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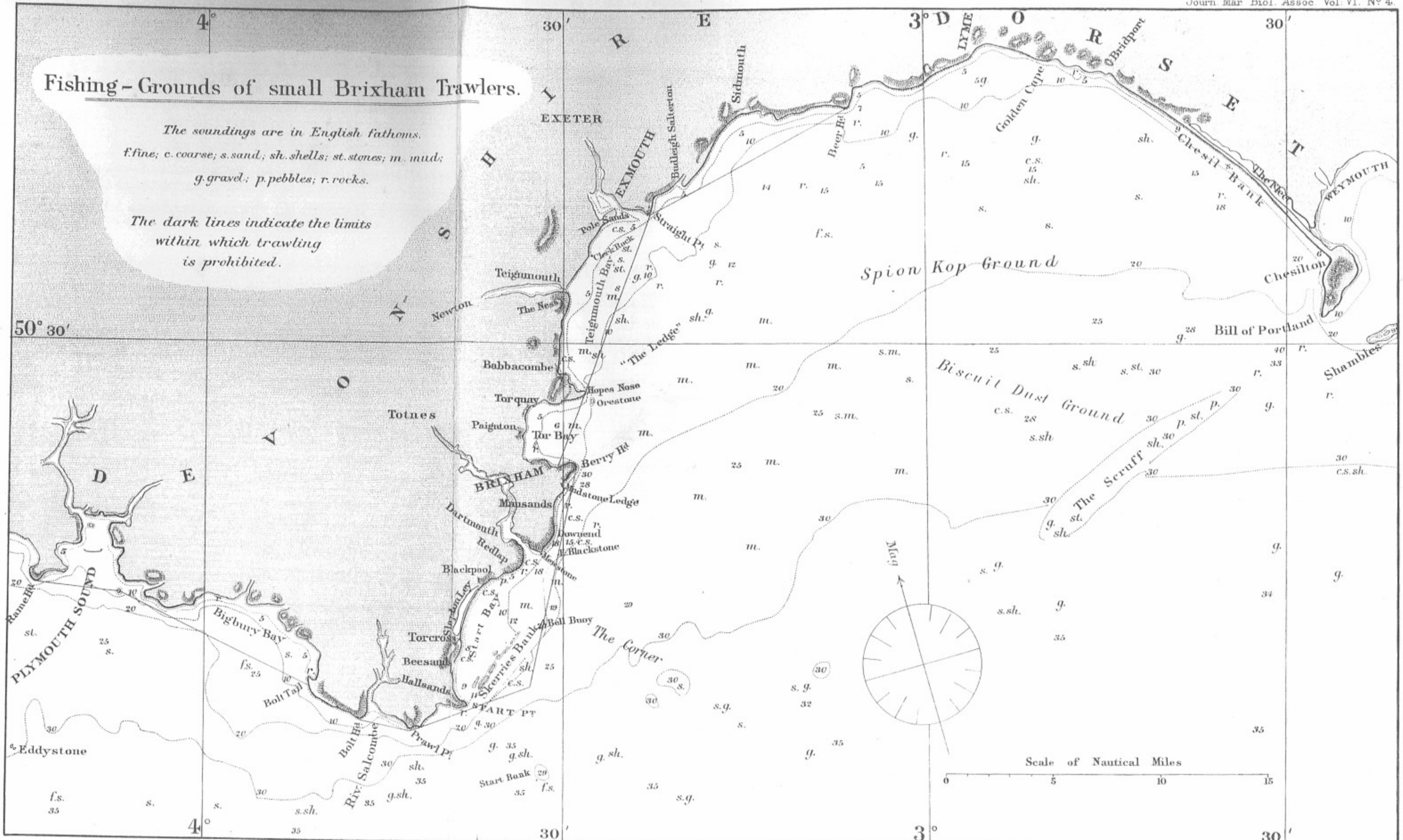


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# Report on Trawling and other Investigations carried out in the Bays on the South-East Coast of Devon during 1901 and 1902.

Prepared for
The Information of the Devon Sea Fisheries Committee.

By

**Walter Garstang, M.A., F.Z.S.,**

Naturalist in charge of Fishery Investigations.

(*With one chart.*)

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## Introduction.

The investigation of the trawling-grounds in Start Bay, Torbay, and Teignmouth Bay, which had been previously investigated in 1895–8 by Messrs. Stead * and Holt,† was resumed by the Marine Biological Association in 1901, under authority from the Devon Sea Fisheries Committee.

* Stead, "Preliminary Note, etc.," *Journ. M. B. A.*, iv., 1896, pp. 90–6.

† Holt, "Report on Trawling, etc.," *Journ. M. B. A.*, v., 1898, pp. 296–329.

The new investigations were placed in the hands of Dr. H. M. Kyle, on his appointment as Assistant Naturalist to the Association, and were carried out by him at nearly regular monthly intervals from the end of July, 1901, to the beginning of September, 1902, by means of the Association's s.s. *Oithona*, and with the assistance from time to time of various members of the staff, especially Mr. Todd. Mr. L. W. Byrne, during his visits to the Plymouth Laboratory, also volunteered his assistance in the work at sea on several occasions.

In addition to the trawling investigations, Dr. Kyle arranged for the collection of special statistics dealing with the Brixham fisheries. These covered the period from the beginning of February, 1902, to the end of January of the current year.

The manuscript of Dr. Kyle's report was received in March, but owing to difficulties in the work of revision which supervened after Dr. Kyle's removal to Copenhagen, I received instructions from the Council of the Association to draw up a new report, embodying as much of Dr. Kyle's manuscript as might be possible, which accounts for the delay which has taken place in the publication of the results. With the exception of the tables dealing with the reproduction of the plaice, which were prepared by Dr. Kyle, the figures representing the *Oithona's* work in the present Report have all been compiled under my supervision direct from the original log-books. Mr. T. C. Jerrom was appointed to assist me in this work, and I have much pleasure in acknowledging the care and accuracy in detail with which he has carried out his task. The special statistics of the quantities of fish landed at Brixham have been retained in the form in which they were submitted by Dr. Kyle, except for the correction of some insignificant arithmetical errors.

## SECTION I.

## The Brixham Fishing-Grounds and Fishery Statistics.

By

**H. M. Kyle, M.A., D.Sc.,**

Late Assistant Naturalist to the Association.

(*With Table A at end.*)

---

There was a time, and that not many years ago, when the fishing-boats of Brixham sailed round to the east coast of England and joined with the fleets of London, Lowestoft, Yarmouth, and Grimsby in exploiting the fishing-grounds of the North Sea.* This carries us back at least two generations, but if one chose to hunt through old records, one might find mention of Brixham and its fishing many centuries ago.† The records may even go back to an earlier date than the Armada, but its past history, though of exceptional interest, is of no importance to our present purpose, and we may turn to the doings of the men of Brixham at the present day.

Even a casual visitor to this port of South Devon would notice at once that the big boats are of two distinct types and sizes, the larger ones ketch-rigged, the smaller mostly with the cutter rig, and this would suggest differences in the size of gear employed and in the fishing-grounds visited by each. The large boats are over fifty tons burden, intentionally under-rigged, and able to go anywhere and stand any sea short of that raised by a hurricane. The trawl they use is of forty-five to forty-seven-foot beam. The small boats mostly run about twenty-five tons, and in unsettled weather cannot venture more than a few miles from land. Their trawl has only a thirty-six to forty-foot beam. Between these two types of boat there is a third of about thirty tons, which from the fact of its being modelled on the boats of Ramsgate is, like them, called a "Tosher." Very few boats of this type, however, exist at Brixham.

* For the place which Brixham has taken in the development of the North Sea fishing, see E. W. L. Holt, *Journ. M. B. A.*, vol. iii. p. 363.

† See Holdsworth, *Deep Sea Fishing*, who suggests that Drake used the Brixham men and boats against the Spaniards.

The large boats, generally called the smacks or dandies, formerly journeyed every year to the North Sea, but some twelve years ago they were crowded out by the ever-increasing fleets of Lowestoft, Yarmouth, and Grimsby. Some of the men remained at these ports, and have aided in making them great fishing centres, but the majority turned in the opposite direction, and as the English Channel was seemingly not rich enough to support all, they made their way into the Bristol Channel. There they discovered new and exceedingly rich trawling-grounds, and year by year they have continued to pass round Land's End in early spring, gradually extending their field of operations along the North Cornwall, Welsh, and Irish coasts as far north as the Irish Sea, and opening up new fishing centres, as Milford and Dublin, wherever they went.

Since the majority of these boats are away from Brixham for the greater part of the year, and mostly land their fish at other ports, it is impossible to obtain even an approximate measure of the value of the grounds on which they fish. Some impression of their richness may, however, be obtained from the quantities of soles occasionally sent over to Brixham by rail from Padstow in North Cornwall.

| | | | | |
|---|---|---|---|---|
| During March, | 1902, | 12,700 | pairs of | soles. |
| „ April | „ | 17,400 | „ | „ |
| „ May | „ | 8,300 | „ | „ |

The ground on which these are caught, said to be very coarse and rough, is called by the fishermen "ross"-ground on account of the hard masses of Lepralia and of Alcyonium on shells, which abound there. Plaice, turbot, and rays are also caught in considerable quantities, but the distinctive feature is undoubtedly the large supply of soles.

As the boats move further up the Bristol Channel and on to the Welsh grounds, their catches are quite lost to Brixham, which renders it impossible to give even a sample of what they obtain. According to all accounts, however, the characteristic of the fishing is still the great capture of soles.

Whilst the majority of the smacks spend the greater part of the year on the west coast, a varying number remain nearer home, and in the autumn all the boats are fishing in the English Channel. The grounds they work over extend from Portland to Land's End, usually between the twenty- and forty-fathom lines. The nature of the grounds is practically the same throughout, and is of coarse sand, shell, and gravel, with patches of stones and occasionally fine sand. As may be imagined, the catches consist largely of rays, red gurnards, and the prime fish—soles, turbot, etc. Sometimes the turbot seem to be exceedingly abundant, as during the past autumn, and in certain places, *e.g.* Mount's Bay, large quantities of plaice and soles are caught in their seasons. On the rough patches, off the Start and off Portland, the liners ("bolters") procure great hauls of conger, cod, ling, and rays. Since the smacks frequently land their catches at Plymouth, or at various ports in the south of Cornwall, it has been found impossible to give even an approximate measure of the value of the grounds in question. That these are rich and valuable there can be no doubt, for they support the Plymouth sailing-trawlers all the year round as well as frequent steam-trawlers from French and English ports. But the roving instinct of the Brixham fisherman, as well as his desire for greater gains, leads him to prefer the Bristol Channel.

We come lastly to the home grounds and the small trawlers. A few of the large smacks fish on these grounds occasionally in the intervals of coming from and going to the Bristol Channel; but they may be neglected for the present until we have discussed the fishing of the small boats. These number about seventy, and are known locally by the peculiar term "Mumble Bees," said to be derived from a small fishing village called Mumbles, near Tenby in Wales. Some of the fishermen who went round to the Bristol Channel found at Mumbles this smaller type of boat, cutter-rigged and about twenty-five tons, and adopted it for the inshore fishing near Brixham. It follows that the Mumble Bees are a comparatively recent innovation, though it must not be supposed that there were no small trawlers at Brixham before their introduction. As a matter of fact, there was a smaller class of boat, under five tons and without deck, which still persists at that port and other places round the coast, but they are for the most part employed in hooking or lining at the present time.

The fishing-grounds of the Mumble Bees lie within the area Start Point to Portland (see chart). If a line were drawn from Start Point six miles to the south-east, thence to the inner edge of the "Scruff" and on to Portland, it would embrace the region beyond which the Mumble Bees seldom venture. The line would enclose about 700 square miles of sea, little more than one-half of which is worked by the trawlers. Rocks prevent trawling within the fifteen-fathom line from the Orestone off Torbay right to Portland, and there are several rocky patches off Downend, *i.e.* between Berry Head and Start Point. The trawlable area is thereby reduced to less than 400 square miles, and 70 square miles have been further cut off by the closure of the inshore grounds—that is to say, the proportion of the enclosed grounds to the outside trawlable area is about one-fifth.* Before the closure

* The proportion is less in reality, because the crab-pots on the Skerries Bank and the rocks closer inshore cut off one-third of Start Bay as a trawlable area. The proportion of trawlable area within the enclosed waters to that outside is therefore about one-sixth.

of the bays the outside trawling-grounds were more restricted, but since that time the fishermen have been driven by force of circumstances to trawl on grounds they had never before frequented.

The various parts of the trawling area are fairly well differentiated from one another by the bottom-soil, and are known to the fishermen by distinctive names. Along the northern portion, in fifteen to twenty-two fathoms, lies the "Spion Kop" ground, so called by the Brixham men from some fancied resemblance of the promontories along the coast to the famous battlefield in Natal. The soil is composed of medium to fine sand, with coarse patches here and there. Pectens (queens) and other shell-fish are abundant, and the ground is liable to become very foul by sudden incursions of star-fishes, sea-urchins, and drift-weed. How these can suddenly appear and as quickly disappear within a few days is one of the unsolved mysteries of the region.

The Brixham men did not trawl on this Spion Kop ground till three years ago, and visit it only during the spring. At that season the plaice are returning to the inshore waters, and this is one of the main lines of the migration. The plaice are not large, and last year (1902) they were said to be smaller on the average than in previous years. Soles are also obtained there, likewise whiting, dabs, and gurnards; but the mainstay of the fishing is the plaice.

To the south-east of the Spion Kop ground lies the "Biscuit Dust" ground, twelve miles off Berry Head and running up to within six miles of Portland. It is so called from the bright golden yellow colour of the coarse sand and shells which compose its soil. Starting at about twenty-seven fathoms, it extends out to thirty fathoms, where it merges into the "Scruff." The fish obtained here are plaice at the spawning time in early spring, soles, rays, and sometimes in the autumn considerable quantities of red mullet.

The Scruff is not a regular trawling-ground, its coarse soil and "hummocky" nature being too dangerous, especially for the comparatively light materials of which the small trawlers' nets are made. The large smacks with their stronger nets of manilla might tow over it, and at the eastern corner the liners often procure large catches of ling and rays. At the western end of the Scruff, however, lies a favourite trawling-ground, especially in late spring, when fine catches of whiting are often obtained.

Following along the line of the Scruff, towards Start Point, we come to the "Corner," which in late spring and summer is the rendezvous of all the small trawlers. It lies across the thirty-fathom line, six to ten miles off Dartmouth Fairway with Prawle Point clear of Start Point. Fish are abundant there during the season, and include soles, lemon-soles, a few turbot, plaice, dabs, whiting, gurnards, and rays; in fact, it is the richest ground within the area. The invertebrate fauna is also rich and distinct from that of the other grounds. The crabs Polybius, Atelecyclus, Corystes, and the heart-urchin Echinocardium are more plentiful here than anywhere else.

The central region of muddy ground has no particular name, but is well fished over at all seasons of the year for the sake of the ubiquitous whiting. Along the western margin of the area there are several well-known trawling-grounds, *e.g.* "New Ridge," off Downend, and the "Hitches," off Berry Head, which really form part of the central region, and require no special mention.

Although the grounds are so distinct from one another that an expert salesman can tell where a catch of fish has come from, it has not been thought of any practical importance to distinguish them in the statistics. Also, as the Mumble Bees rarely go beyond the limits mentioned, it has been a comparatively easy task to obtain an approximate measure of the value of these grounds. A few small trawlers from other ports—Torquay, Exmouth, Beer—fish on the same grounds, but the quantities they catch are quite negligible. The same cannot be said, however, with regard to the large Brixham smacks which occasionally fish within the area, and their catches require to be taken into account.

