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Horizontal distribution of Capelin (Mallotus villosus) during the Spawning Season in Inshore Areas of West Greenland

by

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1. Introduction.

Capelin (Mallotus villosus) is a very common and well known fish at West Greenland. It is caught locally in the spawning season in shallow waters, especially in the fiords.

During the last two years there has been a growing interest in Greenland for catching female roe-bearing capelin for the Japanese market.

Similar beach-spawning capelin populations are known e.g. at Newfoundland (Templeman, 1948), in Gulf of St. Lawrence (e.g. Bailey, Able & Legget, 1977), in Balsfjorden in northern Norway (Sørensen, 1983) and in fiords in northern Iceland (Vilhjalmson, 1974) and in East Greenland.

Information from other beach-spawning populations (e.g. Sørensen, Templeman, Bailey et al., log. cit.) indicates a sex and maturity dependent migration of capelin in the spawning season, making it possible to perform a fishery on maturing females separately. For instance, Templeman (1948) describes such a pelagic fishery at 4 - 5 fathoms depth some distance away from the shore. In 1974 Jakupstovu & Røttingen (1974) carried out investigations on West Greenland capelin, indicating that such a fishery might be possible also in Greenland.

In 1985, from the beginning of May to the end of June, the Greenland Fisheries and Environment Research Institute (GFM) carried out a cruise at West Greenland to investigate if among other things there is such a sex and maturity dependent distribution of capelin in the spawning season. At the same

time a commercial experimental fishery for roe-bearing females took place in West Greenland inshore waters.

Data from both research and the experimental fishery are presented in this paper.

2. Materials and Methods.

The material analysed in this work originates partly from samples taken by GFM, partly from commercial catches. All catches were taken inshore during the spawning season from early May to the end of June, 1985. Locations of catches are seen in Fig. 1.

2.1. GFM cruise.

2.1.1. Areas and gear.

The aim was to take samples from 3 zones on every fishing location along the coast.

Zone 1: Shallow water (app. 0-10 m deep) near shore (spawning area).

Zone 2: Deeper water (app. 10-50 m deep), but still near the coast.

Zone 3: Deep water (app. 50-600 m deep), in the middle of the fiords.

Gears were used as follows:

Beach-seine in zone 1 (and partly zone 2). A total of 2 catches.
Pound-net in zone 1. A total of 6 cathes.
Landing-net in zone 1. A total of 2 cathes.
Pelagic trawl (except at St. 14) in zone 3. A total of 11 catches.
Pelagic trawl St. 14 in zone (1) 2 + 3. A total of 1 catch.

The pelagic trawl used was a so called Wingless Wonder, a type of trawl with big meshes (400-200 mm.) in the front part. This trawl has a vertical opening of app. 15-18 m and it is 67 m long without bridles and warps.

Several attempts were made to use the pelagic trawl so that the hauls covered zone 2 exclusively, but it was not possible to performe such a precise fishing operation with gear of this size in such shallow water.

During the cruise capelin was searched for by echosounding, and when traces supposed to be capelin were seen, trawling was conducted in the appropriate places and depths. Beach-seine was used when and where capelin was seen near shore, and pound-net was placed on what was supposed to be a spawning ground.

2.1.2. Handling of the catches.

Only when using trawl the total weight of capelin in each catch was estimated. From all catches random subsamples were taken. Sample analyses included determination of standard length, sex, maturity stage and age. Total weight and roe-weight were determined at 286 females in various maturity stages. A total of 3464 specimens were analysed. Maturity stages are described in Appendix 1.

2.2. Commercial catches.

On the institute's recommendation the commercial experimental fishery was conducted mainly in zone 2. Some of the catches in zone 2 were taken by pelagic pair-trawling, others by single-boat pelagic trawling. In some cases small shrimp trawls were turned upside down and used as pelagic trawls. The boats used were rather small, i.e. not bigger than 40 feet. A few catches were taken by beach-seine.

Catch data and samples are available from 22 commercial catches, all from the Aasiat-area (Div. 1A-1B). Of these 19 were fished by pelagic trawl in zone 2, and 3 by beach-seine in zone 1 (+2).

The catches were examined at the fish plant for percentage of 'Females for the Japanese market'. This means the females with more than 13% roe (of total body-weight), but not running gonads, taken as percentages by weight of the whole catch. From measurement of roe percentages in different maturity stages in the research samples we know that this corresponds to females in maturity stage 3 or 4.

3. Results.

3.1. GFM cruise.

3.1.1. General impression.

From echograms it appears that capelin in the middle of the fiords were distributed in small pelagic schools in two layers. One layer above app. 50 m depth and another in about 100 m depth. Catches in these depth were relatively small. (From 0 - 700 kg per hour trawled).

