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DIVING OBSERVATIONS ON BARENTS SEA CAPELIN AT THE SPAWNING GROUNDS OFF NORTHERN NORWAY

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ABSTRACT

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During the spring of 1971 divers made observations at the spawning grounds of the Barents Sea capelin.

Large masses of capelin eggs were found at two localities: Loppa, (35—70 m depth) and Nordvågen (12—18 m depth). The eggs were mixed down to a depth of 5 cm with fine gravel (0.5—1.5 cm diameter).

Two behaviour patterns of the capelin were observed: Loosely packed schools in the upper layers and dense circulating schools close to the bottom. The latter are believed to be males waiting for ripe females.

Egg mortality caused by trawlers was experimentally investigated by dragging trawl bobbins along the egg beds. Eggs stirred up by the bobbins showed higher mortality (up to 10.2% after ten days incubation) than undisturbed eggs and eggs from bobbin tracks (up to 2.5% mortality after ten days incubation). Less than 1% of the eggs on the investigated spawning grounds is believed to be damaged by trawlers.

Diverse estimated a 5—10% decrease in the number of eggs on the spawning grounds over a four week period. This was due to a drift of eggs largely caused by wave action and water currents.

No predation of the capelin eggs was observed.

INTRODUCTION

The aim of this investigation was to obtain information about the spawning grounds of the Barents Sea capelin, the fishes' behaviour and the egg mortality on these grounds. The observations were made in spring 1971.

The spawning behaviour and the morphology of the spawning grounds have been described for the Newfoundland capelin. TEMPLEMAN (1968) reports both beach spawning and spawning down to at least 55 m. A substrate of fine gravel from 0.25 to 1.50 cm in diameter seemed to be especially favourable for capelin spawning (TEMPLEMAN 1948). On the offshore spawning grounds the bottom substrate was somewhat finer, from 0.5 to 2.2 mm in diameter (PITT 1958).

Spawning behaviour and spawning grounds of the capelin in the northeastern Atlantic have not been well investigated. COLLETT (1903) reports that the capelin search along the shores of bays and fjords for suitable spawning grounds. He mentions that spawning mostly takes place on sandy bottoms, sometimes at depths of only a few metres, but

more often at depths of 70 to 90 m. PROKHOROV (1965) refers to Russian authors who unanimously state that spawning takes place on sandy grounds with an admixture of fine shell gravel. He concludes that a depth range of 50 to 100 m at the spawning places is most usual while MØLLER og OLSEN (1962) suggest that spawning takes place at depths of 10 to 100 m.

MATERIAL AND METHODS

Capelin were found all along the coast of Finmark by using echo sounders. Schools were also observed by divers at three different localities: Hasvik, Trollsund and Nordvågen. (Fig.1) Photographs and films were taken of the fish as close as 0.4 m.

The diving was carried out from the R.V. «Johan Hjort» during the period 15 March — 29 April 1971. The sampling gear included a stainless steel box designed by the authors to take 0.1 m^2 samples from sand and gravel bottoms and two frames of 1.0m^2 and 0.1m^2 for sampling algae and stones from specific areas. At least two bottom samples were taken at each diving locality. Temperatures were measured on the bottom and in the sediment, and the speed and direction of the current was determined. The diving equipment used is described by BAKKE and BJØRKE (1971).

Grab samples were also taken at various localities along the coast to check for the presence of eggs. A total of 46 dives were made.