An explanation may now be given of the method by which the data of the boats' catches have been obtained. As is generally recognised, it is by no means easy to collect statistics which will give precise information on any points other than those considered in the returns of the Board of Trade, for the simple reason that the mode of selling fish determined by custom and practice is in no way suited to theoretical requirements. It would be absurd to expect the fishermen and fish salesmen to alter their customs, and that in several and diverse directions, since theoretical requirements are many; so one is obliged to make the best compromise possible between what one wishes and what one can get.

The practice of the Brixham Mumble Bees in arranging their fish for sale is somewhat different from that employed on the east coast, where the fish are carried ashore in large baskets or panniers, and then put into a standard size of box, or arranged in lots. At Brixham the large boats treat their fish in the latter way; but the small boats, which carry no ice, and are only fishing for a day or two at a time, have them packed and ready for sale before landing. When the trawl is emptied on deck after a haul the smallest fish and the useless species are thrown overboard; the prime fish—soles, turbot, etc.—are laid apart, and the large fish of the remaining species (offal), as plaice and whiting, are separated from the small and placed in the trunks, whilst the small fish are packed into small baskets. A larger basket, called a "maund," is occasionally employed by the Mumble Bees when they have a few large fish, but not sufficient to fill a trunk. On the other hand, the maund is the only small basket which the large smacks employ.*

As the fish are sold in trunks and small baskets, it might be thought a simple matter for an expert to tell the quantities of large and small fish. As a general rule this is the case, and the size used by the fishermen to distinguish large from small, *i.e.* the fish of the trunks from those of the baskets, agrees closely with a standard chosen for a special purpose of the present research. As shown in describing the fishing-grounds, whiting form the staple support of the fishermen for the greater part of the year, and if we omit the prime fish, plaice rank next in importance. Of the whiting and plaice, all below 8 inches are thrown overboard, those between 8 and 11 inches are packed in the baskets, and those over 11 inches in the trunks. Sometimes the small are placed in trunks when very numerous; this happens most often with whiting, but not so frequently with plaice. On the other hand, some larger plaice are often packed into the small baskets when too few to make up a maund, and they may be taken to counterbalance the small plaice packed in the trunks. This has been done in the present work, and it may be remarked that this method of forming an estimate lessens the number of small plaice rather than the large ones.

Sometimes also small plaice, when too few to fill a separate basket, are packed in the same basket with dabs and flounders, and similarly the whiting with gurnards. Their number is, however, negligible, as plaice and whiting are the best of the "offal," and it would be bad policy on the fisherman's part to mix them with the others.

The difficulties of obtaining the numbers of small and large plaice and whiting reduce themselves therefore to those of simple enumeration. When a large quantity of fish is landed at one time there is some difficulty in counting all the baskets and trunks, but as a general rule the task is a comparatively easy one.

The only other species which has been taken into account is the sole. The quantities landed of this fish are readily obtainable, as they are always spread out on the ground in pairs.

Plaice, soles, and whiting were chosen for special investigation, for the reason that they are by far the most important species; and, further, since the work was entirely new, and at first of considerable difficulty, it was considered more desirable to obtain definite information with regard to a few species than imperfect records of many.†

* The maund, four of which are equal to a trunk, is so seldom employed by the Mumble Bees that it might have been disregarded, but where it occurred in the statistics it has been converted into its equivalent in trunks.

† Mr. Will Sanders, a trustworthy fish salesman of Brixham, recorded the daily returns of fish landed. Although the information is definite, no claim is made that it is perfect. There are several shortcomings in detail. . . .

To begin with the plaice, Holt, in his *Examination of the Present State of the Grimsby Trawl Fishery*, p. 409, has given the numbers of plaice that a trunk will hold. He takes 250 as being the average number of plaice under 12 inches; for larger fish the numbers are considerably less. These numbers apply to the North Sea plaice, and it appears that 9 stone is about the average weight of a full trunk. For the plaice landed at Brixham these numbers are somewhat too high; a full trunk only averages about 7 stone, and the numbers vary from 60 or 70 to 200, according as the plaice are 16 to 18 inches on the average or 10 to 12 inches. After counting and weighing the contents of several trunks the number chosen as best representing a trunk was 90,* and the figures in the following tables are based on this.

As the small baskets contain plaice of approximately the same size, there is much less difficulty in finding a number which represents the average they contain. In the following table 25 is employed. The sizes which go into the small baskets are from 8 to 10 inches in the great majority of cases; but as plaice over 10 inches are often sold with those under 10 inches, 11 inches has been the limit chosen.

In the accompanying Table I. the actual numbers of plaice landed by the Mumble Bees † are tabulated for each month of the year. Inasmuch as some of the larger smacks are at times working on the same grounds—namely, between Start Point and Portland—the numbers of plaice captured by them have been added at the end of each quarter.‡

The total number of "large" plaice obtained during the year amounts to 180,180. Of this number more than half were captured during February, March, and April, when the plaice were spawning in the deep water or returning to the inshore grounds after having spawned. The months when the larger fish are least abundant offshore are September, October, and November. It is worthy of remark that the numbers for the months rise from 360 in November to 49,860 in April, and descend again to 450 in October in an almost uniform manner.

* This number was partly based also on the estimate that the average weight of plaice was 1 to 1½ lbs. All the factors stated here—for whiting and soles as well—require further testing.

† The plaice landed at Torquay by the Brixham boats have been omitted. The effect is that the numbers of the small plaice are lower than they might have been. The Brixham boats land their catches at Torquay in the summer-time only. I do not think the omission amounts to more than one or two per cent. of the numbers recorded in the table, and the conclusion as regards distribution of small plaice is quite unaffected.

‡ The returns of the large boats were also taken daily by Mr. Will Sanders, but as they are comparatively few in number, their importance is sufficiently recognised in merely stating the total number of plaice captured by them during each three months.

TABLE I. *Numbers of Plaice captured by Brixham Fishing-Boats on the Grounds between Start Point and Portland, with proportions of small to large.*

(Abridged from Table A, p. 501.)

| Month. | No. of Plaice under 11 inches. | No. of Plaice 11 inches & over. | Proportion of small to large. |
|---|---|---|---|
| February, 1902 | 4,325 | 22,590 | 19 : 100 |
| March ,, | 4,375 | 20,700 | 21 : 100 |
| April ,, | 19,800 | 49,860 | 40 : 100 |
| Total for three months | 28,500 | 93,150 | 30 : 100 |
| Plus number captured by large smacks | 1,225 | 4,365 | 28 : 100 |
| *Grand total for three months* | *29,725* | *97,515* | *30 : 100* |
| May, 1902 | 4,350 | 12,420 | 35 : 100 |
| June ,, | 8,850 | 14,760 | 60 : 100 |
| July ,, | 9,650 | 10,710 | 90 : 100 |
| Total for three months | 22,850 | 37,890 | 60 : 100 |
| Plus number captured by large smacks | 2,950 | 6,705 | 44 : 100 |
| *Grand total for three months* | *25,800* | *44,595* | *58 : 100* |
| **Total for the six months, February to July** | **55,525** | **142,110** | **39 : 100** |
| August, 1902 | 10,650 | 2,250 | 473 : 100 |
| September ,, | 6,550 | 1,260 | 519 : 100 |
| October ,, | 6,800 | 450 | 1,511 : 100 |
| Total for three months | 24,000 | 3,960 | 606 : 100 |
| Plus number captured by large smacks | 16,875 | 2,070 | 815 : 100 |
| *Grand total for three months* | *40,875* | *6,030* | *678 : 100* |
| November, 1902 | 8,350 | 360 | 2,319 : 100 |
| December ,, | 6,700 | 2,700 | 248 : 100 |
| January, 1903 | 10,250 | 7,920 | 129 : 100 |
| Total for three months | 25,300 | 10,980 | 230 : 100 |
| Plus number captured by large smacks | 21,375 | 21,060 | 101 : 100 |
| *Grand total for three months* | *46,675* | *32,040* | *146 : 100* |
| **Total for the six months, August to January** | **87,550** | **38,070** | **230 : 100** |
| *Total for the year, February, 1902, to January, 1903* | *143,075* | *180,180* | *79 : 100* |

The most remarkable fact which this table reveals is the large number of small plaice which are captured in the deep water, not merely in one month or season, but throughout the year. The largest number—that recorded in April—is 19,800, but those for the other months vary between 4,000 and 10,000. On account of this uniform distribution throughout the months, the numbers of small plaice are sometimes greater and sometimes less than those for the large plaice. They are less from February to July, and greater from August to December. The proportions of small to large are stated in hundredths in the third column. The fluctuation in these proportions—from 19 in February to 2,319 in November—is simply another expression of the varying supply of large fish.

The number of small fish landed for the year is a little over 143,000. The total number of plaice, large and small, is about 323,000, and of these the small plaice amount to 44 per cent. The records for the large smacks suggest that the small plaice may be relatively more abundant some distance from land than inshore, as the smacks always fish further out to sea than the Mumble Bees. Fifty-three per cent. of all the plaice landed by these large boats consisted of small fish.*

When we pass later to a comparison of the offshore fishing-grounds with Start Bay, it will be shown how important is the fact that the small plaice under 11 inches are distributed over the offshore grounds. We find similar phenomena in the North Sea off the Dutch coast to the east of the Dogger Bank † and elsewhere,‡ so that to naturalists the fact will come as no surprise.

Though the plaice is of higher importance for the purposes of the present paper, it is of less value to the Brixham Mumble Bees than the soles or whiting. The whiting is undoubtedly the most abundant

* It must be admitted that there is a possibility of error in these records for the large smacks, owing to the fact that the plaice landed by them are mostly in small quantities at a time and all sizes are mixed together. The percentage of small fish may therefore be a little lower than that stated.

[It must also be borne in mind that, while the number of Mumble Bees is practically constant throughout the year, the smacks work in greater numbers in the autumn than in the spring period ; *i.e.* their hauls are most numerous in the season when the small fish predominate. I cannot on this account share my colleague's opinion that the figures suggest a higher proportion of small fish to large on the grounds worked by the smacks than on those worked by the Mumble Bees. On the contrary, the quarterly ratio of small fish to large is seen in the table to be lower for the smacks than for the Mumble Bees in each quarter except the third. In that quarter it is much less than the ratio yielded by the catches of the Mumble Bees for the last month in the quarter, viz. October, and it was during this month that the smacks appear to have increased in number.—W. G.]

† See E. W. L. Holt, *Journ. M. B. A.*, vol. iii. p. 405.

‡ Mr. J. T. Cunningham, *Journ. M. B. A.*, vol. iv. p..24, has already remarked on the presence of small plaice over the area described in these pages, but records no actual observations. (Mr. Garstang kindly pointed out this reference to me.)

species and the one on which the fishermen are mostly dependent. Some notion of the numbers caught throughout the year may be obtained from the subjoined tables. Accuracy is not claimed for these figures, because the approximations made are even greater than in the case of the plaice. As with the latter, whiting are brought to market in trunks and small baskets. Their size varies from 9 to 17 inches, and all sizes may be placed in the trunks, whilst the small baskets seldom contain any over 11 inches. It is necessary, therefore, to state the proportion of small whiting which are placed in the trunks.

The following proportions are based on personal experience and checked by information from fishermen and fish buyers. The whiting may be divided into three classes—"small" from 9 to 11 inches, "medium" from 11 to 14, and "large" above 14 inches. Only the small are placed in the baskets, each of which holds 36 on the average. The great majority of the fish in the trunks are also small, and in the tables one half of the trunks are allocated to the small fish, the multiplier used being 350.* The resultant product is added on to the quantity in the small baskets, and the total given in the last column.

Large whiting are never very plentiful nowadays, and it has been calculated that they are adequately represented by $\frac{1}{10}$th of the trunks. A trunk contains about 130 large whiting, so that the numbers in the second column are obtained by dividing the number of trunks by 10 and multiplying the remainder by 130, or more simply by multiply- the number of trunks by 13. When $\frac{6}{10}$ths of the trunks are thus disposed of for the small and large whiting, $\frac{2}{5}$ths remain for the medium-sized. A trunk holds from 150 to 250 medium-sized whiting, and the number chosen as the average is 200. Consequently if the number of trunks be multiplied by $\frac{2}{5} \times 200$, or more simply by 80, we get the total number of medium-sized whiting.

The numbers of whiting given in Table A speak for themselves; it is only necessary to mention that the great decrease during March to June is at the spawning time. It thus appears that the whiting are in mid-water, or, at least, not on the bottom when spawning. For the rest of the year the numbers per month are fairly constant, the highest record being in December (over 700,000) and the lowest in February (315,000).

There is little difficulty in ascertaining approximately the number of soles landed day by day, because, as already stated, they are laid out in pairs on the market. The data in Table A may therefore be regarded as fairly accurate. Few soles were obtained during March and April, and as these months form their spawning season it seems that, like the whiting, they disappear temporarily from the grounds

* That is to say, each trunk is taken to contain 175 small whiting on an average.—W. G.

where the Mumble Bees work. It is possible that they may be swimming up in the water more at that time than at others, but they may be further offshore in deeper water or on rough ground, *e.g.* the Scruff, where the Mumble Bees cannot get at them. It is well for the fishermen that the plaice are abundant during the months when soles and whiting are scarce.

* * * * * *

The important points displayed in the present section may be briefly summarised. The trawling area over which the Mumble Bees work is about 400 square miles. This area is divisible into a number of separate trawling-grounds, each of which has its "season." The most valuable species of food-fishes are the soles, whiting, plaice, in the order named. The proportion of small plaice on the offshore grounds is considerable, 44 per cent. of all the plaice captured being under 11 inches.

## SECTION II.

## Distribution and Migrations of Food-Fishes.

By

**Walter Garstang, M.A., F.Z.S.**

### 1.—TRAWLING INVESTIGATIONS.

(*With Tables B, C, D, E at end.*)

The trawling investigations in the bays were carried out at monthly intervals by means of the Association's steamer *Oithona*, a small yacht of 69 tons gross tonnage. Only one gap appears in the monthly records for Start Bay (March), and three in those for the other bays. The total number of hauls recorded in the tables is 138, viz. 70 for Start Bay, 36 for Torbay, and 32 for Teignmouth Bay. A few hauls were made on the offshore grounds, but they were not sufficiently numerous to furnish a basis of comparison with the inshore records. Their publication is therefore deferred.

During the previous investigation of the bays by the Association in 1895–8, already reported on by Messrs. Stead and Holt, operations were much hampered by the lack of a suitable steamer, and only 45 hauls in all were recorded. These, however, included a number of hauls by the Brixham smack *Thistle,* so that the actual numbers of fish dealt with in the former report fell not far short of those included on the present occasion, *e.g.* 5,467 plaice as against 6,089.

The apparatus employed during the *Oithona's* work is described more fully by Dr. Kyle in a separate paper.* It was a form of otter trawl specially adapted to the Brixham grounds. For greater lightness the twine employed was cotton, not manilla as in the ordinary otter trawl, and the mesh throughout was graded as in the trawls of the Brixham Mumble Bees. There has been no essential change in the structure of the nets of the latter since Mr. Holt carried out his investigations; and as the mesh of the trawls used by him was of a similar character, the present records are directly comparable with his, so far as regards the proportions of large and small fish. The differences between the nets, in regard to their total catching power, will be adverted to below in the discussion of the results.

The work at sea consisted in the enumeration and, with few exceptions, the measurement of all the fishes caught. During 1901 the measurements were recorded to the nearest half-inch, but during 1902 to the nearest half-centimetre. Experiments with marked plaice were also undertaken, as a means of studying the migrations of this fish.

