Environmental Features of the Capelin Spawning Grounds South of Iceland

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ABSTRACT

In March 1979 the annual spawning of capelin off southern Iceland took place in water depths of up to 90 meters. The spawning substrate was gravelly sand with a mean grain-size of 1–4 mm but scattered spawn were found in finer sediments. Near-bottom temperatures at the spawning grounds range from 5–7°C. A comparison with other spawning areas indicates that water depth and circulation are important factors in the selection of spawning grounds, with sediment grain-size and water temperature playing a secondary role.

INTRODUCTION

Capelin (*Mallotus villosus*) spawn annually off the Icelandic coast. The bulk of the spawning takes place off the southern and western coasts, where the capelin gather in February and March. Spawning starts somewhat later off northern and eastern Iceland (Vilhjálmsson, 1968).

Much of the present knowledge of the spawning of Icelandic capelin is based on the distribution of capelin larvae after hatching (cf. Friðgeirsson, 1979). In addition, the spawning behaviour of Icelandic capelin has been observed in an aquarium tank (Friðgeirsson, 1976).

Outside Iceland capelin are known to spawn on the bottom, mainly in shallow water and sometimes even on beaches. Templeman (1948) described beach spawning in Newfoundland where additional spawning had taken place offshore, in several fathoms of water. Capelin are also known to spawn in water depths of up to 80 m on Grand Banks (Pitt, 1958). The Barents Sea capelin spawn offshore and egg samples have been obtained from depths of 12–280 meters although most of the spawning takes place in less than 75 meters of water (Sætre and Gjøsæter, 1975).

Most of the spawning of the Icelandic capelin appears to take place offshore. Records of dead capelin on beaches in southern Iceland in earlier times indicate that beach spawning occasionally takes place in the area.

In addition to water depth, water temperature and sediment grain-size appear to affect the selection of spawning grounds. Templeman (1948) recorded spawning on two Newfoundland beaches in 1941 in water temperatures ranging from 6.2–8.4° and 5.6–7.2°C with little or no spawning at higher or

lower temperatures. He also found that ,,the best spawning occurred where the gravel was 0.5 to 1.5 cm in diameter."

Spawning on Grand Banks takes place under very different conditions. Pitt (1958) recorded temperatures as low as 2.8°C during spawning which took place on a sandy bottom (0.5–2.2 mm grain diameter). Temperatures similar to those of Grand Banks have been measured at the spawning grounds of the Barents Sea capelin, ranging from 1.5° to 4.0°C. The sediments were found to be coarser, however, with a median size of 5–15 mm (Sætre and Gjøsæter, 1975).

In March 1979 a large number of grab samples was taken off southern and southwestern Iceland in an attempt to identify spawning areas (Friðgeirsson, 1979). This sampling programme provided an opportunity to study sediment grain-size and water depth on the spawning grounds.

MATERIAL AND METHODS

Of the 416 grab stations occupied in March 1979 (Fig. 1), some 105 yielded no samples, indicating rock floor. Out of 311 sediment samples a total of 141 were selected for grain-size analysis, the remainder being rejected for reasons of high mud content, or small sample size. The 141 samples analysed included the 31 samples in which capelin eggs were found.

On board ship an estimate was made of egg density per unit area by counting eggs in a subsample. The grain-size distribution of the sediments was later determined by dry-sieving the sand and gravel fractions at 1-phi intervals (for phi-scale and other grain-size parameters see Folk (1968)).

RESULTS

Grain-size

Fig. 2 portrays the grain-size distribution of the samples as well as egg densities in samples containing eggs. Capelin eggs were found in mixtures of sand and gravel, the latter generally making up less than half the weight of each sample. In pure sand, the egg concentration is small, and muddy sediments do not seem to be utilized as a spawning substrate. The highest mud content of a sample containing eggs was 12 percent. Sand makes up the major portion of the samples and when the sand fraction is examined on its own (right-hand side of Fig. 2) it turns out that egg densities are greatest in the coarser grades. Only scattered spawn were found where fine sand predominated.

The gravel fraction of the samples is taken to be the portion retained by a 2 mm sieve. Of the 31 samples containing capelin eggs, 22 were more than 1% gravel by this definition. Of these 22, some 13 contained pebble-size material (coarser than 4 mm) and only 2 contained material coarser than 8 mm.

