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Some Information on the Development of Ovaries in *Benthosema glaciale* from Different Areas of the North Atlantic

by

G. P. Mazhirina

Polar Research Institute of Marine Fisheries and Oceanography (PINRO)
6 Knipovich Street, 183763 Murmansk, USSR

ABSTRACT

A subject of the present study is Benthosema glaciale from the North Atlantic. Sexual cycle in female benthosema is studied. Maturation of fish from the Grand bank and Flemish Cap (Northwest Atlantic) is found to start when they are 45-48 mm in length and those from the Hatton Plateau (Northeast Atlantic) at 33-35 mm.

Continuous asynchronous vitellogenesis, typical of female benthosema, is prerequisite for a serial spawning. Trophoplasmatic growth of ova continues for about 3-4 months, from October-November to January in females from the Northwest Atlantic. The spawning period in the Northwest Atlantic continues from January till April and till June in the Northeast Atlantic.

Number of eggs in a series/individual fecundity ratio, from 17% to 26%, shows that, at least, 5 series of eggs are spawned. The number of ova with yolk in ovaries before spawning amounts to 7.5-18 thou.

INTRODUCTION

Benthosema glaciale is a most common and abundant myctophid species in the North Atlantic with a distribution range from 35° to 72° N in the west and from 30° to 80°N in the east. The distribution of benthosema is closely re-

lated to circulation of water masses. Largest concentrations were found at 54°N, 40°W and 58°N, 21°W (Bekker, 1983).

Together with other species of anchovy benthosema appears to be a link in the trophic web of oceanic pelagial and, therefore, is of interest for scientists. Some aspects of the life cycle have been described by Tåning (1918), Gjøsaeter (1973). Some problems of maturation and reproduction have been considered in papers by Halliday (1970), Gjøsaeter (1981).

The aim of the present paper is to describe separate stages of the reproductive cycle, spawning pattern, to determine individual fecundity and specify the time of spawning of female benthosema from western and eastern areas of the North Atlantic.

MATERIAL AND METHODS

The majority of samples was collected by research vessels MG-1356 "Kokshaisk" and MG-1362 "Vilnyus" in the period from October to July 1984-1985. Observations were made in the area from 42° to 53°N in the west and from 54° to 58°N in the east of the North Atlantic (Fig. 1). Sampling depth was from 200 to 500 m. Benthosema glaciale was one of most plentiful myctophid species in all samples.

The species is characterized by sexual dimorphism: there was a supracaudal gland in the upper side of the caudal peduncle in males and an infracaudal fluorescent gland outlined by a strip of black pigment in the lower side of the caudal peduncle in females.

The length of fish ranged from 30 to 80 mm, no differences were observed between males and females. Sex ratio was 1.2:1, males predominated.

A total of 282 females was fixed in the Bouin's fluid for microscopic examination, 10 fish were preserved in 10% formalin for bathymetric analysis.

Preparation and histological treatment were made in accordance with standard methods: treatment by alcohols of

increasing concentration, paraffin-xylene, imbedding in paraffin. Thin sections (5-6 μm) were stained in hematoxylin after Heidenhein.

To determine the number of eggs in a series and fecundity, ripe ova and oocytes with yolk were counted by size groups.

Whole ovaries and samples were weighed in torsion balance of the PRLT type.

Ripness of gonads was evaluated following a 6-point scale (Sakun, Butskaya, 1968).

RESULTS

Northwest Atlantic. The length of female benthosema from the Grand bank and Flemish Cap varied from 30 to 80 mm. Ovaries in fish smaller 45 mm looked like translucent filaments. Developing oocytes were completely invisible. Ova of older generation were in a phase of single-layer follicle. Maturity factor did not exceed 0.7%. These fish were considered immature.