In the present report the original measurements have been converted into inches, in order to facilitate comparison with Mr. Holt's results; but in the case of the marked fishes the original records in centimetres have been retained, owing to the greater convenience of this unit for comparisons of a minuter character.

The selection of the trawling stations was left entirely to Dr. Kyle, who is also responsible for the accuracy of the identifications and measurements, and for the general conduct of the work at sea. My own part has been limited to the tabulation and analysis of the records, and to the formulation of such conclusions as appeared to be substantiated by the facts and to be relevant to the main questions before the Devon Sea Fisheries Committee as to the advantage or disadvantage to the fishery of the closure of the bays to trawlers.

It will be convenient, before proceeding to details, to present a summary showing the general characteristics of the three bays as regards distribution and abundance of the chief kinds of fish. The following table has been prepared from Dr. Kyle's records, and represents the sum of the *Oithona's* catches of each species throughout the year, reduced to the average catch for one hour's fishing. This procedure is necessarily somewhat drastic, especially in the case of seasonal migrants, and in the case of the less common forms it naturally reduces the numbers in many instances to mere fractions. Where this fraction exceeds 0·5 it has been treated as 1; in cases where it is less than 0·5 the plus sign has been inserted in place of the fraction to indicate the

* Kyle, "Fishing Nets, with Special Reference to the Otter-Trawl," *Journ. M. B. A.*, this number, p. 562.

occasional presence of the fish. The minus sign, which is also employed, indicates entire absence so far as our records show.

The fish have been classified as "small" and "marketable" according to the limits assigned in the table for each species. The dimensions are those of total length, except in the case of the rays (Thornback, Homelyn, and Blonde), for which the maximum breadth has been substituted.

TABLE II., *showing, for each of the bays, the Average Catch per Hour of the Chief Fishes, distinguishing the small fish from those of marketable size.*

| | Size of "small" fish. Below | Start Bay. | | | Torbay. | | | Teignmouth Bay. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Total. | Small. | Marketable. | Total. | Small. | Marketable. | Total. | Small. | Marketable. |
| Plaice | 8 ins. | 19 | 1 | 18 | 38 | 19 | 19 | 38 | 23 | 15 |
| Dabs | 8 ins. | 23 | 13 | 10 | 61 | 55 | 6 | 13 | 9 | 4 |
| Flounder | 8 ins. | + | – | + | 2 | – | 2 | + | – | + |
| Sole | 8 ins. | 1 | + | 1 | 1 | + | 1 | 2 | + | 2 |
| Brill | 10 ins. | 1 | + | 1 | + | + | + | 1 | + | + |
| Grey Gurnard | 8 ins. | 10 | 5 | 5 | 4 | 4 | + | 3 | 3 | + |
| Whiting | 8 ins. | 2 | + | 2 | 5 | 4 | 1 | 5 | 3 | 2 |
| Dory | 8 ins. | 2 | + | 1 | + | + | + | + | + | + |
| Thornback | 12 ins. | 1 | 1 | + | 9 | 8 | 1 | 16 | 10 | 6 |
| Homelyn | 12 ins. | 1 | 1 | + | + | + | – | + | + | + |
| Blonde | 12 ins. | 4 | 2 | 2 | + | + | – | + | + | + |

The table shows at a glance that, if both size and numbers are taken into consideration, the **Plaice** is the dominant fish in each bay, and that the fish which competes with it most closely in abundance is the **Dab,** the small size of which, however, renders it of little commercial value. The **Grey Gurnard** and **Whiting** occur in each bay, though mostly of small size, and in insufficient numbers to be of much value to the fishermen. The **Thornback** ray attains a certain measure of importance in Teignmouth Bay, but in Torbay it is represented mostly by small specimens, and in Start Bay it is virtually replaced by two other species, the **Homelyn** (or spotted ray) and the **Blonde,** which are practically absent from Torbay and Teignmouth Bay. The **Brill** is less rare in Start Bay than in the others, and the **Sole,** though present in all the bays, only approaches importance, in point of numbers, in Teignmouth Bay.

It will be seen that, speaking generally, Torbay occupies a position biologically as well as geographically between the other bays. It stands somewhat nearer to Start Bay than to Teignmouth Bay as regards its numbers of marketable plaice, but it shows a still closer resemblance to Teignmouth Bay than to Start Bay in the abundance of small plaice within its limits. The peculiar feature of Torbay is the abundance of small dabs, which distinctly outnumber the plaice. In Start Bay, also, these fishes are numerically in excess * of the plaice, though slightly, and a far larger proportion of them attain the marketable size. In Start Bay alone are the marketable plaice in excess of the small ones, and these they outnumber by eighteen to one.

The problem of the bays, so far as it is a biological one, clearly hinges upon the plaice, and in the succeeding sections our records of the distribution and sizes of this fish have been accordingly subjected to a much closer analysis than those of the other species.

## START BAY.

The following description of the trawling-grounds has been provided by Dr. Kyle :—

"The area closed by the by-laws includes about twenty-five square miles, but owing to the presence of crab-pots on the Skerries Bank and of rocks along the shore, the trawling-grounds are reduced to fifteen square miles. The bottom-soil is of three distinct kinds. Coarse sand to gravel is found along the shore from Blackpool to Hallsands, extending outwards about a hundred yards off the former; but off Hallsands it stretches right round the promontory, and extends outwards to join on to similar soil along the inner and outer margins of the Skerries. In the centre of the bay the soil is of medium to fine sand, whilst round Dartmouth Fairway it is of mud. As mentioned in a separate paper, storms make considerable alterations, for the time being, in the distribution of the various soils throughout the bay. During neap tides there is very little movement of the water in the centre of the bay, but during spring tides a current of two to three knots runs through it. This is stronger on the ebb and alongshore, where a two and a half to three hours' eddy on the latter half of the flood makes with the ebb a nine hours' current flowing from Slapton Sands to the Point. The presence of this current is of considerable importance, as it prevents the bay from becoming foul with drift-weed, mud, jelly-fishes, diatoms, etc., a fate which periodically overtakes the other bays during the summer. For this reason the sand of Start Bay is particularly clean and bright-coloured, and the plaice which live there have the same qualities. The brightness of their orange-coloured spots and the shiny appearance of their skin readily distinguish them from those of any other region. It is probable, also, that the general cleanliness of the bay has some influence for good on the invertebrate fauna which constitutes their food; certainly the plaice from Start Bay used to obtain the highest price on the market.

* As shown below (p. 458), this excess, in the case of Start Bay, was limited to the summer season of 1902, when, however, the preponderance of dabs was very conspicuous.

"The rocks which break up the trawling area of the bay lie in the south-west corner off Hallsands and Beesands and along the northern shore from Blackpool to the Mewstone on the far side of Dartmouth Fairway. To the south-west of Blackpool is a further patch of rocks, and off Torcross there is a shelving bank of slate-rock, running about a mile out to sea, with several isolated rocks near it. Since all these lie within or close to the zone of the coarse sand, and the plaice prefer this kind of soil, it may be well understood that the largest and strongest plaice are safe from the trawler, except when they are migrating from one region to another. There are one or two passages between the rocks close inshore, as well as open spaces at Blackpool and along Slapton Sands, and it is on these grounds that the large plaice are obtained.

"The inner passages are only known to the older fishermen who worked in Start Bay before the by-laws came into force, and the *Oithona* could not work there. The largest plaice are not truly represented in the statistics for this reason, and their presence would have remained unknown had we not ventured on several occasions to trawl closer to the rocks than was altogether good for the nets."

The total number of hauls of the trawl recorded for Start Bay amounts to seventy, and, as may be gathered from Table E, they were distributed through the successive months of the year with fair uniformity, the only month which is altogether unrepresented being March. Since the ground varies in character in different parts of the bay, the hauls have been classified into four stations, which approximately correspond with these natural distinctions. They have been defined as follows:—

**Station I.** The central and north-eastern parts of the bay. In practice an attempt was made to distinguish between these two parts as follows:—

Sub-station (i). "Centre of the bay; along the line Mewstone Rock, to the east of Dartmouth just inside Downend Point, to Freshwater Bay near Start Point. The trawl was shot in 12 to 15 fathoms, and lifted as a rule in 8 to 9 fathoms after passing Torcross. The bottom-soil is mud to fine sand" (H. M. K.).

Sub-station (ii). "The north-eastern triangle of the Bay, formed by the Mewstone, Blackpool, and Skerries Buoy. The depth varies from 10 to 20 fathoms, and the bottom-soil is for the most part mud" (H. M. K.).

The hauls referred to these sub-stations by Dr. Kyle have been distinguished in the detailed list of hauls (p. 503); but they have not been separated in the summary tables, since considerable overlapping took place, and the general results of the work on the two sub-stations were practically identical. As Dr. Kyle remarks, "they display the general or average condition of the bay, omitting the Skerries Bank."

**Station II.** "Along Slapton Sands, [usually] in 6 fathoms. The bottom-soil is here coarse sand" (H. M. K.). Occasionally the haul was made in 7 to 8 fathoms (No. 19), or extended to 10 fathoms (No. 8). "The hauls on Station II. were made, for the most part, in summer, when the plaice are inshore; during winter this ground is almost devoid of fish of all kinds" (H. M. K.).

**Station IIa.** "This represents the trawling-ground from Start Point to off Torcross. It means skirting the rocks at the latter place, so that no further comment need be made on the fact that only one haul is recorded" (H. M. K.).

**Station III.** "Along the inner margin of the Skerries Bank. The depth varied from 5 to 10 fathoms, and the soil is also coarse sand" (H. M. K.).

The biological features of the different stations may be gathered from the accompanying table, which represents the *Oithona's* average catch per hour for the whole year on the different grounds.

TABLE III., *showing Average Catch per Hour for the entire period on the various stations in Start Bay.*

| Species. | Station I. | | | | Station II. 19 hrs. 15 min. | | Station III. 15 hrs. 50 min. | | Station IIA. 0 hrs. 40 min. | | Totals. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | hrs. | min. | Small. | Marketable. | Small. | Marketable. | Small. | Marketable. | Small. | Marketable. | hrs. | min. | Small. | Marketable. | Total. |
| Plaice . . | 101 | 10 | + | 18 | 2 | 21 | + | 14 | – | 71 | 136 | 55 | 1 | 18 | 19 |
| Dabs . | 88 | 10 | 13 | 10 | 14 | 9 | + | 5 | – | 12 | 123 | 55 | 13 | 10 | 23 |
| Sole . . | 92 | 10 | + | 1 | + | 2 | – | + | – | 1 | 127 | 55 | + | 1 | 1 |
| Brill . . | 92 | 10 | + | + | + | + | – | 4 | – | 1 | 127 | 55 | + | 1 | 1 |
| Grey Gurnard | 88 | 10 | 5 | 5 | 10 | 6 | + | 2 | – | 4 | 123 | 55 | 5 | 5 | 10 |
| Whiting . | 92 | 10 | + | 2 | + | + | – | + | – | – | 127 | 55 | + | 2 | 2 |
| Thornback . | 89 | 10 | + | + | 3 | + | + | – | 6 | 4 | 124 | 55 | 1 | + | 1 |
| Homelyn . | 85 | 15 | + | + | 1 | – | + | – | 7 | – | 121 | | 1 | + | 1 |
| Blonde . . | 85 | 15 | 1 | 1 | + | – | 11 | 11 | – | 1 | 121 | | 2 | 2 | 4 |

The difference between Stations I. and II. is one of degree rather than of kind, and is for the most part due to differences in depth. It will be seen that plaice were somewhat more abundant on the inshore grounds than on Station I., and it was only on the former station that small plaice were present in appreciable numbers. Small dabs were also slightly more abundant on Station II. than on Station I., and large dabs slightly less numerous. Thornback and homelyn rays were more plentiful on Station II. than Station I.; while blondes, both large and small, were more plentiful on Station I. Station III., which corresponds with the Skerries Bank, is seen to possess distinct features. "It is characterised," as Dr. Kyle remarks, "by the numbers of large brill and blondes (rays) found nowhere else in such abundance over the whole fishing area of the Mumble Bees. The plaice obtained here are also large, but there is a comparative absence of soles, dabs, gurnards, and other species."

Station IIA. is characterised by the general absence of small fish, and by the large size of the flat-fish which occur upon it. Only one haul of the trawl, however, is recorded for this station.

In order to represent the seasonal differences in the fishing of Start Bay it will be necessary to combine the records of all four stations, since there is a considerable amount of migration within the bay at different seasons from the shallower to the deeper parts and *vice versâ*. In view of the differences which the preceding table reveals, it will readily be understood that combinations of the results of trawling over these different stations will not be strictly comparable with one another unless the different stations are represented in each combination in equivalent proportions. In practice, the maintenance of any fixed proportional representation of the different stations throughout the monthly investigations was not found to be practicable. It is necessary, therefore, before proceeding to discuss the seasonal differences observed, to note the actual duration of trawling over the different stations in each season of the year. These details are provided in the following table:—

TABLE IV., *showing the Amount of Trawling over each station in Start Bay for each quarterly period of the year.*

| Season. | Station I. No. of hrs. | | Station II. No. of hrs. | | Station IIA. No. of hrs. | | Station III. No. of hrs. | |
|---|---|---|---|---|---|---|---|---|
| | hrs. | min. | hrs. | min. | hrs. | min. | hrs. | min. |
| July, August, September | 9 | 25 | 7 | 45 | — | | 6 | 0 |
| October, November, December | 38 | 25 | 7 | 55 | 0 | 40 | 5 | 20 |
| January, February | 9 | 15 | — | | — | | 1 | 30 |
| April, May, June | 27 | 55 | 1 | 0 | — | | 3 | 0 |
| July, August | 14 | 40 | 2 | 35 | — | | — | |
| October | 1 | 30 | — | | — | | — | |
| TOTALS | 101 | 10 | 19 | 15 | 0 | 40 | 15 | 50 |

It will be seen that during the first quarter Stations II. and III. received considerable attention as compared with Station I., but that in succeeding quarters Station I. was investigated far more extensively than the remaining grounds. The hauls on Station III. ceased after April, 1902.

## SEASONAL CHANGES.

Although it is possible by an examination of Table E to obtain some general ideas as to the effect of the seasons on the numbers and distribution of the plaice in the bay, it is necessary to condense the results in order to grasp the chief features in these changes. Table F provides a series of monthly summaries showing the total catch, the catch per hour, and the percentage frequencies of the fish of different size. The limits between the various size-groups are the same as those previously adopted by Mr. Holt, although the groups themselves are presented in this report in slightly different form. The groups are as follows:—

I. Unsaleable, or small immature—under 8 ins. in total length.
II. Immature medium-sized—from 8 ins. to 11 ins., both inclusive.
III. Medium-sized mature—from 12 ins. to 14 ins. inclusive.
IV. Large—15 ins. and upwards.

The study of Table F throws important light on various matters of detail, especially on the succession of changes which took place in the distribution of fish during the autumn and early winter of 1901; but the relatively short duration of the hauls made in certain of the months prevents the monthly summaries from possessing an equally representative character. It is accordingly desirable to summarise the results still more closely in quarterly periods. This has been done in the following table, which shows the average catch of plaice per hour for the different size-groups, and also the percentage frequency of the fish of these sizes during the five quarterly periods covered by the investigations.