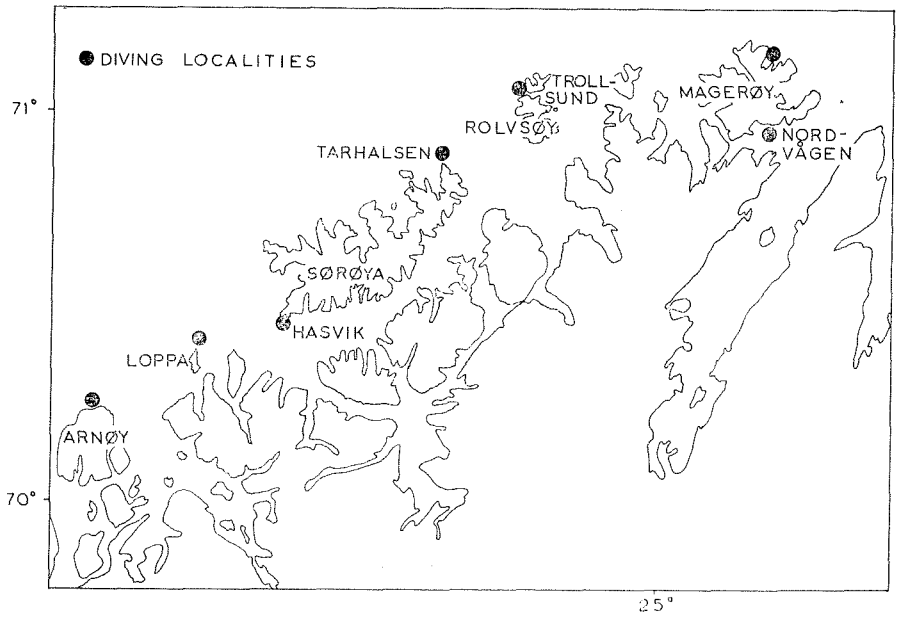

Fig. 1. Diving localities in the investigated area.

RESULTS

OBSERVATION ON CAPELIN SCHOOLS

Two different behaviour patterns of the schools could be distinguished. Firstly, and most commonly, the schools could be at least 100 m in length and 20 m in width and depth. The fish swam slowly, well above the bottom at depths between 5 and 20 m and were about 40 to 80 cm apart. Initially they reacted simultaneously to movement by the divers, but this reaction eventually ceased as they became accustomed to the divers' presence. The schools changed course several times while observed; they often made a wide circular movement, but whether this was due to the presence of the diver or not, is unknown.

Secondly, the schools swam close to the bottom (20 m) in a very dense formation with the fish less than 10 cm apart. The schools were sharply delineated in all directions and were less than 2 m in depth. The school was most dense nearest the bottom with the fish head to tail and their sides nearly touching. The movement of the school was still circular, but within a very small radius. These schools did not react to the presence of the divers and pictures could be taken from as near as 0.4 m with the school in effect circulating around the divers. The pictures indicate that such schools consisted mainly of males (Fig. 2).

Individuals were frequently seen to lag behind the schools. Such

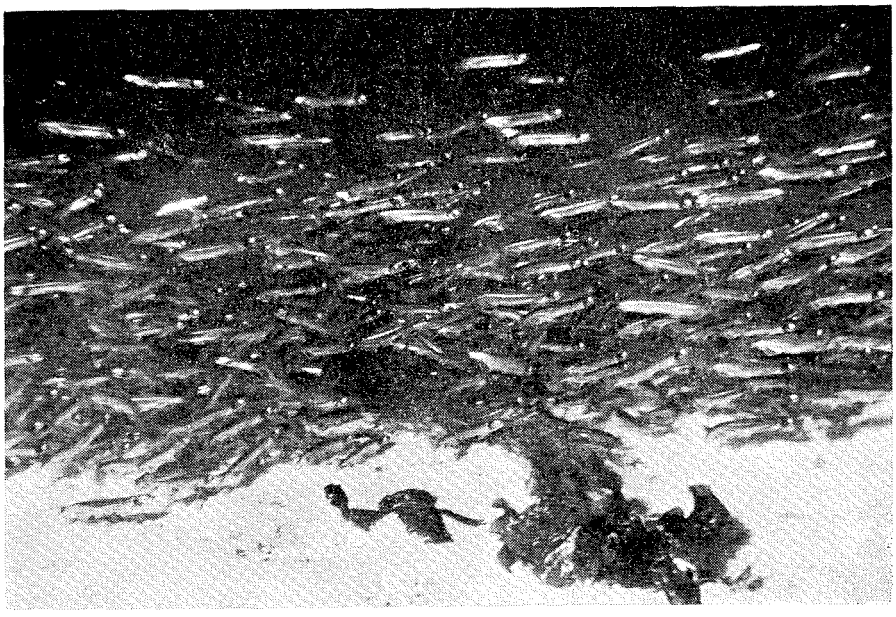

Fig. 2. Male capelin circulating around the photographer at Nordvågen.

