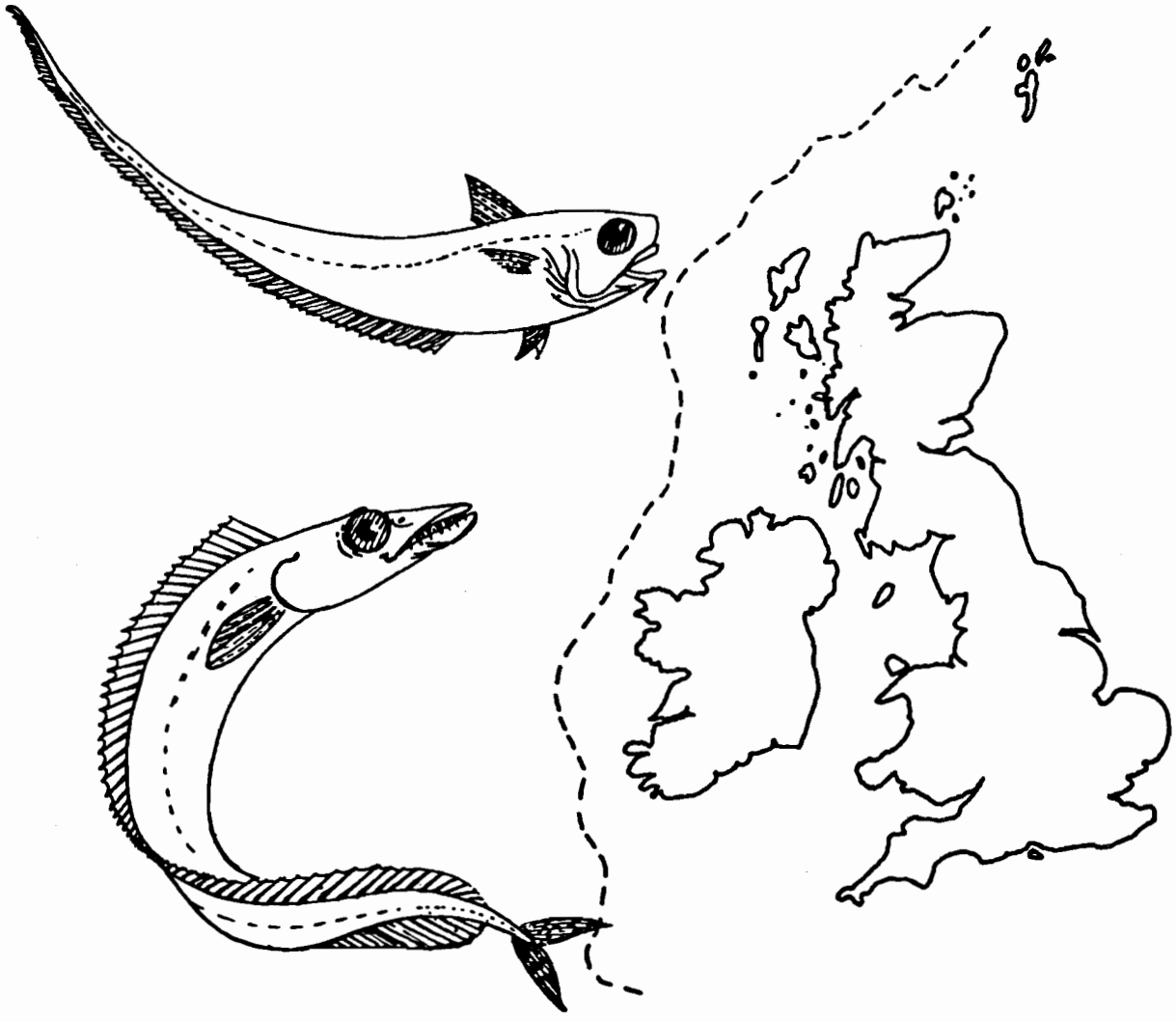
ISSN 0072-6699

MINISTRY OF AGRICULTURE FISHERIES AND FOOD

DIRECTORATE OF FISHERIES RESEARCH

# NEW DEEP-WATER TRAWLING GROUNDS TO THE WEST OF BRITAIN



J.P. BRIDGER

LABORATORY LEAFLET No. 41

LOWESTOFT

1978

The author:

J. P. Bridger is a Senior Scientific Officer in the Fish Stock Management Division of the Directorate of Fisheries Research. He is stationed at the Fisheries Laboratory, Lowestoft.

Lab. Leafl., MAFF Direct. Fish. Res., Lowestoft, (41), 40 pp.

John Pinnegar.

CONTENTS

## INTRODUCTION

This report is based on the results of six voyages in 1973-74 to the deep water lying to the west of the British Isles. Four of these voyages were carried out by the Ministry of Agriculture, Fisheries and Food's (MAFF) research vessel CIROLANA and two by commercial trawlers on charter from J. Marr and Son, SWANELLA in September 1973 and LUNEDA in February 1974. The charters were arranged by the White Fish Authority (WFA) on behalf of MAFF. Staff from WFA, the Department of Agriculture and Fisheries for Scotland, Torry Research Station and British Museum (Natural History) participated on several of the voyages.

Short preliminary reports on the major findings of each voyage were sent via the District Inspectors of Fisheries to all trawler owners in England and Wales immediately after each voyage. This report includes all the basic data and the results of various analyses not completed at the time of the earlier reports.

Depths are referred to in fathoms; a fathoms/metres conversion table is in Appendix 2.

## BACKGROUND TO THE SURVEYS

Interest in the possibilities of trawling at depths of over 400 fm began in 1970 when Faroese factory trawlers reported catches of up to 100 tons of large cod per day at Banana Bank, West Greenland and Forlander Bank, Spitsbergen. Some British vessels also made big catches in 400-450 fm off Spitsbergen in March/April 1970. The Industrial Development Unit of the WFA followed up these reports with a visit to Faroes, a computer study of the forces involved in very deep trawling, and a short charter voyage on J. Marr and Son's stern freezer trawler SOUTHELLA to the deep water north of Shetland. Their reports showed that by the use of extra-heavy otter boards, extra-strong headline floats and heavy-duty rubber bobbins, existing large British trawlers could operate successfully at depths of up to 650 fm.

The MAFF Fisheries Laboratory at Lowestoft had, during the period 1960-70, carried out a number of research cruises to the west of the British Isles and had commissioned several charter voyages by BOSTON HERON (Milford Fisheries Ltd) to explore for new hake fishing grounds to the south of Porcupine Bank off the west coast of Ireland. Records of some 300 hauls in depths of up to 300 fm were available. No information was available as to the nature of the sea-bed nor the fishery potential in the deeper waters of the continental slope. In 1970, when the new research vessel CIROLANA became available, it was envisaged that these surveys would in future be extended into deeper water. To this end plans were made to assemble the necessary gear, test it and carry out a brief survey in April 1973.

## TIMING AND EXTENT OF THE SURVEYS

To date six surveys have been carried out. The approximate positions of the hauls are shown in Figure 1 and further details of each haul are given in Appendix 1.

Survey 1 April 1973 by CIROLANA: one day's fishing at each of eight widely separated localities on the continental slope, totalling 35 hauls of 1½ hours duration each.

Survey 2 July 1973 by CIROLANA: one day's fishing at each of nine localities on the slope, totalling 36 hauls.

Survey 3 September 1973 by SWANELLA: a total of 35 days' fishing yielding 116 hauls at five localities on the slope and on seven offshore banks lying to the west of the continental shelf.

Survey 4 January 1974 by CIROLANA: six days' fishing at six localities on the slope, totalling 23 hauls.

Survey 5 February 1974, a follow-up chartered commercial voyage by LUNEDA: 12 days' fishing in the two most productive areas located on survey 4, totalling 49 hauls.

Survey 6 June 1974 by CIROLANA: a day's fishing at each of five localities on the slope, two days on the slopes of Rockall Bank and one day on Rosemary Bank, totalling 27 hauls.

On CIROLANA the aim was to make four hauls in each locality at depths of approximately 300, 400, 500 and 600 fm. Since each haul took nearly three hours, inclusive of shooting and hauling times, this programme was mainly carried out by day followed by an overnight steam to the next locality. The commercial vessels fished 24 hours per day unless prevented by bad weather. No significant differences were observed between the catch-rates by day, night or at dawn and dusk.

## THE FISHING GEAR AND METHODS USED

### CIROLANA

The otter boards were 'Fearnought' rectangular boards measuring 11 ft x 5 ft 3 in (3.35 x 1.6 m), and were fitted with extra soles, side weights and extra-heavy scrub plates and side plates. They weighed about 27 cwt (1 373 kg) each in air, some 8 cwt (400 kg) more than most boards of this size.

Heavy spherical rubber bobbins (Cosalt BY 93 and BY 94) of 21 in (533 mm) and 18 in (457 mm) diameter were used, six 21 in bobbins and 14 Lancaster spacers in the 20 ft (6.1 m) bosom and three 21 in bobbins and three 18 in bobbins with 14 Lancasters in each bunt.

The 60 headline floats used were mainly Cosalt 'XX' 8 in (229 mm) alloy floats, but some blue 'Nokalon' plastic floats were also used. For the most part both these floats survived the pressures exerted on them at depths down to 625 fm.

Iron 21 in (533 mm) bumper bobbins and 24 in (610 mm) Dan Leno bobbins were used but one of the latter imploded at 625 fm.

Bridles of 3 in (24 mm) diameter wire 40 fm long were used on all the grounds but the indications were that longer bridles could be used on most of the grounds fished.

Headline legs were 15 ft (4.6 m) long. Ground chains of drag alloy chain 45 ft (13.7 m) long were used with bumper bobbins but without rubber discs.

The trawl net was a standard synthetic small Granton of 78 ft (23.8 m) headline, 116 ft (35.4 m) groundrope, with the lower wings 'flying'. The nylon cod-end was of 110 mm mesh fitted with a small 'blinder', since for research purposes it was necessary to sample the small fish as well as the large. As it turned out, all the fish of any likely commercial importance taken would have been retained by the cod-end alone.

The warps were of $3\frac{1}{4}$ in circumference (26.3 mm diameter), 6 x 19 construction.

Plate 1 illustrates the trawl being hauled.

SWANELLA

The net was an enlarged Granton trawl, the so-called 'Stella' trawl, having a 96 ft (29.25 m) headline and 147 ft (44.8 m) groundrope. The otter boards measured 10 ft 6 in x 6 ft (3.2 x 1.8 m) and were even more heavily ballasted than CIROLANA's, weighing about 1.5 tons each in air. The groundrope consisted of a mixture of steel and rubber bobbins with Lancaster spacers in the bosom and bunts. The bunt sections of the groundrope were connected to the Dan Lenos by 50 ft of steel wire rope and 9 ft of chain, with a bumper bobbin at each wing-end. The bridles were 40 fm in length.

Plate 2 shows the bag at the top of the ramp.

LUNEDA

The net was a 103 ft (32 m) headline 'Portuguese' trawl. It was connected by 40 fm bridles to the same otter boards as were used by SWANELLA. Headline floats and ground tackle were similar to those used by SWANELLA.

Catch-rates of all three vessels were approximately the same, so it would seem that any bottom trawl currently used in the distant-water fisheries will suffice.

The biggest problem in fishing at these depths is to ensure that the gear is hard down on the bottom at all times, while using the minimum length of warp in order to reduce the time taken to shoot and haul. Each skipper had his own ideas as to how this could be achieved and was given freedom to experiment. All three skippers slowed the vessel's speed down to about 1 knot while shooting the last 50 or 100 fm of warp and after an interval of 5-10 minutes built the speed up again slowly to about 3 knots. SWANELLA carried 1 300 fm of warp on each drum while CIROLANA and LUNEDA carried 1 250 fm. SWANELLA normally used 50 fm more warp for any given depth and towed rather more slowly than the other two vessels. The most warp shot by CIROLANA was 46 lengths or 1 150 fm.

The warp lengths and towing speeds used at each depth are given in Table 1.

Table 1 Minimum, maximum and mean warp lengths (in fathoms) and mean towing speeds (in knots) at depth

| | Depth (fm) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 300 | 350 | 400 | 450 | 500 | 550 | 600 | 650* |
| Minimum warp | 750 | 850 | 950 | 1 000 | 1 000 | 1 100 | 1 125 | 1 250 |
| Maximum warp | 900 | 1 100 | 1 150 | 1 200 | 1 200 | 1 250 | 1 250 | 1 250 |
| Mean warp | 825 | 950 | 1 050 | 1 075 | 1 150 | 1 150 | 1 150 | 1 250 |
| Mean speed | 3.6 | 3.3 | 3.1 | 3.1 | 2.9 | 2.9 | 2.8 | 2.1 |

*SWANELLA only.

In order to keep the gear on the bottom towing speed was deliberately reduced when fishing at the greater depths, as shown in Table 1. No attempt has been made anywhere in this report to correct the catches for this reduction in speed for the following reasons: three vessels were involved at different times and no calibration of their logs was possible; the speed of the vessel through the surface water may be very different from the speed of the trawl through the water close to the sea-bed; distances covered over the ground are not precise since Decca Navigator coverage of many of these grounds is unre-

liable. Consequently catch-rates, here expressed as kilogrammes per hour, at depths of over 600 fm may have underestimated fish abundance by 28-57% as compared with that at 300 fm. Over the depth range 400-550 fm, where the majority of the hauls were made, the effect of reduced towing speed on the catch-rate was probably less than 7%.

The average times taken to shoot and haul the gear when fishing with 1 000 fm of warp aft were: CIROLANA 29 and 32 minutes; SWANELLA 27 and 31 minutes; and LUNEDA 35 and 36 minutes respectively.

Once the net was on deck, handling times varied considerably due to the size of the bag and the deck layout of the vessel. On CIROLANA the cod-end was slewed over pounds on the port side and so once it was emptied the gear could be shot away again immediately. On SWANELLA, due to the fact that the deep-water species of fish do not 'run' down the ramp to the factory deck as easily as cod and haddock, large bags at times delayed operations for 30-40 minutes, since the central hatch could not be closed until the catch had been manhandled below by the crew.

## TREATMENT OF THE CATCHES

On CIROLANA the catches were basketed separately by species. Each basket was weighed and a substantial fraction, if not the entire catch, of all the important species was then measured. Apart from the small quantities of fish gutted and deep frozen for filleting and tasting trials by Torry Research Station, the catch was then dumped overboard.

On SWANELLA the catches were usually basketed separately by species, then weighed and measured prior to gutting, washing and freezing. On some hauls, in order not to slow up the work on the factory deck, the fish were not weighed. For these hauls the number of 90 lb blocks produced as reported by the factory manager were recorded and subsequently converted to ungutted weights so as to be comparable with the other catches.

On the commercial voyage of LUNEDA the catches were not weighed at sea nor were any fish measured. The catches and catch-rates for this voyage are therefore based on estimates of the number of baskets of each species caught. Failure to weigh the species separately prior to gutting makes strict comparison with the other voyages extremely difficult. The average weight of gutted fish per basket, obtained by dividing the total weight of fish landed by the estimated total number of baskets retained, was 39.33 kg. This figure has been used to convert 'baskets' to kilogrammes for all species, whether they were retained or discarded at sea. When the same method was applied to individual species, however, it became apparent that some species had been consistently overestimated while others had been underestimated. The issue is further complicated by the fact that some of the catch was passed unweighed to Torry Research Station and some eaten on board. Most species were gutted, a few left ungutted and others both beheaded and gutted. Since for many of these species no reliable conversion factors exist to convert landed weight to round fresh weight, LUNEDA's catches given in this report approximate to the gutted weight and so will in the main be underestimates compared with the other five voyages. Only in Table 2 has an attempt been made to express LUNEDA's catches as round fresh weight.

In order to simplify the subsequent analysis, the 88 different species taken on these grounds, many of them new to the British market and having no common English names, were separated into four categories.

1. Marketable: those species already sold on British markets (hake, saithe, ling, blue ling, torsk, forkbeard, halibut, Greenland halibut, megrim, witch and rays).

2. Potentially marketable: those species already eaten outside the UK or found by Torry Research Station to be suitable for direct human consumption (roundnosed grenadier, black scabbard, 'director' fish (Gephyroberyx darwini), redfish, blue whiting, greater silver smelts and Mora moro, a species very similar in appearance to the forkbeard).

3. Sharks: all dogfish and small sharks ranging from 60 to 120 cm in length which, when skinned, look, and apparently taste, very much like the spurdog and nursehound currently sold in Britain (Deania calcea, Centrophorus squamosus, Centroscymnus coelolepis and C. crepidater).

4. Trash: those species condemned by Torry Research Station as being unpalatable and all the small or rare species unlikely to warrant attention by the industry (comprising over 40 different species, some of them previously regarded as extreme rarities; by weight the dominant species were: smoothheads (Alepocephalus bairdi), rabbit fishes (Chimaera monstrosa and Hydrolagus mirabilis) and a number of small macrourids).

## THE GROUNDS SURVEYED

These may be divided into two groups: those of the continental slope and those on the lower slopes of the offshore banks. Between the continental slope and the offshore banks to the west of Britain lies a tongue of deep water, the Rockall Channel, having a depth of 1 000-1 500 fm.

The continental slope is of course a continuous topographical feature but, for convenience, it is here divided into sections and each section named after the nearest geographical feature or known fishing ground. The continental slope is generally regarded as the sea-bed lying between the 100 and 1 000 fm isobaths, but here we are concerned only with that portion which lies at depths of 300-650 fm, where almost all the fishing took place. As can be seen from Figure 1 the width, and hence the steepness, of the slope varies considerably from section to section.

Over most of the surveyed area bottom temperatures ranged from 5-10°C throughout the year, but on the Foula section, separated from the rest of the area by the Wyville-Thomson ridge, the bottom temperature seldom exceeded 1.5°C and no worth-while catches were taken there.

Despite its steep east-west slope almost all the continental slope from the South Hake ground northwards to Sulisker is trawlable. There is however some very rough ground to the north-west of Porcupine Bank and one trawl was damaged beyond repair by hard coral in 400-425 fm on the Eagle section at 54°17'N 11°34'W. A few boulders and large stones occurred on the Flannan section and at times the otter boards dug into very soft mud on the St Kilda section. Of 204 hauls made on the slope only 22 suffered any damage and only two nets were 'paralysed'.

The northern sections of the continental slope from Tory to Sulisker, where the catch-rates are highest and hence where exploitation is most likely to begin, are also the grounds where serious gear damage seems least likely to occur.

The slopes of the offshore banks are in the main much harder on the gear. Of 80 hauls made on the offshore banks 22 resulted in damage to the gear, some of it serious. Hatton Bank proved to be the worst; only on the north-west corner in over 600 fm could a clear tow be more or less relied upon.