TABLE V., *showing, for Start Bay, the Average Catch of Plaice per Hour, and the Percentage Frequency for each size, over all stations combined, for each quarterly period.*

| Season. | hrs. | min. | Total caught. | Catch per Hour. Total. | 0–7″ | 8–11″ | 12–14″ | 15″+ | Percentages. 0–7″ | 8–11″ | 12–14″ | 15″+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| July, Aug., Sept.,'01 | 23 | 10 | 444 | 19 | 2 | 3 | 8 | 6 | 9 | 18 | 44 | 29 |
| Oct., Nov., Dec. ,, | 52 | 20 | 1064 | 20 | 0·2 | 3 | 10 | 7 | 1 | 18 | 47 | 34 |
| Jan., Feb. '02 | 10 | 45 | 115 | 11 | 1 | 4 | 4 | 2 | 10 | 36 | 32 | 22 |
| April, May, June ,, | 31 | 55 | 570 | 18 | 1 | 4 | 8 | 5 | 4 | 23 | 45 | 28 |
| July, August ,, | 17 | 15 | 403 | 23 | 1 | 11 | 8 | 3 | 3 | 47 | 35 | 15 |

The investigations began in the summer period, and it will be seen that the total catch of plaice, irrespective of size, increased slightly during the autumn period, fell to a minimum in the winter, and then increased steadily through the following spring and summer, the maximum in the summer season of 1902 being distinctly higher than during the corresponding season of the previous year.

The quarterly average catch of small plaice never exceeded two fish for an hour's fishing. The immature medium-sized fish steadily increased throughout the period of the investigations from an average catch of 3 per hour in the summer of 1901, to a catch of 11 per hour in the summer of 1902. The mature medium-sized fish began in the previous summer with an average abundance of 8 per hour, which increased to a maximum of 10 per hour in the autumn, declining conspicuously to

4 per hour in the winter, and again rising to the same original level of 8 per hour in the spring, which was maintained throughout the summer. The largest fish showed a similar sequence of changes for the first twelve months, but, according to the figures, declined during the last summer season to half their original frequency.

The sequence of changes shown by the mature medium-sized plaice is readily explained by the seasonal migrations of the fish, which are dealt with in a later section of this report. It is there shown that the plaice tend to immigrate into Start Bay from all quarters during the spring and summer months, from the offshore spawning-grounds in the spring, and from the other bays to the northward in summer and autumn. Towards the end of the year they again leave the bay for the offshore spawning-grounds. The figures illustrating the seasonal changes in the abundance of the largest fish would also be explicable in the same way, were it not for the unusual decline shown by the figures for the last summer quarter. If reference, however, be again made to Tables III. and IV., it will be seen, as previously mentioned, that Station III. is represented in the records for the first four quarterly seasons, but is not represented in the last, and it will be remembered that this station is characterised by the large size of its plaice. Station II. also, in which the actual abundance of marketable plaice is greater than in the other stations, is represented far more conspicuously during the summer season of 1901 than during that of the succeeding year. If the hauls on the Skerries Bank (Station III.) be omitted from the records for the first summer quarter, and if the influence of Station I. on the records for the second summer quarter be reduced to the same proportions as prevailed during the first, the catch per hour of the different groups of plaice takes the following dimensions:—

| Season. | Catch per Hour. | | | | | Percentages. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total. | 0–7″ | 8–11″ | 12–14″ | 15″+ | 0–7″ | 8–11″ | 12–14″ | 15″+ |
| July–Sept., 1901 | 18 | 2 | 4 | 8 | 4 | 13 | 22 | 44 | 21 |
| July–Aug., 1902 | 28 | 1 | 15 | 9 | 3 | 4 | 53 | 32 | 11 |

It will be seen that there is now no longer any material difference in the evidences of abundance of the largest groups of plaice in this season during the two years; while, on the other hand, the great increase in the abundance of immature medium-sized plaice becomes still more obvious. As will be seen in the case of the other bays, a marked increase in the numbers of this group of plaice in the summer of 1902, as compared with the summer of 1901, was a general feature which characterised each of the bays.

The important question now arises: Which of these years was most typical of the conditions normally prevalent in Start Bay? Was the scarcity of small plaice in 1901 normal or abnormal? Was this marked increase during 1902 an exceptional feature, or merely the prelude of a return to more normal conditions?

There is no available means of answering these questions except by a comparison with the results contained in Mr. Holt's previous report on the Association's work in the bays during 1895 to 1898, from which the following table has been prepared.

TABLE VI., *showing the Catch per Hour and the Percentage Frequency of Plaice of different sizes in Start Bay during* 1895–1897, *based on the records of the "Thistle" and "Busy Bee" (compiled from Mr. Holt's report).*

| Season. | Vessel. | hrs. min. | Total | Catch per Hour. | | | | | Percentages. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Total | 0–7″ | 8–11″ | 12–14″ | 15″+ | 0–7″ | 8–11″ | 12–14″ | 15″+ |
| March, '96, '97 | *Thistle*, 3 hauls; *Busy Bee*, 1 haul | 9 0 | 423 | 47 | 13 | 23 | 8 | 3 | 26 | 50 | 18 | 6 |
| May, June, '97 | *Busy Bee*, 4 hauls | 8 50 | 144 | 16 | 7 | 7 | 1 | 1 | 46 | 40 | 8 | 6 |
| July, '98 | ,, 2 hauls | 3 45 | 58 | 15 | 4 | 8 | 2 | 1 | 29 | 50 | 14 | 7 |
| Oct., Dec., '95, '96 | *Thistle*, 6 hauls | 23 (ea.) | 1011 | 44 | 0·1 | 16 | 23 | 5 | 1 | 37 | 52 | 10 |

The chief difficulty in a comparison with these records arises from the fact that the previous investigations of the Association were carried out by means of two boats, the smack *Thistle* and the small steam yacht *Busy Bee*, which were of different catching power compared with one another as well as with the *Oithona*. It will be seen that the work in the winter and autumn seasons during the previous investigations was mostly carried out by the *Thistle*, and during the summer by the *Busy Bee*.

It will also be seen that the average catch of the *Busy Bee* in spring and summer was so markedly inferior to the catch of the *Thistle* in autumn and winter that no conclusions can be drawn from the figures as they stand in regard to the seasonal changes which formerly took place in the abundance of plaice in the bay; but at least two methods of comparison with the records of the *Oithona* are open to us, viz. (1) the percentage distribution of plaice of different sizes can be compared with the corresponding figures for the *Oithona's* work, and (2) the average hourly catch of the *Busy Bee* may be assumed to have been *not greater* than that of the *Oithona*, since the *Busy Bee* was a somewhat smaller vessel and carried a smaller trawl.

If we take the latter point first into consideration, we may observe that whereas in the spring and summer seasons the *Busy Bee* made, in Start Bay, an average hourly catch of 16 and 15 plaice respectively, the *Oithona*, during the corresponding seasons, caught 18 plaice per hour in the spring, from 18 to 19 per hour in the summer of 1901, and from 23 to 28 per hour in the summer of 1902. The total catch, as was to be expected, was therefore higher in the case of the *Oithona* than in that of the *Busy Bee*. Nevertheless, on turning to the table again, we see that during the spring quarter the *Busy Bee* caught a far higher average quantity of small plaice per hour than did the *Oithona*, viz. 14 plaice per hour below 12 inches in length, as against only 5 per hour in the case of the *Oithona*. Again, during July the *Busy Bee* caught an average of 12 fish per hour below 12 inches in length, whereas in the summer quarter of 1901 the *Oithona* caught only 6 per hour. The conclusion appears to be that the small plaice below 12 inches in length were abnormally scarce in Start Bay during the summer of 1901; and the records show that this abnormal scarcity continued until the corresponding season of the following year.

We have already seen that in the summer of 1902 the *Oithona* caught a far higher number of immature medium-sized fish than in the corresponding season of the previous year. In Start Bay the average catch of these immature fish was from 13 to 16 per hour. For this bay, therefore, we may conclude that the marked increase in the small plaice during the summer of 1902 was not in itself an abnormal feature, but was rather a sign of the resumption by the bay of its normal characteristics, the scarcity of the small fish during the previous year having been an exceptional phenomenon.

The marking experiments, to be described below, give good ground for believing that the actual increase in numbers of the medium-sized plaice during the summer of 1902 was due to immigration from Teignmouth and Tor bays. There is also no evidence that any material proportion of the plaice of this size in Start Bay were derived by growth from the small stock of small plaice (below 8 ins.) previously in the bay.

The explanation of the scarcity of the small plaice during 1901 and the earlier half of 1902 is dealt with at a later stage (pp. 472 and 474); but it is worthy of note that the phenomena described in the case of the plaice were closely paralleled by changes which took place during the same period in the abundance of small dabs.

TABLE VII., *showing, for Start Bay, the total number of* DABS *measured, and the Catch per Hour and Percentage Frequency of Small and Marketable Fish for each Monthly or Quarterly Period.*

| Season. | No. of Hours. | | Total caught. | Catch per Hour. | | | Percentages. | |
|---|---|---|---|---|---|---|---|---|
| 1901. | hrs. | min. | | 0-7″ | 8″+ | Total. | 0-7″ | 8″+ |
| July, August | 8 | 55 | 93 | 6 | 5 | 11 | 55 | 45 |
| September | 14 | 15 | 231 | 3 | 13 | 16 | 21 | 79 |
| October | 13 | 5 | 486 | 5 | 32 | 37 | 13 | 87 |
| November | 17 | 5 | 290 | 3 | 14 | 17 | 16 | 84 |
| December | 18 | 10 | 89 | + | 5 | 5 | 6 | 94 |
| 1902. | | | | | | | | |
| January, February | 10 | 45 | 77 | 3 | 4 | 7 | 36 | 64 |
| April, May, June | 25 | 55 | 472 | 13 | 5 | 18 | 74 | 26 |
| July, August | 14 | 15 | 1077 | 66 | 9 | 75 | 88 | 12 |
| October | 1 | 30 | 69 | 45 | 1 | 46 | 97 | 3 |
| Totals | 123 | 55 | 2884 | 13 | 10 | 23 | 56 | 44 |

Table VII. shows that in the summer and autumn of 1901 there was a great scarcity of small dabs as compared with the corresponding season of 1902. The difference cannot be attributed to differences in the combination of the stations, since Station III., which alone exhibits a deficiency of dabs, is not represented in the averages for July and August in either year.

If we again use Mr. Holt's figures for 1895–8 as a test, we find that in July the *Busy Bee* made an average catch of 29 dabs per hour, of which 22 were small and 7 marketable. Thus the *Oithona's* figures for 1901 may be taken as indicating an abnormal scarcity of dabs, especially small dabs, in Start Bay; while the figures for the spring and summer of 1902 indicate the gradual resumption by the dabs of at least their former abundance.

As a matter of fact, during the investigations in 1895–8, the dabs in Start Bay outnumbered the plaice in each season of the year; whereas in 1901–2 the reverse was the case until the summer of 1902, when three times as many dabs were taken as plaice.

TABLE VIII., *showing, for Start Bay,* (1) *the total proportion of Dabs to Plaice, and* (2) *the proportion of Large Dabs* (8 *inches and upwards*) *to Large Plaice* (12 *inches and upwards*), *for each quarter during the two sets of investigations. The number of Plaice has been taken in each case as* 100.

| | Total Dabs to Plaice. | | Large Dabs to Large Plaice. | |
|---|---|---|---|---|
| | 1901–2. | 1895–8. | 1901–2. | 1895–8. |
| July to September | 73 | 186 | 68 | 225 |
| October to December | 86 | 120 | 91 | 126 |
| January to March | 67 | 114 | 79 | 139 |
| April to June | 91 | 106 | 32 | 255 |
| July to September, 1902 | 311 | — | 77 | — |

These facts are shown in the accompanying table, in which the relative abundance of large dabs and plaice is also compared for the two periods. The size limits selected correspond roughly with the size of maturity in the two species. It will be observed that in 1895–8 the mature dabs outnumbered the mature plaice in Start Bay in each season of the year, whereas in 1901–2 the reverse was the case, even during the summer of 1902, when so many small dabs were taken.

It appears permissible to conclude from these data that, whatever the causes which had led to the scarcity of immature intermediate-sized plaice in 1901, the previous abundance of dabs was reduced to a still greater extent; and that both species were recovering from this wave of depression in the course of 1902. The previous scarcity of these fish cannot therefore be attributed to the "fouling" of the ground from lack of trawling, since under such circumstances the dab, as a mud-loving species, would probably have suffered less than the plaice, and the subsequent signs of recovery of both species would receive no explanation.

The results of the *Garland's* experiments in the closed waters of the Scottish bays and firths have given rise to the belief that the prohibition of trawling in inshore waters may protect the dab more efficiently than the plaice, and increase the proportion of the former to the latter. It is therefore of interest to note that this idea receives no support from a comparison of the two series of trawling experiments in Start Bay. The chief feature of these experiments as regards the dab appears to be the liability of this species to fluctuations in numbers, which are more extensive even than in the case of the plaice.

## TORBAY.

Dr. Kyle describes the characters of the trawling-grounds and stations as follows:—

"The physical conditions existing in Torbay are widely different from those of Start Bay. The tidal movements of the water are weak at all times, and so are the currents alongshore, except at the south-west corner, where the strong eddy of the Great West Bay makes itself felt as it passes round Berry Head. The direction of the currents is greatly affected by the prevailing winds.

"The comparative lack of tidal movements is reflected in the nature and disposition of the bottom-soil. In the centre of the bay there is nothing but mud, which is continuous from the long stretch of similar soil extending some ten to twelve miles off Berry Head. The mud is continued on the northern aspect right on to the beach at Torquay, where it grades into fine sand. Under the present bed of Torbay lie the remains of an ancient forest, and lumps of peat were occasionally brought up in the trawl. At times, also, fossil bones are obtained on the beach at Torquay, where, as at Brixham, there are famous caves containing fossil remains. On the southern half of the bay, from Paignton to Berry Head, the beach is quite free from mud, and various grades of sand extend from the shore for some distance, varying from a few yards off Fishcombe Rocks to a quarter of a mile off Goodrington Sands and the back of the breakwater at Brixham. Off the angle of the bay formed by Ellbury Cove lies a small patch of rocks, locally known as the 'Rough,' and it is close to this that the finest and largest fish are caught. There are several detached rocks on the Torquay side, extending from Torquay out to the Orestone, and various ('innumerable,' according to the fishermen) anchors scattered about the bay. The trawlable area is about seven square miles.

"As may be gathered from the preceding account of the physical conditions, Torbay is very liable to become 'foul,' especially during the summer. The Brixham and Torquay fishermen will have it that this is partly, if not entirely, due to the absence of trawling, and though it is merely a matter of opinion, it is possible that they have a certain amount of right in their contention. Even a slight scraping of the bottom in, say, a stagnant pool has some influence on the distribution and circulation of muddy material. It is difficult, on the other hand, for the fishermen to recognise that the 'foulness' of the bay has not been caused by the Devon Committee's by-laws, but is due to its geographical situation and the weakness of its tides and currents. In the summer time, indeed, it is a veritable sink for a great part of the débris of the great West Bay, and it has sufficient decomposing material in its own composition to serve three or four bays.

"The trawling stations in Torbay are four in number, as follows:—

"**Station IV.** From Paignton Head to Torquay Harbour, half a mile from the shore. The bottom-soil is fine sand and mud, and the depth 3 to 4 fathoms. [Haul No. 4 on September 11th extended eastwards beyond Brixham breakwater.—W. G.]

"**Station IVa.** Round the 'Rough' from Paignton Head to off Ellbury, thence outward towards Brixham breakwater. The bottom soil is at first sand, later mud, and the depth from 3 to 4 fathoms.

"**Station V.** Centre of the bay, on line Brixham breakwater to Ilsham Valley, between Torquay and Hope's Nose. The bottom-soil is mud, and the depth 6 fathoms.

"**Station VI.** On line Berry Head to Orestone. The bottom soil is again mud, and the depth 8 to 10 fathoms. [This station lies just outside the limit fixed by the Devon Sea Fisheries Committee.—W. G.]

