

LINE-FISHING ON THE CONTINENTAL SLOPE. II

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From 1964 to 1967, 163 deep-sea fish have been caught from 28 line hauls in depths of from 1000 to 3300 m. Slightly over half the total catch consisted of elasmobranchs. The largest individual fish was a shark *Pseudotriakis microdon* of 2.25 m length taken from 1400 m. The distribution of the eleven species taken regularly in these and previous hauls is compared and contrasted.

Since the results of deep-sea line-fishing previously reported (Forster, 1964), three further short cruises on R. V. 'Sarsia' have produced additional catches of deep-water fish. In the 1967 cruise successful hauls were made from over 3000 m depth. Two improvements to the original lining technique have been introduced. First, to assist in rapid hauling, a 400 lb spring balance is now attached above the hauling block. This gives some indication if the tension in the line is unduly high. Secondly, stainless-steel spring clips (manufactured for this purpose) are used to attach the snoods to the ground line. These clips facilitate both hauling and shooting the ground line.

The results are presented in tabular form (Table 1). The areas worked are spread along the same stretch of continental slope as before (Forster, 1964, fig. 4), i.e. from roughly 150 miles WSW of Scilly to about 100 miles south of Ushant. The depths of the sea-bed where the line has been worked range from 620 to 3329 m (340-1820 fm). The length of the ground lines was altered from time to time. In the first two cruises (1964 and 1966) it was about 180 fm in length with 24-30 hooks. In 1967 the ground line was 240 fm long with 50 hooks, until 14 June, when it was lost and replaced by one of 165 fm with 30-33 hooks. The bait used was mainly squid (*Loligo* spp.), although mackerel, herring and, rarely, other fish were tried from time to time. These different baits did not produce noticeable variations in the catches. The frequency of the hauls, including those made before 1964, in relation to depth was as follows:

600-1000 m	6	2000-2500 m	18
1000-1500 m	8	2500-3000 m	4
1500-1000 m	7	3000-2200 m	4

The total number of hauls was forty-seven. There were, in addition, five hauls that were unsuccessful, either because the ground line failed to sit on the bottom or because it was lost altogether.