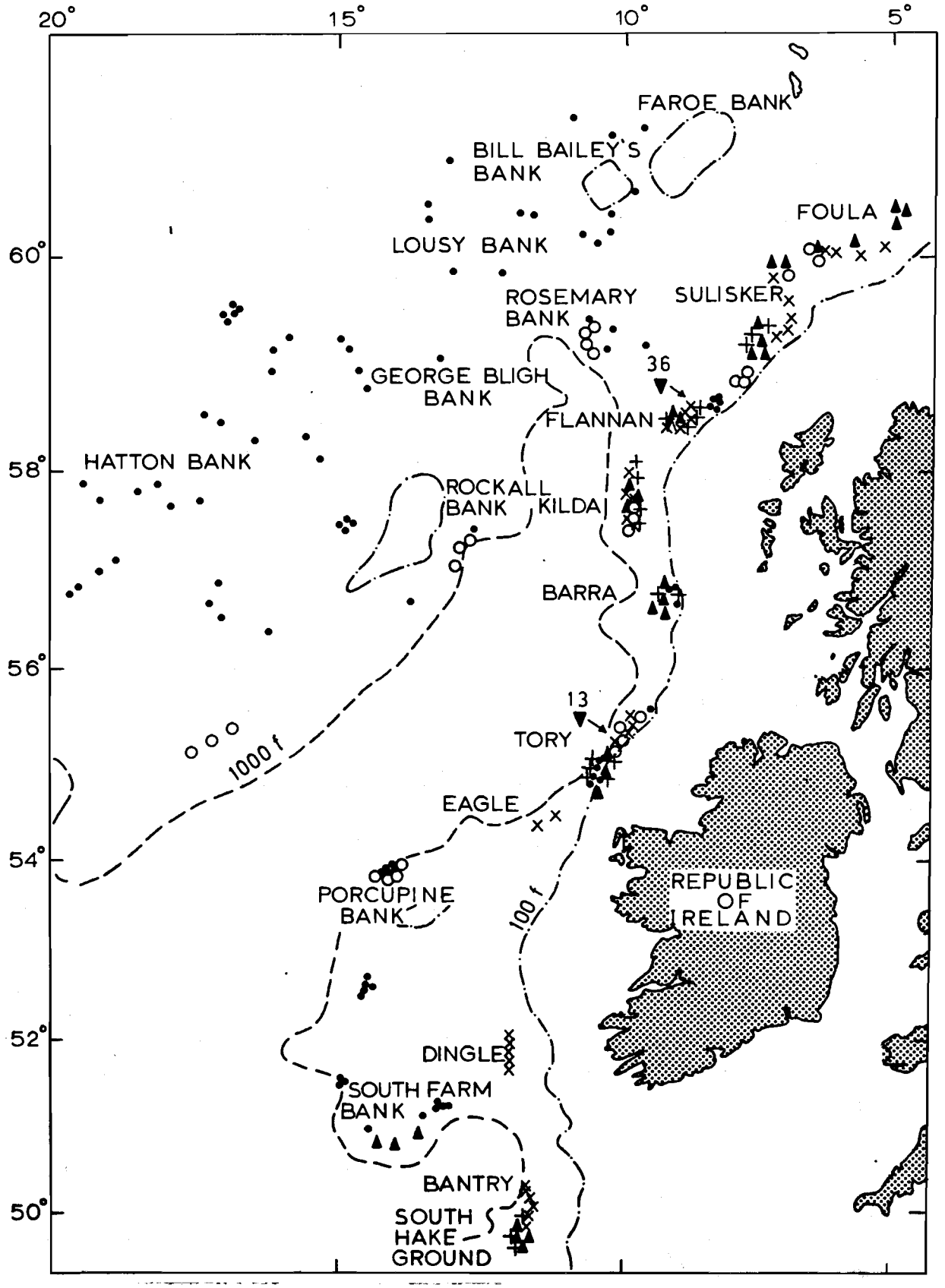



**Figure 1** Chart of the areas surveyed showing the approximate positions of the hauls. ▲ CIROLANA, Apr 1973; X CIROLANA, Jul 1973; o SWANELLA, Sep 1973; + CIROLANA, Jan 1974; ▼ LUNEDA, Feb 1974; O CIROLANA, Jun 1974.

## CATCHES AND CATCH-RATES

Catches mean very little unless some indication of fishing time is also given. The most commonly used index of the catch-rate of a freezer trawler is tons per day's fishing. This is normally adequate where a vessel fishes a relatively small number of grounds and its catches consist of only a few major species. For such surveys as the present ones it is not a good index of profitability since of necessity much time was spent steaming, both between grounds and between hauls, in order to locate the desired depth. Further, up to 20 different species were frequently taken in each haul. Short hauls of 1-1½ hours were necessary in order to reduce the chance of the haul being invalidated by gear damage. This fact, plus the increased time spent shooting and hauling, reduced fishing time to 8-12 hours per day. Consequently catch-rates are expressed as kilogrammes per hour actually fishing.

The total catch in tonnes round fresh categorized by marketability; the hours fished; and the mean catch-rate in kilogrammes per hour for each of the six voyages are given in Table 2. The mean useful (excluding trash) catch-rate of 517 kg/h should be compared with catch-rates of our freezer trawlers on the better distant-water grounds in 1973: Barents Sea 640, Norway Coast 560, Newfoundland 428 kg/h. (Details of catches of main species were taken from Table 17 of 'Fishing Prospects 1975-1976', published by this laboratory. They were multiplied by 1.2 to convert to ungutted weight.) In the comparison it must be borne in mind that these six voyages were largely surveys. Except for three short spells at Hatton, Tory and Porcupine Banks on the SWANELLA voyage and on the LUNEDA voyage to Flannan and Tory, the vessels did not stop in an area of high catch-rates as would a skipper when fishing commercially. The average catch-rate is thus artificially reduced by fishing time 'wasted' at Foula, South Hake, Farm, Bantry and Dingle where no commercial skipper would have stayed for more than a couple of hauls at most.

Table 2 Hours fishing, catch (kg, round fresh) and catch rates (kg per hour) by categories for six voyages

| Cruise | | Hours fishing | | Marketable | Potentially marketable | Sharks | Trash | Useful | Total |
|---|---|---|---|---|---|---|---|---|---|
| CIROLANA | Apr 1973 | 48.47 | kg | 5 309 | 8 674 | 7 345 | 11 452 | 21 328 | 32 780 |
| | | | kg/h | 110 | 179 | 152 | 236 | 441 | 677 |
| CIROLANA | Jul 1973 | 47.90 | kg | 1 963 | 8 973 | 4 520 | 4 905 | 15 456 | 20 361 |
| | | | kg/h | 41 | 187 | 94 | 102 | 322 | 424 |
| SWANELLA | Sep 1973 | 126.03 | kg | 2 898 | 36 800 | 19 442 | 26 928 | 59 140 | 86 068 |
| | | | kg/h | 23 | 292 | 154 | 214 | 469 | 683 |
| CIROLANA | Jan 1974 | 31.33 | kg | 2 164 | 11 815 | 5 688 | 4 710 | 19 667 | 24 377 |
| | | | kg/h | 69 | 377 | 182 | 150 | 628 | 778 |
| LUNEDA | Feb 1974 | 88.47 | kg | 27 432 | 19 127 | 11 816 | 2 183 | 58 375 | 60 558 |
| | | | kg/h | 310 | 216 | 134 | 25 | 660 | 685 |
| CIROLANA | Jun 1974 | 28.05 | kg | 1 207 | 11 991 | 4 152 | 3 391 | 17 350 | 20 741 |
| | | | kg/h | 43 | 427 | 148 | 121 | 618 | 739 |
| Total | | 370.25 | | 40 973 | 97 380 | 52 963 | 53 569 | 191 316 | 244 885 |
| Mean (kg/h) | | | | 111 | 263 | 143 | 145 | 517 | 661 |

A more meaningful picture is given in Figure 2 in which the catch-rate at each depth for each ground on each cruise is shown separately. The consistently high catch-rates of useful species on the northern slope grounds is well shown, as are the lower catches and

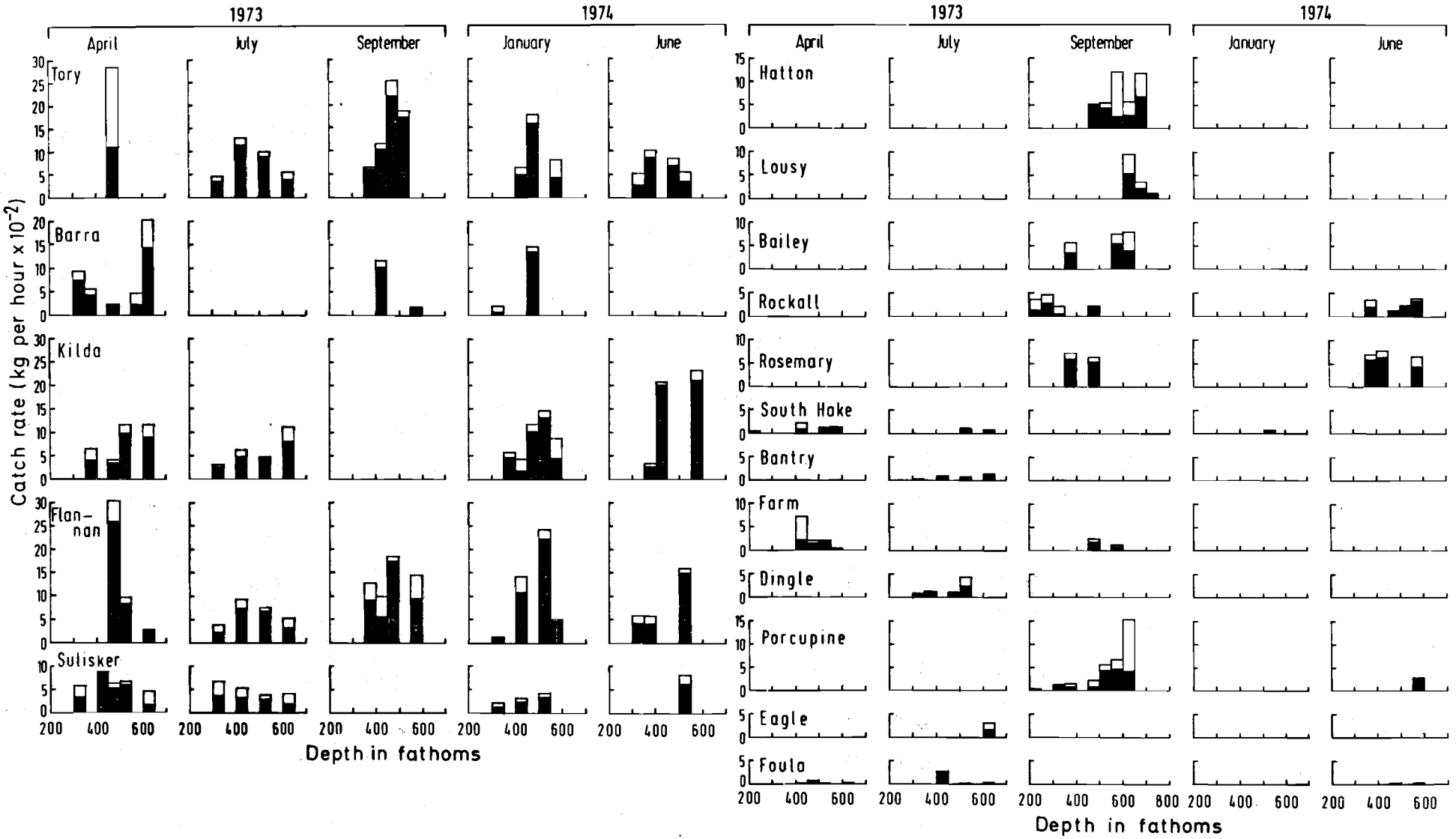



**Figure 2** Catch-rates by ground and depth on five surveys. ■ Marketable and potentially marketable species (including sharks); □ Trash species.

increased proportion of trash on most of the offshore banks. Figure 2 also shows that the highest catch-rates occurred most frequently in 400-550 fm, although strictly the catch-rates at greater depths are somewhat underestimated due to the fact that, as can be seen in Table 1, the towing speed when fishing at these depths was reduced in order to maintain ground contact when using warp/depth ratios of 2:1 or less. If speed is taken into account the deepest hauls did not produce markedly smaller catches than those made at more moderate depths, but the percentage of trash species taken at depths of over 500 fm is higher, mainly because the smoothhead abounds at these depths.

In general the most productive areas were found to be on the northern sections of the slope at Tory, Barra, Kilda, Flannan and Sulisker at depths of 400-500 fm. It is perhaps significant that all the most productive grounds lie on the steeper eastern slopes of the Rockall Channel, suggesting that the fish are funnelled to these sections by the topography.

Since many of these species move up and down the slope with the changing seasons a certain amount of hunting is necessary. To assist in locating some of the more important species and to avoid catching an undue proportion of trash some notes on the seasonal distribution of these species are given in the next section.

## SEASONAL DISTRIBUTION AND SOME BIOLOGICAL DATA ON SOME DEEP-WATER SPECIES

### 1. Blue ling, Molva dypterygia (Pennant, 1784)

Blue ling (Plate 3) occurred in small numbers on most of the grounds surveyed, but the only worth-while catches came from the northern slope grounds in winter and spring. The total catch amounted to 33 tonnes round fresh weight, of which about 25 tonnes were taken by LUNEDA in February 1974 from 480-525 fm on the Flannan section.

The best single catch of blue ling was taken on 14 February 1974 by LUNEDA in 480-510 fm around 58°07'N 09°42'W. It was estimated as 40 baskets for the 2 hour haul, but comparison of the estimated catch of blue ling with the quantity landed suggests that this was an underestimate. The true catch-rate on that haul was probably in the order of 1 000 kg/h. In April 1973 CIROLANA took 811 kg of blue ling in a 39 minute haul (1 247 kg/h) on the Flannan section around 58°33'N 08°52'W in 394-470 fm. On the same cruise 1 023 kg were taken in a 90 minute haul on the Sulisker section at 59°18'N 07°22'W in 490 fm.

Elsewhere catches of blue ling were very much lower. In September 1973 SWANELLA never exceeded 40 kg/h on any of the offshore banks. The southern slope from Tory to the South Hake ground never produced worth-while catches of blue ling even in winter when a southwards shift in the population might be expected to occur.

In summer the best catches again came from Flannan, Kilda and Sulisker but in 300-350 fm. It appears that blue ling moves up the slope on to the shallower shelf grounds in summer and overwinters in deep water. The French fishery for blue ling in these areas takes place mainly in the spring when the shoals are moving up the slope.

In April 1973 small catches of blue whiting were taken in all the hauls when good catches of blue ling were taken. This, and the fact that both species are infected with the roundworm Anisakis, suggests a predator/prey relationship. So in March/April blue ling are likely to be found where the shoals of blue whiting, usually clearly visible on an echo-sounder, build up against the slope.

The length distribution of blue ling taken by CIROLANA is given in Figure 3. The modal length on each of the four research vessel cruises lay between 95 and 99 cm. The mean weight of individual fish ranged from 4 kg in summer to 4.8 kg in autumn and winter.

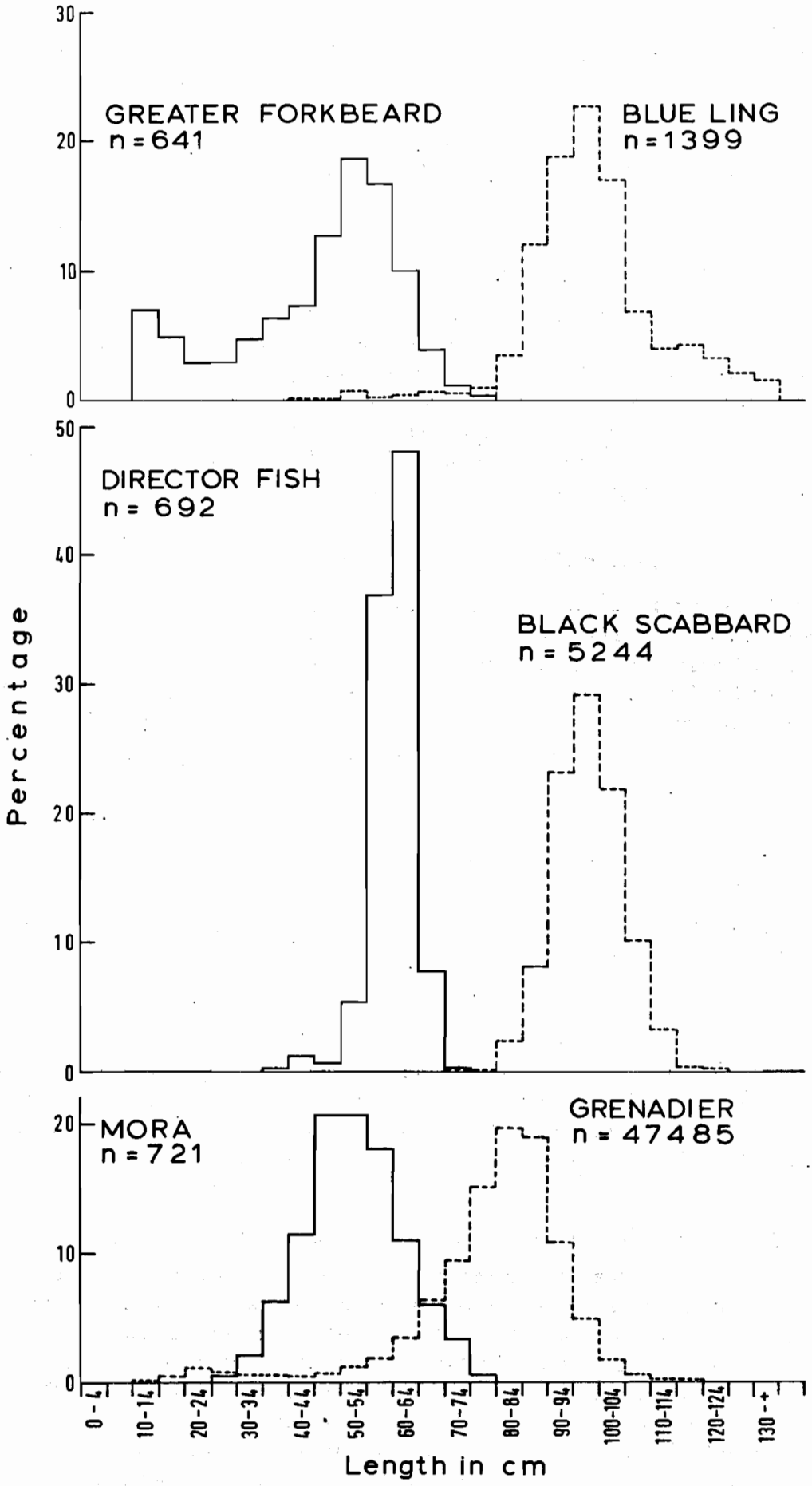



Figure 3 **Percentage length distributions of the major species.**

Despite the use of a shrimp mesh blinder in CIROLANA's cod-end no juvenile blue ling were taken anywhere in the surveyed area and no running ripe adults were observed. Consequently these voyages provide no evidence as to where the spawning or nursery grounds lie. It does mean however that exploitation of blue ling on the northern sections of the continental slope would have little or no direct effect on the numbers of immature fish entering the fishery but the possibility that overexploitation of the adult stock would in time reduce the number of recruits cannot be neglected.

