# Rays and Skates of Devon and Cornwall. II. A Study of the Fishery; with Notes on the Occurrence, Migrations and Habits of the Species.

By

**G. A. Steven, B.Sc., F.R.S.E,**

*Assistant Naturalist at the Plymouth Laboratory.*

With 6 Figures in the Text.

Contents.

| | | PAGE |
|---|---|---|
| I. | Growth of the Fishery | 1 |
| II. | Fishing Methods and Gear | 4 |
| III. | Research Apparatus and Methods | 6 |
| IV. | Species Landed and the *Numerical* Contribution of each to the Fishery | 9 |
| V. | Occurrence and Distribution | 14 |
| VI. | Migrations | 18 |
| VII. | Food and Feeding | 23 |
| VIII. | The Toll of the Fishery | 26 |
| IX. | Acknowledgments | 27 |
| X. | Summary | 27 |
| XI. | Literature Cited | 28 |
| XII. | Appendix | 28 |

## I. Growth of the Fishery.

There have been, in recent years, certain drastic changes in the sea fisheries of England and Wales. Not least among these has been the rapid rise in importance of Rays and Skates.

Prior to the beginning of the present century there was little or no demand for these Elasmobranchs in this country. Colonel Montague, writing in 1809, comments upon the immense quantities of Rays and Skates landed in Devonshire and states that they were then used chiefly for baiting crab-pots. In times of scarcity, however, some of the small ones were eaten by fishermen's families, *but were never exposed for sale.* Fifty years later this state of affairs had changed but little. Jonathan Couch, writing in 1862 (**3**, Vol. 1, p. 84), gives the following instructive account of fishing in the West of England at that time. "An adventure in the fisheries, at least in the West of England, is usually set on foot by

some practical fisherman, who provides the boat and her outfit, and who himself acts as the principal fisherman ; and who seeks his profit as owner by what is called the boat share, which commonly amounts to a fifth part of the fish sold in the market : for the remainder he has a common share with his men. But other fishes will come to the hook besides those which find a place at fashionable tables, or the public are accustomed to buy, and which, indeed, are intrinsically as valuable as any which have a ready sale. The Grey Gurnard, Scad, Comber, Power, the Wrasses, Dogfish, Rays, and Skates, are in this class, and by the fishermen they are collectively known as rabble-fish, as being rejected from the market ; and they consequently fall to the lot of the fishermen themselves, who take them for the subsistence of their families, without deducting any portion for the boat share. The Skate is the largest, and, on the whole, the most important of these rejected fishes, and the Saxon word *Skitan*, to reject, is expressive of the fact of its being so. The same word is the parent of several expressions still in common use as significant of being thrown out, aside, or rejected." Again (*loc. cit.* p. 89), in writing specifically of the Blue Skate, *Raia batis*, he says, " The Skate is never the special object of the fisherman's search and when it chances to take the hook it may give him perhaps a greater amount of trouble than the prize can repay."

During the succeeding quarter of a century the fish-eating public in this country must gradually have grown aware of the value of Rays and Skates as food-fishes, for Day (**4**, Vol. II, p. 335), writing some time between 1880 and 1884, refers to Couch's account of Rabble-fish and adds the significant statement, " Things are altered now, much of this rabble-fish going to Billingsgate and other large inland markets."

Nevertheless, Rays and Skates even then were not considered to rank as food fishes. Cunningham, in his *Natural History of the Marketable Marine Fishes of the British Islands*, published in 1896, dismisses them with only a few words in the opening general section of the book. In the main part of the work dealing with the history of particular fishes they find no place. McIntosh and Masterman also, in their *Life Histories of the British Marine Food Fishes*, published in 1897, all but ignore the Raiidæ though they, too, discourse at length on such Teleosteans as the Gobies, Rocklings, Sticklebacks, and Blennies.

Towards the opening of the twentieth century, however, a definite fishery for Rays and Skates gradually arose and by 1906, the first year for which reasonably reliable statistical returns are available, no less than 384,953 cwt. of these fishes were landed at the various ports in England and Wales, to which total Devon and Cornwall contributed 44,618 cwt.

From that time onwards until the outbreak of the Great War in 1914, the annual landings remained fairly uniform, fluctuating only between 350,000 and 400,000 cwt. The prices, however, steadily rose—apart

from two minor drops in 1909 and 1911—from an average value on landing of 11s. 2d. per cwt. in 1906 to 14s. 1d. per cwt. in 1913.

During the first five years of the post-war period (1919–1923) the landings of Rays and Skates in England and Wales steadily increased in total weight and total value. Since then, the quantity of fish landed has remained practically constant, averaging approximately 420,000 cwt. per annum (*vide* Fig. 1, p. 4).

Prices, however, gradually fell from the artificial peak produced by post-war conditions; but the average value per cwt. over any full year has never fallen below 26s. 8d. (in 1927), a figure which is almost double that of 1913. At the present time prices are steadily rising (*vide* years 1927–30 in Table I, Column 4).

## TABLE I.

### England and Wales.

Total Weight of Skates and Rays landed (in cwts.); Total Value (in pounds); and Average Value per cwt—1906–30 inclusive.*

| Year. | Weight (in cwt.). | Value (in £). | Average price per cwt. |
|---|---|---|---|
| 1906 | 384,953 | 214,556 | 11/2 |
| 1907 | 378,773 | 216,170 | 11/5 |
| 1908 | 381,134 | 225,097 | 11/10 |
| 1909 | 415,704 | 230,591 | 11/1 |
| 1910 | 367,678 | 225,127 | 12/3 |
| 1911 | 351,729 | 200.972 | 11/5 |
| 1912 | 368,207 | 235,632 | 12/10 |
| 1913 | 359,446 | 253,729 | 14/1 |
| — | — | — | — |
| 1919 | 244,656 | 464,998 | 38/– |
| 1920 | 356,869 | 625,534 | 35/1 |
| 1921 | 375,480 | 684,674 | 36/6 |
| 1922 | 438,505 | 608,048 | 27/9 |
| 1923 | 448,436 | 639,098 | 28/6 |
| 1924 | 422,161 | 599,761 | 28/5 |
| 1925 | 399,723 | 577,776 | 28/11 |
| 1926 | 364,523 | 539,905 | 29/7 |
| 1927 | 430,508 | 573,644 | 26/8 |
| 1928 | 424,724 | 573,238 | 27/– |
| 1929 | 446,317 | 614,729 | 27/7 |
| 1930 | 435,818 | 638,896 | 29/4 |

Within the area under survey—Devon and Cornwall—the Ray and Skate fishery is of primary importance (*vide* Fig. 2, p. 5). The various species of the genus Raia collectively constitute the heaviest landings of demersal fish. In 1929 they formed no less than 35% of the total weight and 30% of the total value of all demersal landings for the year.†

* From the Ministry of Agriculture and Fisheries Statistical Tables of Sea Fisheries.

† It is of interest also to note that, with regard to quantity of fish landed in Devon and Cornwall in 1929, Dogfish come second to Skates and Rays, with 16% of the total by weight. That is to say that slightly over 50% by weight of all demersal fish landed in Devon and Cornwall in that year was Elasmobranch.

Actually, they are of still greater importance than even these figures indicate. Forming, as they do, the only large and staple fish supply within the area throughout the year, they play a large part in attracting buyers to the district and in keeping them there, thus helping to maintain a demand for other fish as well, with higher resultant prices.

## II. Fishing Methods and Gear.

Rays and Skates are demersal fishes fitted by structure and habit for life on the sea floor. They may be fished by any of the usual methods

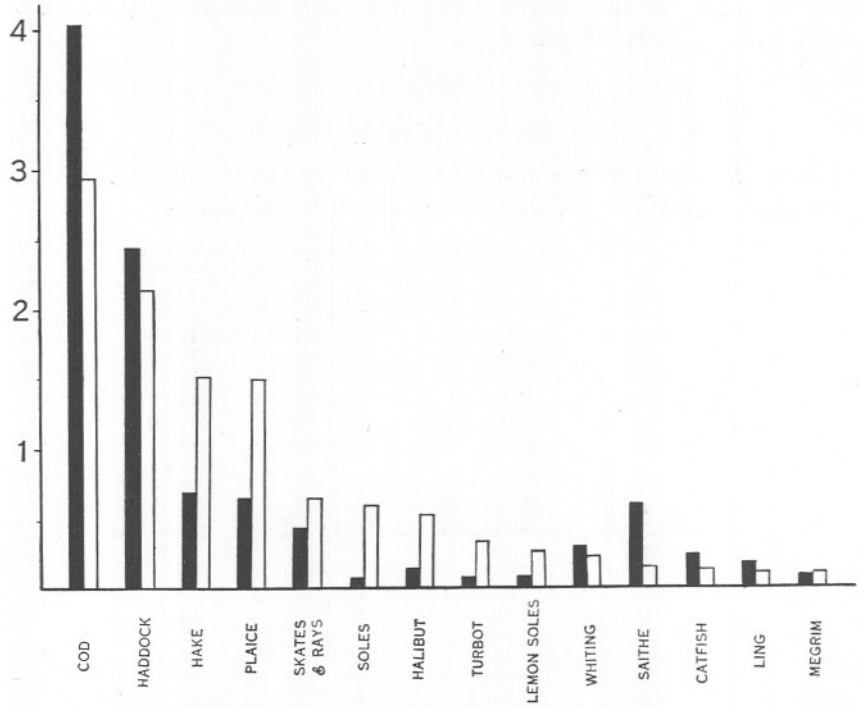


Fig. 1.—Graphical representation of the landings of the principal species of demersal fish of British taking landed in England and Wales in 1930, showing (*a*) total quantity (black columns) in millions of cwt., and (*b*) total value (white columns) in millions of pounds. *Note important position of Skates and Rays.*

employed in the capture of demersal species. In Devon and Cornwall they are caught in beam, V.D., and otter trawls, on long lines, and in set nets.