Closer to the shore denser schools were seen (according to the echo-recordings). We did not manage to fish these schools.

In all fiords visited during the cruise , spawning had started, but only at Paamiut (St. 1,2 and 3), in Evighedsfjorden (St. 11) and in the Aasiat-area we managed to catch capelin in shallow water (1-20m deep) very near shore.

3.1.2. Maturity and sex composition in different zones and gear.

When comparing maturity composition by sex in the different samples it appeared that all trawl-catches taken in the same zone were similar. Also the two beach-seine samples were similar regarding maturity composition, and the same was the case for pound-net samples. Therefore it was decided to pool the samples by zone. In beach-seine and pound-net samples the sex composition varied considerably from catch to catch, and at the end of the period there were no females in the pound-nets catches.

In Table 1 the total maturity composition (in %) of females caught with different kinds of gear (and in the different zones) are shown. Though maturing has started in maturity stage 1 and 2, these stages must be considered as non-spawners this season (Forberg, 1983). Stage 8 and 9 are pooled, as both stages are spent capelin.

It is seen that female non-spawners (maturity stage 0, 1 and 2) and spent females represent the greatest part of female capelin caught in zone 3. Mature (stage 4), spawning (stage 6) and spent females are caught in zone 1, while maturity-stage 3 is caught almost only when the gear has been in zone 2.

From Table 2 it is seen that male non-spawners may be assumed to be found only in zone 3. The spawners of the year (stage 3-8) form a very small proportion of male capelin caught in zone 3. Mature, spawning and spent are the only stages present in zone 1. Maturity-stage 3 is represented only in catches from zone 3, and in very small proportions.

Tables 3 and 4 show female and male maturity-composition at St. 11, where catches were taken at the same time in zone 1 (landing-net) and zone 3 (pelagic trawl).

It is seen that juvenile females (stage 0, 1 and 2) are caught only in zone 3, mature and spawning females in zone 1 only, spent females both in zone 1 and 3. Females of maturity-stage 3 are not represented in any of the zones.

All male capelin caught in zone 3 were juveniles, while in zone 1 almost all male capelin were spawners. Maturity-stage 3 is not represented in any of the catches, and stage 4 (mature) are very poorly represented in zone 1 and not at all in zone 3.

In general maturity-stages 3 and 4 seem to be very poorly represented in the samples. This may be either because these stages have been passed at this time of the year or because

they are to be found in areas or/and depths where fishing was not performed.

Females of maturity-stage 9 were found only in trawl catches, while males of maturity-stage 8 were found only in trawl catches in the case where the trawl was fishing in zone (1) 2 + 3.

3.2. Commercial experimental fishery.

3.2.1. Maturity and sex composition.

The average percentages of ´Females for the Japanese market´ in the 19 trawl catches was 81.0 (s. dev. 16.2), ranging from 48 - 100%. The percentages in the 3 beach-seine catches were 20, 0 and 0.

Since % ´Females for the Japanes market´ is the proportion of the catches which does not include males and females with too low roe percent, spawning females and spent females , the 81.0% ´Japanese´ females in trawl catches must be females in maturity-stage 3 and/or 4. The total percentage of females in these trawl catches might thus be higher than 81.0 weight percent. If the males in the catches are mature, the percentage by numbers of females in numbers might be even higher, since females on average weigh less than males at same maturity stage.

The very low percentage by weight of females in the commercial beach-seine catches corresponds fairly well to the percentage of females by numbers (22.8 and 19.4) obtained in research fishery with the same kind of gear.

4. Discussion.

Data from commercial and research catches of capelin in the inshore area of West Greenland show a maturity and sex-dependent horizontal distribution in the spawning season.

Looking at the distribution of capelin the migration pattern in the spawning season must be as follows:

Immature and maturing capelin stay in the pelagic schools in areas with deeper water (50 - 600 m) (zone 3). When maturity-stage 3 is reached the migration towards the spawning areas commences. The males migrate directly to the spawning ground at very shallow water (zone 1). The females stop somewhat outside

the spawning ground, and stay in that area (zone 2) in pelagic schools. The maturation proceeds during the spawning migration.

When the females are fully mature (stage 4) and the environment fits for spawning, they migrate to the spawning ground, spawn and, if not dying, they leave the ground soon after spawning and return to the area, where immature and maturing capelin stay. It seem that some of the spent females start a new maturating-cycle.