Fish larger 46 mm were considered mature, because from October-November the ovum diameter and weight of ovaries in those females were observed to increase. In early October these females had small genital glands. Pair roundish ovarian lobes were different in weight and their colour was opaque white. Ovarian sections did not show single ova, because their diameter did not exceed 0.1 mm. By late November the diameter of older oocytes increased to 0.3 mm. Histological analysis suggested evidence that there was an intensive accumulation of yolk in cytoplasm. The maturity factor varied from 0.9% to 2.7%.

In December ovaries in mature fish were found to increase in weight and became pale yellow or creamish. Eggs with the diameter of 0.4-0.5 mm were visible to the naked eye through a membrane. In older the accumulation of yolk was nearly completed. The maturity factor varied from 1.8% to 5.7%.

In January ovaries in the majority of females were filled with ova with yolk. Fish in a pre-spawning condition were also found. In those fish ovaries occupied the whole vacant space in the abdominal cavity. Transparent eggs 0.8-0.9 mm in the diameter were observed throughout the whole ovary among ova with yolk with the diameter from 0.1 to 0.5 mm. The maturity factor in pre-spawning fish reached 9.4%.

In the end of the month ovaries in a part of fish were flaccid, gland cavity was filled with ovarian fluid. Nearly half of ripe eggs was released. The maturity factor was below 4.5%.

In February and March female benthosema larger 48 mm were found to have next series of ripening oocytes. Sections of genital glands showed residual follicles from released eggs. The maturity factor varied from 2.4 to 5.9%.

The maturity factor in females from the western slope of the Flemish Cap (Fig.1) did not exceed 2.1%. Histological analysis showed that there was massive resorption of eggs with yolk in the ovaries. The resorption started with distructive transformations in a nucleus. It became firmer and reduced in size. Epithelial cells, forming a follicle around degenerating oocytes, acquire cubic form, their nuclei became roundish. Yolk granules resolved inside vacuoles, which gradually filled the cytoplasm.

In April the majority of females continued spawning. The ovaries contained ova at stage of vitellogenesis, however, a great portion of the potential fund had been spent, which was confirmed by the presence of numerous residual follicles.

In the end of the month completely spent fish appeared. Ovarian membrane was thicker and internal cavity emptier. Egg-carrying lamellae contained residual follicular membranes and a small number of ova at "overtaking stages". The maturity factor decreased to 1.9-2.5%.

In May and June all fish larger 50 mm were found to have traces of completed spawning. Post-spawning recovering was resumed in the ovaries. In sections of genital glands remnants of atretic bodies were observed and groups of epithelial cells in resorption sites. The maturity factor remained low from 1.3 to 1.5%.

Northeast Atlantic. Our material is restricted to samples collected in April, May and June.

In April females benthosema from the Hatton Plateau were 44 to 57 mm in length. Their ovaries were large and pale yellow. Eggs were seen through a membrane. Older ova 0.3-0.4 mm in the diameter were at final phases of yolk accumulation. Empty follicular membranes were observed in ovarian sections, an indication of partial spawning. The maturity factor was from 2.9 to 8.6%.

In May females 33 to 60 mm in length pertained to fish which continued spawning. Next generations of ova were ripening in the ovaries of those females. The maturity factor tended to decrease and was 2.2 to 4.6%.

In June the majority of females from the Hatton Plateau still contained ova with yolk. Numerous empty follicles observed in ovarian sections indicated that a greater portion of eggs from the potential fund was released. Completely spent fish were found. Remnants of follicular membranes and a small number of eggs at "overtaking stages" were found in the ovaries together with oocytes from a reserve fund. The maturity factor constituted 2.1 to 4.3%.

After summarizing the data we made an attempt to construct a scheme of a sexual cycle for females. Observations made by Halliday (1970) and Gjøsaeter (1981) showed that benthosema spawned at age 2-3 years. First female spawners from different areas differed in length, for example, the minimum length of fish, participating in the spawning, was 33-35 mm on the Hatton Plateau and it was 44-46 mm on the Grand bank and Flemish Cap.