The main trawling ports are Brixham and Plymouth, from both of which fishing operations are carried out continuously over the whole year. From Brixham about 50 sailing smacks operate, all of which carry beam

trawls. Nine small steam trawlers work from Plymouth and fourteen sailing smacks, the former equipped with V.D. and otter and the latter with beam trawls. At Padstow a fairly intensive trawl fishery is usually carried on during the first three or four months of the year by East-country steamers of the drifter-trawler type. There also work from each of these

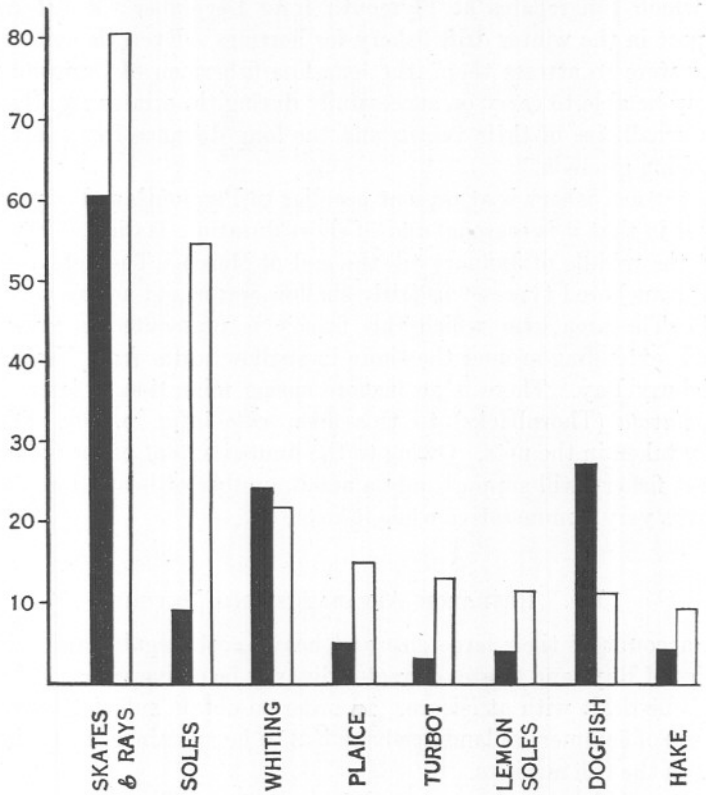


FIG. 2.—Graphical representation of the landings of the principal species of demersal fish of British taking landed in Devon and Cornwall in 1929, showing (*a*) total quantity (black columns) in thousands of cwt., and (*b*) total value (white columns) in thousands of pounds. *Note the leading position of Skates and Rays.*

ports and from the numerous other smaller harbours along the coast small motor trawlers which fish the inshore grounds.

At all seasons of the year Rays and Skates are caught on the usual trawling grounds with little variations in numbers except what can largely be attributed to weather conditions—a state of affairs which indicates a minimum of migratory movements, at any rate on a large scale. A certain amount of migration, however, does take place (*vide infra*, p. 18).

Long-lining is prosecuted mainly by Cornish fishermen with Newlyn as

the main port. A certain amount of line fishing is also carried on from various other smaller ports on the Cornish coast, e.g. Looe, Mevagissey, and St. Ives. The line fishery continues for only part of the year, roughly from April till October. This is due not to any change or movement on the part of the stock of available fish, but to the movement of the fishing fleet which congregates at Plymouth from December till February to take part in the winter drift fishery for herrings. Even though no other fishery were to attract them, the long-line fishermen of Cornwall would scarcely be able to carry on successfully during the winter months owing to the small size of their vessels and the long distance from port of the line-fishing grounds.

The set-net fishery is at present peculiar to Plymouth and of particular interest in that it is seasonal and of short duration, lasting at most from about the middle of January till the end of March. The nets are of the fixed or anchored type set in fairly shallow water and acting as " tangle nets." The area over which this fishery is prosecuted is exceedingly limited, extending around the shore in shallow water from Yealm Point to Bigbury Bay. There is an inshore spring migration of large mature *Raia clavata* (Thornbacks) to this area (*vide infra*, p. 20), which are readily taken in the nets. Owing to the limited extent of the fishing area this net fishery will support only a small number of boats, but for these it proves very remunerative while it lasts.

## III. Research Apparatus and Methods.

On account of their large size and heavy cost, regular and adequate samples of Rays and Skates cannot ordinarily be delivered at the Laboratory to be dealt with at leisure. In order to obtain sufficient data large numbers of commercial landings have had to be examined in considerable detail on the fish markets.

Rays and Skates, when exposed for sale, generally are spread out in lots on the fishmarket floor, all with their ventral surfaces uppermost. In order to avoid handling the fish—too much interference with which would not be tolerated by fishermen, salesmen, or buyers—it was necessary at the outset to learn rapidly and accurately to distinguish the various species landed in this area without raising each fish to view its dorsal side. After considerable practice this was found to be possible. The diagnostic characters which have proved most useful on the fishmarket have been described in a previous paper (Steven, **8**).

The problem of obtaining measurements of the fish also presented difficulties to be overcome. Amidst the bustling activity of a busy market it is quite impossible successfully to use an ordinary measuring board for several reasons. These are :

1. This method necessitates handling and moving every fish examined.

2. Amidst the conditions prevailing an adequate number of fish could not be dealt with in the limited time available while the fish are exposed for sale.

3. Any attempt to use such a board would prove a grave hindrance to the normal activities of the workers on the market.

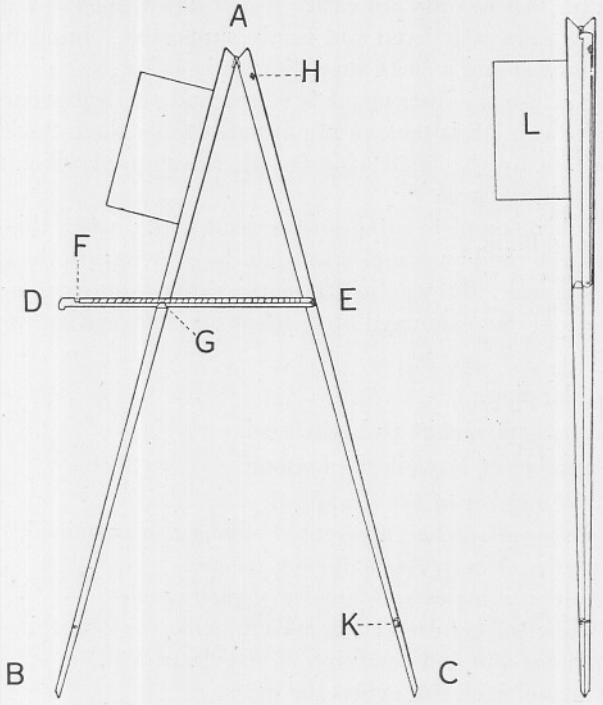


FIG. 3.—Measuring instrument used on the fishmarkets.
Left: open; Right: closed.

4. The use of an ordinary measuring board demands the services of two persons—one to carry out the measuring and another to record the data.

To overcome these difficulties an instrument was devised which renders possible rapid measurement of Rays and Skates spread out in lots, without handling or in any other way interfering with them, and at the same time enables a single unaided worker quickly and easily to record his data (Fig. 3).

The instrument is essentially a pair of large dividers 4′ 6″ in length. Twenty-two inches down from the hinge at the top an arm DE is fixed which can be moved around its point of attachment at E. When the instrument is in use the arm is dropped into a horizontal position and runs

in a small slot G (on the leg AB) open at the top. The arm DE is bevelled along its upper edge and the sloping surface graduated to indicate in centimetres the distance between the points BC of the dividers.

Attached to the leg AB, in a convenient position near the top, is a small rectangular plate L measuring 12 inches by 6 inches. On this plate are carried numerous sheets of paper held in position by two rubber bands. All records are easily jotted down upon the uppermost sheet which is always at hand and firmly supported. Immediately it is filled it is removed and a clean sheet lies ready below.

When not in use the instrument is closed and the legs secured by the catch K. The arm DE is then swung upwards to lie along the leg AC and fixed in position by the small wing-nut H, the stem of which fits into a small recess F in the arm.

When possible, complete catches were dealt with ; when this could not be done, as large random samples as could be overcome in the time available were examined. But whether the entire catch or only a representative part of it could be examined, the following information was always recorded.

1. Date of landing.
2. Locality where caught and gear used.
3. Total number of Rays in the landing.
4. (*a*) Total number of fish examined.
   (*b*) Number of species represented among fish examined.
   (*c*) Number of individuals of each species.
   (*d*) Number of males and females of each species.
   (*e*) Number of mature and immature males, as determined roughly from the size and condition of the claspers.*
   (*f*) Width of each fish across the disc.

In practice it was found necessary to use a more simplified system of notation than the usual male and female symbols (♂ and ♀) for denoting sex, and also to devise a method for recording mature and immature conditions in the males as indicated roughly by the size and condition of the claspers. The following scheme was adopted and proved highly successful.

A measurement without any accompanying symbol denotes a female fish, a horizontal stroke above the figures denotes an immature male, while mature males were indicated by a $\wedge$ over their measurements. Thus 49, $\overline{33}$, $\hat{75}$, denote a female, an immature male, and a mature male of 49, 33, and 75 cm. respectively in width across the disc.

