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# THE FOOD AND FEEDING HABITS OF THE SPERM WHALES TAKEN OFF THE WEST COAST OF ICELAND

by

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## INTRODUCTION

Previous studies on the diet of sperm whales have shown that their principal food is squid. However, fish have been found frequently in the stomachs of these animals, particularly in those of whales caught in inshore waters. Table 1 lists the regions where fish have been recorded as part of the diet of sperm whales, but all the authors referred to concluded, when they had sufficient material, that fish were but a subsidiary part of the total intake of food.

In July and August 1967 I examined the stomach contents of 57 sperm whales processed at the whaling station of Hvalur H.F. on the west coast of Iceland. In complete contrast to previous records from other parts of the world, it was found that fish were the dominant food of these whales throughout the period covered and that squid were only a minor part of their diet.

The sperm whales examined were all large bulls caught in the Denmark Strait up to 275 miles from the station, and there was usually a considerable time delay between death and examination of the stomach contents. The average of this delay for 54 of the animals considered here was 27 hours 3 minutes, and consequently fresh food was rarely found in the stomachs. The contents of the first stomach of 57 whales were examined and the degree of cephalopod scarring of the head and body was recorded for 65 whales.

## THE OVERALL DIET

Food was present in the stomachs of 49(86%) of the 57 whales examined. Forty eight (98%) of the stomachs with food contained fish or fish remains; twenty two (45%) contained solely fish, and one (2%) contained only squid. These data contrast strikingly with those reported from other parts of the world, though it is difficult to find many comparable analyses since several authors who have recorded fish in sperm whale stomachs have not given a figure for the total number of stomachs in which fish were found, However, the present data from Iceland are compared with appropriate data from elsewhere in table 2.

In some other areas, not given in table 2, fish apparently form a rather higher proportion of the diet. For example, Okutani and Nemoto (1964), working on material from the coast of the Alaskan Gulf, gave figures for the occurrence of squid and fish in sperm whale stomachs as, respectively, 45 and 94, but they did not make clear from how many stomachs these data were derived. Gaskin and

Cawthorn (1967) reported on the sperm whales taken in the Cook Strait and gave a quantitative ratio of squid to fish of 1.69:1. They found that fish species made up to 37% of the stomach contents by weight, but they did not give the total number of stomachs in which fish were found.

The Icelandic data in table 2 have only been compared with similar data from male animals where this was available. It is possible, as suggested by Mizue (1951) that the males, being solitary, take a more miscellaneous diet than the females which live in a harem structure. Even if this is the case the incidence of fish in the diet of the whales taken at Iceland is still higher than in those taken elsewhere.

The difference in the importance of fish as food between the Icelandic whales and those taken elsewhere is in fact far greater than table 2 suggests. These figures refer only to a total number of whales in which fish were found in the stomachs, and give no indication of the relative proportions of squid and fish when both are found together. In most parts of the world fish are only present in the stomachs of these whales in very small numbers, and very often as just single specimens (see references in table 1). The frequent occurrence of fish bones, and on one occasion a very fresh lumpsucker (Cyclopterus lumpus), in the throats of the Icelandic whales suggested that many of these whales had vomited when they were caught. This factor, combined with the long time delay before the stomachs could be examined, made any detailed quantitative estimates of food impossible. However, the proportions of fish and squid were noted and these are shown in table 3, together with the amounts of food found in the stomachs of those whales which contained fish or squid only.

Table 3 shows that only on 3 occasions were large amounts of squid remains found, and only once in a stomach containing both fish and squid did the latter predominate. In the great majority of cases squid remains were found in very small numbers and often as only one or two beaks per stomach. The tendency of the whales to vomit may account for the high proportion (61%) of stomachs which contained little food of any description, but even so, 43% of these contained only fish remains and it is extremely unlikely that the whales had selectively vomited any squid.