"The stations in Torbay differ less from one another than those of Start Bay, but the proportions of the various species of fish are, on the whole, similar. The dabs and plaice are the most numerous, whilst the remaining species taken together are fewer in numbers than the plaice by itself."

The following table represents the results of the *Oithona's* catches in Torbay during the year reduced to the average catch per hour for each of the four stations:—

TABLE IX.

| Species. | Station IV. 9 hrs. 55 min. | | Station IVa. 11 hrs. 30 min. | | Station V. 10 hrs. 35 min. | | Station VI. 7 hrs. 25 min. | | Totals excluding Station VI. 32 hrs. | | Totals including Station VI. 39 hrs. 25 min. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Small. | Marketable. | Small. | Marketable. | Small. | Marketable. | Small. | Marketable. | Small. | Marketable. | Small. | Marketable. | Total. |
| Plaice | 36 | 29 | 11 | 18 | 22 | 21 | 3 | 6 | 23 | 22 | 19 | 19 | 38 |
| Dabs | 82 | 4 | 19 | 1 | 103 | 8 | 7 | 10 | 66 | 4 | 55 | 6 | 61 |
| Sole | – | 1 | – | 1 | + | + | – | + | + | 1 | + | 1 | 1 |
| Brill | + | – | + | + | + | – | – | + | + | + | + | + | + |
| Grey Gurnard | 4 | + | 1 | + | 11 | + | 3 | + | 5 | + | 4 | + | 4 |
| Whiting | 1 | 1 | – | – | 12 | 3 | 6 | – | 4 | 1 | 4 | 1 | 5 |
| Thornback | 9 | – | 2 | – | 6 | + | 23 | 3 | 5 | + | 8 | 1 | 9 |
| Homelyn | – | – | – | – | – | – | + | – | – | – | + | – | + |
| Blonde | + | – | – | – | – | – | – | – | + | – | + | – | + |

The table illustrates the following extract from Dr. Kyle's report:—

"The accompanying table shows that there are only two species in Torbay—the **plaice** and the **dabs**—which are worthy of any attention, amongst trawled fish that is to say, for the fishermen, especially of Torquay, earn a good living from the mackerel and other roving round fish which enter the bay. With these, however, we are not concerned; they are seldom obtained by the trawl, and to the trawlers as trawlers they are of no value. Amongst the trawled fish the large proportion of **thornback rays** demands a word of explanation. They are almost entirely small fish under 12 inches from wing to wing, and are most probably migrants from the neighbouring Teignmouth Bay, where their spawning ground seems to be.

* * * * * *

"The **dabs** are even more numerous in Torbay than in Start Bay, and their distribution over muddy ground is more clearly shown. On Station IVA., near the Rough, the proportion of dabs is less than that of the plaice, and the bottom-soil here, it will be remembered, is of a sandy nature. Over the rest of the bay, where the soil is muddy, the proportion of dabs is greatly in excess of the plaice.

"It appears from the table that the proportion of small dabs under 8 inches greatly exceeds that of the larger over this size and at all times of the year. This is not to be wondered at when it is remembered that the dab is mature on the average below 8 inches.

"**Soles** are by no means numerous, but the great majority were over 8 inches, only one being captured under that size. **Flounders** are more numerous, and were taken at all seasons of the year. Useless species, as **solenette, dragonet, bib,** and **scaldback,** are very common, but the useful forms other than those mentioned are few in numbers and mostly small."

It is, however, necessary to add to Dr. Kyle's remarks that Station VI., strictly speaking, lies outside the trawling limit of the bay, as fixed by the Sea Fisheries Committee.

The station, owing to its greater depth, naturally exhibits a preponderance of large fish over small, in the case of plaice and dabs. The actual catch per hour of the larger plaice is less than on the other stations, and of the larger dabs somewhat greater. The station exhibits a higher catch of thornbacks than any other in the bay.

As will be seen from a comparison of the parallel columns of "totals" excluding and including this station, the inclusion of the station in the summaries has the effect of slightly depressing the average catch of plaice, both small and marketable—the former slightly more so than the latter. It is obvious, also, that its inclusion will have a tendency to slightly increase the percentage of large fish in the general averages at the expense of the small.

The following table shows the actual amount of fishing carried out by the *Oithona* on the various stations at different seasons of the year.

TABLE X., *showing the Amount of Trawling over each station in Torbay, for each quarterly period of the year.*

| Season. | Station IV. No. of hours. hrs. | min. | Station IVA. No. of hours. hrs. | min. | Station V. No. of hours. hrs. | min. | Station VI. No. of hours. hrs. | min. |
|---|---|---|---|---|---|---|---|---|
| July, Aug., Sept., 1901 | 3 | 10 | 1 | 0 | 2 | 5 | 2 | 40 |
| Oct., Nov., Dec. „ | 3 | 15 | 5 | 20 | 4 | 0 | 1 | 0 |
| Jan., 1902 . . . | 1 | 0 | — | | — | | 0 | 45 |
| April, May, 1902 . | 1 | 0 | 2 | 10 | 1 | 15 | 1 | 0 |
| July, Sept. „ . . | 1 | 30 | 3 | 0 | 3 | 15 | 2 | 0 |
| Totals | 9 | 55 | 11 | 30 | 10 | 35 | 7 | 25 |

## SEASONAL CHANGES.

The following table represents a quarterly summary of the average hourly catches of plaice by the *Oithona* in Torbay, distinguishing the various size-groups.

TABLE XI., *showing, for Torbay, the Average Catch of Plaice per Hour, and the Percentage Frequency for each size, for each quarter of the year, over all the stations combined.*

| Season. | hrs. | min. | Total caught. | Catch per Hour. Total. | 0–7″ | 8–11″ | 12–14″ | 15″+ | Percentages. 0–7″ | 8–11″ | 12–14″ | 15″+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| July, Aug., Sept.,'01 | 8 | 55 | 408 | 46 | 22 | 13 | 9 | 2 | 47 | 27 | 20 | 6 |
| Oct., Nov., Dec. ,, | 13 | 35 | 507 | 37 | 21 | 7 | 6 | 3 | 57 | 19 | 15 | 9 |
| Jan., 1902 . . | 1 | 45 | 48 | 27 | 21 | 2 | 3 | 1 | 77 | 8 | 11 | 4 |
| April, May, 1902 . | 5 | 25 | 133 | 25 | 17 | 4 | 3 | 1 | 66 | 16 | 13 | 5 |
| July, Sept. ,, . | 9 | 45 | 404 | 41 | 14 | 22 | 3 | 2 | 35 | 53 | 7 | 5 |

The total catch, irrespective of size, is seen to have steadily fallen from a maximum of 46 per hour in the summer of 1901 to a minimum catch of 25 per hour in the spring of 1902, after which the catch rose to 41 per hour in the following summer quarter. This second summer maximum is less than that which obtained in the previous year. The small fish, from 0 to 7 inches in length, are seen to have steadily diminished in abundance from 22 per hour in the summer of 1901 to 14 per hour in the summer of the following year. It is remarkable that the figures should show no sign during the last quarter of the increase in numbers which is usual at this season.

It will be seen, however, upon reference to Table X., which shows the relative amount of fishing on different stations for each season, that during the summer of 1901, as compared with the summer of 1902, the *Oithona* trawled twice as long over Station IV., where the small fish are most abundant, and only one-third as long over Station IVA., where they are much less abundant. If the influence of Stations IV., IVA., and V. for 1901 be reduced to the same relative proportions as prevailed in 1902, omitting Station VI. in each case, the catch per hour during the two seasons becomes altered as follows:—

| Season. | Catch per Hour. Total. | 0–7″ | 8–11″ | 12–14″ | 15″+ | Percentages. 0–7″ | 8–11″ | 12–14″ | 15″+ |
|---|---|---|---|---|---|---|---|---|---|
| July–Sept., 1901 | 45 | 15 | 14 | 11 | 5 | 33 | 32 | 24 | 11 |
| July–Sept., 1902 | 51 | 18 | 27 | 3 | 3 | 35 | 53 | 7 | 5 |

Now that the two seasonal averages have been made comparable, it will be observed that the discrepancies in the general averages were largely attributable to the disproportionate combination of hauls over different grounds in the two seasons. Instead of a relative fall in the total catch of fish in 1902 as compared with the previous year, the maximum for 1902 is now seen to be somewhat in excess of that for 1901, and the small fish below 8 inches in length are seen in reality to have been not less numerous, but slightly more abundant in the later than the earlier year. The figures for the other size-groups are not so seriously affected, but the hourly catch of large fish above 15 inches is slightly raised in both years by the omission of Station VI., which, strictly speaking, lies outside the limits of the bay. It will be further noticed that the marked increase in the number of immature medium-sized plaice, which the general average in Table XI. revealed for the summer season of 1902, is confirmed.

With the exception of the season just referred to, it will be noticed that the smallest plaice were more abundant than any of the other size-groups at each season of the year, in spite of the depressing effect of a somewhat high representation of Stations IVA. and VI. in the general averages. Indeed, for the greater part of the year the fish below 8 inches in length were actually more numerous than the plaice of all other sizes taken together. This result contrasts markedly with the condition previously shown to have obtained in Start Bay, where the predominant group of plaice was, for the most part, that from 12 to 14 inches. In other words, the mature medium-sized plaice were the most abundant in Start Bay, while the small unsaleable fish took the lead in Torbay.

Nevertheless, the actual abundance of mature medium-sized plaice in Torbay during the latter half of 1901 was scarcely less than in Start Bay. Their greater scarcity in the summer of 1902 is an isolated feature which it is not easy to explain with certainty. The results of the marking experiments in the spring of 1902 demonstrate that the plaice in the mouth of Torbay showed a far stronger tendency to migrate southwards into Start Bay than into Torbay itself during the summer season; so that the trawling statistics accord with the migration experiments on this point. Why the larger fish should have displayed this disinclination to enter the bay remains unexplained. It is not improbable that variations in the "foulness" of the ground in Torbay may be largely responsible for such fluctuations in the numbers of summer immigrants, as well as for emigrations of the normal inhabitants of the bay, as suggested below by Dr. Kyle in the case of Teignmouth Bay.

We may now compare these results with the distribution of the different sizes of plaice in Torbay, as recorded by Mr. Holt for 1895–8.

TABLE XII., *showing the Catch per Hour and the Percentage Frequency of Plaice of different sizes in Torbay during* 1895–8, *based on the records of the "Thistle" and "Busy Bee"* (*compiled from Mr. Holt's report*).

| Season. | Vessel. | hrs. | min. | Total caught. | Catch per Hour. Total. | 0–7″ | 8–11″ | 12–14″ | 15″+ | Percentages. 0–7″ | 8–11″ | 12–14″ | 15″+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan., March, '97 | *Thistle*, 3 hauls | 4 | 50 | 420 | 87 | 23 | 35 | 26 | 3 | 26 | 40 | 30 | 4 |
| June, '97 . . | *Busy Bee*, 2 hauls | 2 | 55 | 410 | 141 | 90 | 27 | 20 | 4 | 64 | 19 | 14 | 3 |
| July, '98 . . | ,, ,, | 2 | 25 | 110 | 45 | 11 | 29 | 4 | 1 | 24 | 63 | 9 | 4 |
| November, '95 . | *Thistle*, 2 hauls | 3 | 20 | 100 | 30 | 1 | 15 | 13 | 1 | 4 | 50 | 42 | 4 |

Bearing in mind the reservations previously expressed with regard to the comparability of these records (p. 456), it is nevertheless apparent that in July, 1898, the *Busy Bee*, in spite of its somewhat smaller catching power, caught a larger average number of plaice from 8 to 11 inches than did the *Oithona* in the summer season of either 1901 or 1902, and that the higher catch of the *Oithona* in 1902 more closely approached the *Busy Bee's* record than did the smaller catch of 1901. We may therefore conclude that in Torbay, as in Start Bay, the numbers of plaice of this size were abnormally low in 1901, but were increasing to more normal proportions in the course of 1902. The June records of the *Busy Bee* in 1897 suggest the further point that the smallest plaice (especially the 5-inch fish) were more abundant in that year than subsequently. As these fish, after one year's growth, would form the greater part of the 8-to-11-inch group in the succeeding year (see p. 489), it appears to be in the highest degree probable that the observed abundance of the 8-to-11-inch plaice in July, 1898, is traceable to the corresponding abundance of the smallest plaice in the preceding year. In a similar manner the increased abundance of the larger immature plaice in the summer of 1902 was preceded, according to the *Oithona's* records (Tables XI. and D), by a high average catch of the smallest fish (4 and 5 inches) throughout the preceding autumn and winter, an average much higher, it will be noted, than the *Busy Bee's* catches in July and November, and almost as high as the *Thistle's* catch in January to March.

Upon a consideration of all the data, it thus appears fairly certain that in Torbay the observed fluctuations in the numbers of the 8-to-11-inch plaice during recent years are attributable to corresponding fluctuations in the abundance of the still smaller fish in previous years.

Turning now to DABS, it will be seen from the following table that, as in Start Bay, there was a considerable increase in the abundance of small dabs in the summer of 1902 as compared with 1901—a result which is not attributable to any marked inequality in the combination of the stations.

TABLE XIII., *showing, for Torbay, the total number of Dabs measured, and the Catch per Hour and Percentage Frequency of Small and Marketable Fish for each quarterly period.*

| Season. | No. of Hours. hrs. | min. | Total caught. | Catch per Hour. 0-7″ | 8″+ | Total. | Percentages. 0-7″ | 8″+ |
|---|---|---|---|---|---|---|---|---|
| 1901. | | | | | | | | |
| July, August, Sept. | 8 | 55 | 641 | 62 | 10 | 72 | 87 | 13 |
| October, Nov., Dec. | 13 | 35 | 511 | 33 | 5 | 38 | 87 | 13 |
| 1902. | | | | | | | | |
| January | 1 | 45 | 10 | 6 | — | 6 | 100 | — |
| April, May | 5 | 25 | 138 | 22 | 3 | 25 | 87 | 13 |
| July, September | 9 | 45 | 1096 | 107 | 5 | 112 | 95 | 5 |
| Totals | 39 | 25 | 2396 | 55 | 6 | 61 | 91 | 9 |

In this case Mr. Holt's records show that the catch of dabs in the summer of 1901 was slightly less, in the case of small dabs, than the average catch of the *Busy Bee* for July, 1898, viz. 66 small, 4 large; total, 70. In June of 1897 the *Busy Bee* caught nearly twice as many dabs per hour as did the *Oithona* in the spring of 1902, the numbers being 38 small, 13 large; total, 51. There was, therefore, to some extent, a deficiency of dabs in 1901 and the first half of 1902, as compared with the previous period, 1895–8; but an increase in the summer of 1902, which caused the ultimate numbers of small dabs to attain a higher maximum than had previously come under observation.

As regards the relative numbers of dabs and plaice, there is no such striking contrast between the two series of investigations as was noticeable in the case of Start Bay. The proportion of mature dabs to mature plaice appears, in general, to have been slightly higher in 1901–2 than in 1895–8, especially during the summer of 1902, when, for the first time, the dabs above 7 inches outnumbered the plaice above 11 inches.