* The females could not be so divided as there is no external morphological difference between mature and immature individuals. Since this paper was written, however, a possible method of distinguishing between them without having to open the body-cavity for examination of the gonads, has been discovered. Further work is proceeding in order to test the accuracy of the method.

A typical fishmarket sheet is shown below :

5/3/30 S.T. .....
Fishing Mount's Bay (40–50 fm.)

Landed *ca.* 1200 small, 310 large } fish.

*Sample of large fish.*

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| R. brachyura .. | $\overline{58}$ | 69 | 59 | $\overline{41}$ | 62 | $\hat{69}$ | 55 | | | |
| | 71 | 79 | 49 | $\overline{64}$ | $\overline{55}$ | 54 | 53 | | | |
| | 62 | $\overline{59}$ | 44 | $\overline{59}$ | 65 | 77 | 75 | | | |
| R. clavata .. .. | $\overline{49}$ | 49 | 44 | 55 | $\overline{44}$ | 52 | | | | |
| | 62 | 41 | $\hat{59}$ | 51 | 63 | 61 | 55 | 59 | | |
| | 59 | 57 | $\overline{42}$ | $\overline{55}$ | 59 | 49 | $\overline{41}$ | | | |
| | 48 | $\overline{47}$ | 47 | $\overline{40}$ | | | | | | |
| R. fullonica .. .. | 49 | 40 | 48 | 49 | 44 | 42 | 51 | | | |
| R. montagui .. .. | 41 | $\overline{40}$ | $\overline{39}$ | 44 | 47 | $\overline{41}$ | 39 | 41 | $\hat{42}$ | |
| | 42 | 46 | $\overline{40}$ | $\overline{32}$ | 41 | $\overline{39}$ | | | | |
| R. circularis .. .. | 57 | $\overline{59}$ | $\overline{54}$ | 61 | 72 | 51 | $\overline{52}$ | 48 | 46 | |

From such a sheet the information set out under heads 1–4 *f.* above is then directly obtainable.

## IV. Species Landed and the Numerical Contribution of each to the Fishery.

In the Ministry of Agriculture and Fisheries Statistical Tables of Sea Fisheries all the species of Raia are grouped together under the inclusive heading " Skates and Rays." From these returns, therefore, no information can be extracted concerning the separate contributions of the different species to the total " Skate and Ray " landings for either the country as a whole or for any statistical region within it. By the detailed examination of large numbers of fish in the manner described above, accurate information on this point so far as the markets of Devon and Cornwall are concerned has been sought.

It has previously been recorded by Clark (**1**, p. 581) that eleven species of Raia appear more or less regularly on the fishmarkets within this area. These are shown in Table II below.

## TABLE II.

SPECIES OF RAIA LANDED IN DEVON AND CORNWALL.

| | Scientific name. | Usual name in Devon and Cornwall. | More generally recognised common name. |
|---|---|---|---|
| 1. | *R. clavata* Linnæus. | Thornback Ray.<br>Greeja (St. Ives).<br>Roker (Commercial name). | Thornback Ray. |
| 2. | *R. montagui* Fowler. | Spotted Smoothback. | Spotted Ray.<br>Homelyn Ray. |
| 3. | *R. brachyura* Lafont. | Blonde Ray.<br>Smoothback Sand Ray.<br>Calaber (St. Ives). | Blonde Ray. |
| 4. | *R. microcellata* Montagu. | (Painted Ray). | Small-eyed Ray. |
| 5. | *R. undulata* Lacépède. | (Marbled Ray). | Undulate Ray.<br>Painted Ray. |
| 6. | *R. nævus* Müller and Henle. | Cuckoo Ray.<br>Butterfly Ray. | Cuckoo Ray. |
| 7. | *R. circularis* Couch. | Sand Ray. | Sand Ray. |
| 8. | *R. fullonica* Linnæus. | Owl Ray (Newlyn). | Shagreen Ray. |
| 9. | *R. batis* Linnæus. | Common Skate.<br>Blue Skate. | Blue Skate. |
| 10. | *R. marginata* Lacépède. | White-bellied Skate.<br>Mule (St. Ives).<br>*Owl (young). | Bordered Ray (young).<br>White-bellied skate (adult). |
| 11. | *R. oxyrhynchus* Linnæus. | Long-nosed Skate (Bottled-nosed Skate).† | Long-nosed Skate. |

The numerical compositions of the catches obtained by the two main methods of capture—long-lining and trawling—differ greatly from each

* When small, this Ray is not distinguished by the fishermen from *R. fullonica*.
† Should more correctly be applied to *R. marginata* (adult).

other and from that of the total combined landings by all types of fishing vessels.

In long-line landings, the mean numerical composition by species is as follows (Table III) :—

TABLE III.

COMPOSITION OF LINERS' LANDINGS.

| | |
|---|---|
| R. clavata | 45% |
| R. fullonica | 22% |
| R. nævus | 15% |
| R. batis | 10% |
| R. montagui | 4% |
| R. circularis | 3% |
| Total supplied by six species | 99% |

Three species, *R. marginata*, *R. brachyura*, and *R. oxyrhynchus*, each of which occurs in small numbers, supply the remaining 1%. *R. undulata* and *R. microcellata* seldom or never occur, even as single specimens, in line catches.

The landings by steam trawlers are made up as follows (Table IV):

TABLE IV.

COMPOSITION OF LANDINGS BY STEAM TRAWLERS.

| | |
|---|---|
| R. montagui | 26% |
| R. brachyura | 24% |
| R. nævus | 24% |
| R. clavata | 11% |
| R. fullonica | 8% |
| R. batis | 6% |
| Total supplied by six species | 99% |

The remaining 1% is made up by the five other species, all of which occur occasionally in the catches in small numbers.

Steam trawler Ray landings are generally separated for sale on the fishmarket into small and large fish, the " smalls " consisting of fish less than about 40 cm. (about 16 inches) across the disc. The compositions of the " small " and " large " fish differ fundamentally from each other. In the smalls the species occur as follows (Table V) :—

TABLE V.

COMPOSITION OF TRAWLERS' "SMALLS."

| | |
|---|---|
| 1. R. nævus | 30% |
| 2. R. montagui | 29% |
| 3. R. brachyura | 22% |
| 4. R. fullonica | 8% |
| 5. R. batis | 6% |
| 6. R. clavata | 5% |
| Total for six species | 100% |

Below is shown the totally different composition of the "large" fish (Table VI) :—

TABLE VI.

COMPOSITION OF STEAM TRAWLERS' "LARGE" FISH.

| | |
|---|---|
| 1. R. clavata | 33% |
| 2. R. brachyura | 30% |
| 3. R. montagui | 20% |
| 4. R. fullonica | 7% |
| 5. R. circularis | 4% |
| 6. R. batis | 4% |
| Total supplied by six species | 98% |

The remaining 2% is made up by five other species all of which occur in small numbers from time to time.

A third class of landings, from the point of view of numerical composition by species, is obtained by sailing smacks (beam trawls) and inshore motor trawlers (otter trawls). The catches by the last-named vessels are very similar to each other, both being drawn from shallower water than those of steam trawlers and liners, and are made up on an average as follows (Table VII) :—

TABLE VII.

COMPOSITION OF CATCHES BY SAILING TRAWLERS AND INSHORE MOTOR TRAWLERS.

| | |
|---|---|
| 1. R. clavata | 36% |
| 2. R. montagui | 30% |
| 3. R. nævus | 23% |
| 4. R. fullonica | 8% |
| Total supplied by four species | 97% |

Two species, *R. brachyura* and *R. microcellata*, supply between them most of the remaining 3%, but all the other species present in the area occur in small numbers from time to time.

To obtain the numerical composition by species of the total landings within the area is not possible by direct methods as records of the total number of fish landed by the different types of vessel are not available. The weight of fish landed, according to the different methods of capture, is, however, obtainable from the Ministry of Fisheries official records of landings at major ports.

These reveal that approximately 37% by weight of the total trawled fish landed at the major ports in Devon and Cornwall is caught by steam trawlers and 63% by weight by wind and motor trawlers. Again, it has not been possible to obtain any accurate determination of the relation between the number of fish landed by the various methods of capture and their total weight. But from general observation of the landings it would appear that for the two classes of landings by trawlers the number/weight relations are not widely different. Calculating on this assumption, the numerical composition by species of the total *trawl* landings at the major ports of Devon and Cornwall is as follows (Table VIII) :

TABLE VIII.

Composition of Total Trawl Landings.

| | |
|---|---|
| R. montagui | 29% |
| R. clavata | 27% |
| R. nævus | 24% |
| R. brachyura | 10% |
| R. fullonica | 8% |
| Total produced by five species | 98% |

The six other species in small numbers make up the remaining 2%.

The total trawled fish forms 42% by weight of the complete total of Rays and Skates landed—by all methods of capture—and liners produce 58% of that total. Here, however, it is certain that trawled landings contain a greater mean number of fish per cwt. than do liners' landings.

To calculate the percentage numerical composition of the total landings for the area, therefore, on a basis of 42% trawl and 58% line fish will give a slightly higher value than the true one to those species which bulk largely in liners' landings. Bearing this source of error in mind, the figures obtained by calculating on this basis are nevertheless instructive. These are as shown below (Table IX) :

## TABLE IX.

Composition of Total Landings at Major Ports of Devon and Cornwall.

| | |
|---|---|
| R. clavata | 37% |
| R. nævus | 19% |
| R. fullonica | 16% |
| R. montagui | 15% |
| R. batis | 7% |
| R. brachyura | 4% |
| Total supplied by six species | 98% |

The remaining five species collectively make up the remaining 2% of the total.