It has been shown above that the diet of the sperm whales taken off the west coast of Iceland, at least for the two months of my visit to the station, is very

unusual. It is, however, possible that there may be seasonal changes in the nature of the food. Gaskin and Cawthorn (1967) found some monthly variation in the fish diet of the whales taken in the Cook Strait, and the figures presented by Okutani and Nemoto (1964) indicate that there may be some annual changes in the diet of the sperm whales caught in the Bering Sea and off the Aleutian coast. It would be of interest to compare the results given here with some from a future season at Iceland, but there is no evidence to suggest that the sperm whales caught there do not normally take fish as the principal item of their diet. It is, perhaps, significant that from conversations with the whalers on the flensing platform at Iceland it seemed that squid were very rarely seen in the sperm whales processed there.

Apart from the curious nature of the diet, the species of fish eaten and the positions at which the whales were caught pose interesting problems regarding the feeding habits of the sperm whales in the Denmark Strait.

SPECIES OF FISH EATEN AND THE FEEDING HABITS OF THE WHALES

Most of the fish remains found in the stomachs consisted of bones and otoliths, and only infrequently were intact recognisable specimens present. Thirteen samples were collected and these were very kindly and quickly identified by Mr A.C. Wheeler of the British Museum (Natural History). Table 4 lists all the specimens identified, the numbers of some of the species in individual stomachs, and the sizes and weights of some of the individual fish. Table 5 gives the frequency of occurrence of the different species found.

Tables 4 and 5 show that the lumpsucker (C. lumpus), redfish (Sebastes sp.), and the angler fish (L. piscatorius) were the commonest species of fish eaten. Two types of fish crania were present in the great majority of stomachs examined; some specimens of these were collected and found to be of C. lumpus and Sebastes sp These two species were, therefore, much commoner than table 5 suggests. L. piscatorius was also more frequent than is apparent in table 5, but not to the same extent as C. lumpus and Sebastes.

All of the fish species found, with the possible exception of P. virens, live on, or near to, the sea bed for the majority of their lives. Saemundsson (1949) lists the marine fish of Iceland but is mainly concerned with those species living inside the 400 m. depth contour. With the exception of S. mentella all the

species in tables 4 and 5 are given by him, together with their depth distributions. Andriyashev (1954) gives depth distributions for all these species in the north Atlantic and Arctic Oceans the lower limits of some of which are considerably deeper than those of Saemundsson. It therefore seems possible that some of these species may live in deeper waters off the Icelandic continental shelf.

Three of the species found are, as adults, more or less confined to the bottom:-

L. piscatorius; to a depth of 225 m. (Saemundsson 1949). It has been recorded to 2000 m. (Andriyashev 1954).

A. minor; to a depth of 400 m. (Saemundsson 1949); to 460 m. (Andriyashev 1954).

Raja sp.

The other species are, as adults, normally found on the bottom, but are also known occasionally to be pelagic:-

C. lumpus; almost always found on the bottom, but it migrates inshore to spawn in spring and early summer. During the rest of the year it lives at considerable depths far off shore, but at what depth is, for Iceland, unknown. (Saemundsson 1949). It has been recorded to 400 m. in the North Sea (Andriyashev 1954).

Sebastes sp; S. marinus normally lives on the bottom, usually at depths between 100 and 500 m. (Andriyashev 1954). It is found off Iceland to depths of 1000 m. (Saemundsson 1949). S. mentella apparently lives in deeper water than S. marinus and is found mainly between 300 and 400 m. plus (Andriyashev 1954).

G. morhua; partly pelagic on its feeding migrations (Andriyashev 1954). Off Iceland it is found to a depth of 400 m. (Saemundsson 1949), but it also occurs rarely to 500 m. (Andriyashev 1954).

G. aeglefinus; found to a depth of 200 m. (Saemundsson 1949, Andriyashev 1954).

Somniosus sp.?; S. microcephalus, the Greenland shark, is the only species of this genus known to occur off Iceland (Bigelow and Schroeder 1948). It is recorded to a depth of 1000 m. by Saemundsson (1949), and, according to Bigelow and Schroeder (1948) it lies on, or near to, the bottom during the summer, most often at depths of 100 to 300 fathoms. (183-549 m.).

It seems, therefore, that almost all of the fish species taken by sperm whales off Iceland are likely to be found in depths of at least 400 m, and it is possible that some of them may live at considerably greater depths. It also seems probable that the sperm whales feed on the bottom to obtain these species, and the presence of stones in the stomachs of some of these whales is additional evidence for this. It is interesting to note that the Greenland shark also includes in its diet skates, Sebastes, Cyclopterus, P. virens, cod, haddock, and Anarhichas. (Bigelow and Schroeder 1948).