The Icelandic capelin thus spawn on sediments ranging in grain-size from muddy sand to sandy gravel (as defined by Folk, 1968). Most of the spawning off southern Iceland takes place on gravelly sand ((g)S and gS of Folk (1968)). The

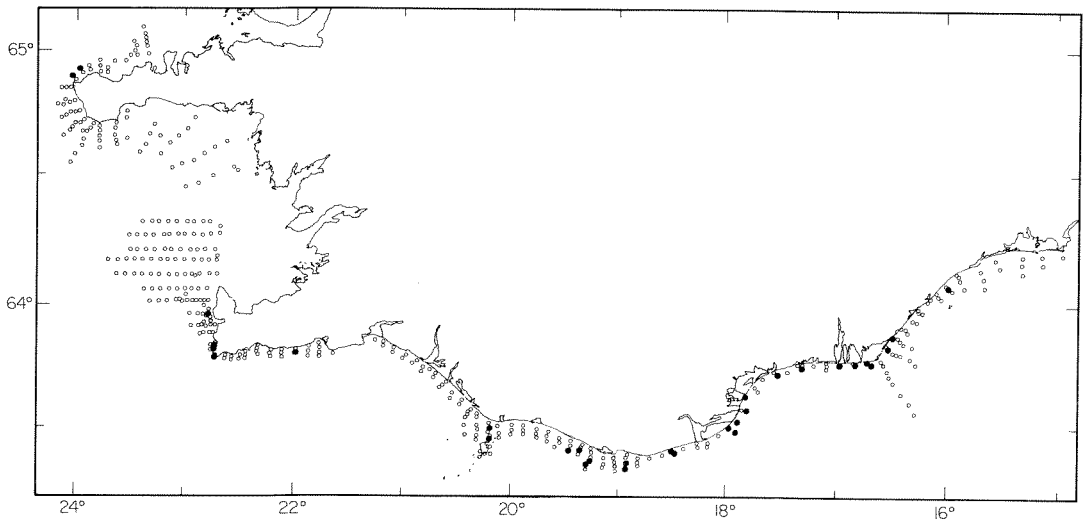

Figure 1. Sampling stations off southeastern, southwestern and western Iceland. Black dots indicate where capelin eggs were found in samples.

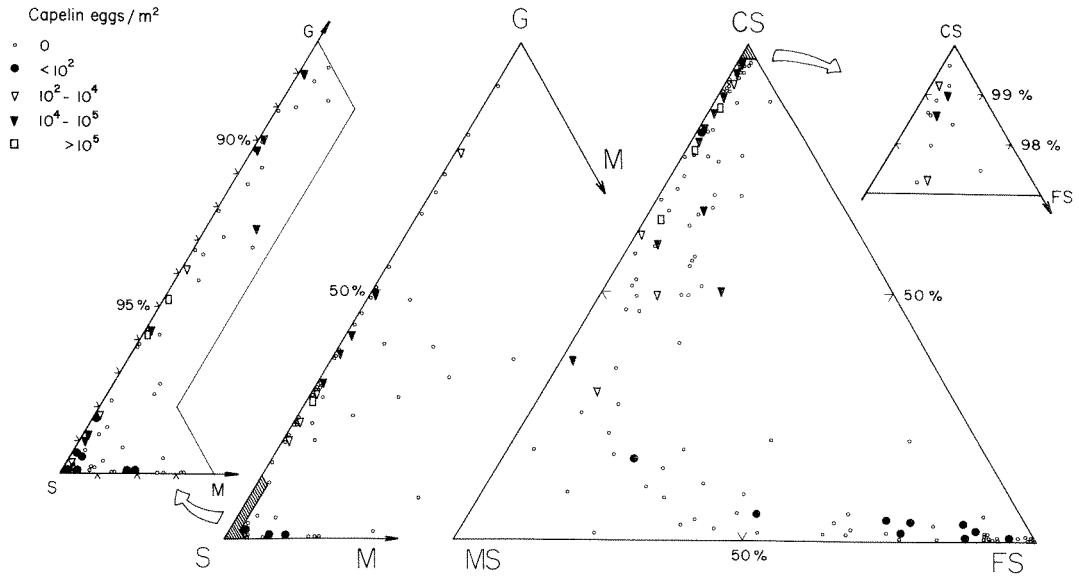

Figure 2. Grain-size distribution of the sediments indicated on a GSM triangle (left) where G represents gravel (coarser than 2 mm), S. is sand (0.063—2 mm) and M stands for mud (less than 0.063 mm). The ,,S"-corner is shown enlarged on the far left. Symbols indicate different densities of eggs. The triangle on the right shows the proportions of coarse sand (CS, 0.5—2.0 mm), medium sand (MS, 0.25—0.5 mm), and fine sand (FS, 0.063—0.25 mm) in the samples.

mean grain-size of spawning substrate ranges from 0.125 to 4.0 mm (Fig. 3), but dense spawning was observed in sediments ranging in mean size from about 1 mm to 4 mm.

Water depth

The samples were taken from depths ranging from 8 to 120 meters. Capelin eggs were found down to about 90 meters. A plot of depth versus mean size shows a weak trend of increasing grain-size with depth (Fig. 4). Fine-grained sediments with scattered spawn were therefore found mainly in shallow water (10–25 meters).