TABLE XIV., *showing, for Torbay,* (1) *the total proportion of Dabs to Plaice, and* (2) *the proportion of Large Dabs* (8 *inches and upwards*) *to Large Plaice* (12 *inches and upwards*) *in each quarter during the two sets of investigations* (*Plaice* = 100).

| | Total Dabs to Plaice. | | Large Dabs to Large Plaice. | |
|---|---|---|---|---|
| | 1901–2. | 1895–8. | 1901–2. | 1895–8. |
| July to September | 157 | 152 | 82 | 64 |
| October to December | 101 | 46 | 54 | 56 |
| January to March | 21 | 26 | — | 11 |
| April to June | 104 | 36 | 75 | 54 |
| July to September, 1902 | 271 | — | 102 | — |

With one insignificant exception the total proportion of dabs to plaice was higher in each quarter of 1901–2 than during the previous period, the excess being particularly marked during the spring and summer of 1902. On the whole, therefore, the number of dabs does not appear to have diminished in Torbay during the recent fluctuations to anything like the extent which was manifest in Start Bay, or even to the same degree as the plaice—a difference which is possibly attributable to the muddy character of the bottom, which renders Torbay the chief headquarters of small dabs in the district.

## TEIGNMOUTH BAY.

The following account of the physical conditions and trawling stations has been drawn up by Dr. Kyle:—

"With regard to the physical conditions, this bay is intermediate between Torbay and Start Bay. There is comparatively little tidal movement in the centre of the bay, with the result that we find there a long belt of mud extending from Hope's Nose to off Exmouth. In this respect it resembles Torbay. There are moderate currents alongshore, however, which in the northern portion of the bay seem in the main to tend northward towards Exmouth, but in the southern half towards Hope's Nose. We find, consequently, that there is a long stretch of sand, mostly coarse, extending from five fathoms on to the beach and from Hope's Nose to the Pole Sands at Exmouth. The best trawling-ground is along this belt of sand, and in the fall of the year it is quite as rich as any part of Start Bay in large plaice and soles. Along the line from Hope's Nose to Straight Point (the Rubicon for trawlers) lies the beginning of the rough ground called the Ledge. At this point it is not yet untrawlable, but the large quantity of oysters and stones make it somewhat dangerous for the net.

"This bay differs from the others in that two rivers, the Teign and the Exe, flow into it. These are of importance because the young plaice of one to three years find them a harbour of refuge—from the trawlers only, for the seiners and cormorants exact toll.

"For the purpose of the experiments the bay was divided as follows:—

"**Station VII.** Off Babbacombe Bay to the Ness, near Teignmouth. The depth is 4–5 fathoms, and the bottom-soil sand. [Haul No. 4 was made in somewhat deeper water, but the particulars are doubtful.—W. G.]

"**Station VIII.** A continuation of the preceding to the Fairway Buoy off Exmouth. The depth and bottom-soil are still the same. Very few hauls were made over the entire length of this station. As a rule it was divided into two portions, one from off Teignmouth to off the Clerk Rock, the other along the Pole Sands at Exmouth, but as the composition of the ground and the fauna are practically identical the records are taken together.

"**Station IX.** On the line, Orestone to the Fairway Buoy off Exmouth, from near the Orestone to off Teignmouth. The depth is 11–12 fathoms, and the bottom-soil stones, large shells, but mostly mud. One haul [No. 26] was made from off Teignmouth towards the Fairway Buoy, but it is also included under Station IX. [This station lies just outside the limits fixed by the Devon Committee.—W. G.]

"The differences between these stations are so strongly marked as a rule that one can at once distinguish them by the catches. Station VII. lies in the southern corner of the bay, and is sheltered from the prevalent winds. Here we find a very large proportion of small fish, especially plaice. Station VIII., on the northern half of the bay, is very much exposed to the southerly and south-easterly gales, and the sand which composes its bottom-soil is in constant movement. Small plaice are consequently less abundant, and dabs are comparatively few. A further consequence of the variable nature of the physical conditions is that the catches vary greatly both as regards quality and quantity. The sole and painted ray (*R. microcellata*) are good examples of this. On one occasion, 13th September, 1901, nineteen large painted rays were obtained in one haul. On all other occasions it was almost entirely absent. Again, a considerable number of soles was twice obtained there in November, 1901, and September, 1902, the total number then caught making more than half of the soles obtained in Teignmouth Bay for the whole period. At other times, again, soles seem entirely absent from this region. Plaice and other species show the same fluctuation, and as already mentioned, all forms are more abundant in the fall of the year than at other times.

"Station IX. is readily distinguished by the greater variety of species, especially those useless for food, and the invertebrate fauna. The dominant species is the thornback ray. From the accompanying tables it might appear as if the plaice were the most abundant, but an examination of the tables at the end shows that more than two-thirds (116) of the total (169) were obtained in one haul during July, 1902. Disregarding this haul as exceptional, probably due to the exceptional physical conditions during 1902 to be presently referred to, all the remaining hauls show that coarse fish, thornbacks, buffoons, and dog-fish are the distinguishing features of Station IX. The invertebrate fauna is also peculiar, cuttle-fish, oysters, Turritella, Trochus, Natica, Buccinum, hermit-crabs, Porcellana, swimming-crabs (especially *P. puber*), with various species of sea-anemones (especially *Actinoloba*), and hydroids being of exceptional abundance. The relation of the fish fauna to the invertebrates was not determined, but it may be gathered from what has been said that Teignmouth Bay offers a rich field for future research.

"Teignmouth Bay, like Torbay, is very liable to become 'foul' during the spring and summer, on account of the large quantities of drift-weed which the eddy of the Great West Bay carries down. The difficulties of trawling are thereby greatly increased, and the summer hauls are not truly representative of the fish of the bay. Station VII. is perhaps the worst in this respect, and it is probable that its normal inhabitants migrate outwards towards Station IX., whilst the seaweed 'plague' persists. This may account for the unusual number of plaice and dabs caught on the latter station in July, 1902.

"Holt has also remarked upon the incursion of seaweed into Teignmouth Bay during the summer."

The general characteristics of the stations may be gathered from the accompanying table, which has been prepared on the same lines as the corresponding ones for Start Bay and Torbay. The large proportion of small plaice usually caught in Station VII. shows that in any seasonal combination of the records of the different stations the results will not be strictly comparable unless due attention is paid to their proportional representation.

TABLE XV., *showing the Average Catch per Hour for the entire period on the various stations of Teignmouth Bay.*

| Species. | Station VII. | | | | Station VIII. | | | | Station IX. 9 hrs. | | Totals excluding Station IX. | | | | Totals including Station IX. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | hrs. | min. | Small. | Marketable. | hrs. | min. | Small. | Marketable. | Small. | Marketable. | hrs. | min. | Small. | Marketable. | hrs. | min. | Small. | Marketable. | Total. |
| Plaice . . | 21 | 50 | 41 | 21 | 20 | 20 | 10 | 11 | 9 | 10 | 42 | 10 | 26 | 16 | 51 | 10 | 23 | 15 | 38 |
| Dabs . . | ,, | ,, | 16 | 5 | ,, | ,, | 2 | 2 | 8 | 1 | ,, | ,, | 10 | 4 | ,, | ,, | 9 | 4 | 13 |
| Sole . . | ,, | ,, | + | 1 | ,, | ,, | + | 4 | + | 2 | ,, | ,, | + | 2 | ,, | ,, | + | 2 | 2 |
| Brill . . | ,, | ,, | + | – | ,, | ,, | + | + | + | + | ,, | ,, | + | + | ,, | ,, | 1 | + | 1 |
| Grey Gurnard | ,, | ,, | 3 | – | ,, | ,, | + | – | 7 | + | ,, | ,, | 2 | + | ,, | ,, | 3 | + | 3 |
| Whiting . | ,, | ,, | 5 | 2 | ,, | ,, | + | 4 | + | 1 | ,, | ,, | 3 | 3 | ,, | ,, | 3 | 2 | 5 |
| Thornback . | 19 | 35 | 12 | 3 | 15 | 35 | 7 | 9 | 9 | 8 | 35 | 10 | 10 | 6 | 44 | 10 | 10 | 6 | 16 |
| Homelyn . | ,, | ,, | + | – | 20 | 20 | + | + | 1 | 1 | 39 | 55 | + | + | 48 | 55 | + | + | + |
| Blonde . | 21 | 50 | + | – | 15 | 35 | + | 1 | + | – | 37 | 25 | + | + | 46 | 25 | + | + | + |

In the following table the seasonal duration of the trawling on each station is indicated.

TABLE XVI., *showing the Amount of Trawling over each station in Teignmouth Bay for each quarterly period.*

| Season. | Station VII. hrs. | Station VII. min. | Station VIII. hrs. | Station VIII. min. | Station IX. hrs. | Station IX. min. |
|---|---|---|---|---|---|---|
| August, September | 4 | 0 | 4 | 25 | 2 | 0 |
| October, November, December | 9 | 35 | 6 | 15 | — | — |
| January | 1 | 30 | 0 | 45 | — | — |
| April, May | 5 | 15 | 4 | 45 | 4 | 30 |
| July, September | 1 | 30 | 4 | 10 | 2 | 30 |
| Totals | 21 | 50 | 20 | 20 | 9 | 0 |

It will be observed that while Stations VII. and VIII. were investigated for fairly similar periods in the summer of 1901 and spring of 1902, Station VII. monopolised two-thirds of the time in the autumn of 1901, and only one-fourth of the total time allotted to the stations in the summer of 1902. Station IX. does not appear at all in the records for the autumn and winter, and received relatively more attention in the summer of 1902 than in the corresponding season of the previous year.

The following table shows the general averages for the five seasons :—

TABLE XVII., *showing, for Teignmouth Bay, the Average Catch of Plaice per Hour, and the Percentage Frequency of each size, for each quarter of the year over all the stations combined.*

| Season. | hrs. | min. | Total caught. | Catch per Hour. Total. | 0–7″ | 8–11″ | 12–14″ | 15″+ | Percentages. 0–7″ | 8–11″ | 12–14″ | 15″+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aug., Sept., 1901 | 10 | 25 | 329 | 32 | 14 | 7 | 6 | 5 | 43 | 22 | 19 | 16 |
| Oct.,Nov.,Dec. „ | 15 | 50 | 969 | 61 | 39 | 11 | 7 | 4 | 65 | 18 | 11 | 6 |
| January, 1902 | 2 | 15 | 89 | 40 | 35 | 1 | 2 | 2 | 88 | 3 | 5 | 4 |
| April, May „ | 14 | 30 | 292 | 20* | 13 | 3 | 2 | 2 | 65 | 14 | 11 | 10 |
| July, Sept. „ | 8 | 10 | 298 | 36 | 19 | 12 | 3 | 2 | 54 | 34 | 8 | 4 |

In the case of Teignmouth Bay it is not possible to draw a comparison between the *Oithona's* records and those of Mr. Holt as regards the abundance of fish in the summer quarter, since the latter was not represented during the previous investigations. It is obvious, however, that Teignmouth Bay is characterised, like Torbay, by the presence of a large stationary population of plaice of the smallest size which, with one exception, form the majority of the total catch in each season of

* The figures for the total catch per hour, and catch per hour of small plaice, during the spring quarter, are unduly depressed by the exceptionally large amount of trawling which took place over Station IX. If Station IX. be omitted, as in the two quarters preceding it, the total catch per hour is raised to 25, and the other figures become 19, 2, 2, 2 respectively. The percentage of small plaice also becomes raised to 76 per cent.

the year. It is also clear that the numbers of immature medium-sized plaice increased considerably in the summer of 1902 as compared with 1901—a feature which we have already seen was characteristic of each of the other bays. The influence of the winter emigrations from the bay is clearly shown for all the groups of plaice of 8 inches and upwards.

These features are not dependent on the disproportionate combinations of the stations in the different seasons, or on the inclusion of Station IX. (which does not materially influence the figures for any of the size-groups except the smallest). The influence of Station VII. on the averages for the first summer season was much greater than for the second, but its reduction to the same proportions merely reduces the total average catch for the first season from 32 to 28, the figures for the four size-groups becoming respectively 12, 6, 5, 5.

For the study of minuter points than those mentioned above, however, it is impossible to reduce the quarterly figures to a comparable basis of a reliable character owing to the small amount of trawling on Station VII. in the second summer, and to the irregular character of the midsummer records caused by the presence of drift-weed (cf. Tables C, D, hauls 2 and 29 on Station IX.). The most comparable records in the two years are those for September, the hauls for which month are limited to the inshore Stations VII. and VIII. It would appear from Table E that while the number of 8-to-11-inch plaice was twice as great in September, 1902, as in the same month of the previous year, the numbers of the smallest fish were about the same. These, however, as appears from the detailed Table D, were mostly 6- and 7-inch fish in the second year, with little admixture of 4-to-5-inch fish, whereas in the first year there was a considerable number of the latter. It would thus appear that in 1901 there was a greater abundance of the smallest plaice than in 1902, a view confirmed by the detailed records of the catches in July and August. As these smallest plaice would, a year later, become 8-inch fish, and as fish of this size preponderate in the 8-to-11-inch group, it is probable that the marked increase in the numbers of the 8-to-11-inch group during 1902 should be attributed to the abundance of 4- and 5-inch fish in the previous year. This conclusion has already been drawn in explanation of the same phenomenon in Torbay.

The increase of Dabs during the summer of 1902, which has already been noticed in the case of Start Bay and Torbay, is equally conspicuous in the records for Teignmouth Bay, as the following table reveals:—

TABLE XVIII., *showing, for Teignmouth Bay, the total number of Dabs measured, and the Average Catch per Hour and Percentage Frequency of Small and Marketable Fish for each quarterly period.*

| Season. | | No. of Hours. hrs. | min. | Total caught. | Catch per Hour. 0–7″ | 8″+ | Total. | Percentages. 0–7″ | 8″+ |
|---|---|---|---|---|---|---|---|---|---|
| August, Sept., | 1901 | 10 | 25 | 127 | 9 | 3 | 12 | 71 | 29 |
| Oct., Nov., Dec. | „ | 15 | 50 | 265 | 9 | 7 | 16 | 57 | 43 |
| January | 1902 | 2 | 15 | 4 | 2 | – | 2 | 100 | – |
| April, May | „ | 14 | 30 | 22 | 1 | 1 | 2 | 50 | 50 |
| July, September | „ | 8 | 10 | 242 | 27 | 2 | 29 | 92 | 8 |
| Totals | | 51 | 10 | 660 | 9 | 4 | 13 | 73 | 27 |

In the following table the relative numbers of dabs and plaice caught during the two periods of investigation are displayed according to the plan adopted for the other bays. It will be observed that during each period the total number of dabs was generally less than half the total number of plaice at each season of the year, the only important exception being in the summer quarter of 1902, when, as in the other bays, there was a great relative increase in the number of dabs. This increase did not, however, lead to the plaice being actually outnumbered, as was the case in Start Bay. The fact that in Teignmouth Bay the plaice always maintain their superiority in point of numbers over the dabs is doubtless due to the perennial supply of young plaice from the estuaries which open into this bay, whereas the young dabs do not derive the same advantage from the proximity of these estuaries, owing to their less restricted habits. It will also be observed that during 1901–2 the proportion of dabs to plaice was distinctly lower than during the previous period 1895–8 at each season of the year for which there are corresponding records. This contrast holds whether the totals or the large fish alone are taken into consideration.

TABLE XIX., *showing, for Teignmouth Bay,* (1) *the total proportion of Dabs to Plaice, and* (2) *the proportion of Large Dabs* (8 *inches and upwards*) *to Large Plaice* (12 *inches and upwards*), *for each quarter during the two series of investigations* (*Plaice* = 100).

| | Total Dabs to Plaice. 1901–2. | 1895–8. | Large Dabs to Large Plaice. 1901–2. | 1895–8. |
|---|---|---|---|---|
| July to September | 39 | (?) | 32 | (?) |
| October to December | 27 | 51 | 67 | 165 |
| January to March | 5 | 29 | None | 27 |
| April to June | 8 | 22 | 18 | 43 |
| July to September, 1902 | 81 | — | 51 | — |

## The Causes of the Observed Fluctuations.

It has been shown in the preceding pages that during the year 1901–2 there was a remarkable scarcity of immature medium-sized plaice (8 to 11 inches) in all three bays, as compared with the period 1895–8, previously investigated. This scarcity was limited to the year 1901 and the first half of 1902, and was followed in the summer of 1902 by an increased abundance of plaice of this size, as well as of small dabs.