Figure 1 shows the positions where 48 of the 49 sperm whales with food in the stomach were caught.

Figure 1 shows that all the animals considered here were caught in waters of about 500 to 2000 m. depth. If the whales were feeding on the bottom near to these positions then they must dive to considerable depths.

There is good evidence, from the presence of stones and bottom living animals in the stomachs, that sperm whales do feed on the sea bed. From this evidence it has been concluded that sperm whales off the Kruile Islands feed at depths greater than 300-400 m. (Betesheva and Akimushkin 1955) and that in the Bering Sea they dive to deeper than 200 m. (Nemoto and Nasu 1964). Gaskin and Cawthorn (1967) suggest that sperm whales in the Cook Strait feed on the bottom, and observed 11 animals diving, (which were presumed to be feeding), all of which were in water between 200 and 1100 fathoms deep (366-2,012 m.). Direct evidence of the depths to which sperm whales can dive is provided by Heezen (1957) who lists 16 records of these animals found entangled in submarine cables; six occurred in depths of about 500 fathoms (914 m.) and one at 620 fathoms (1,134 m.).

It is apparent, therefore, that sperm whales can dive to depths of at least 1,000 m. However, the known depth distributions of some of the fish species eaten by the Icelandic whales do not extend below 500 m. Taking this fact into consideration together with the positions at which the whales were caught, it is suggested that the sperm whales taken off the west coast of Iceland feed on the bottom to depths of at least 500 m. and possibly, occasionally, to much greater depths.

RECORD OF CEPHALOPOD SCARS

It has been shown above that squid form only a minor part of the diet of the Icelandic sperm whales. The samples of squid beaks collected have yet to be identified, but despite the scarcity of these in the stomachs, cephalopod scars were present on all the 65 animals examined for this feature.

The sizes of "sucker" scars were recorded for 15 whales, the individual diameters ranging from 1.7 to 11.5 cms. The size frequency of these scars is shown in table 6, where it is seen that the majority were between two and three cms. in diameter.

Murray and Hjort (1912, p.651) record that a sperm whale taken off the east coast of Iceland in 1903 had numerous sucker scars of about 2.7 cms. diameter which were attributed to Architeuthis sp. The whale also had large numbers of parallel scars and contained a piece of squid tentacle having a maximum diameter of 17 cms. It had disgorged a tentacle of 6 metres in length when being caught.

It seems doubtful whether the very large scars in table 6 and figure 2 were, in fact, caused by squid. Although their appearance, a conspicuous ring, was similar to the much smaller sucker scars the size of squid necessary to produce these would far exceed the known dimensions of these animals. (M.R. Clarke pers. comm.). It is difficult to see what else could cause these rings, but it is possible that they are old sucker scars which have stretched as the whale has grown.

Scars, presumed elsewhere to be caused by hooks on the arms of squid (see for example R. Clarke 1956, p.255) were present on all 65 animals. Twenty-eight of the whales (43%) had them in an abundance varying from moderate to very many. As the sperm whales off Iceland do not apparently feed to any extent on squid, then either they are very unsuccessful in getting these animals into their mouths or, more probably, they obtain these scars elsewhere. These whales presumably migrate from further south and return there sometime in the autumn, and off the Azores (R. Clarke 1956) and Madeira (M.R. Clarke 1962) sperm whales are known to feed largely upon squid. The sizes of these "claw" scars and their positions on the heads of Icelandic whales, however, preclude their being made by any known squids from the N. Atlantic. Taningia danae, the only large hooked squid known from the N. Atlantic has very short arms and it is difficult to see how they could produce

scars at such a distance from the mouth of the whale (M.R. Clarke pers. comm.). It is possible that these long scars are caused, not by squid, but by the teeth of rival bulls, but it is somewhat difficult to see how this could be done. Clearly it is desirable that specimens of these "claw" scars and also of the large "sucker" scars found at Iceland should be collected, in order to determine whether in fact they are caused by squid.