Temperatures off Southern Iceland

The sampling programme did not include temperature measurements but the temperature distribution off southern Iceland is well documented.

In an analysis of temperature data collected up to 1973 Stefánsson and Jónsdóttir (1974) found that mean near-bottom temperatures off SW-Iceland ranged from 5–7°C in February-March. Data from 1971–1975 agree with their findings (Malmberg, 1978 a, b). Temperature distribution off SE-Iceland has been studied annually since 1971 and a similar temperature range found for the inner shelf (Malmberg, 1979 and pers. comm.). In very shallow water (10 m or less), freshwater runoff might be expected to lower the temperature somewhat. Nevertheless, Malmberg's (1974) study of the effects of a jökulhlaup in March 1972 indicates that dilution by freshwater close to shore caused temperature to drop below 5°C only in surface water, while near-bottom temperatures re-

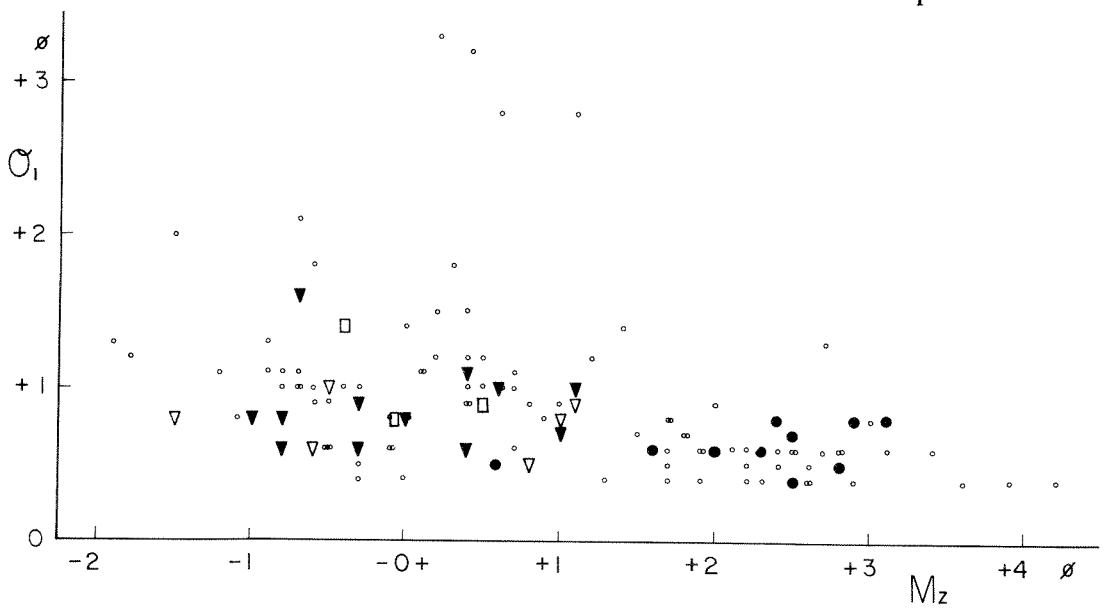

Figure 3. Mean size of sediments vs. sorting (Inclusive graphic standard deviation, Folk). The sediments are mainly well to moderately sorted. Symbols indicate number of capelin eggs in samples as in Fig. 2. The diagram illustrates that only scattered spawning was found in the finest-grained sediments.