The combined results for the most important species are summarised in Table X.

## TABLE X.

Percentage Numerical Composition of Landings (Summary).

| | Steam Trawlers. | | | Wind and inshore motor. | Total Trawled. | Total Landings. |
|---|---|---|---|---|---|---|
| | Liners. | Large. | Small. | Total. | | | |
| R. clavata | **45** | **33** | 5 | *11* | **36** | **27** | **37** |
| R. nævus | *15* | — | **30** | **24** | **23** | **24** | *19* |
| R. fullonica | **22** | 7 | 8 | 8 | 8 | 8 | *16* |
| R. montagui | 4 | **20** | **29** | **26** | **30** | **29** | *15* |
| R. batis | *10* | 4 | 6 | 6 | — | — | 7 |
| R. brachyura | — | **30** | **22** | **24** | — | *10* | 4 |
| R. circularis | 3 | 4 | — | — | — | — | — |

## V. Occurrence and Distribution.

Within the area under survey Clark (**1**, p. 581) gives the following general information regarding the distribution of the species.

"Numbers 1, 2, 3, 4, 6, 8, 9 (*vide* p. 10 *supra*) are of frequent occurrence in the neighbourhood, and are taken at all stages. Numbers 5, 7, 10, 11 are periodic in their appearance, but the young of 5 and 10 occur commonly on the outer grounds.

Numbers 7, 10, 11 increase in frequency with deeper water towards the western end of the Channel."

From the data set down in section IV it will be seen that *R. clavata* is the most abundant species among the total landings. It is, in fact, the most generally distributed species at all depths, and on all kinds of bottom, but

generally showing a decided preference for rough ground. Clark (**2**, p. 25) states its bathymetric distribution to be " shallow water to moderate depths," but gives no actual figures. At the western entrance to the English Channel it is abundant down to 80 fathoms, and appears not to diminish in still deeper waters, although definite data from greater depths in this particular region are not at present available. But that it is common down to over 100 fm. is shown by the results obtained during a trawling cruise in the *George Bligh* in August of last year. A series of nine trawl-hauls, each of four hours' duration, was taken roughly 80 miles N.N.W. of the " Bull " in various depths from 89 fm. down to 180 fm. As the ship was trawling specially for Hake, Rays did not figure largely in the catches, but some were present in every haul except one. Of the species taken, *R. clavata* was always most abundant down to roughly 100 fm. and was not absent in depths of from 160–180 fm. Beyond about 100 fm., however, *R. fullonica* became definitely more numerous and *R. clavata* less numerous in the catches (Table XI, p. 16).

*R. brachyura* is also fairly abundant in the Channel area but is practically absent from liners' catches, although numerous in trawl landings—especially those of steam trawlers. The reason for this is twofold.

(1) The main long-line fishing fleet which operates from Newlyn, fishes generally in from 60–80 fm. of water or even more. *R. brachyura*, however, according to Clark (**2**, p. 16) is confined to depths less than about 60 fm. This species has a decided preference also for sandy ground, such as is suitable for trawling, and therefore is taken by trawlers whose main fishing grounds lie in depths of under 60 fm.

(2) Liners can and do work on rough ground such as is favoured by *R. clavata* but not by *R. brachyura*, and avoid the softer trawling grounds on account of the danger to their lines. This also tends to prevent their taking *R. brachyura* in any numbers.

The periodic appearance of *R. undulata* and *R. microcellata* on the fish-market (Clark, **1**, p. 581) does not appear to be due to any periodicity in the movements or occurrence of the fish themselves. These two species are very restricted in their distribution, *R. undulata* being confined to a trawling ground 18–20 miles outside the Eddystone* and *R. microcellata* to a few sandy bays and estuaries. It is because of their very restricted distribution that those two species do not appear regularly in the landings. When the grounds on which they do occur are visited they seldom fail to appear in the catches.

*R. nævus* is most abundant in this area between 35–60 fm. No useful information can so far be added regarding the general distribution of the other species.

It has been found that unispecific shoals and unisexual shoals of one

* An occasional specimen may sometimes be taken off Start Point.

## TABLE XI.

| Serial number of haul. | Depth in Fathoms. (a) on shooting. | (b) on hauling. | (c) mean of a and b. | Rays present in Trawl. R. clavata. | R. fullonica. | R. nævus. | R. batis. | R. oxyrhynchus. |
|---|---|---|---|---|---|---|---|---|
| 2 | 89 | 102 | 95½ | 5 | — | — | — | — |
| 1 | 120 | 89 | 104½ | 15 | 5 | 2 | 2 | 2 |
| 4 | 115 | 96 | 105½ | 45 | 15 | 3 | 2 | 1 |
| 3 | 102 | 115 | 108½ | 5 | 9 | 2 | 10 | 2 |
| 9 | 110 | 120 | 115 | — | — | — | — | — |
| 5 | 96 | 158 | 127 | 43 | 12 | — | 4 | — |
| 8 | 162 | 110 | 136 | 9 | 11 | — | 3 | — |
| 6 | 145 | 145 | 145 | 2 | 20 | — | 3 | — |
| 7 | 180 | 162 | 171 | 12 | 57 | — | 1 | — |

Extra haul off Black Rock—53° 40′ N. : 11° 20′ W.

| | | | | | | R. circularis. |
|---|---|---|---|---|---|---|
| 17 | 137 | 124 | 130½* | 7 | 26 | 4 |

* Trawl was fishing for part of the time in at least 150 fm.

species occur—as for instance is shown for *R. clavata* landed from the Ray net fishery at Plymouth (*vide* p. 22 *infra*). Liners' catches, too, occasionally furnish evidence of this segregation. On 23rd August, 1930, a liner which had been fishing 45 miles S.W.×W. of Carn Du Point near Mousehole, had an almost blank haul, catching only nine fish. All these nine were *R. fullonica* and *all females*.

On 3rd June, 1930, a small inshore trawler fishing near Newlyn brought in 205 Rays, 183 of which were *R. brachyura*. Of these 152 were male and 31 female.

There can be little doubt, therefore, that there do occur unispecific shoals which at times may be almost if not entirely unisexual.

Such separation of species, however, unless the shoal be very large and cover an extensive area, or if small, be alone in a fairly large area, is not noticeable as a general rule in trawl landings as there is no indication in the catch of the order in space and time in which the captured fish were taken. When emptied on deck the contents of the " cod end " are all thoroughly mixed up. Nevertheless, an almost completely unspecific and unisexual haul was made by a steam trawler in Mount's Bay in March, 1930 (*vide* p. 23 *infra*).

As a general rule, on most of the larger fishing grounds, although one species may predominate, several species are present. In those circumstances do the various species mix indiscriminately or do the members of each species tend to keep together ? An attempt to answer this question was made by taking an accurate census of every fish which came up in three hauls of a full fleet of long-lines ordinarily used by a Cornish long-liner. On the vessel in question the fleet consists of 24 baskets of line, each basket carrying roughly from 110–120 hooks about 11 feet apart.

If the various species are in separate shoals or groups there should be a tendency for the same species to appear more or less together on the same part of the line. Any such grouping will always tend to be obscured, of course, by the fact that the lines remain on the sea floor for anything up to six hours at a stretch. Therefore, even though at the outset there may be a definite distribution of the species along the line, other fish, or shoals of fish, will come along and take the hooks which have not previously been occupied. Thus the distribution of fish caught on the lines at any particular point of time unless they occupy adjacent hooks—which is unlikely —will be obscured by those which were hooked previously and by those which subsequently come along and are caught.

The possibility must also be recognised that purely as the result of chance, two or more fish of the same species may occur together here and there on the line though the population be entirely and indiscriminately mixed.

An examination of the distribution of fish along the above-mentioned

lines reveals a definite tendency for the same species to appear more or less together on the line. This grouping is too pronounced to be explained purely as the result of the laws of chance.

In Figure 4A is shown diagrammatically the catch of fish on a continuous section of line 1½ miles in length, hauled during the forenoon of 22nd July, 1931, from a fishing ground roughly 80 miles S.S.W. of Mousehole, near Newlyn, Cornwall. Each short vertical stroke denotes a hook which came up empty. A stroke produced downwards indicates a hook on which a fish of some kind was taken, while a stroke produced both downwards and upwards and ending above in a large dot denotes one on which *R. montagui* was taken. It will at once be seen that this fish shows a very definite grouping on this part of line. A similar grouping of *R. montagui* is shown in Figure 4B on a half-mile stretch of line hauled during the afternoon of 23rd July, 1931, on slightly different ground.

In Figure 5 is shown a continuous stretch of line 2½ miles long with the upwardly extended strokes denoting *R. nævus*, this being part of the same haul as the second one mentioned above. Here again a very definite grouping of the fish is seen. These results agree with other more general observations made at sea by the author when, however, a definite record of each hook and fish could not be made.

It appears, therefore, that, on the sea floor, where various species of Raia are present within a limited area at the same time, the species do not mix indiscriminately but segregate into unispecific groups or shoals.

## VI. Migrations.

As yet little is known regarding the migrations and shoaling habits of the Raiidæ. What little information there is on record applies mainly to *Raia clavata*, perhaps because its movements are more marked than those of the other species or perhaps because it is the most generally distributed and most abundant Ray in inshore shallow waters and at moderate depths down to at least 80 fm. Meek (**5**, p. 41) states definitely that there is, in this species, a periodical migration inshore in summer and into deeper water for the winter. Unfortunately he gives no actual data as to depths. At the western entrance to the Channel, there is little evidence of such a wholesale inshore migration in summer at any rate within the area inside the 80 fm. line. The long-liners, which are responsible for over 50% of the total Ray landings in Devon and Cornwall, fish throughout the summer months only, mainly in depths of from 60–80 fm., and the present tendency is for the boats to go still farther offshore into ever deeper water in order to maintain the level of their catches.