In contradiction to what is the case for females the males do not leave the spawning ground immediately after spawning. Presumably, all males die short time after spawning.

The described migration pattern agrees well with the migration pattern described by Templeman (1948), Baily et. al (1977) and Sørensen (1983) for beach-spawning capelin at Newfoundland, in the Gulf of St. Lawrence, and in Balsfjorden respectively. The same pattern is described for Icelandic capelin of offshore origin observed during spawning in an aquarium (Fridgeirsson, 1976).

Investigations by Jakupsstovu & Røttingen (1975) indicates a similar migration pattern in the fiords at West Greenland. But since Jakupsstovu & Røttingen (loc. cit.) found very few maturing and fully mature capelin and a lot of spent capelin, they concluded that the spawning season was over at the time of their investigation. However, the reason might as well be that they did not get samples from zone 2 where the maturing and ripe female capelin stay.

The significance of this migration pattern for representative sampling from a capelin stock is that one should be very conscious about its implications for the sampling strategy around spawning season.

On the other hand, the migration pattern makes it possible to get clean catches of maturing and mature males and females seperatet by sex.

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Table 1 . Total maturity composition among females (in percentages) in samples from different geartypes and fishing-zones.

MATURITY STAGE	TYPE OF GEAR AND ZONE POUND-NET ZONE 1 n= 47	BEACH-SEINE ZONE 1(+2) n= 50	PELAGIC TRAWL ZONE 3 n= 762	PELAGIC TRAWL ZONE (1+)2+3 n=149
Immature (0)	0	0	21.8	8.1
Maturing (1)	0	0	39.6	0
Maturing (2)	0	0	1.4	0
Maturing (3)	0	2.0	0.8	14.1
Mature (4)	29.8	8.0	1.7	6.7
Spawning (6)	44.7	30.0	0	0.7
Spent (8+9)	25.5	60.0	34.7	70.5

Table 2 . Total maturity composition among males (in percentages) in samples from different geartypes and fishing-zones.

MATURITY STAGE	TYPE OF GEAR AND ZONE POUND-NET ZONE 1 n= 330	BEACH-SEINE ZONE 1(+2) n= 146	PELAGIC TRAWL ZONE 3 n= 710	PELAGIC TRAWL ZONE (1+)2+3 n=17
Immature (0)	0	0	63.5	76.5
Maturing (1)	0	0	27.8	0
Maturing (2)	0	0	3.5	0
Maturing (3)	0	0	1.7	0
Mature (4)	4.2	64.7	0.6	0
Spawning (6)	72.1	23.7	2.7	17.7
Spent (8+9)	23.6	11.5	0	5.9

Table 3 . Maturity composition among females (in percentages) in samples taken at the same time at st. 11 in landing-net (zone 1) and trawl (zone 3).

MATURITY STAGE	TYPE OF GEAR AND ZONE LANDING-NET ZONE 1	PELAGIC TRAWL ZONE 3
Immature (0)	0	14.3
Maturing (1)	0	66.7
Maturing (2)	0	2.4
Maturing (3)	0	0
Mature (4)	60.0	0
Spawning (6)	35.0	0
Spent (8+9)	5.0	16.7

Table 4 . Maturity composition among males (in percentages) in samples taken at the same time at st. 11 in landing-net (zone 1) and trawl (zone 3).

MATURITY STAGE	TYPE OF GEAR AND ZONE LANDING-NET ZONE 1	PELAGIC TRAWL ZONE 3
Immature (0)	0	59.3
Maturing (1)	0	35.2
Maturing (2)	0	5.6
Maturing (3)	0	0
Mature (4)	0.6	0
Spawning (6)	99.4	0
Spent (8+9)	0	0