2. Hake, Merluccius merluccius (Linnaeus, 1758)

Small catches of hake were made at many points on the continental slope but none was taken on the offshore banks. The total hake catch amounted to some 1 100 kg, of which 307 kg were taken by CIROLANA in January 1974. The biggest single catch, 125 kg, was taken then in 400 fm on the Tory section around 55°28'N 09°52'W. In winter almost all the slope grounds produced a few hake in the hauls made at 300-450 fm. In spring and summer the shallowest haul normally produced some hake. Most of the hake taken were 'jumbos' of 70-100 cm in length and no immature hake were taken anywhere.

3. Greater forkbeard, Phycis blennoides (Brünnich, 1768)

Although taken on all six surveys the total catch of this species (Plate 4) amounted to rather less than 1 tonne. The catch in any one haul never exceeded 40 kg. It did not occur at Hatton or Lousy Banks in September and was never taken in the cold water at Foula. Otherwise its distribution over the grounds and by depth strata shows no clear pattern. In winter the southern sections of the slope produced rather less of this species than the northern sections. This is somewhat surprising since it is generally regarded as being a southern species.

Immature fish of length 10-14 cm were taken on two of the three occasions when the South Hake section was surveyed, suggesting that its nursery grounds lie at latitudes south of the British Isles.

In all 641 specimens weighing 713 kg, mean weight 1.1 kg, were measured. The length distribution of these fish is given in Figure 3.

4. Other already marketed species

The catches of ling, torsk, halibut, Greenland halibut, megrim, witch, angler and rays occurred so sporadically that little can be learnt of their seasonal distribution. Naturally, since these species are mainly inhabitants of the continental shelf, they tended to occur more often in hauls made in 300-350 fm than at greater depths.

5. Roundnosed grenadier, Coryphaenoides rupestris (Gunnerus, 1765)

This species (Plate 5) was by far the most abundant in the potentially marketable category. It accounted for about 73% by weight of the catch in that category and 37% of the total useful catch. It was taken on all the sections of the continental slope except Foula and on all the offshore banks. The larger catches however were taken between Tory and Sulisker. Because the lower slopes of Faroe, Bill Bailey, Lousy, George Bligh and Hatton Banks were surveyed only once, in September 1973, it is possible that some or all of these banks might give better catch-rates at some other season. However, when Rosemary and Rockall Banks were revisited in June 1974 the catch-rates obtained there were very similar to those obtained in the previous September.

On the northern sections of the slope the seasonal consistency of catch-rates makes the grenadier the most commercially attractive of all the deep-water species, although catch-rates can vary enormously from one depth stratum to another as well as from section to section. However, catches of over 1 tonne/1½ hours fishing were taken at all seasons of the year in 450-550 fm at one locality or the other in the area between Tory and Flannan.

The more noteworthy catches of this species are listed in Table 3.

Table 3 Position, depth and catch-rates of some of the better hauls of grenadiers

| Cruise | Ground | Shooting position | | Depth (fm) | Catch-rate (kg/h) |
|---|---|---|---|---|---|
| Apr 1973 | Kilda | 57°43'N | 09°44'W | 503 | 729 |
| | Barra | 56 41 | 09 05 | 553 | 864 |
| Jul 1973 | Tory | 55 31 | 09 49 | 394 | 677 |
| | " | 55 14 | 10 05 | 405 | 875 |
| Sep 1973 | Flannan | 58 36 | 08 49 | 400 | 1 123 |
| | Tory | 54 56 | 10 22 | 450 | 1 567 |
| | " | 55 30 | 09 49 | 500 | 1 166 |
| Jan 1974 | Flannan | 58 17 | 09 38 | 514 | 1 871 |
| | Kilda | 57 32 | 09 39 | 503 | 905 |
| | Tory | 55 24 | 09 59 | 481 | 1 059 |
| Jun 1974 | Sulisker/Flannan | 58 45 | 08 15 | 481 | 1 137 |
| | Kilda | 57 27 | 09 32 | 454 | 1 595 |
| | " | 57 13 | 09 28 | 561 | 1 635 |

While grenadiers can sometimes be taken in fair quantities almost anywhere between 350 and 550 fm it is more usual to find the greatest concentration confined to quite a narrow depth range. This is probably due to hydrographic conditions, particularly temperature, near the sea-bed. In the Labrador/Newfoundland area very few roundnosed grenadiers are caught at bottom temperatures of less than 3.5°C. The temperature range in areas where they are encountered in quantity is very narrow - generally 3.5-4.5°C (Parsons 1975). Unfortunately in the present series of surveys insufficient hydrographic observations were made to be so specific. On the SWANELLA voyage temperature recorders were attached to the trawl but both instruments became inoperative during the first part of the survey. Prior to this instrument failure the observations given in Table 4A were obtained.

On CIROLANA sea-bed temperatures were taken as and when time permitted, often when the day's trawling had been completed. These results are given in Table 4B, together with the catch of grenadiers in the haul most nearly comparable in position and water depth to that of the hydrographic station. It is clear from these observations that the roundnosed grenadier population living to the west of the British Isles inhabits warmer water than that living on the western side of the Atlantic. The biggest catches for which temperature data are available have come from water of 7.6°C (January) to 11.5°C (September). Small quantities have been taken at times in temperatures of 5.0-6.0°C but none on the Foula section of the continental slope where the bottom temperature is normally below 1.5°C throughout the year.

It is perhaps significant that most of the juvenile fish of under 30 cm in length occurred in hauls made at over 600 fm where the bottom temperatures were 5-6°C. Unfortunately no bottom temperatures are available for the deep water at Hatton Bank, where, in September 1973, juvenile grenadiers were most numerous.

Table 4A Bottom temperatures, depth and catches of grenadiers on some grounds observed by SWANELLA

| Station no. | Ground | Depth (fm) | Bottom temperature (°C) | Remarks |
|---|---|---|---|---|
| 1 | South Farm Bank | 550 | 10.7 | 14 kg grenadiers |
| 3 | Tory | 450 | 10.5 | 885 kg " |
| 4 | " | 450 | 10.5 | 2 350 kg " |
| 5 | " | 500 | 10.5 | 1 808 kg " |
| 7 | Barra | 500 | 11.0 | 97 kg " |
| 9 | Flannan | 450 | 11.5 | 1 684 kg " |
| 17 | Rockall Bank | 175 | 11.5 | No grenadiers, too shallow |
| 18 | " | 220 | 11.5 | " |
| 19 | " | 295 | 12.5 | " |
| 56 | Lousy Bank | 670 | 6.4 | 233 kg grenadiers ) many |
| 57 | " | 635 | 5.0 | 38 kg " ) juveniles |

Table 4B Bottom temperatures, depth and catches of grenadiers on some grounds observed by CIROLANA

| Station no. | Ground | Depth (fm) | Bottom temperature (°C) | Remarks |
|---|---|---|---|---|
| | Jul 1973 | | | |
| 9 | Foula | 319 | 1.33 | No grenadiers |
| 14 | Sulisker | 414 | 6.41 | 146 kg grenadiers |
| 33 | Kilda | 525 | 7.58 | 359 kg " |
| 58 | South Hake | 646 | 8.00 | 8 kg " |
| | Jan 1974 | | | |
| 9 | Tory | 437 | 7.60 | 1 642 kg grenadiers |
| | Jun 1974 | | | |
| 4 | Sulisker/Flannan | 387 | 8.44 | 1 706 kg grenadiers |
| 8 | Kilda | 431 | 8.56 | 2 452 kg " |
| 13 | Tory | 650 | 5.42 | 207 kg " , few juveniles |
| 17 | Porcupine | 392 | 8.64 | 54 kg " |
| 25 | East Rockall | 630 | 5.62 | 111 kg " , including 3 kg juveniles |
| 27 | Rosemary | 394 | 8.45 | 295 kg " |
| 34 | Foula | 423 | -0.66 | Nil |
| 36 | Sulisker | 509 | 7.82 | 226 kg " |

According to several Russian authors, notably Pechenik and Troyanovskii (1971), the grenadier at Labrador behaves bathypelagically, making considerable diurnal and seasonal vertical migrations so as to maintain contact with its planktonic food. Since the British surveys were designed to cover as many different grounds as possible in the available time it was impractical to carry out a number of hauls in the same place and so test directly for diurnal variation in the catch-rates. Various methods of analysis have been applied to our data to test for diurnal variation but no statistically significant results were obtained. It is possible, however, that our catches reflect not so much the abundance of fish on these grounds as their availability to bottom trawls with a headline height of about 2 m. Whatever the underlying causes there is little doubt that grenadiers are normally very 'depth conscious'. This means that if commercial exploitation occurs whenever a paying concentration of fish is found, very accurate contour fishing along the steeply shelving slope will be necessary. Straying up or down the slope by as little as 55 fm from the preferred depth can reduce catches to almost nothing.

Some clues as to the seasonal distribution of grenadiers by depth can be culled from the data in Appendix 1. In April 1973 the fish were deep; none of the 11 hauls made at depths of less than 450 fm gave a worth-while catch and all the better catches came from over 500 fm. On the Barra and Kilda sections the highest catch-rates were in 600 fm. In July 1973 none of the seven hauls made in depths of less than 350 fm yielded worth-while catches of grenadiers but 50% of all the hauls made in 400-600 fm produced at least 500 kg; at Tory and Flannan the best catches came from 400 fm but at Kilda the best haul was in 600 fm. For September 1973 the pattern is more difficult to interpret because the extent of the grounds surveyed was wider and hence the differences in hydrographic conditions were probably greater. At Tory the grenadiers were in their 'summer quarters', the bottom temperature was fairly constant at around 10.5°C in 350-500 fm and fair catches were taken over this depth range; catch-rates at over 500 fm were lower. A similar situation prevailed at Flannan while at Barra the best catch was made at 400 fm. On the offshore banks the move back into deeper water had already begun, at Hatton the best haul of grenadiers was taken in 650 fm while at Bill Bailey and Lousy Banks the best catches were made at over 550 fm. The autumn period would therefore seem to be a time of change, with paying catches of grenadiers occurring anywhere between 350 and 650 fm depending on local conditions.

In January 1974 the fish had either returned to, or were moving towards, their overwintering grounds in deep water; none of the eight hauls made in less than 400 fm produced a sizable catch but the majority of hauls made in 450-550 fm produced excellent catches.

In June 1974 the fish were found at widely differing depths on the northern sections of the slope; reasonable catches were made at Tory from 350-450 fm but at Kilda and also between Flannan and Sulisker the fish tended to be deeper, some of the best catches for the whole series of surveys coming from 450-550 fm.

Echo-sounder records of grenadiers have been made by Russian vessels working at Labrador when the catch-rates have been considerably higher than on any of the grounds surveyed on the eastern side of the Atlantic. However, it is possible that a powerful echo-sounder with a bottom-lock facility could be useful in locating dense aggregations of grenadiers in the latter area.

Being the most important single species caught during these surveys the catches of grenadiers were extensively sampled, some 12 000 fish being measured out of an estimated total catch of 47 485. The only catches not measured were those taken by LUNEDA and on some of the quasi-commercial hauls made by SWANELLA in good fishing areas located by her survey. Because of the large numbers of fish measured it was possible to analyse

the measurements by cruise, by ground and by depth. In addition to these measurements some 650 age determinations were carried out and the length and weight of individual fish recorded.

The percentage length distributions for the five surveys on which measurements were made are shown in Figure 3. The most striking fact to emerge is that only 1 167 fish of under 30 cm in length were caught despite the use of shrimp-mesh blinders in the cod-end on four of the five surveys. In September 1973 the SWANELLA voyage produced 829 (71%) of these very small grenadiers. Examination of the haul-by-haul records shows that these very small grenadiers were taken at Hatton, Rockall, Lousy, Bill Bailey and Faroe Banks and that they nearly all came from hauls made at over 550 fm. On CIROLANA small grenadiers were taken on various sections of the continental slope between Barra and Sulisker and they too came from the deeper hauls.

The length measurements of the grenadiers caught on the northern slope sections were tabulated by depth of capture. The numbers of fish in each 5 cm length group per 10 hours fishing are given in Table 5. Where only a single haul was made at 600 fm the catch has been added to those made at 500 fm and the column headed 500+. Next the population was split into four categories: 'very small' (under 30 cm), 'small' (30-59 cm), 'medium' (60-89 cm), and 'large' (over 90 cm). When corrected for fishing time the sample consisted of 43 888 grenadiers of which only 301 (0.7%) were in the 'very small' and 1 956 (4.5%) in the 'small' category. More importantly 94% of the 'very small' category and 41% of the 'small' category came from over 500 fm. This finding suggests that if a fishery were to develop in 300-500 fm on these northern slope grounds the 'medium' and 'large' categories would provide the bulk of the landings while the nursery grounds would be little affected.

On 16 September 1973 when fishing on the north-west slopes of Hatton Bank at 59°28'N 16°59'W in 650 fm the logbook records: 'large female grenadiers full of roe, some actually running ripe and a few spent'. This was the only occasion on the six surveys when such an observation was made. These fish ranged from 60-112 cm, the majority being 70-90 cm in length. It is possible that other spawning grounds were not located due to insufficient hauls being made at over 650 fm or because on the surveys made by CIROLANA the majority of the catch was not gutted. However, this one observation plus the fact that very small grenadiers are most abundant at over 600 fm suggests that both the spawning grounds and the nursery grounds of the grenadier lie in very deep water and that spawning takes place in autumn.

Otoliths were taken from stratified samples on two of the surveys and 648 age determinations were carried out. An age/length key was constructed and applied to the length distribution of the total catch. Assuming that the rings visible under a microscope are annual rings, and there is no evidence to suggest that they are not, it is clear that the grenadier can live to a very great age. The numbers caught per 100 hours fishing at each age and the mean length of each age group are given in Table 6. In an unfished population a high mean age and a slow growth rate are to be expected, but these results are quite exceptional. Recruitment appears not to be complete until the fish are at least 22 years of age and thereafter mortality is about 20% per annum. Growth is remarkably constant at about 3.15 cm per annum from the third to the twentieth year and thereafter averages only 0.6 cm per annum. Only 21% of the total catch including all the small fish taken at Hatton Bank by SWANELLA were less than 22 years of age. In June 1974 only 14% of the catch were less than 22 years of age.

The effect of commercial fishing on such a stock is as yet somewhat unpredictable. The numbers of old fish living in 350-500 fm would be depleted quite quickly by heavy fishing but if the Rockall Channel is populated by a large number of young grenadiers,

Table 5 Numbers of grenadiers per 10 hours fishing caught at various depths on the northern sections of the continental slope

| Length group (cm) | Apr 1973 | | | | | Jul 1973 | | | | | Sep 1973 | | | | Jan 1974 | | | | Jun 1974 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Depth (fm) | | | | | Depth (fm) | | | | | Depth (fm) | | | | Depth (fm) | | | | Depth (fm) | | | |
| | 300 | 400 | 500 | 600 | Total | 300 | 400 | 500 | 600 | Total | 300 | 400 | 500+ | Total | 300 | 400 | 500+ | Total | 300 | 400 | 500 | Total |
| **VERY SMALL** | | | | | | | | | | | | | | | | | | | | | | |
| 10- 14 | | | | | | | | | 15 | 15 | | | | | | | 2 | 2 | | | | |
| 15- 19 | | | | 23 | 23 | | | | 55 | 55 | | | | | | | 3 | 3 | | | | |
| 20- 24 | | | | 31 | 31 | | | | 58 | 58 | | | | | | | 3 | 3 | | | | |
| 25- 29 | | | 3 | 34 | 37 | | 13 | | 55 | 68 | | | | | | | 4 | 4 | | | 2 | 2 |
| **SMALL** | | | | | | | | | | | | | | | | | | | | | | |
| 30- 34 | | | 1 | 15 | 16 | | 13 | | 15 | 28 | | | 7 | 7 | | 1 | 4 | 5 | 13 | | 4 | 17 |
| 35- 39 | | | 3 | 16 | 19 | | 33 | 4 | 13 | 50 | | 9 | 7 | 16 | | 4 | 20 | 24 | 20 | | 7 | 27 |
| 40- 44 | | | 1 | 3 | 4 | | 20 | - | 7 | 27 | | 19 | 13 | 32 | | 17 | 29 | 46 | 10 | | 7 | 17 |
| 45- 49 | | | - | 19 | 19 | | 13 | 9 | 21 | 43 | | 9 | 3 | 12 | | 26 | 111 | 137 | 10 | | 18 | 28 |
| 50- 54 | 2 | 4 | 5 | 2 | 13 | | 20 | 2 | 40 | 62 | 11 | 52 | 20 | 83 | | 62 | 159 | 221 | 80 | | 64 | 144 |
| 55- 59 | - | 2 | 8 | 32 | 42 | 2 | 61 | 30 | 55 | 148 | 21 | 64 | 40 | 125 | | 122 | 160 | 282 | 60 | 97 | 105 | 262 |
| **MEDIUM** | | | | | | | | | | | | | | | | | | | | | | |
| 60- 64 | - | 8 | 5 | 82 | 95 | 2 | 60 | 26 | 71 | 159 | 44 | 125 | 30 | 199 | | 187 | 325 | 512 | 162 | 260 | 305 | 727 |
| 65- 69 | 4 | 8 | 20 | 231 | 263 | - | 166 | 57 | 167 | 390 | 110 | 224 | 43 | 377 | | 289 | 463 | 752 | 217 | 400 | 305 | 922 |
| 70- 74 | 7 | 42 | 115 | 223 | 387 | - | 220 | 79 | 147 | 446 | 185 | 364 | 37 | 586 | | 347 | 667 | 1 014 | 228 | 417 | 798 | 1 443 |
| 75- 79 | 13 | 65 | 115 | 632 | 825 | 2 | 413 | 185 | 288 | 888 | 430 | 709 | 87 | 1 226 | | 660 | 882 | 1 542 | 368 | 763 | 895 | 2 026 |
| 80- 84 | 62 | 80 | 288 | 652 | 1 082 | - | 609 | 349 | 314 | 1 272 | 398 | 1 058 | 90 | 1 546 | | 1 016 | 1 320 | 2 336 | 258 | 1 780 | 949 | 2 987 |
| 85- 89 | 44 | 79 | 356 | 684 | 1 163 | 11 | 723 | 472 | 362 | 1 568 | 443 | 1 225 | 50 | 1 718 | | 616 | 847 | 1 463 | 140 | 1 500 | 1 107 | 2 747 |
| **LARGE** | | | | | | | | | | | | | | | | | | | | | | |
| 90- 94 | 40 | 31 | 341 | 242 | 654 | 9 | 563 | 451 | 243 | 1 266 | 233 | 746 | 37 | 1 016 | | 265 | 202 | 467 | 62 | 1 167 | 722 | 1 951 |
| 95- 99 | 22 | 12 | 112 | 168 | 314 | | 288 | 185 | 89 | 562 | 125 | 438 | 3 | 566 | | 28 | 14 | 42 | 3 | 457 | 393 | 853 |
| 100-104 | 2 | | 20 | 84 | 106 | | 208 | 109 | 18 | 335 | 31 | 110 | | 141 | | 1 | 18 | 19 | | 157 | 140 | 297 |
| 105-109 | | | 3 | - | 3 | | 39 | 36 | 21 | 96 | 10 | 70 | | 80 | | | 1 | 1 | | 47 | 75 | 122 |
| 110-114 | | | 1 | 10 | 11 | | 10 | 13 | 3 | 26 | | 25 | | 25 | | | | | | | | |
| 115-119 | | | | | | | | | | | | 17 | | 17 | | | | | | | | |
| TOTAL | 196 | 331 | 1 397 | 3 183 | 5 107 | 26 | 3 472 | 2 007 | 2 057 | 7 562 | 2 041 | 5 264 | 467 | 7 772 | Nil | 3 641 | 5 234 | 8 875 | 1 631 | 7 045 | 5 896 | 14 572 |

*Macrourus berglax

waiting their turn to move into shallower water, then thinning out the old fish might lead to a considerable increase in growth rate among the younger fish. The best available estimate at present is that if only fish of over 22 years of age were exploited, and if the natural mortality rate is in fact about 0.2, then the grenadier could stand a fishing mortality of 0.4 per annum. What annual catch would generate a fishing mortality of 0.4 cannot be computed until commercial exploitation occurs. From the fisheries management standpoint the grenadier would seem to be ideally placed. There is already an 80 mm minimum mesh regulation in force and while the fishery is confined largely by mechanical factors to 350-550 fm then fish of less than 22 years of age would scarcely be affected.