Gonads of benthosema from the Grand bank and Flemish Cap matured during autumn and winter, from October-November to late December. During the whole period ovaries were at stage III, and they were at stage IV for no longer than two weeks. After releasing a next portion of ovulated eggs the ovaries were characterized by developmental stage VI-III. The spawning period continued till April. Ovaries of spent fish were recovering from May to July, during this they were at stage VI-II.

Terms of spawning, from January to April, are confirmed by data on the occurrence of larvae (Serebryakov et al., 1984; Albikovskaya, 1987). The authors reported on the occurrence of larval and post-larval benthosema on the Grand bank and Flemish Cap from March to July.

Some stages of the sexual cycle coincide with changes in the feeding intensity of fish. According to Albikovskaya (1987) the intensity of feeding of benthosema increased during summer and reached its maximum in September-November, it remained at a high level during December and January, i.e. sexual maturation fell at the period of most intensive feeding.

In the Northeast Atlantic maturing and partially spent females were found on the Hatton Plateau, where benthosema seemed to spawn during spring and summer. Our results are in agreement with the data by Karaseva et al. (1986). The researchers inferred that the centre of the spawning area lay between 51° and 55°N, where in late May - early June great quantities of larvae were observed.

Differences in the time of sexual maturation and terms of spawning of benthosema from the western and eastern areas of the North Atlantic are reflected in discrepancies between mean maturity factors in mature females by months (Fig.2).

Ovaries of maturing fish from both western and eastern areas of the North Atlantic contained simultaneously eggs of different diameter; small eggs, from 0.08 to 0.1 mm pre-

vailed and their number was about 30% of the total number of measured oocytes. There was a slight peak generated by eggs from 0.4 to 0.5 mm in the diameter in the end of the length frequency distribution (Fig. 3).

Characteristics typical of serial spawners were determined as a result of histological analysis: eggs at the period of vitellogenesis differed in the diameter, number of oil balls, yolk deposition. There was a group of synchronously maturing oocytes among eggs completing trophoplasmatic growth. The relative number of oocytes in a generated series constituted from 17% to 26% of the total number of eggs with yolk (Table 1).

According to Oven (1976) the like variations in the number of eggs in a series/individual fecundity ratio are indicative of a serial spawning.

Unfortunately, we had no opportunity to count precisely the number of egg releases experimentally, therefore, an attempt was made to determine the number of series from weight characteristics of ripe eggs (Table 2).

CONCLUSIONS

Studies of the reproductive system in female benthosema showed that fish from the Grand bank and Flemish Cap started to mature sexually at length from 46 to 48 mm and those from the Hatton Plateau at 33-35 mm. Trophoplasmatic growth of eggs took place in autumn and winter in fish from western areas and in winter and spring in those from eastern areas.

Maturation of ovaries is of continous type. The total number of ova with yolk in ovaries before spawning amounts to 7.5-18 thou. The spawning occurs once a year and it is composed of several egg releases. No less than 5 series of eggs ripen during the spawning period.

The spawning period of benthosema from the Northwest Atlantic continues from January to April, and in the Northeast Atlantic it is completed not earlier than June.

On the grounds of differences in the maturation rate and time of spawning, at least, two independent spawning populations may be supposed to inhabit the North Atlantic.

Total resorption of eggs with yolk observed in female benthosema indicates that environmental conditions in the distribution area of the species are not always favourable for spawning. In the Northwest Atlantic this refers to areas west of 47°W, influenced by the Labrador Current.

REFERENCES

Albikovskaya L.K., 1987. Peculiarities of feeding of lantern fish, Benthosema glaciale (Reinhardt) from slopes of the Grand bank and Flemish Cap. VNIRO Selected Papers, 14 p. (in press) (in Russian).

Albikovskaya L.K., 1988. Some aspects of Benthosema glaciale reproduction, growth, feeding and distribution on slopes of the Grand and Flemish Cap banks. NAFO Scientific Council Studies (in press).