Certain conditions described by Murie (**6**, p. 166), however, for the Thames Estuary are borne out by observation in this area. According to

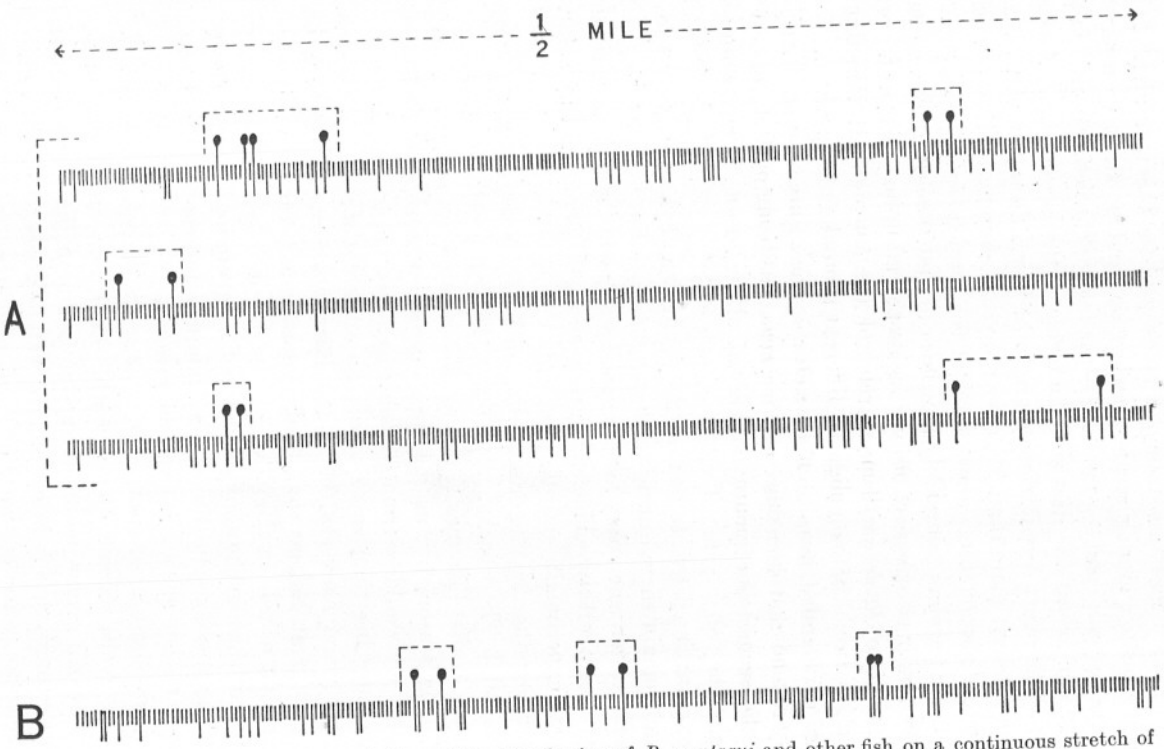


FIG. 4.—A. Diagrammatic representation of the distribution of *R. montagui* and other fish on a continuous stretch of 1½ miles of long-line—22nd July, 1931. For explanation see text, p. 18.
B. Distribution of *R. montagui* on ½ mile of long-line, 23rd July, 1931.

this author the Thornback is captured in shallow water almost at all seasons, especially during its early stages.

Examination of steam trawlers' fish landed on Plymouth market indicates clearly that this statement holds good for this area also. It is the usual custom among steam trawlers on landing Rays to separate them into " small " and " large " fish—the former consisting of fish under about 40 cm. across the disc and the latter of the larger ones. Among their small fish very few *R. clavata* are to be found at any season, giving an average of not more than 5% over the year. Among their larger fish, however, *R. clavata* forms about 33% of the total (*vide* Table X, p. 14).

The steam trawlers fish mainly in water of from 40 to 60 fm. in depth. The Ray landings of vessels fishing inside the 30-fathom line, however, consist mainly of *R. clavata*, the majority of which are of small and medium size, such as would be included in the " smalls " of steam trawlers.

Of 943 fish landed from shallow water by the research vessel *Salpa* during 1930–31 and identified and measured, 83% were *R. clavata*. Of these, 82% consisted of young individuals under 40 cm. in width across the disc.

The explanation seems to be that the young fish are hatched in shallow water and remain there during their early stages of growth, moving out into deeper water when they have reached a size of 40 cm. or over across the disc. Corroborative evidence on this point is being sought by means of marking experiments.

Migrations, either feeding or spawning, or both, do also occur, however, among the adult Thornbacks. Murie (**6**, p. 167) states that, " when long-lining in the Wallet (Thames Estuary), Rokers were few at the beginning of the fishing season, but as the sprats came about so did the Rokers multiply. They would be from 18 inches to 2 feet wide, length in proportion, and more big than small ones. As an instance of a good catch, some thirty years back (1870?) in the Barrow Deep one morning, on 28 lines, 190 great Rokers were hooked, besides several lines being lost through weight of fish on them."

It is evident that, in the above-mentioned areas of the Thames Estuary, the adult Thornbacks appear for a time in large numbers probably feeding on sprats—i.e. they show a feeding migration.

A strikingly similar inshore migration of adult Thornbacks takes place every spring in the vicinity of Plymouth. Each year, usually about the middle or end of January, while herrings are still abundant, large numbers of *R. clavata* congregate in fairly shallow water—inside the 22-fm. line—around the shore to the eastward of Plymouth Sound from Yealm Point to Bigbury Bay, and give rise to the set-net fishery already mentioned.

The landings from this net fishery present certain features of great interest. The first fish to arrive (as shown by the landings—Table XII)

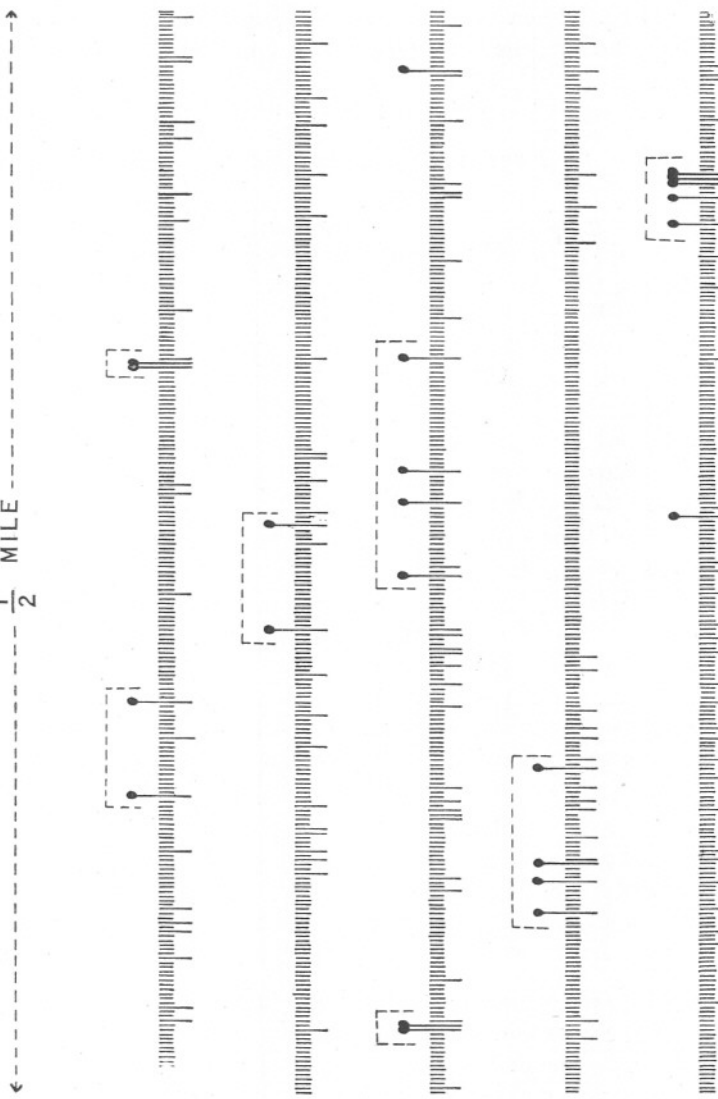


FIG. 5.—Distribution of *R. naevus* on a continuous stretch of 2½ miles of long-line—23rd July, 1931.

are almost entirely females—all fully grown gravid fish nearly, but not quite, ready to deposit their eggs. In a few weeks, adult male fish begin to appear in increasing numbers and finally landings may consist almost entirely of adult males, the females having departed and the males having taken their place. When this happens, the fishery is nearly at an end. These male fish do not remain long behind the females which have already left the area.