## 6. Black scabbard fish Aphanopus carbo Lowe, 1839

This species (Plate 6) occurred at all seasons and everywhere except on the Foula section. In all some 8 tonnes were taken at a mean catch-rate of 21 kg/h. It was most abundant from Tory to Sulisker and on Rosemary Bank. Surprisingly, since there is a long-established fishery for it from Portugal southwards, it was much less abundant on the southern sections of the slope. Since it is an important and esteemed species in some other countries the catches were analysed in an attempt to detect some seasonality in its distribution but without success. Some of the more notable catches of black scabbard are given in Table 7. It will be noticed that all these catches were taken in 300-450 fm. No worth-while catches were taken in hauls at 600 fm and catches of over 100 kg per haul were uncommon at depths of over 500 fm.

Black scabbard is a bathypelagic species, and consequently a bottom trawl is probably not the best sampling device. It is probable that on many of the 80 occasions when

Table 6 Grenadiers: numbers at age per 100 hours fishing, % age and mean length at age

| Age (years) | No. per 100 h | % age | Mean length (cm) | Age (years) | No. per 100 h | % age | Mean length (cm) |
|---|---|---|---|---|---|---|---|
| 1 | 7.2 | 0.04 | 12.5 | 21 | 739.5 | 4.57 | 78.38 |
| 2 | 19.7 | 0.12 | 21.15 | 22 | 1 033.7 | 6.40 | 79.49 |
| 3 | 134.5 | 0.83 | 21.52 | 23 | 833.2 | 5.15 | 78.81 |
| 4 | 133.0 | 0.82 | 23.96 | 24 | 450.4 | 2.79 | 76.85 |
| 5 | 124.5 | 0.77 | 27.01 | 25 | 960.0 | 5.94 | 79.64 |
| 6 | 36.8 | 0.23 | 30.34 | 26 | 1 147.7 | 7.10 | 81.47 |
| 7 | 20.4 | 0.13 | 34.94 | 27 | 1 133.0 | 7.01 | 81.23 |
| 8 | 13.4 | 0.08 | 36.20 | 28 | 735.7 | 4.55 | 83.51 |
| 9 | 42.2 | 0.26 | 39.77 | 29 | 1 144.2 | 7.08 | 84.99 |
| 10 | 47.8 | 0.30 | 45.92 | 30 | 698.4 | 4.32 | 82.65 |
| 11 | 81.8 | 0.51 | 48.62 | 31 | 807.3 | 4.99 | 83.88 |
| 12 | 111.0 | 0.69 | 52.25 | 32 | 735.5 | 4.55 | 87.15 |
| 13 | 27.3 | 0.17 | 57.66 | 33 | 687.3 | 4.25 | 84.37 |
| 14 | 104.2 | 0.64 | 57.94 | 34 | 494.3 | 3.06 | 84.14 |
| 15 | 87.5 | 0.54 | 56.36 | 35 | 526.0 | 3.25 | 87.78 |
| 16 | 122.2 | 0.76 | 60.27 | 36 | 469.4 | 2.90 | 92.26 |
| 17 | 159.3 | 0.99 | 61.84 | 37 | 176.4 | 1.09 | 93.34 |
| 18 | 435.1 | 2.69 | 66.52 | 38 | 146.5 | 0.91 | 90.19 |
| 19 | 361.1 | 2.23 | 69.10 | 39 | 105.0 | 0.65 | 91.15 |
| 20 | 643.7 | 3.98 | 74.12 | 40+ | 429.0 | 2.65 | 91.07 |

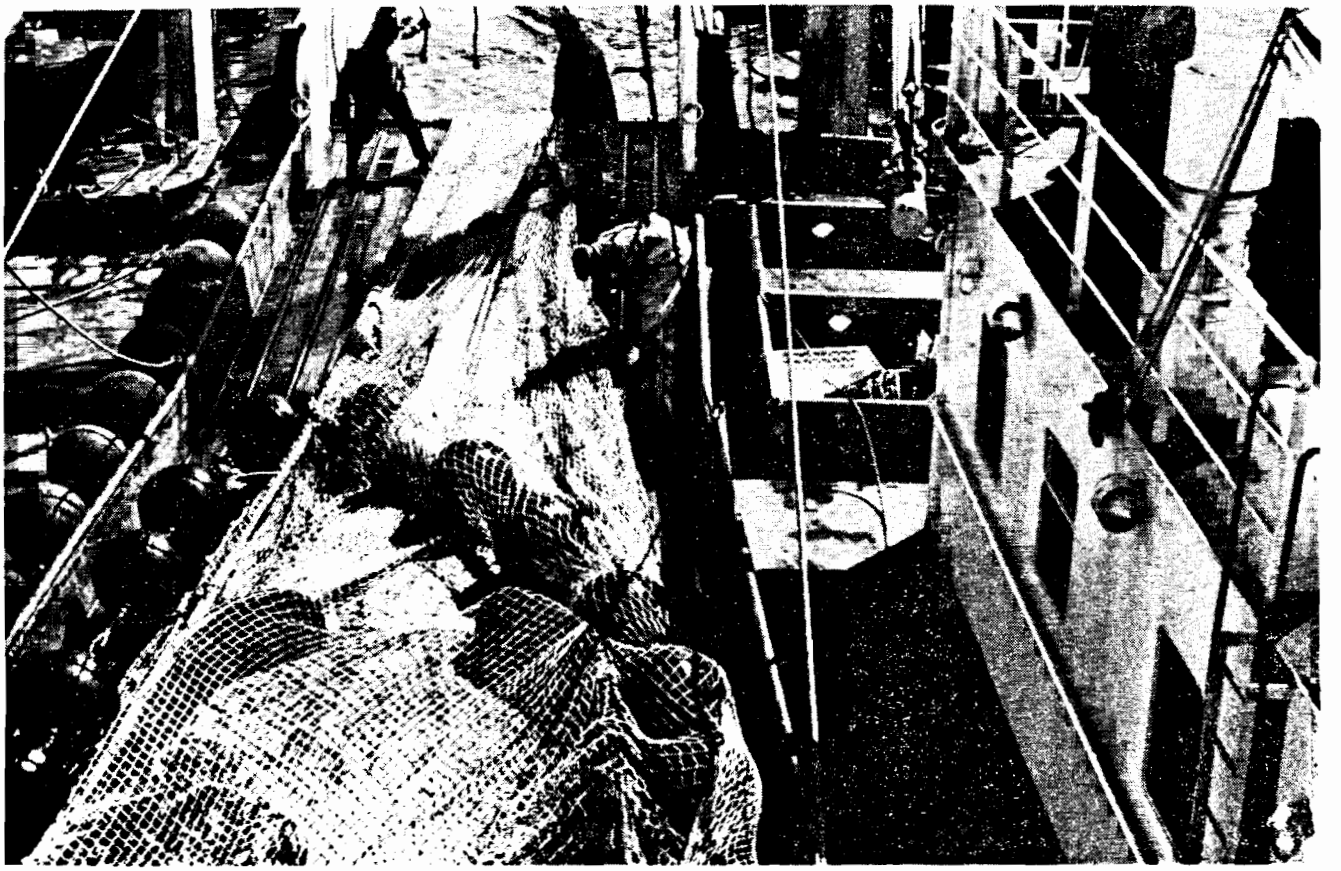


Plate 1 Gear used on CIROLANA.

Plate 2 Large bag of deep-water species taken by SWANELLA.

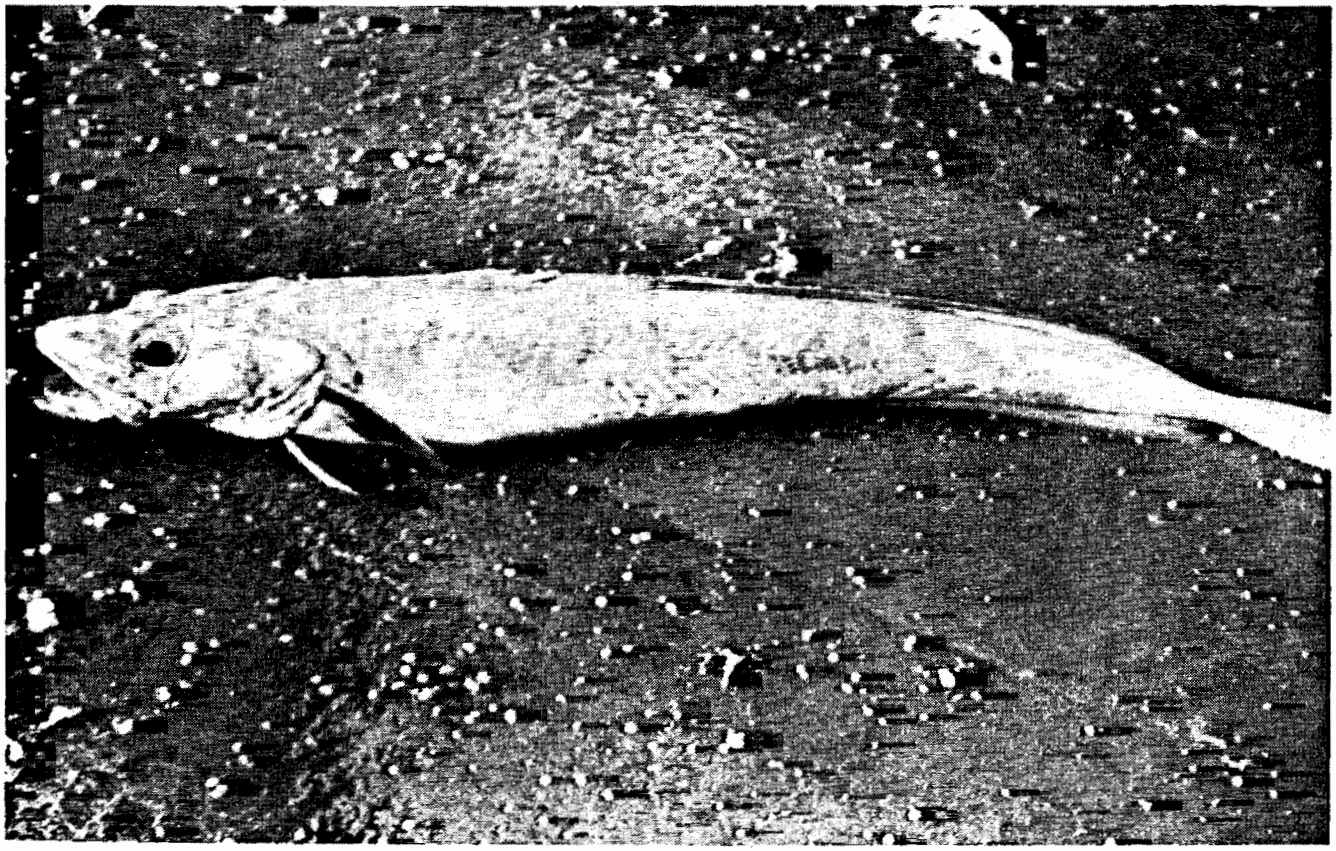


Plate 3 Blue ling, Molva dypterygia.

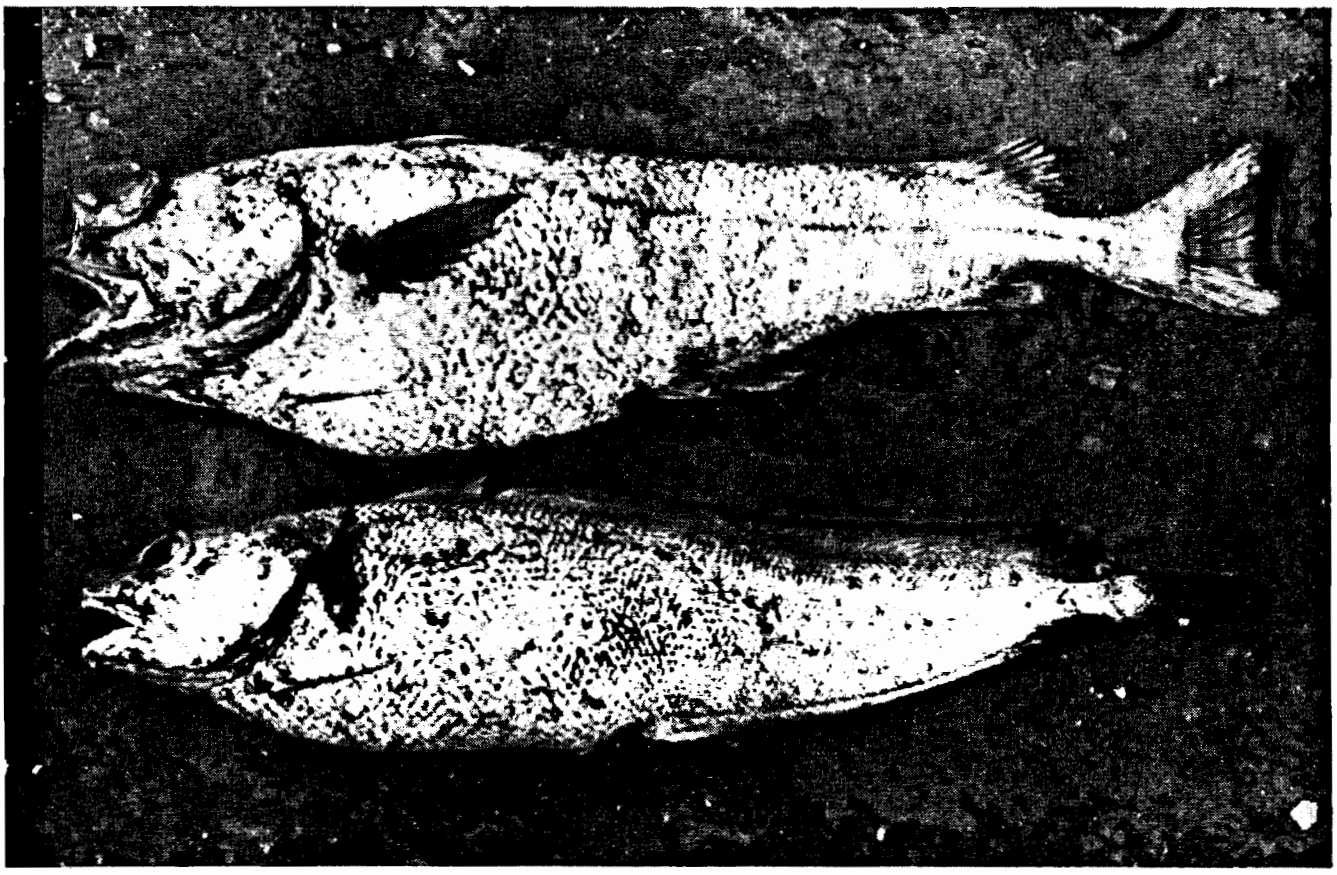


Plate 4 Mora moro and greater forkbeard, Phycis blennoides.

Plate 5 Roundnosed grenadier, Coryphaenoides rupestris.