Bekker V.E., 1983. Myctophidae of the world ocean. Moscow, Nauka Press: 114-116. (in Russian)

Gjösaeter J., 1973. Age, growth and mortality of the myctophid fish, Benthosema glaciale (Reinhardt) from western Norway. - Sarsia, 52: 1-14.

Gjösaeter J., 1981. Growth, production and reproduction of the myctophid fish Benthosema glaciale (Reinhardt) from western Norway and adjacent seas: - Fisk Dir. Skr. HavUnders., 17(3):79-108.

Halliday R.G., 1970. Growth and vertical distribution of the glacier lanternfish, Benthosema glaciale, in the Northwest Atlantic. - J.Fish.Res.Board Canada, 27 (1): 105-166.

Karasev E.M., Romanchenko A.N., Feldman V.N., 1986. Peculiarities of distribution of larval and young lantern fish Benthosema glaciale in off-shore areas of the North

Atlantic. - In: "Life cycles, distribution and migrations of commercial fishes from the Atlantic and Pacific Oceans". Kaliningrad, AtlantNIRO: 77-81 (in Russian).

Oven L.S., 1976. Peculiarities of ovogenesis and spawning pattern of marine fishes. Kiev, Naukova dumka Press: 132. (in Russian).

Sakun O.F., Butskaya N.A., 1968. Determination of maturity stages and studies of sexual cycle in fish. Murmansk, 46 p. (in Russian)

Serebryakov V.P., Astaf'eva A.V., Aldonov V.K. and A.K. Chumakov, 1984. USSR ichthyoplankton investigations within the framework to the Flemish Cap Project in 1978-1983. NAFO Scr. Doc. 84/IX/95, Serial No. N890.

Täning A.V., 1918. Mediterranean scopelidae (Saurus, Aulopus, Chlorophthalmus and Myctophum). - Rep. Danish Oceanog. Exped. 1908-1910, 86:49-69.

Table 1.

Number of eggs in a series/individual fecundity ratio in female B.glaciale from the Northwest Atlantic

Weight of ovary, mg	Maturity factor, %	Number of eggs in a series	Individual fecundity	Number of eggs in a series/individual fecundity ratio, %
136.8	3.3	1436	8270	17.4
167.0	3.8	1303	6610	19.7
199.5	4.1	1764	6910	25.5
176.5	4.3	2259	9600	23.5
303.5	4.5	1966	10980	17.9
239.5	4.9	1666	8120	20.5
232.0	5.9	1355	7350	18.4
220.3	5.1	2115	8940	23.7
280.7	5.5	1390	8020	17.3
174.3	6.0	1255	7530	16.7

Table 2. Number of series of ripe eggs

Body weight, mg	Ovary weight: mg	Sample weight, 100 transparent eggs, mg	Indiv. fecund.	Ovary weight in case it's filled with transp. eggs, mg	Theor. matur. factor: %	Actual matur. factor	Number of series Theor.f. / Actual f.
6800	303.5	14.75	10980	1620	23.8	4.5	5.3
5100	280.7	15.25	8020	1223	24.0	5.5	4.4
3950	232.0	17.25	7350	1268	32.1	5.9	5.4
2900	174.3	10.50	7530	791	27.3	6.0	4.6

* Theoretical maturity factor is calculated from ovarian weight when they are filled with transparent eggs.