SUMMARY

1. The contents of the first stomach were examined for 57 male sperm whales caught off the west coast of Iceland.

2. Forty-nine stomachs contained food (86%), forty-eight (98%) of these had fish remains, twenty-two (43%) had exclusively fish and only one (2%) had exclusively squid.

3. In contrast to other areas of the world, fish is the major part of the diet of the Icelandic sperm whales.

4. All except one of the fish species eaten are normally found on the sea bottom.

5. The most important fish species in the diet are C. lumpus, Sebastes sp., and L. piscatorius.

6. The majority of the fish species eaten occur to depths of at least 400 m. and some may live considerably deeper.

7. All the whales were caught in water between 500 and 2000 m. in depth.

8. It is suggested that Icelandic sperm whales feed on the bottom, to depths of at least 500 m. and possibly much deeper.

9. Scars, assumed to be caused by squid, were present on 65 animals. Some of these scars are abnormally large.

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* Not seen in the original, but taken from Tomilin (1957).

Table 1

| REGION | SOURCE |
|---|---|
| N. Atlantic | Millais (1906) |
| E. coast of Iceland | Murray and Hjort (1912) |
| Shetlands | Haldane (1905), Millais (1906) |
| Faroes | Anon (1936), Degerbøl (1940) |
| Norway | Hjort and Ruud (1929) |
| W. coast of Ireland | Hamilton (1914) |
| Azores | R. Clarke (1956) |
| Newfoundland and Labrador | Sergeant (1966) |
| N. Pacific | |
| Bering Sea and Alaskan Gulf | Okutani and Nemoto (1961) |
| Kamchatka | Tomilin (1957) |
| Kurile Islands | Betesheva and Akimushkin (1955) |
| Japan | Mizue (1951) |
| Brit. Columbia | Robbins et al (1938), Pike (1950) |
| California | Rice (1963) |
| Eastern tropical Pacific | Beale (1839) |
| Ecuador | Krefft (1954) |
| Cook Strait | Gaskin and Cawthorn (1967) |
| Antarctic | |
| Pelagic | R. Clarke (1956), Korabelnikov (1959) |
| S. Georgia and S. Africa | Matthews (1938) |

Table 2

| LOCALITY | SOURCE | NO. STOMACHS WITH FOOD | NO. STOMACHS WITH FISH | % STOMACHS WITH FISH | SEX OF WHALES |
|---|---|---|---|---|---|
| Iceland | Present author | 49 | 48 | 98 | ♂ |
| Azores | R. Clarke (1956) | 28 | 4 | 14 | ♂+♀ |
| Kuriles | Betesheva and Akimushkin (1955) | 360 | 110 | 30 | ? |
| Kamchatka | Tomilin (1957) | 21 | 4 | 19 | ? |
| Japan | Mizue (1951) | 809 | 68 | 8 | ♂ |
| Antarctic (pelagic) | R. Clarke (1956) | 56 | 7 | 13 | ♂ |
| | Korabelnikov (1959) | 115 | 6 | 5 | ♂ |
| S. Georgia & S.Africa | Matthews (1938) | 63 | 7 | 11 | ♂+♀ |

Table 2: % incidence of fish in the stomachs of sperm whales taken from different parts of the world.

Table 3

AMOUNTS OF FOOD IN STOMACH

| | MUCH FISH | MUCH SQUID | MOD. FISH | MOD. SQUID | LITTLE FISH | LITTLE SQUID | TOTAL |
|---|---|---|---|---|---|---|---|
| NOS. STOMACHS WITH SQUID ONLY. | | | | | | 1 | 1 |
| NOS. STOMACHS WITH FISH ONLY. | 5 | | 3 | | 14 | | 22 |
| STOMACHS WITH FISH AND SQUID* | x | x | | | | | |
| | x | x | | | | | |
| | | x | | | x | | |
| | x | | | | | x | |
| | x | | | | | x | |
| | x | | | | | x | |
| | x | | | | | x | |
| | x | | | | | x | |
| | | | x | x | | | |
| | | | x | x | | | |
| | | | x | | | x | |
| | | | | | x | x | |
| | | | | | x | x | 26 |
| | | | | | x | x | |
| | | | | | x | x | |
| | | | | | x | x | |
| | | | | | x | x | |
| | | | | | x | x | |
| | | | | | x | x | |
| | | | | | x | x | |
| | | | | | x | x | |
| | | | | | x | x | |
| | | | | | x | x | |
| | | | | | x | x | |
| | | | | | x | x | |
| | | | | | x | x | |
| TOTALS | 12 | 3 | 6 | 2 | 30 | 22 | 49 |

* Individual animals.