We have seen that there are distinct indications in the trawling records that these fluctuations were generally preceded in the previous year by corresponding fluctuations in the abundance of fish one year younger. The available evidence does not amount to a conclusive demonstration; but the indications of this correlation are sufficiently definite to form the basis of a working hypothesis. The existence of such a correlation would lead at once to the conclusion that the causes of the observed fluctuations were quite independent of the restrictions placed upon trawling in the bays, and were to be sought in the conditions which naturally influence the reproduction of the fish from year to year. The fluctuations in the numbers of small flat-fish in the bays are therefore probably attributable to changes in the physical conditions in previous years, which caused sometimes a larger and sometimes a smaller proportion of the floating eggs and larvæ to set into the bays and undergo a successful metamorphosis there.

These remarks apply to Teignmouth Bay and Torbay, but only indirectly to Start Bay, which apparently possesses no natural rearing-ground (or "nursery") for the smallest plaice, and seems to derive the bulk of its population of medium-sized plaice by migration from the other bays to the northward.

Of the various physical factors capable of producing the changes above mentioned, none would appear to possess so great an importance as the direction of the winds during the spawning season of the fish, owing to their dominant influence upon the set of the currents.* The problem deserves fuller treatment than it is possible to give to it on the present occasion, but an analysis of the meteorological records of the Rousdon observatory (near Lyme Regis) for the years 1891 to 1901 lends distinct support to the view expressed.

For the region under discussion we may assume that south-easterly winds (*i.e.* E., S.E., and S.) would be favourable, and north-westerly winds (*i.e.* N., N.W., and W.) would be unfavourable,—the spawning season of the plaice in this district being January, February, and March.

(1) We have already seen that small plaice of 4 and 5 inches were

* Cf. Garstang, "Report on the Surface Drift of the English Channel and Neighbouring Seas during 1897," *Journ. M. B. A.*, vol. v., pp. 199–231. (Other literature cited.)

unusually abundant in June, 1897, according to Mr. Holt's records. These would be two-year-old fish,* hatched in the early part of 1895. During the first three months of that year the percentage of unfavourable winds was less than normal (49 per cent.), and of favourable winds above the normal frequency (21 per cent.), the range of variation throughout the decade being from 46 per cent. to 60 per cent. for "unfavourable" winds, and from 13 per cent. to 26 per cent. for "favourable" winds.

(2) Similarly the abundance of two-year-old fish in 1901 as shown by the *Oithona's* records may be attributed to the prevalence of south-easterly winds (E. to S.W. through S.) in February, 1899.

(3) The most unfavourable year in the decade was 1898, when the percentage of "favourable" winds was at its minimum (13 per cent.), and that of "unfavourable" winds at its maximum (60 per cent.). The plaice hatched in that year would be three and a half years old in the summer of 1901, *i.e.* for the most part between 8 and 9 inches in length. It can scarcely be without significance that the scarcity of plaice of this size in the summer of 1901 is one of the most striking features of the *Oithona's* records.

Mention may here be made of the fact that towards the end of January and in the early part of February, 1898, three dozen of the Association's drift-bottles were put overboard at various points between 14 and 20 miles S.E. and E.S.E. of Berry Head from the Brixham smack *Sunbeam*, through the instrumentality of Mr. W. J. Sanders, and every one of the bottles recovered was picked up on the French coast, with the exception of one bottle recovered by a Brixham smack two days after it had been thrown overboard. This bottle was found 6 miles S.E. of its initial position. If, as seems probable, an exceptionally large proportion of the eggs of the plaice drifted out to sea in that year in the same direction, it is scarcely surprising to find that the trawling investigations should subsequently reveal a phenomenal scarcity on the Brixham grounds of plaice derivable from that spawning season. The fact at any rate confirms the accuracy of the hypothesis from which we started.

## Summary of the Trawling Records.

The following points appear to be established by the preceding analysis of the trawling records for the three bays:—

1. The population of flat-fish, especially of plaice and dabs, in the three bays is subject to considerable fluctuations, both from season to season and from one year to another.

2. The *seasonal* fluctuations are more pronounced in the case of the

* Fulton, "Rate of Growth of Sea Fishes," *Twentieth Report Scottish Fishery Board*, 1902, pp. 337 to 360.

larger fish of these two species than of the smaller fish. It will be shown below that, for the plaice, the explanation of this difference is to be found in the peculiarities of their migrations.

3. In Start Bay the seasonal fluctuations of plaice are only appreciable in the case of mature fish. Practically the whole of the plaice below 12 inches in length appear to reside in the bay throughout the year, and do not usually emigrate on the approach of winter until they have attained the size mentioned.

In Torbay and Teignmouth Bay the seasonal fluctuations of plaice extend also to the immature medium-sized fish. (Experiments with marked fish, especially in Teignmouth Bay, show that the plaice in these bays emigrate at a smaller size than in the case of Start Bay.)

4. The *annual* fluctuations in the abundance of plaice are traceable to changes which take place from year to year in the numbers of the smallest fish present in the bays. A decrease in the number of the smallest group one year is followed by a decrease in the number of fish one year older in the following year. An increase in the smallest is similarly followed by an increase in the numbers of larger fish in the years immediately following.

5. The observed changes cannot be explained as due to the prohibition of trawling in the bays, since fluctuations in both directions have taken place during the period of closure.

6. The facts are most fully explained on the hypothesis that changes from year to year in the physical conditions which influence the distribution of floating eggs and larvæ cause sometimes a larger and sometimes a smaller proportion of the eggs and fry to set into the bays and undergo a successful metamorphosis on the rearing-grounds there.

The chief agency capable of inducing these changes appears to be the direction of the winds during the spawning season. The records tend to show that a prevalence of south-easterly winds during the spawning season of the plaice in any year in the South Devon district is followed by the survival of a greater percentage of the fry of that year, and an unusual amount of north-westerly winds by an increased mortality.

7. The closure of the bays to trawlers does not appear to have appreciably favoured the dab at the expense of the plaice, since, during the year ending June, 1902, the proportion of dabs to plaice was less in Start Bay and Teignmouth Bay than during the previous investigations from 1895–98, and was higher only in the case of Torbay, where conditions peculiarly favourable to the dab are found. In the summer of 1902 an unprecedented increase in the number of small dabs was shown by the trawling records for each bay, and exceeded a simultaneous increase in the number of small plaice.

Changes of this kind may possibly, after a series of years, bring about a nett result to the advantage of the dab; but, as the spawning season of the dab does not precisely coincide with that of the plaice, a detailed examination of the fluctuations of the dab in relation to the physical conditions prevailing during the various spawning seasons is necessary before any such difference can be attributed with confidence to the differential effects of protection on dabs and plaice respectively. The only point established by the investigations as regards the dab is that this species is subject to even greater fluctuations in abundance than the plaice.

8. In spite of the seasonal and annual fluctuations to which the numbers of flat-fish in the bays are subject, it is clear that there is an essential difference between Start Bay and the other bays to the northward as regards the normal proportions of large and small fish.

The following table shows the extent of the seasonal fluctuations in the percentage of plaice of different sizes for each bay, as shown by the quarterly averages of the *Oithona's* records.

| | Length of fish. | Start Bay. Per cent. | Torbay. Per cent. | Teignmouth Bay. Per cent. |
|---|---|---|---|---|
| Immature | 0–7 ins. | 1–13 | 33–77 | 43–88 |
| | 8–11 „ | 18–53 | 8–53 | 3–34 |
| Mature ... | 12–14 „ | 32–47 | 7–24 | 5–19 |
| | 15 ins. and above | 11–34 | 5–11 | 4–16 |

Start Bay showed a preponderance of mature plaice at all seasons of the year, and an insignificant proportion of small plaice below 8 inches in length (never more than one-eighth of the total number present). On the other hand, Torbay and Teignmouth Bay always showed a preponderance of immature plaice, while the proportion of the smallest fish below 8 inches was never less than one-third, and sometimes (*i.e.* during the winter quarter) exceeded three-fourths of the total number present.

9. The following table shows the average percentage of plaice of each size in the three bays, irrespective of seasonal differences, as shown by the two series of experiments respectively.

| | *Thistle* and *Busy Bee*, 1895–8. | | | *Oithona*, 1901–2. | | |
|---|---|---|---|---|---|---|
| | Start Bay. | Torbay. | Teignmouth Bay. | Start Bay. | Torbay. | Teignmouth Bay. |
| 0–7 ins. | 12 | 39 | 32 | 4 | 50 | 60 |
| 8–11 ins. | 41 | 35 | 56 | 24 | 30 | 20 |
| 12–14 ins. | 38 | 23 | 10 | 44 | 14 | 12 |
| 15 ins. and above | 9 | 3 | 2 | 28 | 6 | 8 |

Thus the preponderance of large plaice over small in Start Bay, and of small plaice over large in the other bays, was even more marked during the *Oithona's* investigations than during the earlier series of experiments. The difference, however, is apparently attributable, not to any permanent change in the distribution and abundance of the fish caused by the closure of the bays, but principally to a temporary scarcity during 1901–2 of medium-sized plaice from 8 to 11 inches in length (three to four years old), caused by an unfavourable spawning season in 1898.

## 2. THE MIGRATIONS OF THE PLAICE.

In order to provide some definite information as to the movements of plaice to and from the bays, a considerable number of living fish were marked with numbered labels and set free in the autumn of 1901 and the early summer of 1902. After some preliminary experiments with other devices, Dr. Petersen's method was adopted. This consists in passing a small piece of silver wire through the dorsal edge of the body, about half-way down, between two of the interspinous bones below the base of the dorsal fin, and in attaching a couple of special bone buttons to the wire, one on the upper (or eyed) side, and one on the lower (or blind) side. One, and in some cases each, of the buttons bore a distinctive number stamped upon it. The numbered bone button on the upper side was advantageously replaced in some of the experiments by a thin oval disc of brass, also numbered. By this modification of Petersen's method the obliteration of the number by wear and decay of the bone was obviated, and the fishes appear to have suffered little, if any, inconvenience. The only observed injuries caused by the labelling were due to an accidental slackness of the wire in two or three cases, thus causing the hinder margin of the lower button to catch and cut into the skin. In the great majority of cases, however, the fish were recovered in good condition.

Neglecting the preliminary trials, the marking experiments fall into two groups: (1) fish marked and liberated in the bays in the autumn of 1901; and (2) fish marked and liberated outside the bays in the early summer of 1902. The details of liberation and recovery are given in Table XXV.

### I. Start Bay.

Four batches of marked plaice were liberated in Start Bay between the 2nd October and the 9th November, 1901. During October 159 were marked, and during November 108, making a total of 267. Of these 62 fish had been recovered to the end of July, 1903, *i.e.* 23½ per cent. Of these 34, *i.e.* 13 per cent., were recovered in the first six months, and 23, *i.e.* 8½ per cent., in the second six months, making a total of 21½ per cent. recovered within one year of liberation. The size of the fishes marked varied from 17·5 cm. to 46 cm., *i.e.* from

7 to 18 inches. The following table shows the number of fish of each size which were marked, and also the number of each size which have been recovered.

TABLE XX., *showing the numbers and sizes of Plaice marked in Start Bay, and the numbers recovered in successive periods inside and outside the bay.*

| Length on liberation. | Total marked. | Total recovered. | First half-year. | | Second half-year. | | Second year. | | TOTAL. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | *In-side. | Out-side. | In-side. | Out. side. | In-side. | Out-side. | In-side. | Out-side. | Locality unknown. |
| 7–8 inches . | 9 | 1 | 1 | — | — | — | — | — | 1 | — | — |
| 9–10 ,, . | 27 | 5 | 2 | 1 | 1 | — | — | 1 | 3 | 2 | — |
| 11–12 ,, . | 69 | 18 | 1 | 10 | 5 | 2 | — | — | 6 | 12 | — |
| 13–14 ,, . | 125 | 30 | 5 | 11 | 3 | 7 | 2 | 1 | 10 | 19 | 1 (1st ½-year) |
| 15–18 ,, . | 37 | 2 | — | 1 | — | — | — | 1 | — | 2 | — |
| Size uncertain. | — | 6 | 1 | — | — | 2 | — | — | 1 | 2 | 3 (2nd ½-year) |
| Totals . . | 267 | 62 | 10 | 23 | 9 | 11 | 2 | 3 | 21 | 37 | 4 |
| | | | 33 | | 20 | | 5 | | | | |
| Locality unknown | — | — | 1 | | 3 | | — | | | | |
| Grand total . | 267 | 62 | 34 | | 23 | | 5 | | | | |
| Per cent. of total marked | | 23½ % | 13 % | | 8½ % | | 2 % | | 8 % | 14 % | 1½ % |

It is worthy of notice that the percentage of recoveries in the case of the largest and the smallest fish is very small. In the case of plaice from 9 to 14 inches in length at the time of liberation, 24 per cent. have been recovered, *i.e.* one out of every four; whereas of the fishes from 7 to 8 inches in length, only one out of nine has been recovered, and of those of 15 inches and upwards only two out of thirty-seven. It will be seen in the sequel that the explanation of this difference is probably to be found partly in the facts that the smallest fishes remain within the bays, and are, therefore, not liable to be captured by the trawlers in the ordinary way during the first year, and that the largest fishes tend to migrate away from the Brixham waters altogether, probably for the most part to the Eddystone trawling-grounds (cf. No. 176, caught on May 23rd, 1902, off the Eddystone).

The table shows further that nearly twice as many fish were recovered outside the bay as were found within its limits. The proportion borne by "outside" to "inside" captures is seen to increase

* NOTE.—The limit between "inside" and "outside" the bays in these tables is a purely geographical one, and does not strictly correspond with the trawling limits of the Devon Sea Fisheries Committee. Similarly the percentage of recoveries inside the bays is not to be taken as a measure of "poaching" on the part of the trawlers, since the returns include the captures by seiners, rod-fishermen, and the *Oithona* itself, as well as by trawlers.

pretty regularly with the size of the fish, the immature fish from 7 to 10 inches having been found mostly inshore, and the fish of the largest size-group only offshore. The smaller mature fish, *i.e.* from 11 to 14 inches, show, however, no such regularity when the season of the year is taken into consideration. During the first half-year, which, it will be borne in mind, included the winter period, twenty-one fishes were recovered outside, as against only six inside the bay. During the second half-year, extending from May to November, as many of these fishes were recovered inside the bay as outside.

The explanation of these facts becomes obvious upon a perusal of the detailed tables in which the localities of capture are recorded in chronological order. It will be seen that during October and November the fish were mostly found in Start Bay, but during December, January, and March most of the recoveries were made at considerable distances from the bay in deep water, especially on the Spion Kop ground, eight to ten miles off Beer Head, and on the Biscuit Dust ground, some twelve to fifteen miles off the same headland. During April and May the fish were still being recovered offshore, but nearer to the bay than during the preceding period, the ground locally known as the Corner being apparently the chief rendezvous of the fish at this season.* During the latter part of May and the succeeding summer months until October a considerable number of the fish were again recovered inshore, mostly in Start Bay, but one at any rate (No. 293) in Torbay.