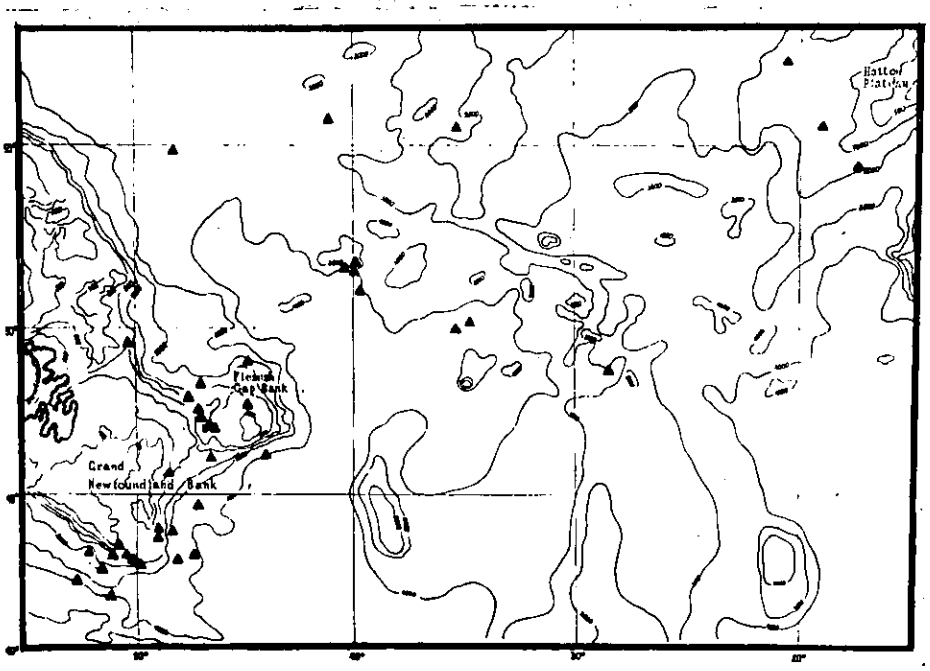

Fig. 1 Sampling sites.

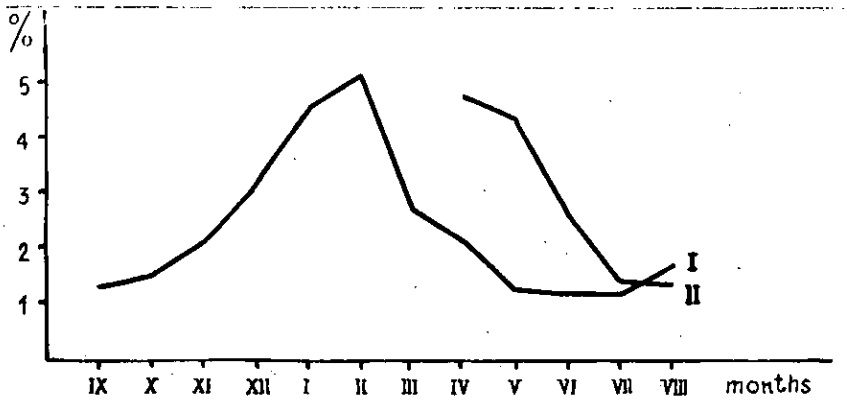

Fig. 2 Mean maturity factors in mature female benthosema fromtthe North Atlantic:
I - Grand bank, Flemish Cap
II - Hatton Plteau

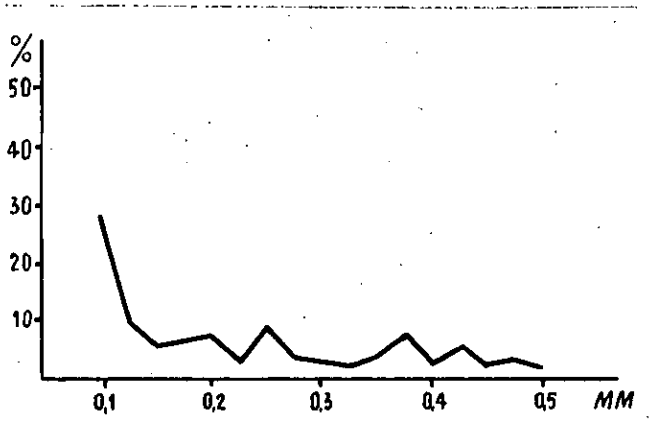

Fig. 3 Length distribution of ova with yolk.