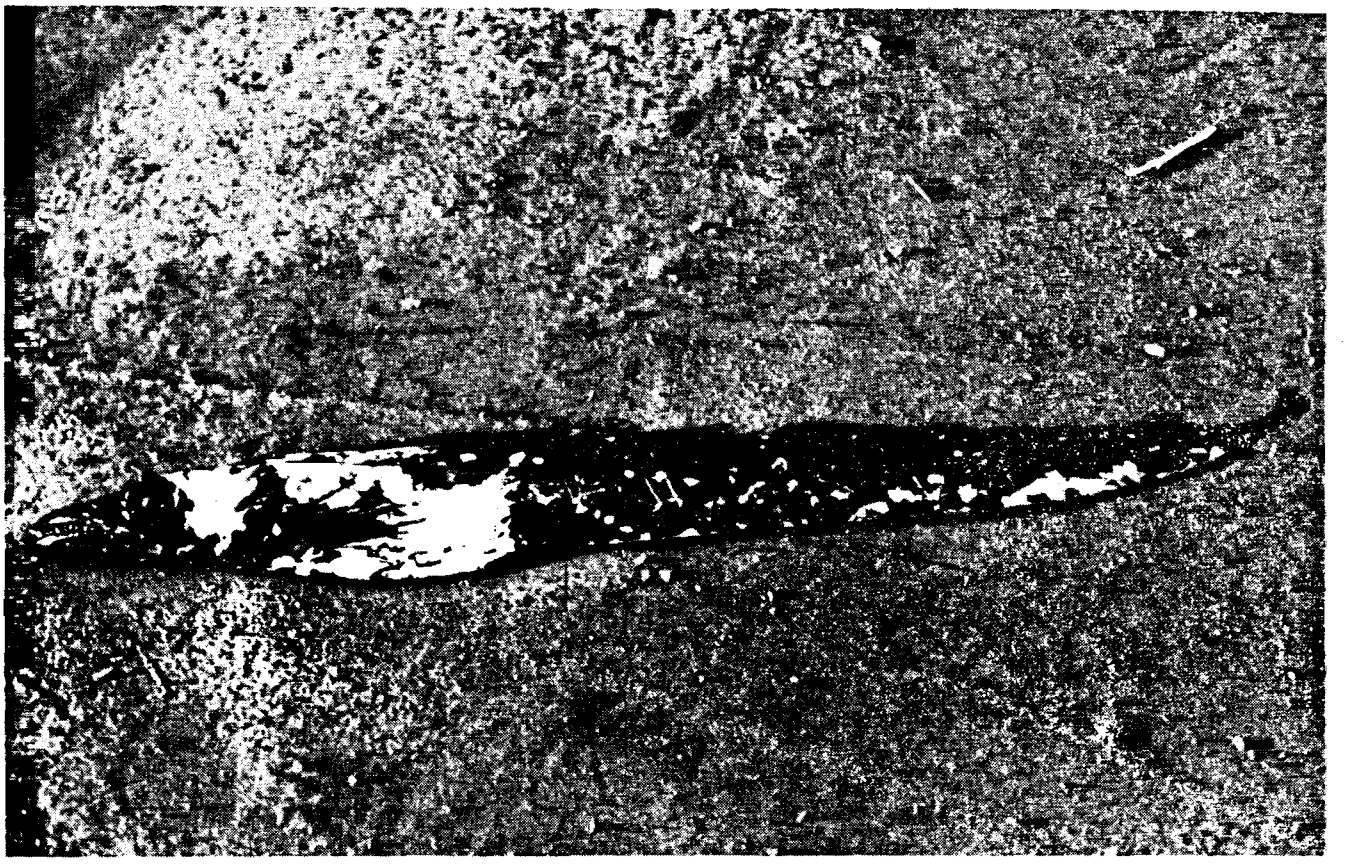


Plate 6 Black scabbard fish, Aphanopus carbo.

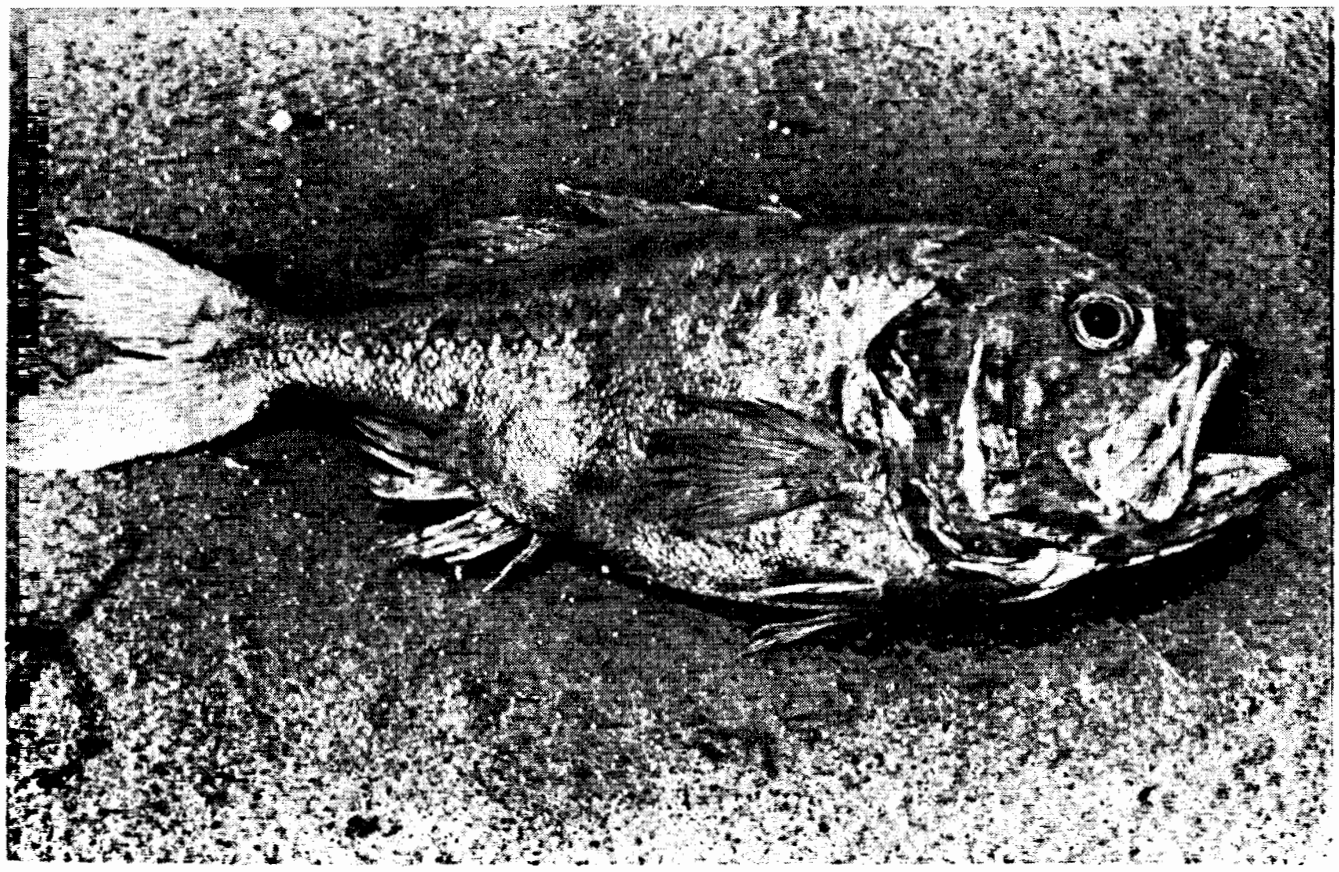


Plate 7 'Director' fish, Gephyroberyx darwini.

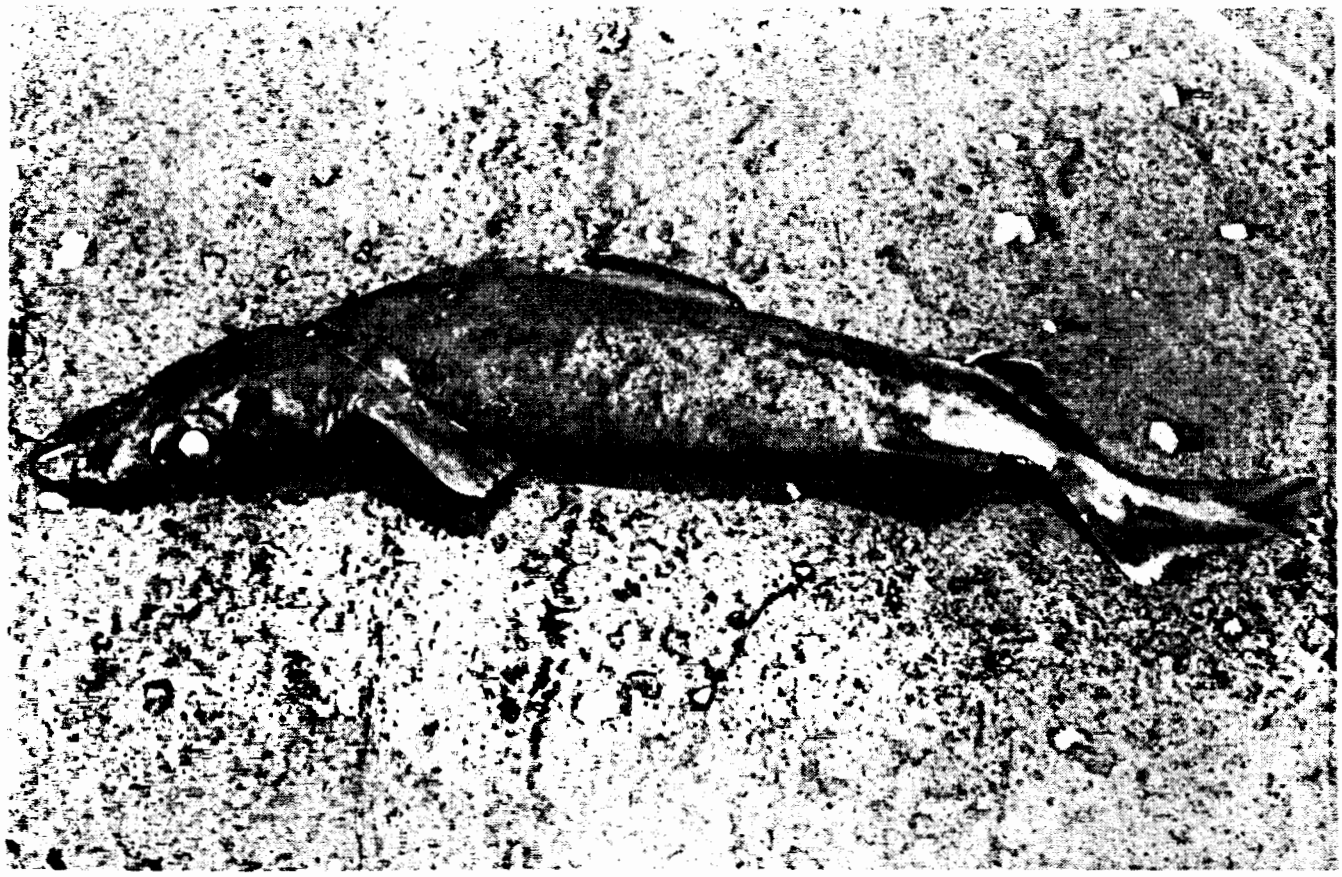


Plate 8 Deania calcea.

Table 7 Position, depth and catch-rates of some of the better hauls of black scabbard

| Cruise | Ground | Shooting position | | Depth (fm) | Catch-rate (kg/h) |
|---|---|---|---|---|---|
| Apr 1973 | Barra | 56°41'N | 09°03'W | 300 | 293 |
| | Tory | 54 57 | 10 21 | 450 | 255 |
| Sep 1973 | Tory | 56 56 | 10 22 | 450 | 135 |
| | Flannan | 58 36 | 08 53 | 350 | 151 |
| | Rosemary | 59 11 | 10 00 | 350 | 426 |
| Jan 1974 | Tory | 54 51 | 10 21 | 450 | 115 |
| | Kilda | 57 17 | 09 29 | 450 | 105 |
| | Flannan | 58 23 | 09 29 | 400 | 414 |
| Jun 1974 | Rosemary | 59 20 | 10 19 | 350 | 288 |

less than 50 kg of black scabbard were taken they were caught somewhere off the bottom while shooting or hauling. When these small catches were made they were most commonly found meshed in the wings and square of the trawl. When the bigger catches were made the fish were found mainly in the cod-end.

The length distributions of black scabbard taken on five cruises are given in Figure 3. No juvenile fish were taken anywhere in the area and no spawning fish were observed. Juveniles have been reported from off Madeira and so it must be assumed that the spawning and nursery grounds lie far to the south-west of the British Isles. Catches from the southern sections of the slope were very sparse but some measurements are available; fish taken on these grounds were not noticeably smaller than those taken further north.

Because of its long sharp teeth and a sharp spine near the anus the black scabbard is not an easy fish to gut by hand. The black outer layer of skin is normally washed off in the trawl but the black lateral line remains and is not easily removed. Nevertheless, the flesh is very firm, white and has a pleasant flavour. In Madeira it is highly regarded as a food fish.

## 7. 'Director' fish, Gephyroberyx darwini (Johnson, 1866)

In all some 1 500 specimens of this supposedly rare fish, weighing 6.8 tonnes, were taken on the six voyages, mainly from very deep water, but it was not found in great abundance anywhere. In April and July 1973 and again in June 1974 the catches amounted to a few individuals only, taken in hauls made at 550-600 fm. In September 1973 it occurred on only one of the offshore banks, Rosemary, but moderate catches (1-20 baskets) were made at Tory and Porcupine. Some were taken in 400-450 fm but the best catches were made in 500-640 fm. LUNEDA in February 1974 also took moderate quantities at Flannan in 500-570 fm. Some noteworthy catches are listed in Table 8.

This species occurred too sporadically to say much about its distribution. It was not recorded at Sulisker or Barra and, apart from some immature specimens which may have been either this species or its near relative Hoplostethus atlanticus, it did not occur to the south of Porcupine. Except in late summer or autumn it is unlikely to be found in any quantity at depths of less than 500 fm.

A large, bright red, deep bodied fish of 50-70 cm in length, normally weighing 4-5 kg, it cannot easily be overlooked when sorting a large catch (Plate 7). It has a very pleasant sweet flavour and keeps well. Tasting panels have given very favourable verdicts on this species and it is unfortunate that so far commercial quantities have only rarely been located.

First described on the strength of a single specimen taken near Funchal, Madeira, by Johnson in 1866, it is now known to occur in the north and south Atlantic and also in Japanese waters. Virtually nothing is known of its biology or abundance. All the larger specimens examined were sexually mature but none appeared to be near spawning.

The length distribution based on 692 fish examined, mean weight 3.97 kg, is given in Figure 3.

Table 8 Position, depth and catch-rates of some of the better hauls of 'director' fish

| Cruise | Ground | Shooting position | | Depth (fm) | Catch-rate (kg/h) |
|---|---|---|---|---|---|
| Sep 1973 | Tory | 55°05'N | 10°06'W | 440 | 198 |
| | " | 54 47 | 10 32 | 400 | 173 |
| | Porcupine | 53 51 | 13 53 | 640 | 287 |
| | " | 53 53 | 13 50 | 580 | 370 |
| Feb 1974 | Flannan | 58 14 | 09 46 | 510 | 256 |
| | " | 58 11 | 09 42 | 510 | 118 |
| | " | 58 32 | 09 15 | 570 | 177 |

8. Mora moro (Risso, 1810)

This species, the largest of the morid fishes occurring in European waters (Plate 4), was taken in moderate quantities on all the grounds fished except Foula. In all some 1 690 kg were taken, giving a mean catch-rate of 4.56 kg per hour. The Tory and Flannan sections gave the best catches. The catch in a single haul seldom exceeded 70 kg. Very small catches were made over the whole range of depths fished but the larger catches at all seasons of the year were taken in hauls made at 450-550 fm. It has a bland flavour and the texture is similar to that of cod. The low catch-rate indicates that it can only be considered as a small by-catch species. The mean weight of the 721 fish examined was 1.58 kg. The length distribution of these fish is given in Figure 3.

9. The sharks

Numerous species of sharks and dogfish occur on nearly all the deep-water grounds, sometimes in large quantities. The total weight of sharks caught amounted to 52 963 kg or 21.6% of the total catch (see Table 2). Sixteen species were positively identified and several others sent to the British Museum for identification. Of these, the species which occur in sufficient quantity to warrant commercial interest are: Deania calcea (Lowe, 1839), Centrophorus spp., Centroscymnus coelolepis Bocage & Capello, 1866, C. crepidater Bocage & Capello, 1864, Dalatias licha (Bonnaterre, 1788) 'Darkie Charlie', and on the offshore banks Etmopterus princeps (Bonnaterre, 1788) and Centroscyllium fabricii (Reinhardt, 1825). Other species such as Galeus melanostomus Rafinesque-Schmaltz, 1810 'Black-mouthed dogfish', Apristiuris laurussonii (Saemundsson, 1922) and Etmop-

terus spinax (Linnaeus, 1758) 'Velvet belly' occurred frequently but are normally too small to be of commercial importance.

Deep-water sharks form such an important part of the total catch that the viability of trawling on these grounds largely depends on obtaining fair market prices for them. As can be seen from Table 2 the catch-rate of sharks was remarkably consistent on all six cruises. Further, unlike the trash species, the catches of which can be reduced by fishing the continental slope grounds rather than the offshore banks, by using a cod-end mesh of at least 80 mm and by fishing in less than 550 fm (which avoids most of the smoothheads) sharks cannot be avoided. If no market for sharks is forthcoming then the catch-rates of marketable and potentially marketable species, which on these six cruises were respectively: 289, 228, 315, 446, 526 and 470 kg/h round fresh weight (mean 379), would probably not sustain a fishery. Assuming a loss in weight of 20% due to gutting this represents only just over 300 kg of saleable fish per hour's fishing. The inclusion of sharks in the list of saleable species would increase the useful catch to 517 kg/h round fresh and 414 kg/h gutted. In 1975 the landings of dogfish in the United Kingdom amounted to 16 678 tonnes which sold for £2 033 000 or £122 per tonne (source: MAFF Sea Fisheries Statistical Tables for 1975, HMSO).

Palatability tests on Deania calcea carried out by Torry Research Station suggest that this species is in no way inferior to the spurdog Squalus acanthias. It seems likely therefore that all the deep-water sharks would find a ready market in this country since both imports of Norwegian dogfish and British catch-rates are declining while the demand for dogfish appears to be increasing. Reductions in the landings of cod, haddock and saithe, which are almost certain in view of the introduction of 200 mile fishing limits and quota restrictions, will create a further demand for dogfish by the fish friers.

Deania calcea

This moderate-sized grey spiny shark (Plate 8) occurred in almost every haul made between the South Hake Ground and Sulisker and on most of the offshore banks. The overall average catch-rate amounted to some 50 kg/h and the total catch, excluding the LUNEDA voyage of February 1974 (on which no sharks were identified), amounted to nearly 15 tonnes. No clear seasonal pattern of distribution, either by ground or by depth stratum, emerges from our data.

As in all the sharks examined, the females are larger than the males; of the 4 621 fish examined the majority of males measured 75-89 cm, the females 80-109 cm. The smallest male which showed signs of maturing was 62 cm in length, the smallest fully mature male was 65 cm. The smallest female which showed signs of sexual maturity measured 69 cm and the smallest fully mature female 78 cm. No attempt was made to determine the age of any of the elasmobranchs caught on these surveys so the age at which maturity first occurs is unknown.

The mean weight of 3 900 Deania which were both counted and weighed was 3.1 kg.

Of 1 470 Deania examined for stomach contents 1 053 (71.6%) were found to be empty. Of the 417 stomachs containing some food mackerel was recorded 17 times and horse mackerel eight times. These were in fish caught in 300-320 fm in July 1973 and again in June 1974. While these observations cannot be taken as proof that mackerel and horse mackerel descend to depths of over 300 fm they imply either that they do so or that Deania makes very extensive vertical migrations in search of food.