## TABLE XII.

### Landings from Ray Nets.

| | 1930. | | | | | |
|---|---|---|---|---|---|---|
| | *R. clavata.* | | *R. brachyura.* | | *R. batis.* | |
| | ♂♂ | ♀♀ | ♂♂ | ♀♀ | ♂♂ | ♀♀ |
| February | | | | | | |
| 20 | 10 | 192 | — | — | — | — |
| 21 | 10 | 198 | — | — | 2 | — |
| 24 | 34 | 199 | — | — | 3 | 3 |
| March | | | | | | |
| 4 | 1 | 33 | 2 | — | 2 | 4 |
| 8 | 20 | 44 | | | | |
| 10 | 2 | 47 | 6 | — | — | — |
| 11 | 67 | 37 | — | — | — | — |
| 12 | 28 | 41 | — | — | — | — |
| 15 | 38 | — | 1 | — | — | — |
| January | | | 1931.* | | | |
| 12 | 2 | 159 | 1 | — | — | — |
| 13 | — | 121 | 1 | 1 | — | — |
| 16 | 2 | 49 | — | — | — | — |
| 19 | 2 | 198 | 3 | — | — | — |
| 20 | 5 | 156 | 1 | — | — | — |
| 22 | 1 | 75 | 2 | — | — | — |
| 23 | 17 | 123 | 2 | — | — | — |
| February | | | | | | |
| 3 | 2 | 77 | 12 | 3 | | |
| 4 | — | 121 | 2 | 2 | | |

All the fish move off before " spawning " takes place. Although the females landed all contain almost ripe ova, in scarcely any of them are egg capsules to be found.

This congregation of Thornback Rays around the shore from Yealm Point to Bigbury Bay, upon which the Plymouth Ray net fishery depends, is therefore an inshore feeding migration of mature adult fish (*Vide* pp. 23 and 24).

* Owing to stormy weather the fishery this year came to a premature close.

There is evidence of similar brief inshore migrations in early spring at other points along the south Cornwall coast. In March, 1930, a steam trawler after fishing with little success for a week " off the Wolf " moved into Mount's Bay. There, in 25–30 fm. of water, on the night of Saturday–Sunday, 15th–16th March, between the hours of 7 p.m. and 2 a.m. she caught 210 large Rays, 207 of them being *R. clavata*,* of which every one, without exception, was a large female. Another trawler, fishing at the same time just outside in 45–50 fm., had the usual mixed trawl catch.

Certain fishermen say that these large Rays appear every year off Falmouth, but the trawlers cannot always get at them because they go too far in. Unfortunately, there is no inshore Ray net fishery there from which to obtain corroborative evidence. Nor is there such a fishery at any point around the coasts of Devon and Cornwall, except at Plymouth.

Evidence of a somewhat similar migratory movement on the part of *R. brachyura* is furnished by the catches of a small motor liner fishing from Newlyn. This vessel, being unable to go as far to sea as the regular fleet of larger liners working from the port, normally fishes on a small sand-bank close inshore.

On 4th June, 1930, this small liner landed 853 Rays, consisting of 824 *R. brachyura* (and 29 *R. montagui*), not a single fish being more than 50 cm. across the disc. In August of the same year, this vessel, fishing on the same bank with the same gear, was bringing in catches consisting again almost entirely of *R. brachyura*, and all 65–75 cm. in width across the disc.

As it does not seem possible for a growth of 15–25 cm. to have taken place in two months, it must be assumed that the large fish had migrated to the bank from elsewhere and that the smaller fish had moved away. Unfortunately, no observations on the landings at Newlyn were possible in the period between June, when the immature fish were being landed, and August, when the large mature fish had taken their place.

## VII. Food and Feeding.

As is already well known, young Rays feed very largely upon small crustaceans, especially Amphipods and Crangonids (Clark, **1**, p. 635). In the vicinity of Plymouth the Amphipod *Ampelisca spinipes* is of primary importance, being present in large numbers on certain grounds (Steven, **6**, p. 681). As the fish increase in size they turn their attention to larger crustacea such as Upogebia, Portunus, and Corystes, and—in certain species at least—to fish.

Adult Thornbacks, however, sometimes feed entirely on fish. The

* The three others were large male *R. brachyura*. It is interesting to note that, in nearly every catch of *female R. clavata* from the Ray nets there is also nearly always present one or two *male R. brachyura*.

large Rays of this species taken by the nets already mentioned (p. 20) were in both 1930 and 1931 found to be feeding exclusively on herrings and sprats. Of several hundreds of stomachs examined, not one was found to contain anything but fish, mainly herring (sometimes as many as six in one stomach), and not more than half a dozen empty stomachs were encountered. Several large *R. brachyura* and a few large *R. batis* taken in the same locality also had their stomachs full of herrings. One of the latter, a female measuring 143 cm. across the disc, contained no less than nine large fish.

Other fish, commonly including Rays, also enter largely into the diet of adult *Raia batis*.* Of 41 stomachs of these fishes ranging from 89 cm. upwards in width of disc, examined on and between 25th and 30th July last year, 13 contained one or more Raia sp. Those specimens of which the species could be determined consisted of *R. nævus* and *R. montagui*, with one doubtful *R. clavata* among them. The full results of the examination of the stomachs are tabulated below.

FOOD OF SKATES (*R. batis*).

25th July, 1930.

| Serial No. of Fish. | Width across disc (in cm.). | Food in Stomach. |
|---|---|---|
| 1 | 101 | *Raia nævus* |
| 2 | 94 | *Scyllium canicula*<br>*Homarus vulgaris* |
| 3 | 124 | Empty |
| 4 | 145 | *Lophius piscatorius* |
| 5 | 100 | Raia sp. |
| 6 | 108 | *Acanthias vulgaris* |
| 7 | 129 | Empty |
| 8 | 125 | *Eledone cirrosa* |
| 9 | 93 | *Raia nævus*† |
| 10 | 90 | *Eledone cirrosa* |
| 11 | 105 | *Pleuronectes limanda* |
| 12 | 98 | *Lophius piscatorius.* |
| 13 | 110 | Empty |
| 14 | 99 | *Raia nævus* |
| 15 | 91 | Raia sp. (? clavata) |
| 16 | 97 | Empty |
| 17 | 102 | *Caranx trachurus* |
| 18 | 100 | Raia sp. remains |

* See also Murie, **6**, p. 165.

† This fish had been caught on one of the hooks of a long-line. It was then swallowed by a Skate which was itself also caught on the same hook.

| Serial No. of Fish. | Width across disc (in cm.). | Food in Stomach. |
|---|---|---|
| 19 | 104 | Empty |
| 20 | 98 | Empty |
| 21 | 96 | *Acanthias vulgaris* |
| 22 | 95 | Empty |
| 23 | 109 | *Cancer pagurus*<br>*Eledone cirrosa* |
| 7th July, 1931. | | |
| 24 | 116 | *Acanthias vulgaris* |
| 25 | 104 | *R. nævus* |
| 26 | 123 | *R. montagui* |
| 27 | 119 | Empty |
| 30th July, 1931. | | |
| 28 | 121 | *Cancer pagurus* |
| 29 | 104 | *R. montagui* |
| 30 | 98 | *Cancer pagurus* |
| 31 | 89 | *Eledone cirrosa* |
| 32 | 96 | *Acanthias vulgaris* |
| 33 | 125 | Empty |
| 34 | 139 | Empty |
| 35 | 146 | Empty |
| 36 | 144 | *Raia nævus*<br>*Trigla cuculus* |
| 37 | 142 | *Clupea pilchardus*<br>*Cancer pagurus*<br>*Pleuronectes microcephalus* |
| 38 | 119 | Empty |
| 39 | 126 | *R. nævus* |
| 40 | 98 | *R. montagui* |
| 41 | 94 | *Cancer pagurus*<br>Raia sp. remains |

Nine large *Raia marginata*, 90–135 cm. in width across the disc, examined at the same time, were all found to have empty stomachs. The food of six *R. oxyrhynchus*, 83–114 cm. across the disc, included *Cancer pagurus*, *Atelecyclus septemdentatus*, *Corystes cassivelaunus*, other crustacean remains, Trigla sp. and *Callionymus lyra*.

Of the foraging habits of the Raiidæ little is known. It is nevertheless certain that they depend upon " scent "—or at any rate on some sense other than sight—for the finding and recognition of their food or prey. For in long-line fishing, where the catch depends upon the fish finding and

taking the bait, there is no difference at all in the magnitude of day and night hauls. Neither the brightest day nor the darkest night appreciably affects the catches of Ray. They thus differ markedly from Turbot which, being sight feeders, are seldom caught in any number on lines during the night, but are readily taken by day (*vide* appendix, pp. 28–33 *infra*).

## VIII. The Toll of the Fishery.

Further work on the Rays and Skates of the Channel Area is proceeding with a view to ascertaining, if possible, their growth-rate and of discovering some method of age determination. Only when more precise information is forthcoming on these points can any definite estimate be made of the toll of the fishery. It seems worth while, nevertheless, to mention here certain facts concerning the fishery which appear to point very definitely to a possible depletion of the stock if the present intensity of fishing continues.

The statistics at present available show an alarming decline in the total British catches of Rays and Skates from the English Channel as a whole during the last five years, the total landings from regions VII d and e (Channel) in the years 1926–1930 being 64,061 cwt., 57,344 cwt., 54,238 cwt., 50,771 cwt., and 45,037 cwt. respectively. Certain factors external to the fishery itself have, in some years at least, helped to cause this decline. But that these figures reflect a real change in the available stock of fish is indicated by events and conditions in the Cornish long-line fishery, according to the following statement by the fishermen concerning the number of hooks used and the grounds fished.

Whereas in pre-war and the immediate post-war years the Cornish long-line fleet working from Newlyn used on an average from 1000 to 1500 hooks per vessel on from $2\frac{1}{2}$ to 3 miles of lines, they now shoot from 2000 to 3000 hooks on from 5 to 7 miles of lines in order to capture approximately the same amount of fish. Moreover, instead of fishing as a rule within a radius of 50 miles from port, they are now obliged, in spite of the inadequacy of their vessels, to seek grounds up to 90 or even 100 miles distant.