fish were found either close to the bottom or near the surface; sometimes they even swam upside down. These individuals did not show any external signs of abnormality other than the often bloodshot and swollen base of the male anal fin.

At Nordvågen (Fig. 1) where extensive trawling took place, large masses of dead capelin were seen on the bottom. Whether this high mortality was the result of spawning or fishing by trawlers, is not known. Dead fish were seen at all diving localities, but it must be concluded that the dead capelin seen at Hasvik died a natural death as no fishing had taken place there. All samples of dead fish consisted of spent males.

OBSERVATIONS AT THE SPAWNING GROUNDS

At Loppa and Nordvågen (Fig. 1), where the greatest egg masses were found, the substrate changed progressively with increasing depth, starting with rocks and boulders just below the surface and ending with fine sand. This sequence did not occur at the other six localities where only small numbers of eggs were found attached to algae and stones.

The main spawning ground at Loppa was much more exposed to wave action than the ground at Nordvågen. The shallowest edge of the spawning bed at Loppa was at 35 m where coarse gravel was succeded by finer gravel with a grain size of 0.5—1.5 cm. Grab samples revealed that the gravel and egg mixture extended to at least 70 m water depth. The concentration of eggs on this ground was the highest observed; and numerous clumps consisting only of eggs were seen.

The other more closely observed spawning locality was just outside Nordvågen (Fig. 3). This relatively sheltered area had fine gravel from 12 to 18 m in depth with coarse gravel at lesser and sand at greater depths. Divers surveyed the main spawning ground and found it to be about 180 000 m^2. No eggs were found closer than 250 m to the shore. The ground consisted of fine black gravel and was bordered either by coarser gravel with stones or by sand (Fig. 3). Grab samples which covered a greater area, later confirmed these observations and showed that the main spawning ground lay within the area of the fine gravel (DRAGESUND, GJØSÆTER and MONSTAD 1971). Eggs were found in the substrate to a depth of about 4 cm in the centre of the main spawning ground, but penetrated less deeply towards the borders. Samples from the centre indicated a density of about 3×10^6 eggs per square m. On one occasion, a diver's sample taken from fine sand at greater depths showed densities of up to 4×10^5 about 100 m from the main spawning ground.