Centrophorus squamosus

The vast majority of the Centrophorus taken were C. squamosus but a few were tentatively identified as C. granulosus or C. uyato. When big catches of Centrophorus were taken the fish were not always critically examined, so it may be that the abundance of the two rarer species was in fact somewhat greater than our records suggest. Just over 12 tonnes of this large rough skinned shark were taken apart from those taken by LUNEDA. It was more abundant on the northern slope grounds, particularly at Tory and Flannan, than on the offshore banks or the southern slope grounds, but a few specimens were taken on every ground fished except Foula, Faroe Bank and Lousy Bank. The biggest catches were made at Tory in April 1973 where 92 fish weighing 1 618 kg were taken in two hauls at 450 fm. A further 1 268 kg were taken in four hauls in the same area by SWANELLA, again in 450-500 fm. On the same cruise SWANELLA took 1 233 kg of Centrophorus in four hauls at Flannan, the biggest haul (513 kg) being taken in 350 fm. A single haul at Flannan in January 1974 produced 508 kg of Centrophorus for 1½ hours fishing in 400 fm.

Over 800 fish were counted and weighed; the mean weight of these was 14.8 kg. The smallest male found to be maturing sexually was 101 cm and the smallest fully mature male 103 cm. Corresponding figures for females were 106 and 115 cm respectively. Of 571 fish examined most of the males measured 100-114 cm; the females 110-139 cm.

Centroscymnus coelolepis

This is another widely distributed spiny shark, but one which appears in the catches rather spasmodically. Only 10 specimens were taken in April 1973, seven of them on the South Hake Ground. In July this species was scarcer still, only two specimens being taken at Eagle. In September over 500 specimens were taken by SWANELLA including large catches at Lousy, Hatton and Bailey Banks. In January 1974 CIROLANA took 104 specimens from the Northern Slope grounds especially Barra. In June 1974 this species occurred on every ground except Foula. In all over 7½ tonnes of this species were taken. The average weight of an individual fish was 10.6 kg based on a sample of 476 fish examined during the five cruises. The majority of the males ranged in length from 85-99 cm; the females 85-114 cm.

Centroscymnus crepidater

This small black spiny shark, average weight 1.8 kg, is widely distributed but is not particularly abundant on any of the grounds yet surveyed. It is somewhat more abundant on the offshore banks, especially Hatton Bank, than on any of the slope grounds but even there only one haul produced more than 100 kg of this species. The total catch for five voyages amounted to just under 1.8 tonnes. The males ranged from 55-64 cm in length, the females from 70-84 cm.

Dalatias licha

This large deep-water shark is one of the few to have an English name - 'Darkie Charlie'. It occurred on all sections of the continental slope except Foula but was not taken on any of the offshore banks except for a single juvenile at Rosemary Bank in June 1974. In all some 3.7 tonnes of this species were caught (excluding the LUNEDA voyage on which shark species were not separated) of which over 2 tonnes were taken in April 1973, mainly on the Barra, Kilda and Tory sections in 550-600 fm. The catches were lowest in January 1974, when the few fish that were caught were taken in 300-450 fm, as was the case on the other cruises in this series.

The average weight of the fish varied considerably from cruise to cruise due to differing proportions of males and females. The big catches of April and July 1973 consisted mainly of immature males and the average weight was 7.6 kg. On the other three cruises the fish were mainly large females which increased the average weight to 15.3 kg. The smallest mature male was 89 cm in length and the smallest mature female 105 cm. The majority of the males examined ranged from 85-99 cm; the females from 105-150 cm.

Etmopterus princeps

Only three specimens of this medium-sized spiny shark were caught on the continental slope, these being taken on the north-west slopes of Porcupine Bank in September 1973. On the same voyage small quantities were taken on Faroe, Bailey, Lousy and Bligh Banks and over 190 fish weighing in all ½ tonne were taken on Hatton Bank. The mean weight based on 259 fish examined was 2.6 kg, the females being larger than the males. Almost all the males ranged in length from 60-69 cm, the females from 70-89 cm.

Centroscyllium fabricii

This species was recorded on 23 of the hauls made at Hatton, Bligh, Lousy, Bailey and north-west Rockall Banks during the first part of the SWANELLA voyage, some 620 kg being taken in all. It was not reported in any haul made on the continental slope, nor was it reported during the second part of the SWANELLA voyage, part of which was spent on Hatton Bank. It is possible that some of the fish identified as Etmopterus princeps on the second part of the SWANELLA voyage were in fact Centroscyllium fabricii, the two species being similar in size and general appearance. The smallest mature fish examined were: male 70 cm, female 77 cm. Males examined ranged from 51-74 cm, females from 72-90 cm.

## 10. Trash species

Some 53.5 tonnes of fish, comprising about 40 different species, for which no market for human consumption is likely to be found were taken on the six voyages. Smoothheads (Alepocephalus spp.) and rabbit-fishes (Chimaera monstrosa and Hydrolagus mirabilis) were by far the most abundant, together amounting to over 43 tonnes or nearly 80% by weight of fish in this category. The 38 or so other species, mainly small macrourids and morid fishes, seldom amounted to more than 1-2 baskets per haul even when shrimp-netting cod-end blinders were used. They are unlikely to prove an embarrassment to any vessel using an 80 mm cod-end. None, as far as is known, is poisonous and some, such as Hoplostethus mediterraneus Cuvier & Valenciennes, 1828, look quite attractive; they are simply too small or too rare, or both, to be worth processing.

Alepocephalus spp. (Smoothhead)

Two species of smoothhead were caught: Alepocephalus bairdi Good & Bean, 1870 and A. rostratus Risso, 1820. The former species produced all the large catches and a total catch of 29.29 tonnes. A. rostratus occurred only on the southern sections of the continental slope at the South Hake ground, Bantry and Farm where 53 specimens weighing 27 kg were taken. Both species were normally most abundant in the deepest haul. An exception occurred at Tory in April 1973 when a very large catch of spawning fish was taken in 450 fm. Including this haul of 4 925 kg in the calculation, 58% of the catch was taken in depths of over 500 fm. In 650 fm eight hauls by SWANELLA at Hatton Bank produced over 7 tonnes of A. bairdi, while on almost all the northern sections of the slope the haul at 600 fm seldom failed to produce at least 150-200 kg of this species. Unless a

spawning concentration is encountered, embarrassingly large catches of smoothheads are unlikely at depths of less than 500 fm.

The flesh of the smoothhead is very soft, being 92% water, while the numerous bones are fine and very tough. Although the flesh has a mild pleasant flavour and keeps well, its very sloppy texture would make it unacceptable as food. The protein content is less than half that of most other fish (Anon. 1973). It is unlikely therefore to find a market even for meal and oil.

Spawning fish were caught on 19 April 1973 at Tory in 450 fm; on 21 January 1974 at Tory in 550 fm; and also on 30 August 1973 at Hatton Bank in 600 fm. The largest catch of juvenile smoothheads, of which 95 were less than 20 cm in length, was made at Sulisker in 600 fm in July 1973. In June 1974 a further 18 juveniles were taken in 500 fm between Sulisker and Flannan.

Attempts to age smoothheads by examination of their otoliths have so far failed. The length distribution of over 10 000 smoothheads caught on the various cruises are given in Table 9.

Table 9 Length distribution of smoothheads (Alepocephalus bairdi) on five cruises

| Length group (cm) | N | % | Length group (cm) | N | % |
|---|---|---|---|---|---|
| 10-14 | 37 | 0.36 | 65- 69 | 641 | 6.26 |
| 15-19 | 89 | 0.87 | 70- 74 | 1 213 | 11.85 |
| 20-24 | 277 | 2.71 | 75- 79 | 1 644 | 16.06 |
| 25-29 | 392 | 3.83 | 80- 84 | 1 943 | 18.99 |
| 30-34 | 267 | 2.61 | 85- 89 | 1 238 | 12.10 |
| 35-39 | 229 | 2.24 | 90- 94 | 451 | 4.41 |
| 40-44 | 210 | 2.05 | 95- 99 | 88 | 0.86 |
| 45-49 | 244 | 2.38 | 100-104 | 9 | 0.09 |
| 50-54 | 373 | 3.64 | 105-109 | 2 | 0.02 |
| 55-59 | 405 | 3.96 | | | |
| 60-64 | 482 | 4.71 | TOTAL | 10 234 | |

Chimaera monstrosa Linnaeus, 1758 and Hydrolagus mirabilis Collett, 1904 (Rabbit-fish)

These two species occurred on all the grounds except Foula and at all depths. They have been treated as one since they are very similar in appearance and were not always basketed separately. In all some 15 tonnes were taken, mainly in the shallower hauls. At over 450 fm, although the catches are much smaller, the proportion of Hydrolagus in the mixture tends to increase. At any depth from 300 to 600 fm it was normal to get from 1 to 4 baskets (33-132 kg) of rabbit-fish per 1½ hour haul. SWANELLA once took 433 kg of rabbit-fish at Tory in 400 fm and in 300 fm several hauls produced over 300 kg. It is somewhat unfortunate that the two major components of the trash category, smoothheads and rabbit-fish, have such different depth distributions. Catches of smoothheads increase with increasing depth while catches of rabbit-fish diminish. Over the range 350-550 fm these two species are likely to produce between 90 and 150 kg per hour of useless fish to be sorted and dumped overboard.

The length distributions of Chimaera and Hydrolagus are given separately in Table 10. In Chimaera the larger fish tend to be female but the discrepancy in size of the two sexes is not as marked as in many of the sharks.

Table 10 Length distributions of Chimaera monstrosa and Hydrolagus mirabilis on five cruises

| Length group (cm) | Chimaera | | Hydrolagus | |
|---|---|---|---|---|
| | N | % | N | % |
| 30- 34 | | | | |
| 35- 39 | 2 | 0.03 | 7 | 2.15 |
| 40- 44 | 5 | 0.08 | 17 | 5.21 |
| 45- 49 | 6 | 0.09 | 13 | 3.99 |
| 50- 54 | 42 | 0.64 | 12 | 3.68 |
| 55- 59 | 90 | 1.37 | 36 | 11.04 |
| 60- 64 | 123 | 1.87 | 49 | 15.03 |
| 65- 69 | 182 | 2.77 | 64 | 19.63 |
| 70- 74 | 364 | 5.55 | 81 | 24.85 |
| 75- 79 | 692 | 10.54 | 36 | 11.04 |
| 80- 84 | 1 209 | 18.42 | 11 | 3.37 |
| 85- 89 | 1 556 | 23.70 | | |
| 90- 94 | 1 159 | 17.66 | | |
| 95- 99 | 712 | 10.85 | | |
| 100-104 | 306 | 4.66 | | |
| 105-109 | 92 | 1.40 | | |
| 110-114 | 21 | 0.32 | | |
| 115-119 | 3 | 0.05 | | |
| 120-124 | | | | |
| TOTAL | 6 564 | | 326 | |

## SUMMARY AND CONCLUSIONS

During 1973 and 1974 six voyages were made to deep-water fishing grounds lying to the west of Britain. All the grounds surveyed lie within 200 miles of the British Isles, the most productive grounds lie within 100 miles of the coasts of Scotland and the Irish Republic.

In all 286 trawl hauls were made mainly in depths of 300-650 fm. The total fishing time, exclusive of the time taken to shoot and haul the gear was 370¼ hours and the total ungutted weight of the catch was 244.885 tonnes. Of this total 53.569 tonnes were of trash species unlikely to find a market except as meal and oil. The breakdown of the more useful species was:

| | |
|---|---|
| Marketable species | 40.973 tonnes |
| Potentially marketable species | 97.380 " |
| Sharks and dogfish | 52.963 " |

Naturally some grounds produced more fish than others. Excluding the 'commercial' hauls made by SWANELLA and the whole of the LUNEDA voyage, 107.656 tonnes of useful

fish were taken in the course of the surveys. These survey hauls can be used as an index of the relative merits of the grounds surveyed.

Dividing the catch taken during the surveys by the hours fishing on each ground yields the following 'league tables' of catch-rates in kilogrammes per hour:

| NORTHERN SLOPE | | SOUTHERN SLOPE | | OFFSHORE BANKS | |
|---|---|---|---|---|---|
| Tory | 893 | Porcupine | 206 | Rosemary | 538 |
| Flannan | 837 | Eagle | 165 | Bailey | 440 |
| Kilda | 778 | S. Farm | 134 | Hatton | 311 |
| Barra | 629 | Dingle | 113 | Lousy | 311 |
| Sulisker | 461 | S. Hake | 83 | Rockall | 176 |
| Foula | 51 | Bantry | 56 | | |

Comparable catch-rates by English freezer trawlers in 1975 were:

| | |
|---|---|
| Barents Sea | 812 |
| Bear Island/Spitsbergen | 780 |
| Norway Coast | 776 |

As some grounds were visited only once while others were visited four or five times, undue reliance should not be given to the precise order in which these grounds are listed, but it seems clear that the northern sections of the continental slope, with the exception of Foula, are likely to yield the best catches. Of the offshore banks Rosemary and Bill Bailey probably offer the best chances of success. It is difficult to see how any of the southern sections could provide a viable fishery.

Unfortunately no cod or haddock and only small catches of hake were taken in these deep-water hauls. On the northern slope sections the survey hauls yielded 12% of marketable species, 60% potentially marketable species (mainly grenadiers), and 28% sharks and dogfish.

Gear damage is not likely to be a serious problem on the grounds of northern slope sections. Consequently hauls of three hours duration would seem to be feasible. Given winches of sufficient capacity and power, the time taken to shoot and haul in depths of 300-550 fm should not add more than one hour to each haul so that at least 15 hours actual fishing per day should prove possible there. Such a regime should yield some 8.8 tonnes of gutted fish per day on the northern slope grounds. Figure 2 shows the consistency of catch-rates on these grounds throughout the year.

While some traditional distant-water grounds yield on average more than 9 tonnes per day, steaming distance must be considered. All these northern slope grounds can be reached in less than 48 hours from the Humber. Assuming an average of 18 hours towing time per day in the Barents Sea after a five-day steam and taking the 1973 round fresh catch-rate of 640 kg per hour, a 28-day voyage there would yield: 18 days fishing x 18 hours x 640 kg = 207 tonnes. A 28-day voyage to the northern slope grounds would yield: 24 days fishing x 15 hours x 732 kg = 263 tonnes. It follows that in order to gross an equal sum the average price for the deep-water species must reach 79% of that fetched by cod and haddock. While sufficient quantities of cod and haddock to satisfy the market are available either from British vessels or from foreign imports it is doubtful if such prices for deep-water species are realistic. If, however, supplies of the preferred species are reduced to less than the demand then these new grounds could well become a worth-while asset.

Because of the great age attained by the grenadier and, by inference, also by the other useful species caught on these grounds, it is clear that proper management of the stocks is essential. While all the evidence suggests that the nursery grounds lie either further to the south or in very deep water, heavy fishing effort on the adult stock would reduce the mean age and hence the weight of fish caught quite quickly. The most sensible use of these grounds would therefore seem to be to fish there on passage to, or from, whatever distant-water grounds remain available to our trawler fleet and so eke out the national quotas of cod and haddock. With the present high price of fish it is difficult to believe that given a proper programme of market research and advertising there is no market in this country for good quality fish if available all the year round at 20% less cost than that of cod.

## REFERENCES


ANON., 1973. Deepwater Fish as Food. TD 306, Torry Research Station, 6 pp. (mimeo).

PARSONS, L. S., 1975. Distribution and relative abundance of roundnose, roughhead and common grenadiers in the Northwest Atlantic. ICES CM 1975/F:21. 23 pp. (mimeo).

PECHENIK, L. N. and TROYANOVSKII, F. M., 1971. Trawling Resources on the North-Atlantic Continental Slope. Israel Program for Scientific Translations, Jerusalem, 66 pp. (Translation from Russian, Murmanskoe Khizhnoe, Murmansk, 1970).

**Appendix 1** Position and catch details of each haul

| Station no. | Shooting position | Ground | Depth (fm) | Duration (min) | Catch (kg) | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Marketable | Grenadiers | Scabbards | Other potentially marketable | Sharks | Trash | |
| CIROLANA 4a/1973, 16-25 April 1973 | | | | | | | | | | | |
| 5 | 49°28'N 11°14'W | S. Hake | 200 | 90 | 35 | - | - | 11 | - | 27 | |
| 6 | 49 20 11 34 | " | 400 | 90 | 32 | - | - | 16 | 93 | 175 | |
| 7 | 49 29 11 39 | " | 550 | 90 | 17 | - | - | 1 | 133 | 65 | |
| 8 | 49 42 11 36 | " | 550 | 90 | 16 | 4 | - | 26 | 114 | 41 | Coral. No damage |
| 9 | 50 50 14 07 | S. Farm | 500 | 92 | 19 | 5 | 23 | 23 | 191 | 64 | |
| 10 | 50 55 14 37 | " | 450 | 62 | 20 | - | 5 | 17 | 117 | 75 | |
| 11 | 50 59 14 00 | " | 450 | 90 | 43 | - | 4 | 30 | 247 | 767 | 700 kg Hoplostethus |
| 12 | 51 01 13 42 | " | 550 | 90 | - | 2 | 6 | 3 | 17 | 28 | |
| 21 | 55 07 10 10 | Tory Is. | 550 | 102 | - | - | - | - | - | - | Not on bottom |
| 22 | 54 57 10 21 | " | 450 | 92 | 79 | 149 | 383 | 164 | 1 525 | 386 | |
| 23 | 54 49 10 28 | " | 450 | 90 | 27 | 64 | 55 | 37 | 823 | 5 001 | 4 925 kg spawning smoothheads |
| 24 | 56 26 09 17 | Barra | 550 | 91 | 23 | 75 | 9 | - | 233 | 358 | |
| 25 | 56 27 09 10 | " | 450 | 90 | 20 | 25 | 24 | 12 | 174 | 91 | |
| 26 | 56 34 09 11 | " | 350 | 90 | 90 | 73 | 187 | 2 | 297 | 184 | |
| 27 | 56 41 09 03 | " | 300 | 90 | 234 | 25 | 439 | 21 | 393 | 304 | |
| 28 | 56 41 09 05 | " | 600 | 90 | 42 | 1 296 | 55 | - | 761 | 870 | |
| 29 | 57 35 09 40 | Kilda | 350 | 90 | 372 | 28 | 88 | 77 | 31 | 370 | 90 kg hake; 181 kg blue ling |
| 30 | 57 44 09 40 | " | 450 | 90 | 284 | 35 | 5 | 56 | 128 | 105 | 239 kg blue ling |
| 31 | 57 43 09 44 | " | 500 | 90 | 30 | 1 093 | 16 | 5 | 320 | 282 | |
| 32 | 57 45 09 47 | " | 600 | 100 | 12 | 749 | 46 | - | 685 | 441 | |
| 33 | 58 36 09 00 | Flannan | 600 | 90 | 23 | 110 | 25 | 1 | 170 | 94 | |
| 34 | 58 34 09 02 | " | 500 | 91 | 531 | 83 | 17 | 336 | 293 | 202 | 486 kg blue ling; 287 kg greater silver smelt |
| 35 | 58 33 08 52 | " | 450 | 39 | 852 | 6 | 10 | 739 | 78 | 281 | 811 kg blue ling; 698 kg greater silver smelt |
| 36 | 60 23 04 23 | Foula | 400 | 90 | 30 | 4* | - | - | - | 3 | |
| 37 | 60 25 04 31 | " | 500 | 90 | 14 | - | - | - | - | - | Holes in both bunts |
| 38 | 60 30 04 39 | " | 600 | 90 | 33 | - | - | - | - | 3 | |
| 39 | 60 13 04 59 | " | 450 | 90 | 25 | 3* | - | - | - | - | |
| 40 | 60 07 05 44 | " | 600 | 90 | - | - | - | - | - | - | Not on bottom |
| 41 | 60 03 06 35 | " | 450 | 90 | 159 | 6* | - | - | - | - | |
| 42 | 59 55 06 58 | Sulisker | 450 | 91 | 403 | 134 | 38 | 137 | 101 | 150 | 374 kg blue ling |
| 43 | 59 54 07 18 | " | 500 | 90 | 85 | 158 | 87 | 63 | 307 | 228 | |
| 44 | 59 11 07 26 | " | 400 | 90 | 602 | 5 | 85 | 532 | 36 | 47 | 572 kg blue ling; 522 kg greater silver smelt |
| 45 | 59 11 07 19 | " | 300 | 90 | 104 | - | 20 | 369 | 3 | 352 | 300 kg greater silver smelt |
| 46 | 59 18 07 22 | " | 500 | 90 | 1 039 | 33 | 6 | 16 | 2 | 40 | 1 023 kg blue ling |
| 47 | 59 26 07 40 | " | 600 | 90 | 14 | 175 | 6 | 1 | 73 | 418 | |