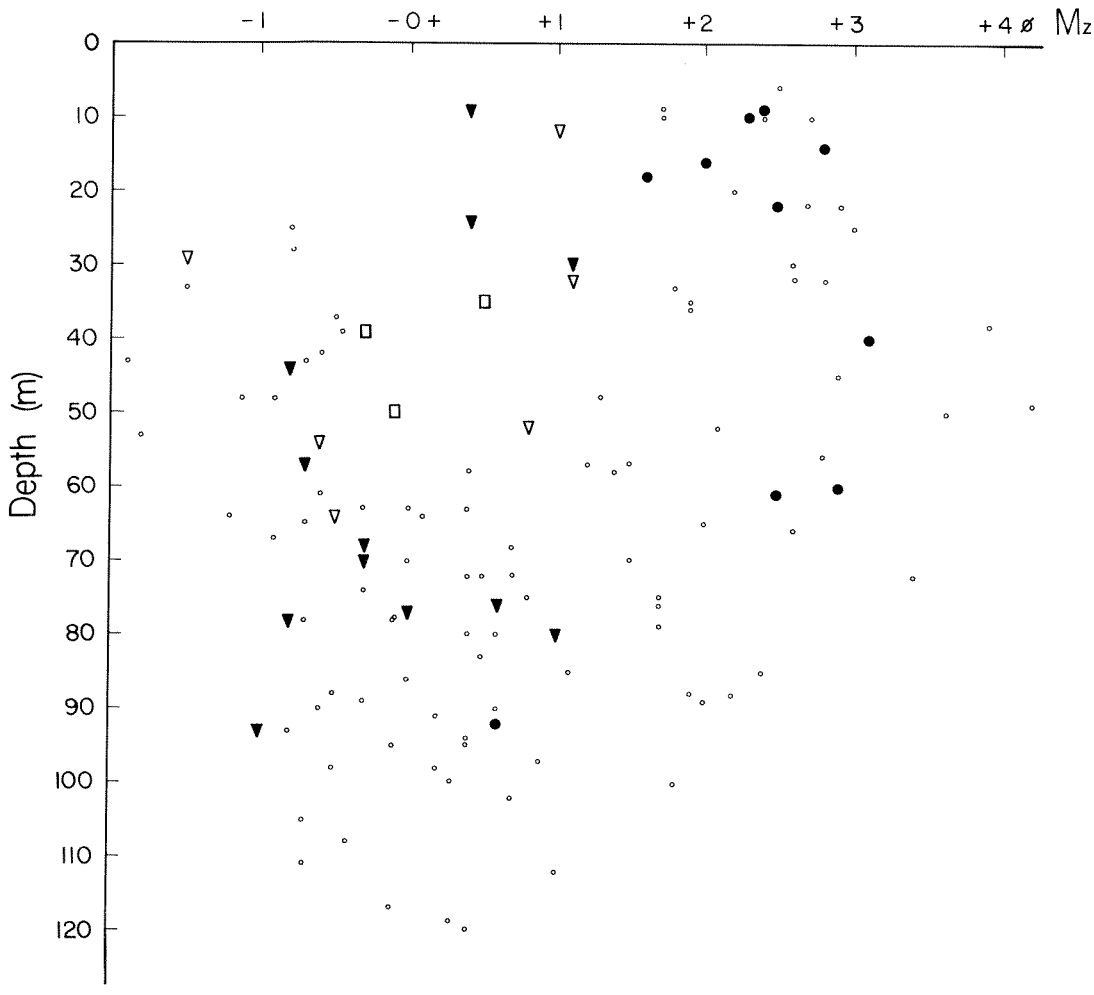

Figure 4. A plot of mean size vs. depth reveals a weak trend of increasing grain size with depth. Symbols are the same as in Fig. 2. Capelin eggs were found down to about 90 meters.

mained high.

Available information thus indicates that near-bottom temperatures at the capelin spawning grounds off southern Iceland are within the range of 5–7°C in the spawning season. This may be compared with the early observations of Jespersen (1920) and Sæmundsson (1926, 1934), who reported spawning temperatures of approximately 6–7°C.

DISCUSSION

Water depth, temperature and sediment grain-size on the capelin spawning grounds off southern Iceland may be compared with the same features of spawning grounds elswhere. Table 1 shows such a comparison.

Water depths are comparable in the three offshore areas, but temperatures

TABLE 1

Enviromental variables on capelin spawning grounds.

	Newfoundland beach	*Grand Banks*	*Northern Norway*	*Southern Iceland*
Depth, m.	0	40–80	12–75	8–90
Temperature °C	5.6–8.4	2.8–	1.5–4.0	5–7
Grain-size, mm	5–15	0.5–2.2	5–15	0.125–4.0

and sediment grain-size are not. Temperatures at the Southern Iceland spawning grounds are higher than recorded elsewhere for offshore spawning. Sediment grain-size on the south Iceland grounds is finer than off Northern Norway and on the Newfoundland beach, but comparable to Pitts's (1958) figures for Grand Banks. These had been questioned by Sætre and Gjøsæter (1975) as they were based on sediment grains found associated with capelin eggs in the stomach of haddock.

The comparison shown in Table 1 indicates that water depth, and, by inference, water motion are critical factors in the selection of spawning grounds with temperature and sediment size playing a secondary role. The importance of vigorous water motion will be appreciated when one considers the fact that capelin eggs are often mixed with the sediments in a layer which may be up to a few cm thick. Active circulation of sea-water will supply the oxygen necessary for successful hatching and remove metabolites. It will also prevent siltation which in turn would reduce circulation within the sediment.

Temperature will affect the rate of developmemt of the embryo. Jeffers (1931, as quoted by Pitt (1958)) found that development was successful from 0° to 12°C. At 0°C hatching took place 55 days after fertilization, but only 9 days at 12°C.

Sediment size does not seem to exercise an important control on the selection of spawning grounds. The sediment must be relatively mud-free, but beyond that, capelin show a tolerance for a broad range of grain-sizes. The choice of comparatively fine sediment on the South-Iceland spawning grounds is probably governed by availability more than anything else, for, as a glance at Fig. 2, 3 and 4 will show, the sediments spawned on are typical of sediments found in the dept interval sampled.

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