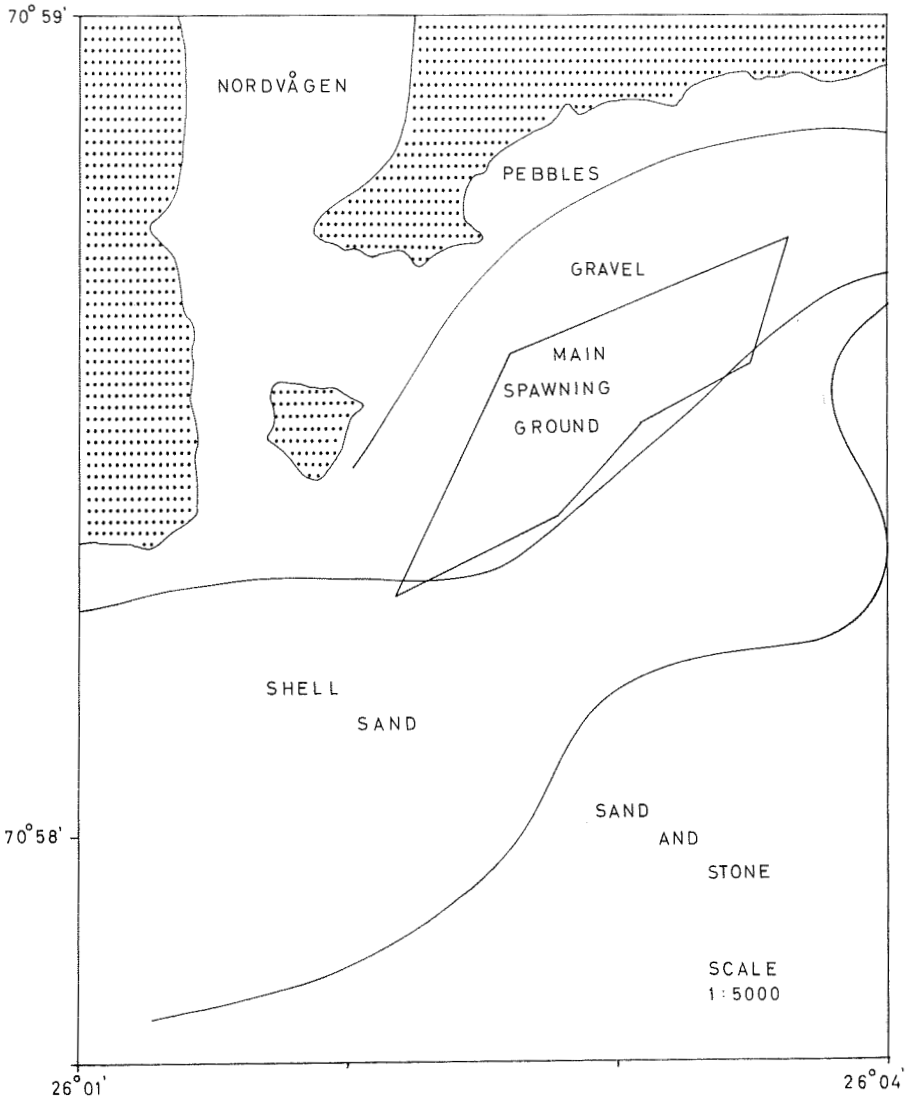

Fig. 3. The spawning ground at Nordvågen. The lines separate different bottom substrata.

The ground at Nordvågen was examined three times, from 29 to 31 March, from 14 to 16 April and on 25 April. During this time the sea temperature near the bottom rose from 1.5°C to 3.2°C. During dives on 14 April the temperature was measured at intervals of 40 m across the spawning area just above the egg layer and at about 5 cm down into the substrate. The water temperature ranged from 3.2°C offshore to

2.8°C nearest the shore. The bottom substrate was consistently slightly cooler than the water above. The current direction at 5 m above the bottom, measured over a 29 hour period, was mainly northnortheast, and the current speed varied from 13 to 46 cm per sec.

From 14 to 16 April and on 25 April, brown patches caused by a filamentous algae that settled on both the stones and the eggs, were observed on the beds. They seemed to have no effect on the eggs since samples of eggs with algae kept in jars did not show a higher mortality than eggs without attached algae (DRAGESUND, GJØSÆTER and MONSTAD 1971). Only a few laminarians and starfishes were found at the spawning ground, and capelin were the only fish observed.

Between 29 March and 25 April a marked decrease was noted in the number of eggs on the surface of the substrate. Below the surface, however, the concentration of eggs remained high during the entire investigation. Drifting eggs were observed at both the Nordvågen and the Loppa grounds except during calm weather. The total decrease in eggs at Nordvågen was probably between 1×10^5 and 4×10^5 eggs per square m.

DAMAGE TO CAPELIN EGGS BY TRAWLERS

Norwegian fishermen have suggested that the lower doors of pelagic trawls may damage capelin eggs if dragged along the spawning beds. Tracks made by trawl doors were observed at the spawning grounds in Nordvågen. These drag marks were about 0.5 m wide and usually more than 40 m long with ridges of an egg and gravel mixture about 10 cm high on one side of the tracks. Altogether, such tracks covered less than 1% of the spawning area.