As increase in the amount of gear that can be used has now attained its maximum for the type of vessel at present employed in the line fishery, and as there is a limit (now reached) to the distance from port at which they can profitably and safely work, it would appear that the landings must in future decline. It is doubtful whether the use of larger vessels capable of working more gear and of going farther away from port would arrest the possibility of this decline more than temporarily.

It seems sufficiently interesting and important finally to mention that, in line fishing, there is a complete absence of any destruction of non-

marketable small fish.* Should the question ever arise in a restricted area of devising means for the preservation of a Ray fishery, a useful preliminary step would be to consider the possibility of substituting lining for other more destructive methods of fishing.

## IX. Acknowledgments.

In carrying out these investigations I have received assistance from so many persons—fishermen, salesmen, buyers, and others—that it is impossible for me here to mention them all individually. Without their aid I could not have worked. To all those, therefore, to whom I am indebted in any way for help and advice I gladly extend my thanks. I am especially grateful to Messrs. Howard and Ben Dunn for much assistance generously given throughout the whole course of the investigations.

I am also under particular obligation to Mr. E. Ford for many valuable suggestions, and for reading the manuscript before it was submitted for publication.

## X. SUMMARY.

1. Until the beginning of the present century there was little demand in this country for Rays and Skates. This fishery is now of major importance both nationally and within the Devon and Cornwall area.

2. Of the eleven species of Raia present in the western area of the Channel, *R. clavata* makes the greatest numerical contribution (37%) to the total landings in Devon and Cornwall. The composition of the catches obtained by different methods of fishing varies greatly.

3. *R. clavata* is the most widely distributed species in the Channel area at all depths and on all kinds of sea bottom.

4. In a series of trawl hauls off the west coast of Ireland *R. clavata* was most numerous in the catches down to about 100 fm. From that depth down to about 170 fm. (the greatest depth fished) *R. fullonica* was most numerous.

5. Unispecific and even unisexual shoals of at least three species of Raia—*R. clavata*, *R. brachyura*, *R. fullonica*—occur.

6. When more than one species of Raia is present within the same area at the same time, the members of the different species have been found not to mix indiscriminately.

7. *R. clavata* appears to hatch out in shallow water close inshore and gradually move seawards into deeper water as it grows.

* The smallest Ray taken in the three shots recorded on pp. 30–33 (appendix) was a *R. nævus* 33 cm. (about 13 inches) in width across the disc.

8. Adult *R. clavata* show definite migratory movements, though the full extent of their wanderings is not yet known. There is an inshore migration in early spring of adult fish to a small part of the coast near Plymouth. The first fish to appear are females, males appearing later.

9. There is evidence of somewhat similar migratory movements by *R. brachyura*.

10. *R. clavata*—and possibly also *R. brachyura* and *R. batis*—at times may feed almost entirely on Herrings.

11. Large *R. batis* feed to no inconsiderable extent on other species of Raia.

12. In foraging for their food Rays and Skates depend upon some sense other than sight.

13. There has been in recent years a steady decline in the landings of Rays and Skates from the English Channel—probably due to depletion of the available stock of fish.

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## XII. APPENDIX.

Below are shown in detail the complete catches of fish, and their distribution on the hooks, taken in three hauls of long-line worked from a Newlyn (Cornwall) motor liner on 22nd and 23rd July, 1931. The

interval between adjacent snoods, each of which carried a single hook, was approximately eleven feet.

The various species of fish captured are denoted by the following

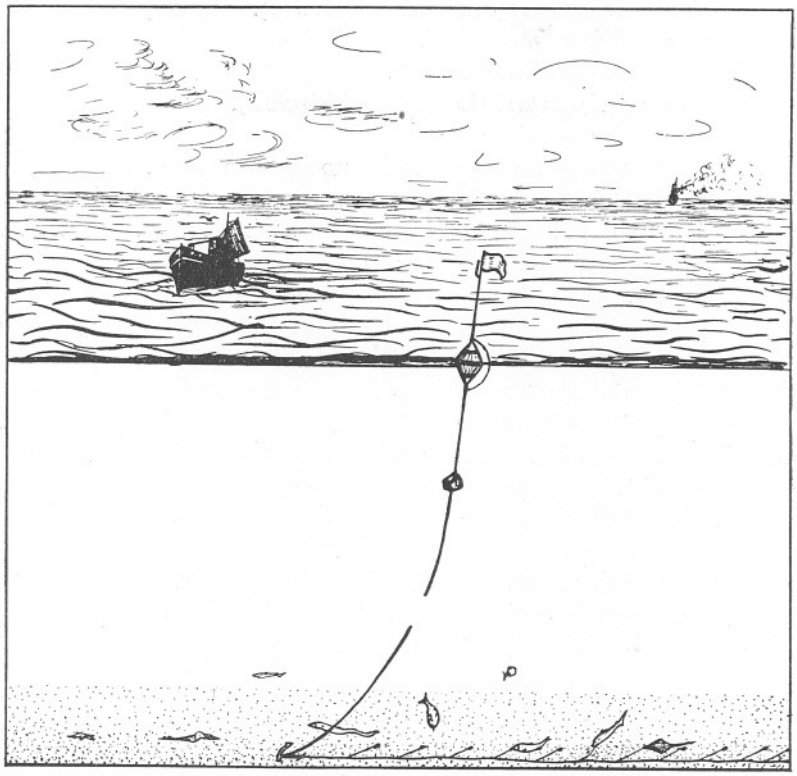

FIG. 6.—Diagram of a Cornish motor liner, and a portion of its long-line which has just been shot. The complete line carries approximately 2600 hooks and extends for a distance of between 5 and 6 miles along the sea floor. For further explanation, see text, p. 30.

symbols in which all *Rays* are indicated by letters and other species by numbers.

C = *Raia clavata* (Thornback Ray).
M = *Raia montagui* (Spotted Smoothback Ray).
N = *Raia nævus* (Cuckoo Ray).
R = *Raia circularis* (Sand Ray).
F = *Raia fullonica* (Shagreen Ray ; Owl Ray).
B = *Raia batis* (Common Skate).

1 = *Acanthias vulgaris* (Spur Dogfish).
2 = *Scyllium canicula* (Rough Dogfish).
3 = *Scyllium catulus* (Nursehound).

4 = *Rhombus maximus* (Turbot).
5 = *Conger vulgaris* (Conger Eel).
6 = *Molva vulgaris* (Ling).
7 = *Trigla gurnardus* (Grey Gurnard).
8 = *Trigla lyra* (Piper).
9 = *Gadus morrhua* (Cod).
0 = *Luidia sarsi* (Long-armed Starfish).

Every dot represents a hook on which no fish was taken.

A record of the blank hooks and fishes caught on the portion of line shown in Figure 6, p. 29, would read as follows: . . . 9 . 1 F . . . .

Here and there along the length of a line small sections frequently become tangled. Such tangled portions have not been recorded in the present census as the hooks which they carry are put entirely out of action as far as their fishing capacity is concerned.

Two of the three shots recorded below are day shots, while one—the second—is a night shot. It will be noticed that Turbot (indicated by the figure 4) are present in both the day catches but that none were taken during the night. Rays and Dogfish are abundant in all three catches.

NOTE.—The first catch here recorded was not considered satisfactory by the fishermen on account of the scarcity of *Raia clavata* (Thornback)—the most remunerative species which is mainly sought. They therefore moved from their first position before shooting the lines a second time.

*First Shot.* 80 miles S.S.W. of Mousehole (Cornwall). Began to shoot lines 4.30 p.m.; finished 6.5 p.m. Shot S.W. (24 baskets). Began hauling 8.30 p.m.; finished 2.15 a.m.. 22nd–23rd July, 1931.

.....2..1.....1 F .....1...M
..... M . M ..1.. F ...6...1. M ....1.....1.....4..... C ....
.....1..1.1.....1.1 0.1.....1 1 2 2.....
.....1.....1 1 1....0.1....1. N ..1.0. M .1.. M ...1....1...1 1
...1. N .0.....1.....4..... N . N . M .....1.. M ...
..... R .1..1 .. N ..... 1 ..... F .....1... N
.....N.1....1.1.....1.....1 ..1 .....1 .....
.....N .....1.1.....C1...1..1 N .....
.....1..1..1..... N .....1..... N .....
C R .1.1.. M .4 M . N .....1 1.....1 1.....1....1.....
1 1.1.....1..0... N ..1....1.....1..1.....
.....4. N .1.1....1....1 1. C ..1 1..1...1.....1 1..1.1... M .....
..... B .....1 1 6....1.. M .1..1..... N . N .... 1 .. 1 C ..1
..... M .....1.....1 F ....1.....1....1.....1....1..
.....1.....1...0.0.....1.....1.....1.....40...