| Station no. | Shooting position | Ground | Depth (fm) | Duration (min) | Catch (kg) | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Marketable | Grenadiers | Scabbards | Other potentially marketable | Sharks | Trash | |
| CIROLANA 6b/1973, 14-23 July 1973 | | | | | | | | | | | |
| 4 | 60°03'N 05°16'W | Foula | 400 | 92 | 385 | 30* | - | 8 | - | 18 | |
| 5 | 60 01 05 38 | " | 500 | 93 | 25 | - | - | - | - | 5 | Marketable - mostly rays, R. hyperborea |
| 6 | 60 02 06 11 | " | 600 | 91 | 35 | - | - | - | - | 1 | |
| 7 | 60 04 06 31 | " | 600 | 95 | 20 | - | - | - | - | 6 | |
| 17 | 59 43 07 12 | Sulisker | 600 | 89 | 4 | 132 | 71 | - | 81 | 329 | |
| 18 | 59 34 06 48 | " | 500 | 102 | 16 | 274 | 58 | - | 145 | 164 | |
| 19 | 59 23 06 47 | " | 400 | 90 | 128 | 48 | 5 | 42 | 256 | 322 | |
| 20 | 59 16 07 01 | " | 300 | 90 | 247 | 1 | - | 58 | 256 | 435 | 217 kg blue ling |
| 23 | 58 35 08 48 | Flannan | 300 | 90 | 164 | - | 2 | 77 | 89 | 262 | 115 kg blue ling |
| 24 | 58 33 09 04 | " | 400 | 9 | - | - | - | - | - | - | Fast |
| 25 | 58 38 08 43 | " | 400 | 90 | 130 | 503 | 36 | 18 | 419 | 287 | |
| 26 | 58 37 08 47 | " | 500 | 90 | 37 | 572 | 84 | 48 | 280 | 118 | |
| 27 | 58 36 08 59 | " | 600 | 92 | 16 | 221 | 22 | - | 253 | 282 | |
| 28 | 57 49 09 47 | Kilda | 600 | 90 | 18 | 690 | 14 | - | 491 | 450 | |
| 29 | 57 43 09 43 | " | 500 | 90 | 5 | 519 | 6 | 10 | 116 | 71 | |
| 30 | 57 35 09 40 | " | 400 | 90 | 28 | 586 | 9 | 59 | 46 | 189 | |
| 31 | 57 27 09 36 | " | 300 | 4 | - | - | - | - | - | - | Fast in mud |
| 32 | 57 24 09 32 | " | 300 | 91 | 148 | 11 | 6 | 31 | 185 | 98 | 135 kg blue ling |
| 37 | 55 37 09 30 | Tory | 300 | 90 | 178 | 5 | - | 151 | 193 | 167 | 147 kg greater silver smelt; 90 kg hake |
| 38 | 55 32 09 37 | " | 400 | 90 | 78 | 861 | 57 | 140 | 349 | 196 | |
| 39 | 55 31 09 49 | " | 500 | 90 | 35 | 1 015 | 41 | 86 | 153 | 159 | |
| 40 | 55 30 09 54 | " | 600 | 90 | 37 | 352 | 43 | 23 | 132 | 223 | |
| 41 | 55 14 10 05 | " | 400 | 90 | 69 | 1 313 | 30 | 95 | 355 | 267 | |
| 43 | 54 27 11 28 | Eagle | 600 | 90 | 1 | 57 | 20 | 7 | 162 | 212 | |
| 44 | 54 20 11 28 | " | 550 | 80 | - | - | - | - | - | - | Net destroyed |
| 47 | 51 50 11 51 | Dingle | 300 | 90 | 17 | 6 | - | 60 | 4 | 12 | 60 kg greater silver smelt |
| 48 | 51 44 11 46 | " | 350 | 90 | 30 | - | - | 63 | 3 | 92 | 55 kg" |
| 49 | 51 38 11 51 | " | 450 | 58 | 8 | 3 | - | 25 | 37 | 28 | |
| 50 | 51 32 11 46 | " | 500 | 90 | 20 | - | - | 93 | 245 | 312 | 61 kg Mora |
| 51 | 51 26 11 47 | " | 600 | 90 | - | - | - | - | - | - | Not on bottom |
| 53 | 50 30 11 18 | Bantry | 600 | 90 | 20 | 42 | 5 | 14 | 52 | 74 | |
| 54 | 50 23 11 12 | " | 500 | 90 | 2 | 32 | 1 | 10 | 32 | 20 | |
| 55 | 50 16 11 09 | " | 400 | 90 | 32 | 1 | - | 27 | 51 | 17 | |
| 56 | 50 09 11 07 | " | 300 | 90 | 14 | - | - | 2 | - | 5 | |
| 57 | 50 02 11 22 | S. Hake | 500 | 90 | 10 | 12 | 8 | 2 | 108 | 26 | |
| 59 | 49 28 11 59 | " | 600 | 90 | - | - | - | - | - | - | Foul gear |
| 60 | 49 22 11 51 | " | 600 | 90 | 6 | 8 | 2 | 10 | 27 | 58 | |

| Station no. | Shooting position | Ground | Depth (fm) | Duration (min) | Catch (kg) | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Marketable | Grenadiers | Scabbards | Other potentially marketable | Sharks | Trash | |
| **SWANELLA, 22 August-10 September 1973 (Part 1)** | | | | | | | | | | | |
| 1 | 51°04'N 13°38'W | S. Farm | 550 | 95 | 29 | 14 | - | 27 | 42 | 110 | Soft mud |
| 2 | 50 50 14 27 | " | 450 | 95 | 19 | 82 | 15 | 60 | 120 | 112 | |
| 3 | 54 47 10 32 | Tory | 450 | 90 | 20 | 885 | 171 | 210 | 250 | 201 | Steep edge |
| 4 | 54 56 10 22 | " | 450 | 90 | 53 | 2 350 | 202 | 92 | 606 | 478 | " |
| 5 | 55 30 09 49 | " | 500 | 92 | 33 | 1 808 | 57 | 55 | 720 | 231 | " |
| 6 | 56 29 09 11 | Barra | 400 | 90 | 62 | 456 | 10 | 442 | 538 | 217 | 431 kg greater silver smelt |
| 7 | 56 44 09 06 | " | 550 | 90 | 3 | 97 | 14 | 20 | 74 | 50 | |
| 8 | 57 41 09 42 | Kilda | 550 | 88 | 2 baskets mixed | | | | | | Not on bottom |
| 9 | 58 36 08 49 | Flannan | 450 | 90 | 64 | 1 684 | 95 | 42 | 730 | 192 | |
| 10 | 57 34 14 40 | W. Rockall | 200 | 90 | 1½ baskets mixed | | | | | | Gear damaged |
| 11 | 57 33 14 52 | " | 250 | 90 | 63 | - | - | 226 | 3 | 236 | Trash, mainly Chimaera |
| 12 | 57 37 14 43 | " | 200 | 90 | 76 | - | - | 65 | 3 | 153 | |
| 13 | 57 23 15 06 | " | 300 | 90 | 58 | - | - | 18 | 21 | 292 | |
| 14 | 57 37 14 46 | " | Few jellyfish only | | | | | | | | Pelagic trawl |
| 15 | 58 14 14 06 | " | 250 | 90 | 238 | - | - | 312 | 10 | 275 | |
| 16 | 58 18 13 44 | " | 200 | 27 | 9½ baskets mixed | | | | | | Fast, damaged |
| 17 | 57 25 12 54 | " | 200 | 88 | 100 | - | - | 237 | - | 569 | Dense traces off bottom |
| 18 | 56 44 13 54 | " | 200 | 90 | 23 | - | - | 69 | - | 308 | Trash, mainly Chimaera |
| 19 | 56 23 16 31 | " | 300 | 90 | 29 | - | - | 28 | 5 | 158 | |
| 20 | 56 21 17 25 | " | 450 | 90 | 15 | 65 | 4 | 19 | 179 | 74 | |
| 21 | 56 32 17 33 | " | 550 | 110 | - | - | - | - | - | - | Foul shot |
| 22 | 56 51 17 30 | " | 650 | 90 | - | - | - | - | - | - | Not on bottom |
| 23 | 57 00 19 51 | Hatton | | | - | - | - | - | - | - | Winch trouble |
| 24 | 57 00 19 53 | " | 500 | | ½ basket mixed | | | | | | Fast |
| 25 | 57 00 19 42 | " | 500 | 55 | 22 baskets mixed | | | | | | Fast, damage |
| 26 | 57 02 19 22 | " | 600 | 92 | 4¼ baskets mixed | | | | | | Parted backstrop |
| 27 | 57 54 18 21 | " | 400 | | - | - | - | - | - | - | Fast, gear damaged |
| 28 | 57 49 18 57 | " | 450 | 90 | 22 | 387 | 60 | 9 | 250 | 49 | |
| 29 | 57 46 19 34 | " | 550 | 90 | 29 baskets mixed | | | | | | Belly split |
| 30 | 57 53 19 26 | " | 600 | 90 | 64 | 219 | 35 | - | 127 | 413 | Trash, mainly |
| 31 | 57 40 18 10 | " | 550 | 90 | 32 | 306 | 45 | 3 | 124 | 346 | smoothhead |
| 32 | 57 42 17 50 | " | 600 | 90 | 18½ baskets mixed | | | | | | |
| 33 | 58 20 16 46 | " | 600 | 90 | 12 baskets mixed | | | | | | Much sponge |
| 34 | 58 26 17 18 | " | 550 | 90 | 3 | 54 | 29 | - | 53 | 191 | Trash, mainly |
| 35 | 58 25 17 50 | " | 450 | 85 | 9 | 99 | 14 | 10 | 37 | 264 | smoothhead |
| 36 | 58 40 18 56 | " | 600 | 90 | 24 baskets mixed | | | | | | Parted headline leg |
| 37 | 59 20 17 17 | " | 650 | 90 | 23 | 883 | 26 | - | 95 | 743 | Mud on doors |
| 38 | 59 25 17 00 | " | 550 | 45 | 29 baskets mixed | | | | | | Fast, damage |
| 39 | 59 19 17 28 | " | 650 | | - | - | - | - | - | - | Pinnacles |
| 40 | 58 58 16 22 | " | 600 | 90 | - | 99 | 10 | - | 9 | 137 | Clear tow |

| Station no. | Shooting position | Ground | Depth (fm) | Duration (min) | Catch (kg) | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Marketable | Grenadiers | Scabbards | Other potentially marketable | Sharks | Trash | |
| **SWANELLA, 22 August-10 September 1973 (Part 1)** (continued) | | | | | | | | | | | |
| 41 | 59°12'N 16°08'W | Hatton | 500 | 80 | 31 | 301 | 11 | 14 | 234 | 135 | Hauled early. Bad ground |
| 42 | 59 14 16 20 | " | 300 | 7 | - | - | - | - | - | - | Lost 1 door and bobbins |
| 43 | 59 09 14 56 | " | 600 | 90 | 2 baskets mixed | | | | | | Not on bottom |
| 44 | 59 15 14 59 | " | 500 | 90 | 16 | 195 | 5 | 8 | 169 | 1 435 | 1 328 kg smoothhead |
| 45 | 58 49 14 33 | G. Bligh | 550 | 82 | 15½ baskets mixed | | | | | | Hauled early. Gully |
| 46 | 58 48 14 40 | " | 450 | 55 | 11 baskets mixed | | | | | | Fast. Belly out |
| 47 | 58 56 14 14 | " | 350 | 30 | 2 baskets mixed | | | | | | " |
| 48 | 58 09 15 38 | N.W. Rockall | 600 | 90 | 10¼ baskets mixed | | | | | | Fast. Lost forepart |
| 49 | 58 07 15 32 | " | 500 | 13 | 2¼ baskets mixed | | | | | | Fast. Wing damage |
| 50 | 59 01 13 25 | G. Bligh | 550 | | - | - | - | - | - | - | Fell off edge bank, tow abandoned |
| 51 | 59 47 12 57 | Lousy | 650 | 90 | - | - | - | - | - | - | Not on bottom |
| 52 | 59 51 12 25 | " | 700 | 90 | 9 | 30 | 10 | 6 | 77 | 27 | Mud on doors |
| 53 | ? ? | " | ? | | - | - | - | - | - | - | Fast, parted warp |
| 54 | 60 31 13 18 | " | 650 | 90 | 36½ baskets mixed | | | | | | Pulled out, wing damaged |
| 55 | 60 45 13 05 | " | 600 | 90 | 38 | 537 | 30 | - | 776 | 984 | 885 kg smoothhead |
| 56 | 60 19 13 44 | " | 650 | 90 | 40 | 233 | 11 | - | 302 | 224 | |
| 57 | 60 25 11 40 | " | 650 | 90 | - | 38 | 6 | - | 30 | 181 | |
| 58 | 60 24 11 43 | " | 650 | 82 | 4 | 45 | 15 | - | 46 | 251 | Hauled early. Uneven ground |
| 59 | 61 09 11 09 | " | 700 | 90 | - | - | - | - | - | - | Foul gear |
| 60 | 61 01 10 22 | B. Bailey | 550 | 90 | 25 | 341 | 229 | - | 318 | 318 | |
| 61 | 58 36 08 53 | Flannan | 350 | 90 | 167 | 352 | 226 | 15 | 593 | 559 | 419 kg smoothhead |
| 62 | 58 39 08 35 | " | 350 | 180 | 9½ baskets mixed | | | | | | Cod-end out |
| 63 | 58 34 08 55 | " | 400 | 120 | 258 | 442 | 81 | 43 | 313 | 842 | 516 kg smoothhead |
| 64 | 58 37 08 53 | " | 550 | 90 | 11 | 589 | 107 | 26 | 688 | 759 | 623 kg " |
| **SWANELLA, 13-27 September 1973 (Part 2)** | | | | | | | | | | | |
| 65 | 60 12 10 30 | B. Bailey | 600 | - | - | - | - | - | - | - | Door dug in, no damage |
| 66 | 60 13 10 33 | " | 600 | 103 | 48 | 268 | 59 | - | 165 | 575 | 528 kg smoothhead |
| 67 | 60 18 10 25 | " | 550 | 90 | 8 | 445 | 19 | - | 202 | 296 | 214 kg " |
| 68 | 60 22 10 20 | " | 350 | 90 | 79 | 152 | 8 | 23 | 231 | 289 | 245 kg Chimaera |
| 69 | 61 05 09 54 | Faroe Bk | 600 | 88 | 27 baskets mixed | | | | | | Bad ground, 350-550 fm |
| 70 | 60 32 09 58 | B. Bailey | 120 | 57 | 19 baskets coley, 4 mixed | | | | | | Good traces |
| 71 | 59 16 10 29 | Rosemary | 350 | 89 | 41 | 293 | 200 | 33 | 104 | 192 | Clear tow |
| 72 | 59 23 10 23 | " | 450 | 90 | 40 | 349 | 162 | 37 | 188 | 154 | |