Several samples were taken from the middle of the tracks and from the top and bottom of the ridges. The proportion of damaged eggs (2.5—5.0%) in these samples was similar to that in samples taken outside the tracks.

An experiment was carried out in Nordvågen to study the effects of mechanical disturbance of the eggs. Three trawl bobbins were hauled along the spawning beds while a diver observed the effect. The bobbins stirred up the eggs and bottom substrate and made tracks on the bottom similar to those made by trawl doors. Egg samples were taken from the tracks and from an undisturbed area nearby, while a plankton net, placed behind and above the bobbins, sampled the eggs which were stirred up. There was no difference in the proportion of damaged eggs, or their subsequent mortality, between the samples taken from the tracks and those from undisturbed areas. Whereas the mortality of

both these types of samples, kept for 12 days in glass jars, was between 0 and 2.1% (DRAGESUND, GJØSÆTER and MONSTAD 1971), the mortality of eggs caught in the plankton net ranged between 6.0 and 10.2%.

DISCUSSION AND CONCLUSIONS

The behaviour patterns observed on the spawning grounds in northern Norway resemble observations made by SLEGGS (1933) in Canada where the schools of mature capelin formed either a dense globular mass or an elongated streak of swimming fish. TEMPLEMAN's statement (1948) also supported this when he described capelin schools prior to spawning and observed that these schools, as in the case of the Barents Sea capelin, consisted entirely of males. In addition, he stated that male capelin are mature when they approach the shore for spawning, and that they are in constant attendance at the beaches. Schools of immature females stay in shallow water, away from the immediate neighbourhood of the beach, and as they reach maturity, swim in groups to the beach to spawn.

The indication in the present results, that greater numbers of eggs are found where there is fine gravel, agrees with observations from the main spawning grounds in Canada (TEMPLEMAN 1948). Only once, at Nordvågen, were large number of eggs found in fine sand close to the main spawning ground. Although sand seems to be a less suitable substrate, it is possible that mass spawning can occur there when the best ground is occupied or when the spawning pressure is great (TEMPLEMANN 1948).

TEMPLEMAN (1948) and SLEGGS (1933) found that spawning movements could bury the eggs to some extent, but most of the burying, to a depth of one foot, was the result of wave action. This did not seem to be the case on the spawning grounds observed in this investigation, since the depth of 35 to 70 m at Loppa and the sheltered conditions in Nordvågen probably prevented strong wave action. It was noticed, however, that the egg and gravel mixture could be stirred up by slight water movements made by the diver's hand just above it due to the extra buoyancy of the gravel with eggs stuck to it. Thus, eggs can be buried more easily when repeated spawning occurs on the same ground. When the egg and gravel mixture reached a maximum thickness of 5 cm, as at Loppa, clumps of eggs were formed after additional spawning.

DRAGESUND, GJØSÆTER and MONSTAD (1971) reported that both the natural egg mortality of the spawning grounds and the mortality of the disturbed eggs was low. However, BURD and WALLACE (1968) carried out laboratory experiments on mechanically disturbed herring eggs and

found that trawling at the spawning grounds might induce a reduction in larval viability. During the investigation, intensive trawling at or near the Nordvågen spawning ground yielded 7300 tons of capelin. In spite of this, less than 1% of the spawning ground was disturbed by the trawl doors. Even if all the disturbed eggs did die, this would affect less than 1% of the eggs at Nordvågen. Pelagic trawling at the spawning grounds therefore seems to have little influence on overall egg mortality.

At Nordvågen, a decrease of 5 to 10% in egg numbers due to drift was observed over a four week period. Since a similar drift of eggs was also observed at Loppa, this may well be the greatest source of loss there and in other areas.

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