TABLE 1. RESULTS OF HAULS OVER THE CONTINENTAL SLOPE

Date	Position, lati- tude	Position, longi- tude	Depth		Dura- tion (h)	Catch
			Fm	M		
24. v. 64	48° 23'	10° 17'	1100	2012	3½	2 <i>Centroscymnus</i> ; no sliding wt used; ?strong tide
24. v. 64	48° 20'	10° 20'	1290	2359	3½	1 <i>Centrophorus</i> , 2 <i>Centroscymnus</i> , 1 Ray <i>R. richardsoni</i> ; baits taken only along distal pt of line
25. v. 64	48° 22'	10° 05'	1400	2561	4	1 <i>Centroscymnus</i> , 2 <i>Nematomurus</i>
25. v. 64	48° 27'	10° 21'	1200	2195	2	1 <i>Centroscymnus</i> , 1 <i>R. richardsoni</i> , 2 <i>Hydrolagus</i> , 1 <i>Parabassogigas</i> , 1 <i>Antimora</i>
	48° 16'	10° 23.5'	1290	2359	2½	1 <i>Nematomurus</i> , 1 <i>Antimora</i>
	48° 26'	10° 24'	1080	1975	2	6 <i>Centroscymnus</i> , 3 <i>Eptmopterus</i> , 1 <i>Nematomurus</i>
22. vi. 66	47° 36'	08° 07'	1125	2058	1¼	1 <i>Centroscymnus</i> , 1 <i>Etmopterus</i> , 1 <i>Lepidion</i> 123 cm
24. vi. 66	48° 21'	10° 24'	1100	2012	3½	6 <i>Centroscymnus</i> , 1 <i>R. richardsoni</i> , 1 <i>Alepocephalus</i> sp., 1 macrurid (head only); lost weight and nine hooks
24. vi. 66	48° 22.5'	10° 28'	1150	2103	3½	1 <i>R. richardsoni</i> , 2 <i>Centroscymnus</i> , 3 <i>Hydrolagus</i> , 1 <i>Antimora</i> (head only)
25. vi. 66	48° 22'	10° 28'	1050	1920	3	1 <i>Hydrolagus</i> on bottom hook rather badly bitten; line arranged vertically
25. vi. 66	48° 22.5'	10° 28.5'	1080	1975	3	4 <i>Centroscymnus</i> , 1 <i>Centrophorus</i>
26. vi. 66	48° 21'	10° 24'	1150	2103	3	1 <i>Centroscymnus</i> , 1 <i>Hydrolaus</i> , 1 <i>Antimora</i> ; first 50% of baits not touched, no fish until last last eight hooks
28. vi. 66	46° 48'	05° 21'	620	1134	2	1 <i>Centrophorys</i> , 1 <i>Centroscymnus</i> , 5 <i>Deania</i> ; 2 hooks lost
29. vi. 66	46° 43.5'	05° 30.5'	1270	2323	3	1 <i>Hydrolagus</i> , 1 <i>Synaphobranchus</i> ; many baits not touched
30. vi. 66	46° 50'	05° 44'	1320	2414	3	1 Ray <i>Breviraja pallida</i> Forster, 1 <i>Nematomurus</i> , 1 <i>Parabassogigas</i>
1. vii. 66	47° 06.5'	06° 19.5'	1220	2231	4	1 <i>Centroscymnus</i> , 2 <i>R. richardsoni</i> , 2 <i>Antimora</i>
2. vii. 66	47° 06'	06° 19.5'	1240	2268	3	1 <i>Nematomurus</i> , 1 large <i>Parabassogigas</i> (on last two hooks) lines arranged more or less vertically
3. vii. 66	47° 04'	06° 23'	1400	2561	4	1 Ray <i>Breviraja pallida</i> , 1 <i>Synaphobranchus</i> ; only last five baits on bottom
7. vi. 67	48° 03.5'	09° 08'	1210	2213	3	1 <i>Etmopterus</i> , 1 <i>Parabassogigas</i> ; most baits not touched, sliding weight jammed
7. vi. 67	48° 10'	09° 00'	770	1408	2½	3 <i>Centrophorus</i> 4 <i>Deania</i> , 1 <i>Mora</i> , 1 <i>Pseudotriakis</i>
9. vi. 67	47° 57'	08° 12'	740	1353	3	7 <i>Centroscymnus</i> , 3 <i>Centrophorus</i> , 2 <i>Deania</i> , 2 <i>Mora</i>
9. vi. 67	48° 01'	08° 18.6'	540	988	2½	1 <i>Centroscymnus</i> , 2 <i>Deania</i> , 9 <i>Mora</i> ; several hooks lost
10. vi. 67	47° 30.5'	07° 48.8'	1820	3329	4½	3 <i>Nematomurus</i> ; only 50% baits on bottom
10. vi. 67	47° 34.5'	07° 50'	1200	2195		Lost ground line except for two hooks
11. vi. 67	47° 33'	07° 59'	1615	2952	5	1 Ray <i>Breviraja pallida</i> , 1 <i>Parabassogigas</i> , 9 <i>Nematomurus</i>
13. vi. 67	47° 53'	08° 40'	1120	2002	4	1 <i>R. richardsoni</i> , 1 <i>Etmopterus</i> , 2 <i>Centroscymnus</i> , 1 <i>Lepidion</i> , 120 cm, 3 <i>Chimaera</i> , 2 <i>Antimora</i> , 2 <i>Chalinura</i> sp.
	47° 51'	08° 48'	1390	2542	2½	1 <i>R. richardsoni</i> , 1 <i>Antimora</i> ; sliding wt jammed, most baits untouched
14. vi. 67	47° 54'	08° 58'	1480	2707	3	Lost all ground line except 1 fm, bottom showed double echo
15. vi. 67	47° 52.5'	09° 2.5'	1750	3200	4	5 <i>Parabassogigas</i> (large), 5 <i>Nematomurus</i> (+ 1 lost), 1 <i>Cirroteuthis</i> (octopod)
16. vi. 67	47° 54'	09° 02'	1800	3293	4	1 <i>Nematomurus</i> on one of last few hooks; only four baits on bottom, all other baits untouched
16. vi. 67	47° 54.5'	08° 58.5'	1695	3100	4	3 <i>Synaphobranchus</i> (eels), 7 <i>Nematomurus</i>

In considering the depth range from which the various species have been caught, it is convenient to apply the term 'the main range' to the limits between which the bulk of the catch was made and over which the distribution of these catches was continuous, allowance being also made for the greater number of hauls at 2000 to 2500 m. Only eleven species have been taken regularly, i.e. more than six specimens. For the elasmobranchs the order of abundance was as follows:

	Total catch	Main range (m) Bot. temp. °C	Absolute range (m)
1. <i>Centroscymnus coelolepis</i> Bocage & Capello	49	1250-2250 7.75-3.50	988-2561
2. <i>Deania calcea</i> (Lowe)	25	860-1400 9.75-6.50	860-1408
3. <i>Centrophorus squamosus</i> (Bonnaterre)	17	800-1400 9.90-6.50	620-2359
4. <i>Hydrolagus affinis</i> (Capello)	16	2060-2280 3.80-3.50	1800-2327
5. <i>Etmopterus princeps</i> Collett	12	1390-2058 6.50-3.80	1280-2213
6. <i>Raja richardsoni</i> Garrick	7	2021-2542 3.90-3.75	2002-2542

With the teleosts similarly:

1. <i>Mora moro</i> (Risso)	33	820-1350 9.90-6.90	620-1800
2. <i>Nematomurus armatus</i> (Hector)	31	2750-3329	2002-3329
3. <i>Parabassogigas crassus</i> (Vaillant)	12	2060-3200 3.00-2.60	2060-3200
4. <i>Antimora rostrata</i> Gunther	11	2100-2360 2.73-3.35	2002-2442
5. <i>Synaphobranchus kaupi</i> Johnson	9	1390-3100 6.50-2.70	1390-3100

The temperature data have been kindly supplied by Dr L. H. N. Cooper for his station Bedivere (47° 20' N, 7° 22' W), which, although situated in rather deeper water than any of the fishing positions, should yet be a reasonable guide to the temperatures prevailing on nearby slopes.

Several of these species show a similarity in their depth ranges. The three shallowest ones—*Centrophorus squamosus*, *Deania calcea* and *Mora moro*—were each chiefly taken from 800 to 1400 m. *Centroscymnus coelolepis* and *Etmopterus princeps* were the next two deeper species, followed by *Hydrolagus affinis*, *Raja richardsoni* and *Antimora rostrata*, found between roughly 2000 and 2500 m. The brotulid *Parabassogigas crassus* was also mainly taken from below 2000 m. but extended to at least 3200 m., and was exceeded in depth only by the macrurid *Nematomurus armatus*, chiefly from 2750 to 3329 m. Only the eel *Synaphobranchus kaupi* shows a less discrete distribution, ranging from 1400 to 3100 m, but the numbers taken were rather less than most of the other species considered. Four of these species have also been taken by the German research ship 'Anton Dohrn' while trawling on various deep slopes

(700–800 m) between Scotland and Iceland (Krefft, 1966, 1967). These were *Centroscyrmus*, *Deania*, *Etmopterus* and *Mora*. The bottom temperatures ranging approximately from 4 to 8° were similar to those obtaining at the 'Sarsia's' line-fishing positions.

The results for 1967 have shown that catches from around 3000 m depth may be just as large as those from 2000 or 1000 m, i.e. up to one third of the hooks with fish. Below 3000 m, only teleosts were taken, but this limit was closely approached by a ray, *Breviraja pallida*, from 2952 m.

Several of the fish caught have been of noteworthy size. The largest was the deep-water shark *Pseudotriakis microdon* of 2.25 m. length from 1408 m depth. A larger example of this species (2.75 m.) was also taken on a line by Prince Albert of Monaco from 1500 m depth off the Cape Verde Islands. The two specimens of *Lepidion guentheri* (Giglioli), of just over 120 cm, were considerably larger than any other reported fish attributed to this genus. These fish have been examined by Dr Cohen, who is engaged on a revision of the Atlantic gadoids. Six of the *Parabassogigas crassus* were also large fish, 1.0–1.3 m; two taken in 1967 had tumours growing from the upper jaw.

The apparent necessity for the baited hooks to be close to the bottom, as observed during the first three cruises, has been amply confirmed. On two occasions the near end of the ground line was deliberately lifted with a float, so that most of the hooks were well off the bottom and the only fish taken were on the bottom two hooks, with all other baits left intact. It was often possible to distinguish the baits which had been touching the bottom by their muddy discoloured appearance, and only occasional fish were ever taken on parts of the ground line with 'clean' baits. Powell (1964) in the course of deep line fishing experiments off Rarotonga with vertical lines also found that his catches were very much confined to the lower hooks even on steep bottom gradients. It was also found important to try to ascertain the times of slack tides from observations on the floating buoys, and it may well be that the line only fishes properly during these periods. The nearest actual tidal stream measurements are those of Cartwright & Woods (1963), showing normal spring rates rarely exceeding 0.6 knots.

A totally different fishing procedure was attempted in 1966 to try to find out whether any fish at all were being taken off the bottom. It was intended to lower the baited hooks to the bottom and immediately haul them again at the normal rate, but the attempt failed owing to the line being bitten through on the three occasions that this method was tried. The line used was braided polypropylene of about 300 lb breaking strain. These and other mid-water line-fishing tests will be described in detail at a later date.

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