| Station no. | Shooting position | Ground | Depth (fm) | Duration (min) | Catch (kg) | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Marketable | Grenadiers | Scabbards | Other potentially marketable | Sharks | Trash | |
| SWANELLA, 13-27 September 1973 (Part 2) (continued) | | | | | | | | | | | |
| 73 | 59°11'N 10°00'W | Rosemary | 350 | 90 | 89 | 162 | 639 | 37 | 150 | 228 | |
| 74 | 59 10 09 46 | " | 650 | 90 | 15 baskets mixed, 60 baskets sponges (duff) | | | | | | |
| 75 | 59 28 16 59 | Hatton | 650 | 140 | 40 | 1 025 | 80 | - | 258 | 655 | 625 kg smoothhead |
| 76 | 59 30 17 05 | " | 700 | 157 | 60 | 611 | 40 | - | 107 | 577 | 551 kg " |
| 77 | 59 32 16 53 | " | 650 | - | - | - | - | - | - | - | Locked doors |
| 78 | 59 32 16 53 | " | 650 | 155 | 40 | 805 | 40 | - | 200 | 1 177 | 1 165 kg smoothhead |
| 79 | 59 26 17 03 | " | 650 | 144 | 120 | 260 | 40 | - | 590 | 4 411 | 4 394 kg " |
| 80 | 59 31 16 53 | " | 650 | 140 | 20 | 220 | 20 | - | 92 | 296 | |
| 81 | 59 26 17 05 | " | 650 | 72 | - | 100 | 10 | - | 137 | 310 | Fast, damage |
| 82 | 59 29 17 01 | " | 650 | 145 | 20 | 40 | - | - | 50 | 107 | Parted headline leg |
| 83 | 59 32 16 50 | " | 650 | 133 | 40 | 376 | - | - | 266 | 388 | |
| 84 | 59 32 16 53 | " | 650 | 105 | 100 | 437 | - | - | 609 | 250 | |
| 85 | 54 57 10 18 | Tory | 400 | 135 | 18 | 1 000 | 353 | 304 | 1 503 | 171 | 228 kg Gephyroberyx |
| 86 | 55 05 10 06 | " | 400 | 120 | 40 | 1 040 | 191 | 440 | 418 | 172 | 397 kg " |
| 87 | 54 50 10 27 | " | 350 | 156 | 120 | 800 | 40 | 44 | 559 | 135 | |
| 88 | 54 43 10 33 | " | 300 | 15 | - | - | - | - | - | - | Fast. Parted backstrop |
| 89 | 54 43 10 35 | " | 450? | 100 | - | 146 | - | 32 | 135 | 101 | Very uneven ground |
| 90 | 54 47 10 32 | " | 400 | 110 | - | 1 500 | 20 | 360 | 789 | 603 | 320 kg Gephyroberyx |
| 91 | 54 50 10 28 | " | 400 | 148 | 2 baskets mixed | | | | | | Parted headline leg |
| 92 | 54 45 10 35 | " | 650 | - | - | - | - | - | - | - | Bad ground |
| 93 | 54 56 10 18 | " | 400 | 120 | - | 180 | 80 | 40 | 540 | 150 | |
| 94 | 54 54 10 25 | " | 450 | 115 | - | 1 160 | 80 | 220 | 541 | 130 | 200 kg Gephyroberyx |
| 95 | 54 47 10 15 | " | 450 | 121 | - | 357 | 60 | 160 | 109 | 90 | 140 kg " |
| 96 | 54 55 10 23 | " | 400 | 120 | 20 | 680 | 180 | 160 | 755 | 244 | 80 kg " |
| 97 | 55 01 10 15 | " | 450? | 80 | 5 baskets mixed | | | | | | Very uneven ground. Parted both headline legs |
| 98 | 53 51 13 53 | Porcupine | 650 | 90 | 7 | 65 | 48 | 434 | 103 | 1 631 | 1 570 kg smoothhead |
| 99 | 53 49 13 54 | " | 550 | 91 | - | 270 | 19 | 31 | 381 | 316 | |
| 100 | 52 55 14 44 | " | 350 | 27 | 3½ baskets mixed | | | | | | Fast, parted bridle |
| 101 | 52 49 14 27 | " | 200 | 129 | 34 | - | - | 39 | 20 | 1 | |
| 102 | 52 38 15 01 | " | 550 | 90 | 18 baskets mixed | | | | | | |
| 103 | 52 32 15 08 | " | 600 | 88 | 4½ baskets mixed | | | | | | |
| 104 | 52 34 14 57 | " | 450 | 90 | 7 | 7 | - | 9 | 93 | 37 | |
| 105 | 52 37½ 14 50 | " | 350 | 62 | 25 | - | - | 10 | 56 | 67 | |
| 106 | 51 26 15 00 | " | 600 | 93 | 10 baskets mixed | | | | | | Position doubtful |
| 107 | 51 31 14 54 | " | 500 | 76 | 35 | 135 | 4 | 72 | 324 | 171 | |
| 108 | 51 25 14 37 | " | 300 | 90 | 38 | 3 | - | 88 | 40 | 37 | |
| 109 | 51 23 13 38 | " | 450 | 90 | 11 | 6 | 4 | 29 | 213 | 358 | |
| 110 | 51 32 13 11 | " | 650 | 90 | 7 baskets mixed | | | | | | 5 baskets sponges |
| 111 | 51 47 12 33 | " | 650 | 95 | 1¾ baskets mixed | | | | | | |
| 112 | 52 02 12 14 | " | 450 | 90 | 24 | - | - | 3 | 30 | 119 | |

| Station no. | Shooting position | Ground | Depth (fm) | Duration (min) | Catch (kg) | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Marketable | Grenadiers | Scabbards | Other potentially marketable | Sharks | Trash | |
| **SWANELLA, 13-27 September 1973 (Part 2)** (continued) | | | | | | | | | | | |
| 113 | 53°50'N 13°53'W | Porcupine | 550 | 122 | 10 | 271 | 10 | 134 | 807 | 141 | |
| 114 | 53 53 13 56 | " | 650 | 120 | - | 100 | 37 | 185 | 52 | 441 | 185 kg Gephyroberyx |
| 115 | 53 53 13 50 | " | 600 | 120 | - | 180 | - | 761 | 209 | 204 | 740 kg " |
| 116 | 53 49 13 55 | " | 550 | 90 | - | 100 | 37 | 55 | 315 | 30 | |
| **CIROLANA 1/1974, 15-27 January 1974** | | | | | | | | | | | |
| 2 | 49 19 11 28 | S. Hake | 300 | 90 | 20 | - | - | 32 | - | 5 | Smooth ground |
| 3 | 49 26 11 33 | " | 400 | 91 | 31 | - | - | 6 | 261 | 158 | 90 kg Hoplostethus |
| 4 | 49 33 11 39 | " | 500 | 90 | 9 | - | 5 | 13 | 49 | 54 | Smooth ground |
| 5 | 54 51 10 21 | Tory | 450 | 90 | 51 | 517 | 172 | 191 | 288 | 220 | Mud |
| 6 | 55 03 10 11 | " | 350 | 90 | 3 baskets mixed | | | | | | Fell into gully, trawl damaged |
| 7 | 55 14 10 08 | " | 550 | 92 | 91 | 130 | 78 | 71 | 273 | 574 | 427 kg smoothhead |
| 8 | 55 24 09 59 | " | 450 | 93 | 106 | 1 642 | 138 | 164 | 420 | 295 | Rolling ground |
| 9 | 55 28 09 52 | " | 400 | 78 | 150 | 43 | 52 | 54 | 328 | 207 | 125 kg hake |
| 10 | 56 36 09 10 | Barra | 450 | 90 | 163 | 792 | 109 | 52 | 914 | 154 | Level ground. Mud. 10 kg hake |
| 11 | 59 12 07 11 | Sulisker | 300 | 92 | 94 | - | 7 | 48 | 58 | 125 | 39 kg hake |
| 12 | 59 15 07 19 | " | 400 | 90 | 168 | 29 | 21 | 20 | 130 | 124 | Level, smooth ground |
| 13 | 59 13 07 30 | " | 500 | 90 | 62 | 198 | 32 | 1 | 216 | 120 | |
| 14 | 58 32 09 11 | Flannan | 500 | 91 | 4 baskets mixed | | | | | | Belly out |
| 15 | 58 23 09 29 | " | 400 | 90 | 176 | 117 | 621 | 66 | 648 | 507 | Rolling ground |
| 16 | 58 17 09 38 | " | 500 | 90 | 128 | 2 806 | 44 | 57 | 319 | 273 | Smooth ground |
| 17 | 58 10 09 33 | " | 300 | 93 | 66 | 7 | 8 | 49 | 53 | 12 | 25 kg hake |
| 18 | 57 32 09 39 | Kilda | 500 | 93 | 302 | 1 402 | 75 | 57 | 200 | 244 | 265 kg blue ling |
| 19 | 57 23 09 32 | " | 400 | 90 | 76 | 81 | 45 | 11 | 55 | 378 | 375 kg Chimaera |
| 20 | 57 17 09 29 | " | 450 | 90 | 289 | 583 | 158 | 8 | 463 | 259 | 119 kg blue ling |
| 21 | 57 09 09 26 | " | 350 | 91 | 99 | 25 | 30 | 16 | 539 | 148 | 2 French trawlers |
| 22 | 56 53 09 05 | Barra | 300 | 80 | 57 | - | - | - | 70 | 132 | Several gullies |
| 23 | 57 59 09 47 | Kilda | 550 | 90 | - | 219 | 26 | 182 | 238 | 630 | 179 kg Gephyroberyx |
| 24 | 58 20 09 35 | Flannan | 550 | 91 | 26 | 370 | 40 | 95 | 166 | 91 | 90 kg " |

| Station no. | Shooting position | Ground | Depth (fm) | Duration (min) | Catch (kg) | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Marketable | Grenadiers | Scabbards | Other potentially marketable | Sharks | Trash | |
| LUNEDA, 12-24 February 1974 | | | | | | | | | | | |
| 1 | 58°17'N 09°22'W | Flannan | 510 | 120 | 275 | 590 | 39 | 20 | 531 | 39 | |
| 2 | 58 23 09 22 | " | 510 | 120 | | | 5 baskets mixed | | | | Locked doors |
| 3 | 58 15 09 42 | " | 510 | - | - | - | - | - | - | - | Winch brake trouble |
| 4 | 58 14 09 46 | " | 510 | 120 | 472 | 472 | 79 | 511 | 590 | 39 | 511 kg Gephyroberyx |
| 5 | 58 07 09 42 | " | 480 | 120 | 1 770 | 197 | 197 | 19 | 787 | 118 | |
| 6 | 58 15 09 35 | " | 510 | 125 | 393 | 393 | - | 99 | 393 | - | |
| 7 | 58 25 09 26 | " | 480 | 120 | 590 | 118 | 275 | 79 | 669 | 79 | |
| 8 | 58 32 09 10 | " | 500 | 120 | | | 13 baskets mixed | | | | Boulder in cod-end |
| 9 | 58 24 09 31 | " | 510 | 120 | 354 | 197 | - | 39 | 393 | - | |
| 10 | 58 17 09 33 | " | 510 | 120 | 865 | 354 | 39 | 40 | 157 | - | |
| 11 | 58 08 09 45 | " | 515 | 122 | 865 | 354 | - | - | 197 | - | |
| 12 | 58 36 08 48 | " | 370 | 122 | - | - | - | - | - | - | Trawl paralysed |
| 13 | 58 37 08 55 | " | 490 | 130 | 1 180 | 236 | 236 | 59 | 1 101 | - | |
| 14 | 58 42 08 34 | " | 570 | 125 | 590 | 315 | - | 49 | 865 | - | |
| 15 | 58 37 08 54 | " | 570 | 125 | 157 | 472 | - | 157 | 1 023 | 79 | 118 kg Gephyroberyx |
| 16 | 58 41 08 37 | " | 540 | 120 | 983 | 157 | - | 20 | 315 | 59 | |
| 17 | 58 16 09 47 | " | 510 | 120 | 197 | 197 | - | 39 | 118 | - | |
| 18 | 58 22 09 44 | " | 480 | 120 | | | 12 baskets mixed | | | | Square and belly damaged |
| 19 | 58 11 09 42 | " | 510 | 120 | 315 | 393 | - | 256 | 197 | 39 | 236 kg Gephyroberyx |
| 20 | 58 03 09 40 | " | 500 | 120 | 472 | 197 | - | 118 | 197 | - | 118 kg " |
| 21 | 58 11 09 42 | " | 520 | 120 | 472 | 315 | - | 314 | 197 | - | 275 kg " |
| 22 | 58 01 09 44 | " | 520 | 120 | 315 | 275 | - | 118 | 393 | - | 118 kg " |
| 23 | 57 51 09 44 | " | 510 | 120 | 157 | 79 | - | - | 118 | - | |
| 24 | 58 03 09 34 | " | 510 | 120 | 787 | 236 | - | - | 39 | - | |
| 25 | 58 11 09 27 | " | 510 | 120 | 374 | 197 | - | 19 | 197 | - | |
| 26 | 58 20 09 38 | " | 510 | 120 | 197 | 236 | - | - | 118 | 39 | |
| 27 | 58 12 09 38 | " | 480 | 120 | 610 | 79 | - | 19 | 118 | - | |
| 28 | 58 23 09 30 | " | 515 | 120 | 236 | 39 | - | 59 | 39 | 59 | 59 kg Gephyroberyx |
| 29 | 58 32 09 15 | " | 570 | 120 | 118 | 79 | - | 393 | 236 | - | 354 kg " |
| 30 | 58 36 08 58 | " | 570 | 120 | 315 | 197 | - | 78 | 669 | - | 78 kg " |
| 31 | 58 40 08 44 | " | 520 | 120 | 433 | 118 | - | 59 | 590 | 20 | 59 kg " |
| 32 | 58 36 08 57 | " | 510 | 120 | 1 003 | 79 | - | 78 | 472 | - | |
| 33 | 58 42 08 29 | " | 360 | 120 | 236 | 15 | 78 | - | 157 | - | |
| 34 | 58 39 08 46 | " | 570 | 120 | - | - | - | - | - | - | Locked doors |
| 35 | 58 35 08 54 | " | 540 | 120 | 79 | 39 | 12 | 18 | 157 | 59 | |
| 36 | 58 41 08 39 | " | 500 | 120 | 1 141 | 79 | - | 78 | 865 | - | |
| 37 | 55 26 09 57 | Tory | 440 | 120 | 197 | 118 | 20 | 39 | 393 | - | |
| 38 | 55 34 09 44 | " | 450 | 120 | 118 | 79 | 39 | 39 | 393 | - | |
| 39 | 55 42 09 31 | " | 600 | 120 | 79 | 118 | - | - | 590 | 590 | |
| 40 | 55 21 10 05 | " | 490 | 120 | 20 | 315 | 10 | 9 | 315 | 79 | |
| 41 | 55 14 10 08 | " | 410 | 85 | 197 | 79 | - | 39 | 590 | 79 | |
| 42 | 55 08 10 08 | " | 400 | 120 | 216 | 197 | - | 78 | 1 180 | - | |

| Station no. | Shooting position | Ground | Depth (fm) | Duration (min) | Catch (kg) | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Marketable | Grenadiers | Scabbards | Other potentially marketable | Sharks | Trash | |
| **LUNEDA, 12-24 February 1974** (continued) | | | | | | | | | | | |
| 43 | 54°56'N 10°18'W | Tory | 250 | 150 | 118 | 118 | - | 158 | 315 | - | |
| 44 | 54 51 10 32 | " | 610 | 120 | - | 79 | - | 157 | 236 | 157 | 157 kg Gephyroberyx |
| 45 | 55 08 10 11 | " | 400 | 120 | 138 | - | - | 20 | 354 | 118 | |
| 46 | 55 18 10 02 | " | 440 | 120 | 197 | 1 298 | - | 78 | 393 | - | |
| 47 | 55 29 09 54 | " | 460 | 120 | 256 | 787 | - | 39 | 393 | 118 | |
| 48 | 55 21 10 03 | " | 475 | 120 | 216 | 669 | 20 | 39 | 393 | - | |
| 49 | 55 31 09 50 | " | 465 | 123 | 197 | 944 | - | 39 | 393 | - | |
| **CIROLANA 5b/1974, 11-19 June 1974** | | | | | | | | | | | |
| 1 | 58 51 07 43 | Sulisker/ | 300 | 88 | 203 | - | - | 253 | 146 | 268 | |
| 2 | 58 47 07 55 | Flannan | 350 | 90 | 231 | 67 | 16 | 227 | 78 | 266 | Steadily deepening |
| 3 | 58 45 08 15 | " | 500 | 91 | 27 | 1 706 | 175 | 21 | 324 | 155 | |
| 5 | 57 32 09 37 | Kilda | 350 | 90 | 168 | 82 | 22 | 24 | 129 | 87 | Mud on doors |
| 6 | 57 27 09 32 | " | 450 | 90 | 73 | 2 393 | 55 | 14 | 489 | 85 | Level ground |
| 7 | 57 13 09 28 | " | 550 | 91 | 47 | 2 452 | 43 | 11 | 615 | 343 | 294 kg smoothhead |
| 9 | 55 32 09 53 | Tory | 500 | 90 | 39 | 207 | 22 | 10 | 232 | 322 | Uneven ground |
| 10 | 55 24 09 59 | " | 450 | 90 | 72 | 645 | 5 | 66 | 246 | 235 | 195 kg Chimaera |
| 11 | 55 19 10 03 | " | 350 | 93 | 80 | 693 | 4 | 78 | 474 | 229 | 168 kg " |
| 12 | 55 06 10 07 | " | 300 | 90 | 111 | 130 | 5 | 62 | 135 | 352 | 318 kg " |
| 14 | 53 57 13 33 | Porcupine | 550 | 27 | | | 1 basket mixed | | | | Fast |
| 15 | 53 49 13 52 | " | 550 | 90 | - | 54 | 49 | 21 | 244 | 55 | Smooth and level |
| 16 | 53 43 14 04 | " | 450 | 21 | | | 1 basket mixed | | | | Fast, headline parted |
| 19 | 55 23 17 19 | Rockall | 450 | 93 | 8 | 61 | 11 | 15 | 66 | 22 | |
| 20 | 55 20 17 47 | " | 450 | 89 | 12 | 127 | 32 | 26 | 90 | 40 | Smooth and level |
| 21 | 55 31 17 08 | " | 300 | 35 | 5 | 47 | 5 | 5 | 16 | 62 | Door dug in, no damage |
| 22 | 57 03 13 15 | Rockall, East | 450 | 40 | 48 | 170 | 1 | 2 | 100 | 48 | Fast, no damage |
| 23 | 57 07 13 05 | " | 550 | 55 | 11 | 108 | 6 | 20 | 141 | 60 | " |
| 24 | 57 25 12 49 | " | 550 | 18 | | | ¾ basket mixed | | | | Fast, headline parted |
| 26 | 59 04 10 24 | Rosemary | 550 | 22 | | | ¾ basket mixed | | | | Fast, net damaged |
| 28 | 59 17 10 34 | " | 550 | 97 | 35 | 295 | 32 | 23 | 269 | 354 | 303 kg smoothhead |
| 29 | 59 19 10 24 | " | 400 | 28 | 2 | 231 | 26 | 4 | 23 | 56 | Fast, little damage |
| 30 | 59 20 10 19 | " | 350 | 90 | 8 | 262 | 432 | 34 | 135 | 158 | 125 kg Chimaera |
| 32 | 59 59 06 07 | Foula | 550 | 91 | 5 | - | - | - | - | - | On bottom only 30 min |
| 33 | 59 56 05 42 | " | 450 | 91 | 10 | - | - | 3 | - | 2 | 10 kg Greenland halibut |
| 35 | 59 48 06 44 | Sulisker | 500 | 60 | 12 | 226 | 175 | - | 200 | 192 | 101 kg smoothhead |

## Appendix 2 Fathoms/metres conversion table

| Fathoms | Metres |
|---|---|
| 100 | 183 |
| 150 | 274 |
| 200 | 366 |
| 250 | 457 |
| 300 | 549 |
| 350 | 640 |
| 400 | 732 |
| 450 | 823 |
| 500 | 914 |
| 550 | 1 005 |
| 600 | 1 097 |
| 650 | 1 188 |
| 700 | 1 280 |
| 800 | 1 463 |
| 900 | 1 676 |
| 1 000 | 1 829 |
| 1 500 | 2 743 |