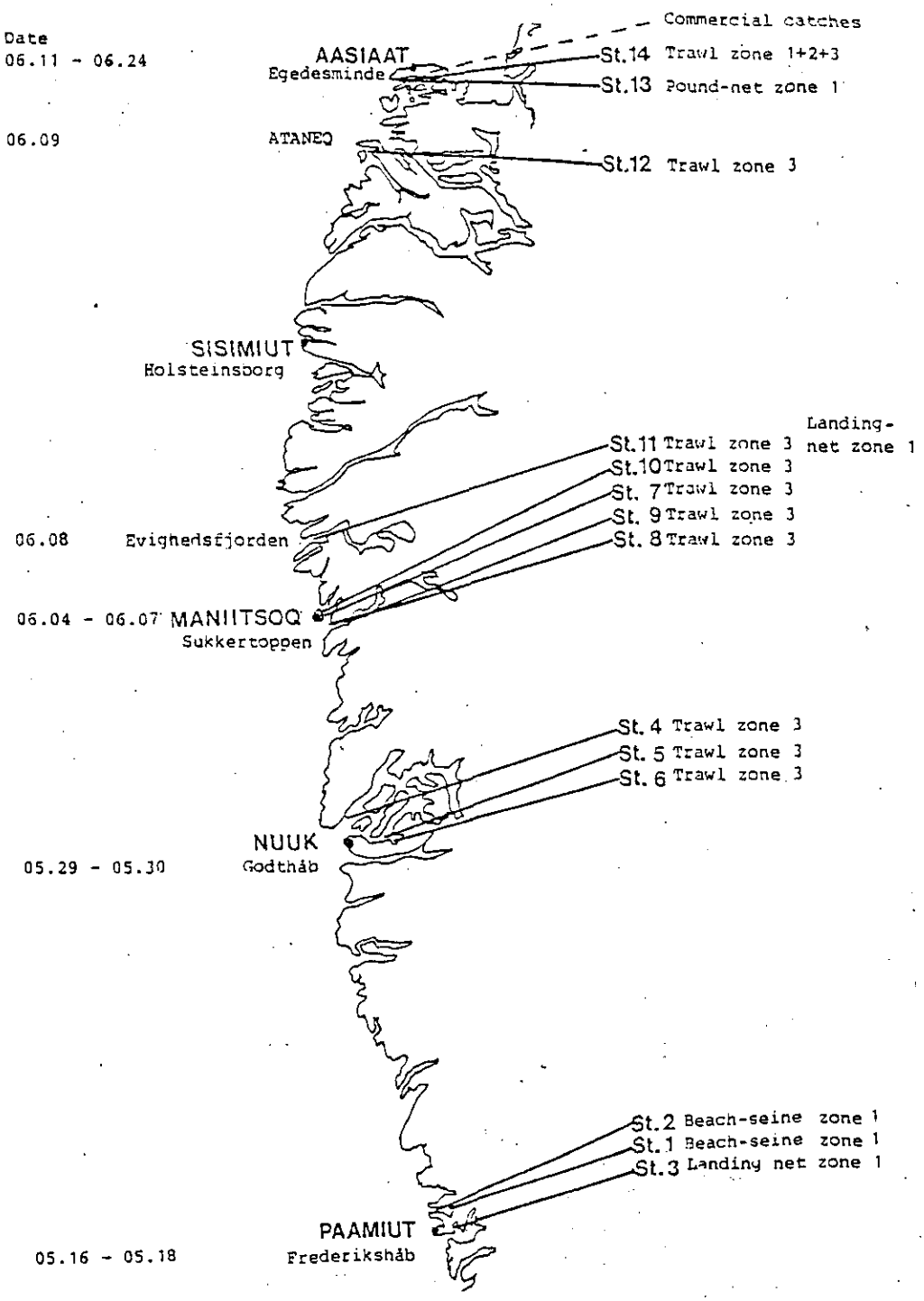

Fig. 1. Dates and localities (in Greenlandic and Danish) for sampling of capelin mentioned in this paper. Station numbers, gears and zones of operations also shown.

Appendixe 1.

Maturity stages.

Females (simplified after Forberg (1983))

Stage	Description
0	Immature: Gonads tread like, transparent and colourless. Late in the stage ovaries can be seen as laminated. Sex not easy to dertermine.
1	Maturing I: Ovaries seen as laminated, with a yellow-reddish shade.
2	Maturing II: Ovaries easily seen as laminated; yellow. - Bigger than at stage 1.
3	Maturing III: Eggs can be seen by the naked eye. Eggs are yellowish-orange. Eggs are lying in lamellas.
4	Mature: Eggs no longer lying in lamellas. Eggs yellow-orange.
6	Spawning: Eggs as in stage 4, but shape of ovaries indistinct, because some of the eggs has been spawned.
8	Spent I: Ovaries empty, old degenerating eggs can be seen in ovaries and abdominal cavity.
9	Spent II: Old eggs seen in the abdominal cavity, new eggs developing in the ovaries.

Males (according to Anon. 1980)

Stage	Description
0	Immature: Gonads are reddish, smooth, transparent and colourless. Sex not easy to distinguish.
1	Maturing I: Testis somewhat wider than at stage 0, smooth and transparent to gray.
2	Maturing II: Testis light gray and smooth.
3	Maturing III: Testis clearly wider than at stage 2. Gray and smooth.
4	Mature: Testis white, wide and smooth.
6	Spawning: Testis white. Milt running.
8	Spent: Testis empty, there might be some milt back.