Table 3. Quantities of food found in the first stomach of the sperm whales taken at Iceland 1967.

Table 4

| WHALE NO. | RECOGNISABLE FISH REMAINS IN THE STOMACH |
|---|---|
| ICE 55 | 20+ *Cyclopterus lumpus** (largest 38 cms length minus tail fin, wgt. 3 Kg). |
| 59 | *Lophius piscatorius* (cranium width 13.8 cms) |
| 62 | *L. piscatorius*, 4 *Sebastes sp.*, *Pollachius virens*? |
| 64 | 1 *Cadus aeglefinus*?,** *Gadus morhua* |
| 65 | *Sebastes sp.*, (cranium length 18.7 cms), 1 *Somniosus sp.*?, 2 *C. lumpus* |
| 66 | 2 *C. lumpus* |
| 74 | *G. morhua*, *Sebastes sp.*, (at least 2), 1 unidentified otolith. |
| 91 | 3 *C. lumpus** |
| 99 | *G. morhua* (at least 3), *Sebastes sp.*, (at least 3, one with cranium length 11.6 cms) |
| 104 | 19 *C. lumpus* (largest S.L. 33.5 cms, wgt. 2.7 Kg.), 6 *L. piscatorius* (largest 108 cms long minus tail fin, one S.L. 56.5 cms., 2 with S.L. 60 cms. +), 1 *Sebastes mentella*, (S.L. 38 cms) |
| 106 | 1 *Sebastes sp.*,* 1 unidentified shark |
| 110 | 3 *C. lumpus** |
| 111 | *P. virens* (cranium length 17.8 cms) |
| 121 | 3 *L. piscatorius** |
| 124 | 1 *C. lumpus** |
| 132 | 12 *C. lumpus*,* 2 *Anarhichas minor*, (one cranium length 13 cms), 1 *Sebastes sp.* (S.L. ca 39 cms). |
| 140 | 1 *Raja sp.* |
| 167 | 1 *C. lumpus** (in throat) |
| 168 | *Sebastes sp.* |
| 172 | ca 6 *. lumpus** |

* Identified on the platform from intact specimens

** Tentatively identified on the platform. Since *G. morhua* otoliths were present in the stomach the specimen may have been of this species.

*Table 4* Fish species identified from the stomachs of the sperm whales at Iceland 1967. The table includes the numbers of some species found in individual stomachs, and the size and weights of some of the individual fish.

| | SPECIES | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | C. lumpus | Sebastes sp. | L. piscatorius | G. morhua | Sharks | P. virens | Raja sp. | A. minor | G. aeglefinus? |
| No. of whales in which species was present. | 10 | 8 | 4 | 3 | 2 | 2 | 1 | 1 | 1 |

Table 5 Frequency of occurrance of identified fish species

Table 6

| Diam (cms) | 1.7 ↑ 2.0 | 2.1 ↑ 2.5 | 2.6 ↑ 3.0 | 3.1 ↑ 3.5 | 3.6 ↑ 4.0 | 4.1 ↑ 4.5 | 4.6 ↑ 5.0 | 5.1 ↑ 5.5 | 5.6 ↑ 6.0 | 6.1 ↑ 6.5 | 6.6 ↑ 7.0 | 7.1 ↑ 7.5 | 7.6 ↑ 8.0 | 8.1 ↑ 8.5 | 8.6 ↑ 9.0 | 9.1 ↑ 9.5 | 9.6 ↑ 10.0 | 10.1 ↑ 10.5 | 10.6 ↑ 11.0 | 11.1 ↑ 11.5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nos.* | 15 | 18 | 36 | 3 | 7 | 1 | 3 | 1 | 1 | 1 | 1 | - | - | - | - | 1 | - | - | - | 1 |

* In addition to the above were 4 between 2.0 - 2.5 cms
16 " 2.0 - 2.6
'Many' " 2.0 - 3.0
'Many' " 2.4 - 2.7

Table 6 Size frequency of individual sucker scars.