. . . . . B . . 0 1 . . M . . . . . 1 . . . . . 1 0 . C 1 F . . . 1 . . . . . 1 . 1 . 1 1 . . . . 1 1 1 . . 0 . . . . . 1 . B . 1 . . N . . . . . 1 1 1 1 . . 1 . . 1 . . . N . . . . B C . . . . C . . . . . N . . . . . R . . . . 1 1 . . . . . M . . . . . 1 . 1 . C 1 1 1 . . . . N . . . . . 1 1 . . . . . C . . . . . 1 N 1 . . . . N . . . . . 1 . . . N . . C . . . . . 1 . . . . . 1 . . . . . 1 1 . . 1 . . 1 1 . . . . . N . . . . N . . . . . 1 . . 1 . . . . . 1 . . . . . F . M 1 1 . . . . . 1 . . M . C 0 . 1 . . . . . 1 . . . . C . . . 1 . . C . N . 1 C . . . . . 1 . . . 1 . . . . . C N . 0 . . . . 1 . . . F . . M 1 . 1 . . 1 . . . . 1 . 1 . N . 1 . 1 . . . . . 1 C . 1 . . M . 1 . M . 1 . . . 1 . 1 . . . . . 1 . . . . . 1 . N . . . . . N . . 1 . 1 . 1 . . . . . 1 . M . 1 . . . . . 1 . 1 . . 1 . N . . 1 . . . M . . . . . . . R N 1 . . . . N . 1 . . . . . 1 . 2 . . . . . 2 N . . . 1 . . 1 . . . . . M . . . . . 1 . . . . . 1 . . . . . N . . . . . . . . 1 . . 1 . N . 1 N 1 . M . . . . . 1 . 1 N . 1 N . . . . N . 1 . 1 . . . . . 1 . . . . 1 . . . . . 1 . . . . . 0 1 1 1 . . . . . N . . . 1 1 . . . . . 1 . . 1 . . 1 1 C . . N . 1 . . . . 1 . 1 . . . . . 1 . . 1 . . . . 1 . . F . . . . 1 . . 1 . . 1 . . . . F . . 1 . 1 . . . . . . . N . . . . . 1 . 1 . . N . . . . . F . . . . 1 . . . . . 1 . R 1 . . 1 . . . . . 1 . 0 . . . . . 1 4 B . . . 1 . . 2 . 1 . . . 1 . . 1 . N . . 2 . . . . . 1 1 1 . . 1 . . . . . 1 . . . . . 1 . . 1 . 1 . 1 1 M . . . . . N . . 1 . 1 . . . . . 1 . 1 . 1 6 . . . . . 1 . 1 1 . C . . C . . . . . 1 . . 1 1 . . 1 . . 1 . . 2 . . . . . 1 . N . 2 . . . B . . . . C . . 1 . N . . . . . C . 1 . 1 . . . . . 1 M . . 1 . . . . . 1 . . . . . C . . . . . . 1 . 1 . . 1 . . . . . 1 . 1 . 1 . . . . . 1 . . . . . 0 . . . 1 . . . . 1 . . . 1 . . . . C 0 6 . . . . 1 . . . . . 1 . 1 . . . 1 . . . 1 . . . . . M . 1 . . . . . N . 1 . . . . . 1 1 . . . 1 . . . . . . 1 1 . . . 1 . . . . . N . . . . 1 . . . . . 1 . . M . 1 . 1 . . N . . . . . 1 . 1 1 1 . . 1 . . . . . 1 . 1 . . . . . 1 . . . . . F . . . R 1 1 1 . M . . . . 1 . . . 1 . M . 6 . . . . 1 0 1 . . . . . 1 . 1 . . . . . R . . . . . . . . . . . . . . . . . 1 . . . . 2 . . N . . . . . 1 . . . 1 . . 1 . 1 . F R 1 . . 2 . . . . . 0 . . . . B . R . . 1 . . . . . B . . . . F . R . . . . . 1 . . . . . F . . . 1 1 1 . . . . 1 1 . . . 1 1 . 1 . . . . 1 . . . . . 1 . . 1 C 1 . . . 1 . F . . R 1 . . 1 . . 1 . . M N . . . . . . . . . . . . . . 1 . . . . . 1 . N . . . . . . . . . . . . . . . . . . . . 1 1 1 . 1 . . . . 2 1 B . . . . . M M . . . . . C . . . . . . . . . . . . . . . . . . 2 . . . . 1 . . . . . 1 1 . . . . . . . 1 . . 1 . . . . . C l . 1 . . . . . . . . . . . . . . . . . . . . . . . . 1 . . . . 1 . . . 1 1 . 1 . . . . . 1 . . . 1 . . . . . 1 . . . . . .

*Second Shot.* " Steamed " 8 miles S.S.W. from previous berth. Began shooting 3.30 a.m.; finished 4.50 a.m. Shot S.W. (24 baskets). Began hauling 6.15 a.m.; finished 11.10 a.m. 23rd July, 1931.

. . . . . N C . 1 . . . N . . . R . . . . . 1 6 . . . . . 1 . . . . . . . . . . . . . . . 1 N . . . . . 6 . . 1 . . . . . N . . . . R . . . . . 1 1 . 1 . . 1 . . . . R . . . C . . . . . N . 1 . . . . . 1 1 . . . . . 1 . . . . . M . . . . . N . C . 1 . . . . . . . . . . . . . . C . . . . . 0 1 . . . . . M C . . . . . C N . . . . . C . . . M . . . . 1 1 . . . . . 1 . . . . . C . . . . . 1 . . . . . 1 . N . . . 1 . . . . . C . . M . 1 . M . . . . . 1 . . 6 . . . . . N 1 . 1 . 1 . . M . . . . M . . . . . 2 . . . . . . . . . 1 . . . 5 . . . . . 1 . 2 . . . . . 1 . N . . . . . 1 1 . . . . 1 . . . .

1 C .1.....1... C .. R ..... F C .....N 1.11.....6.....
1.....5..... C ..... C ..... 1 .... N .....1
.. C . C ..... C C 1....1.. C .1....1.1... C ...1.. C .. N .....
... C ..... C .5.. C . M . B 1..... C ..6.....6....5.6....6.6...
..6 6..5..5 5..1 C C ..1..... 6 .....1.6 C B .. C ...1..1
...6.....1 C C .6.5..... N . C 5..M .....C .1
.....1.1.....6..... R ..... C .....2..21.....
.....1..1.0..... N . N ... C 1. C ... B B 2.1..2.5 1..9 N .. N .....
..... C ....2.1.1...1 5.. N . M 1 2 1.....5 1.. C ...1 1. N ....
N C .....1 1 .... C ....1 1 .....1 0..... C .....1..... C
..... C ..... M ..0.6 M 1.....2.... C 1 .....1. 1 .....6... 1 1
.....1 N N ....6.....1 N ..2.1.1.....1 0....3.....111....1...
.....1....1.1.....0. C ..1.....B .1 1..2C0.2.1.
C ..... 2 .....1.. F 1 6...1.. C 1 .... C .2... C .... C.
B .. C .1..1....1.....1 0.....1....1.....1 C ... N .....1
.....1 1..... M ..... N ..1..1 1. N ..... C ...C 1 N 1 2..C ...
C ...1.1 C .....2.1..... C ..... M ..... C ..2 C..
C .....5....0...2 C C .. B ..2....1.C...6..... N .....
1.. C ..... C .....
.....1.....6..... C .....2 F M .....6..
5 1... C .. N 6.. C ..6 C .1..... C ..... B .. N 2.. C ..
.....1 1.....1..... C 6...1 1 3.....
..... C 1..... C .... C . B ..... C ..... C .....
.....6. C ...1 F .....2 1.....1
.....1.6....0..1.....1.....1....1. C .....1..... C F ...
..1..... C .....1...6..... C ..... B ....1.... C . N 1
F....1 N C 1 1...1.0.....1.....7.1..N .....1.1.....
C .....1.. C ...2..... N .....1.. C . 3 .... C . M ....
...1 N .....0. B N ..... C 2.....6.....1
... C ..... C 1..1.....1..1.1 1... C M .... C .1. C ..... N
1 B... B . N ..... N ...1 1.....1. C .....1 1.1.1 0 1.....
..... C . C . C .....1..6... N . F ....1.....1..... M ..... C
..... M 1 1.1.....1.....1 B . N F .6 6..1 M .1...1..... M ...
.....2..... N ...1 1.1... B .....1.....0. C 1.....
... N .1..... N ....2..... C .1..1.....1 1.. N ..... C . N

*Third Shot.* Same berth as No. 2. Began shooting 11.20 a.m.; finished 12.15 p.m. Shot N.E. (18 baskets only). Began hauling 2.00 p.m.; finished 6.15 p.m. 23rd July, 1931.

...1.....4....4.....4.....4.....4.....
..4.....0.....4..4.....4.....4. F
.. C .....M ..... N .....1.....N .....

.....0.....4. C .....
N N C ..... M .....0.....4.....4...0...
.....0 4.....1.....4.....
.....0.. M .1... F 1.... M .....1.....4.....1.....
... N ..... F ... N .. M .....1.... C 4.....
.....1..... M .....1.....1...
..0.....5.....2..... N N 0.....1.....
.....4.. C .....4 4 0. F ..0..... M ....4...1..
M 0..0 4..... N .1..... N ..... N .....
..... N .....1.....1..... R M .1.....
1.....1 N .....0.....1...1.....
... N ..... N ... N 8....1.....6.2..1... N .1....1.1...0.....
F .. C .....
.....2.....1.....2.....
... C ...1..... M ..... M .....1..1
....1.....0.... C . C ..... C .....1... F ....1.0.....1...C....
..1.. C .. M .....1.... C .1..... N . C .....
.....1.....1.....0..... N ..... N .. N N N .....
.....1..... C F .0.....1.....4. C .1..... C ..
.....1..... C ..... C ..... C....1.....
1. C C N .4..... C 1.. N ....1.....1...1... N .....1 C ..4..
1 1...1..1....4.. N C C C . C ..1 1... C ..0 C 1...1. C.4 N ..... C...
M ..... C 1. C . C .. C ..... C ..... N ..... F M 1.1 0 1.....
..1.1.....1.....1 C .....1.....1....1.1....0.....
.....1..1....1.....11...0.....11..1....1.....1.....
1..1. C .1.....0.1...1 1....1 N ..... M 1...1 M ... N 4
.....1.....1. C ....2.... M ..1... M .....1.....1.C...
1.....1 ..1 C 0....4 1..... M 4 M ..... C ...1 0 C.... F ....
....1 1.0.... C..1.....1.....4 1.1.....