonds, E.J. , 1991. Fisheries Acoustics. Chapman and Hall, London, England, 336P.

Shotton, R. , 1981. Acoustic survey design. In meeting on acoustical methods for the estimation of marine fish population, 25-29 June, 1979 (Ed. J.B. Suomala). The Charles Draper Laboratory, Inc., Cambridge, Mass., USA, 964 P.

Valinassab, T. , 1998. Trial fishing for lantern fishes (myctophids) in the Gulf of Oman (1989-1990). FAO Fisheries Circular No.935, 66P.