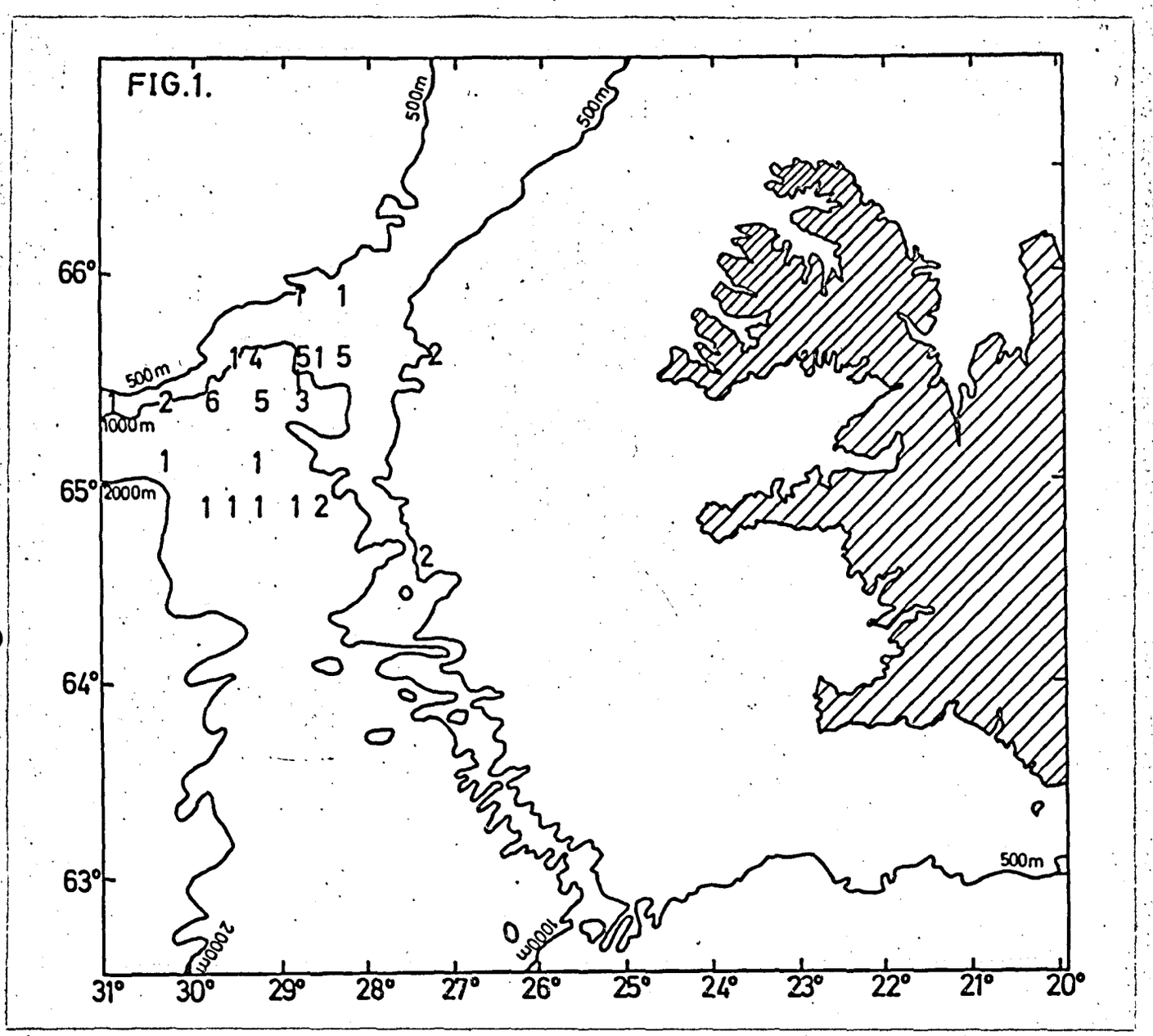


Fig. 1 Catch positions (with number of whales taken) of fortyeight whales in which food was found in the stomach.