There can be no doubt, therefore, that a large proportion of the plaice to be found in Start Bay make a periodical migration to the offshore grounds on the approach of winter. Out of a total of twenty-six fish recovered from December to April (both inclusive) four at most were found in the bay, and two of these were taken on December 1st, while the outward migration was still in progress. It has already been seen that this migration is for the most part limited to the fishes of 11 inches and upwards, *i.e.* to those which have attained the average size of maturity, and Dr. Kyle observed that the majority of the plaice recovered offshore from January to April in this experiment were either spawning or spent.

Analysis of the records also shows that there is no one route of migration, but rather a series of lines radiating fanwise from the bay in directions varying between N.N.E. and E. The smaller mature fish (between 11 and 13 inches) appear to have taken the shallower gradients to the northward, ultimately reaching the Spion Kop ground after passing Torbay and Teignmouth Bay (cf. Nos. 260, 279, 203, 210, 217, and 130). The larger fish, on the other hand, of about 15

* Also of the trawlers, who follow the fish in their migrations (cf. p. 440).

inches in length, appear to migrate more or less directly to the Biscuit Dust ground (cf. Nos. 207, 257, and 305), though the capture of one of these large fishes in Torbay on December 17th (No. 1) suggests that even for the larger fishes the actual route may be somewhat to the northward at the commencement of the migration.

After this spawning migration has taken place the smaller fishes tend to return again to the bays. The largest fishes may either return to the bays (cf. Nos. 57, 75, 139, 10, 252, and 293), or may pass to the south and west of Start Point altogether (cf. Nos. 176, 308, and 277).

## II. Torbay.

Two small batches of marked plaice were liberated in Torbay—eighteen fish on October 10th, 1901, and seven fish on November 14th, making a total of twenty-five fish. Six of these have been recovered altogether, for the details of which reference may be made to the detailed table and the following analysis of the sizes of the fishes marked. The experiment was on too small a scale to render discussion of details necessary.

Table XXI., *showing the numbers and sizes of Plaice marked in Torbay, and the numbers recovered in successive periods inside and outside the bay.*

| Length. | No. marked. | No. re-caught. | First half-year. | | Second half-year. | | Second year. | | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Inside. | Outside. | Inside. | Outside. | Inside. | Outside. | Inside. | Outside. |
| 7–8 inches | 4 | — | — | — | — | — | — | — | — | — |
| 9–10 ,, | 5 | 2 | 2 | — | — | — | — | — | 2 | — |
| 11–12 ,, | 11 | 3 | 2 | 1 | — | — | — | — | 2 | 1 |
| 13–14 ,, | 3 | 1 | — | — | — | — | 1 | — | 1 | — |
| 15–18 ,, | 2 | — | — | — | — | — | — | — | — | — |
| Total | 25 | 6 | 4 | 1 | — | — | 1 | — | 5 | 1 |
| | | | 5 | | — | | 1 | | | |
| Per cent. of total marked | | 24 % | 20 % | | — | | 4 % | | 20 % | 4 % |

## III. Teignmouth Bay.

Three batches of marked fish were liberated in Teignmouth Bay—fifty-three fish on October 9th, twenty-one on November 13th, and twenty-eight on November 29th, making 102 in all. Of these thirty-four have been recovered, eighteen (18 per cent.) in the first half-year, and nine (9 per cent.) in the second half-year, making a total of twenty-seven (27 per cent.) within one year of liberation. The sizes of the fishes marked may be gathered from the accompanying table.

TABLE XXII., *showing the numbers and sizes of Plaice marked in Teignmouth Bay, and the numbers recovered in successive periods inside and outside the bay.*

| Length. | No. marked. | No. recaught. | First half-year. | | Second half-year. | | Second year. | | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Inside. | Outside. | Inside. | Outside. | Inside. | Outside. | Inside. | Outside. |
| 7–8 inches | 32 | 5 | 2 | — | 1 | 2 | — | — | 3 | 2 |
| 9–10 „ | 37 | 16 | 2 | 5 | 3 | 2 | — | 4 | 5 | 11 |
| 11–12 „ | 17 | 10 | 2 | 6 | — | 1 | — | 1 | 2 | 8 |
| 13–14 „ | 13 | 3 | 1 | — | — | — | — | 2 | 1 | 2 |
| 15–18 „ | 3 | — | — | — | — | — | — | — | — | — |
| Total | 102 | 34 | 7 | 11 | 4 | 5 | — | 7 | 11 | 23 |
| | | | 18 | | 9 | | 7 | | | |
| Per cent. of total marked | | 34 % | 18 % | | 9 % | | 7 % | | 11 % | 23 % |

It will be seen that the general percentage of recoveries (34 per cent.) is much higher for this bay than for Start Bay, and that half the fishes from 9 to 12 inches were recovered; whereas in the Start Bay experiments only a quarter of the fishes of this size, and less than 24 per cent. of the total number liberated, were recaught.

The fact that none of the thirty-two fishes from 7 to 8 inches were recaught after the first year tends to show that the explanation advanced above, in the Start Bay section, as regards the small percentage of these fishes caught, is not sufficient to account for all the facts. One year's growth (from 3 to 4 inches for fishes of this size) would bring them to a length of 10 to 12 inches, at which size they would be capable, as the records show, of undertaking the ordinary migrations, and would thus be liable to capture by the trawlers outside the bays. The probability is that the rapid growth of fishes of this size causes the fish to suffer injury towards the end of the summer owing to the rigid character of the labels with which they are marked. The fish grow in thickness, but the length of the silver wire connecting the buttons remains the same. The consequence is that the buttons press too severely upon the skin and, by laceration, cause wounds of a serious character, or wear off altogether. I have seen good examples of this in our North Sea investigations. The statistics of capture of these small marked fishes should, therefore, be treated cautiously, and the fact that none of the fishes marked of this size-group (7 to 8 inches) have been recaptured after the first year in any of the Devon experiments receives an explanation which it would otherwise be difficult to supply.

Turning again to the table, it should be noticed that fully twice as many fish from this experiment have been recovered outside the bay as have been caught inside, and that after the first year none of the fish were recovered within the bay, although as many as seven (= 20 per cent. of the total recovered, and 7 per cent. of the total marked) were taken during the second year outside the bay. We see further that after the first half-year the recoveries within the bay were limited to the immature fish below 11 inches in length. Since fishes exceeding this size formed a third of the total marked, this feature in the results cannot be without significance.

If, for the reasons already given, we omit the smallest fishes (7 to 8 inches) altogether from consideration, we find that 41½ per cent. of the Teignmouth Bay fish were recaught,—31½ per cent. in the first year and 10 per cent. in the second year. During the whole period 11 per cent. were recaptured in the bay and 30 per cent. outside. In the Start Bay experiments only 23½ per cent. of the fish were recaught, —21½ per cent. in the first year and 2 per cent. in the second year. Of the entire number recovered, 1½ per cent. had no locality assigned to them, 8 per cent. were recaught in the bay, and 14 per cent. outside the bay (see Table XXIV.).

The difference between the total percentages recovered (18 per cent.) in the two experiments appears to be an approximate measure of the proportion of Start Bay fish which migrated altogether outside the Brixham trawling-grounds, or acquired habits which placed them beyond the reach of the fishermen during the period under discussion, —10 per cent. escaping during the first year, and 8 per cent. during the first nine months of the second year.

The high percentage of fish recovered from the Teignmouth Bay experiments during the second year, coupled with the fact that after the first half-year none of the mature fish were taken in the bay, shows that this bay in no way approaches the conditions of a self-contained area, so far as plaice are concerned; but that it is essentially a rearing ground (or nursery) for young plaice, which leave the bay even before maturity is reached, and do not, as a rule, return to it.

Turning now to the detailed tables showing the localities of capture, it is obvious at a glance that the Teignmouth Bay plaice, on the approach of winter, migrate eastwards towards the same grounds as those visited by the Start Bay fish. Doubtless the larger fishes which undertake this migration spawn on the same grounds. Accepting, however, 11 inches (= 28 cm.) as the average size at maturity, it cannot escape notice that many of the fishes which had undertaken this migration were too small to be sexually mature (cf. Nos. 219, 225, 247, 337, and 343). It will also be noticed that whereas the Start Bay fish tended to return to Start Bay in the following summer and autumn after the spawning migration was over, the Teignmouth Bay showed no general tendency to return to Teignmouth Bay,—several fishes recovered during the following summer having been found either in Torbay or Start Bay or in their immediate neighbourhood (cf. Nos. 268, 236, 320, and 357).

The details of capture thus confirm the results of the previous statistical treatment of these experiments. They show that Teignmouth Bay is an important source of supply of young plaice, both for the offshore grounds in the Brixham area and for the other bays to the southward. The upkeep of the general stock of plaice in the district would indeed appear to be largely dependent on the preservation from destruction of the young fish in this bay.

### IV. Outside the Bays.

The three preceding sets of experiments in the bays were carried out in the autumn of 1901. In the early summer of 1902 Dr. Kyle marked and liberated a number of plaice outside Start Bay and Torbay in order to throw special light on the summer migrations. Eleven plaice were marked outside Start Bay on April 12th to 14th, and sixty-two plaice were marked and liberated midway between Berry Head and the Orestone on May 29th. As the recoveries in each case show the same general tendencies, they may be taken together. The following analysis shows the sizes of the fishes marked and the numbers recovered inside and outside the bays during successive periods. In comparing this table with the preceding tables referring to the bays, it should be borne in mind that the first half-year is now a summer and autumn period, and not a winter period, as in the previous experiments.

Table XXIII., *showing the numbers and sizes of Plaice marked outside Torbay and Start Bay, and the numbers recovered in successive periods inside and outside the bays.*

| Length on liberation. | Total marked. | Total recovered. | 1st half-year. | | 2nd half-year. | | 2nd year. | | Total. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | In-side. | Out-side. | In-side. | Out-side. | In-side. | Out-side. | In-side. | Out-side. | No locality. |
| 7–8 inches . | 2 | 1 | — | — | 1 | — | — | — | 1 | — | — |
| 9–10 ,, . | 23 | 6 | 3 | 2 | — | 1 | — | — | 3 | 3 | — |
| 11–12 ,, . | 41 | 16 | 7 | 7 | — | — | 1 | — | 8 | 7 | 1 2nd hf.-yr. |
| 13–14 ,, . | 7 | 3 | 1 | 1 | — | — | — | 1 | 1 | 2 | — |
| 15–18 ,, . | — | — | — | — | — | — | — | — | — | — | |
| Totals . . | 73 | 26 | 11 | 10 | 1 | 1 | 1 | 1 | 13 | 12 | 1 |
| | | | 21 | | 2 | | 2 | | | | |
| Locality unknown | | — | — | | 1 | | — | | | | |
| Grand total . | 73 | 26 | 21 | | 3 | | 2 | | | | |
| Percentage of total marked . . | | 36 % | 29 % | | 4 % | | 3 % | | 18 % | 16½ % | 1½ % |

It will be seen that the fishes marked were mostly from 9 to 12 inches in length. The percentage of recoveries over the whole period distinctly exceeds that for Start Bay, and even surpasses that for Teignmouth Bay, viz. 36 per cent. For the first twelve months the percentage is 33 per cent. Unlike the result of the Start Bay and Teignmouth Bay experiments, the majority of the fish were recovered inside the bays, and almost entirely during the first half-year.

On examining the detailed records showing locality of capture, it will be seen that most of the fishes recovered during the first half-year were either travelling towards or had made their way into Start Bay. Only one fish (No. 347) was recovered in Torbay, a fact which is all the more remarkable since the great majority of the specimens were liberated in the mouth of that bay. On November 16th one of the Torbay fish (No. 373) was recovered off the Eddystone by a Plymouth trawler. The movements of the fish during this season were, therefore, very similar to those of the Start Bay fish on their return migration from the spawning grounds, and they confirm the interpretation which was adopted in the section dealing with the Start Bay fish as regards the return migration.

During the second half-year, *i.e.* in the spring of 1903, one fish at least was recovered on the Spion Kop ground (No. 328), and the records of the fishes numbered 383 and 361 tend to show that during June and July the remainder of the fish were again returning to Start Bay.

In the following table the percentage of marked fish recovered from the various experiments, exclusive of the smallest fish from 7 to 8 inches, is shown side by side for the different periods for the sake of easier comparison. It has not been thought necessary to repeat the figures given in the separate tables concerning the totals of *all* sizes marked.

TABLE XXIV., *showing percentage of Plaice of* 9 INCHES AND UPWARDS *marked and recovered in the various experiments.*

| | Numbers. | | Percentages of totals marked. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | First half-year. | | Second half-year. | | Second year. | | Entire period. | | | |
| Locality. | No. marked. | No. recovered. | Inside. | Outside. | Inside. | Outside. | Inside. | Outside. | Inside. | Outside. | Locality unknown. | Total % recaught. |
| Start Bay . . | 258 | 61 | 3·5 | 8·9 | 3·5 | 4·2 | 0·8 | 1·3 | 7·8 | 14·3 | 1·5 | 23·6 |
| Torbay . . | 21 | 6 | 19·0 | 4·7 | — | — | 4·7 | — | 23·8 | 4·7 | — | 28·6 |
| Teignmouth Bay | 70 | 29 | 7·1 | 15·7 | 4·3 | 4·3 | — | 10 | 11·4 | 30·0 | — | 41·4 |
| All the bays combined * | 349 | 96 | 5·1 | 10·0 | 3·4 | 4·0 | 0·9 | 2·8 | 9·4 | 16·9 | 1·1 | 27·5 |
| Outside the bays | 71 | 25 | 15·5 | 14·0 | — | 1·4 | 1·4 | 1·4 | 16·9 | 16·9 | 1·4 | 35·2 |

* In this combination of the bays, Start Bay fish recovered in Torbay and Teignmouth Bay, or *vice versâ*, have been treated as "inside," not "outside," as in the case of the tables for each bay separately.

## Table XXV. *Records of Plaice-marking Experiments.*

### START BAY.

| Particulars of Liberation. | Particulars of Recovery. | | | | | |
|---|---|---|---|---|---|---|
| Date. No. of fish. Locality. | Date. | No. of fish. | Locality. | Initial size. | Ultimate size. | Sex. |
| Batch I. | | | | cm. | cm. | |
| Oct. 2nd to 4th, 1901. | 1901. Oct. 11 | 98 | Start Bay | 33 | — | — |
| 99 Plaice (from hauls No. 16, 18, 19, and 20). | ,, ,, 21 | 90 | ,, | 32 | — | — |
| Inside Skerries, from centre of bay northwards. | ,, Nov. 21 | 95 | Off Dartmouth | 30 | 33 | — |
| Labels: bone buttons. | ,, Dec. 17 | 1 | Torbay | 37 | — | — |
| | 1902. Jan. 15 | 84 | 15 miles off Berry Head (Start W. to W.N.W.) | 34 | — | — |
| | ,, ,, 20 | 110 | Offshore off Berry Head | 36 | — | ♂ s. |
| | ,, Feb. 13 | 120 | Offshore in 25 fms. | 30 | — | ♂ s. |
| | ,, Mar. 20 | 130 | "Spion Kop" | 30 | 31·5 | ♂ s. |
| | ,, ,, 22 | 135 | Off Berry Head | 28 | 29·5 | ♀ s. |
| | ,, April 1 | 12 | 12 miles S. of Start Point | 32 | 34 | ♀ s. |
| | ,, ,, — | 103 (or 105) | 6 to 12 miles off Start Bay | 32·5 (or 32) | — | — |
| | ,, ,, 23 | 87 | "The Corner" off Start Bay | 33·5 | 35·5 | ♂ s. |
| | ,, May 8 | two | Off the Start | ? ? | — | — |
| | ,, ,, 11 | 28 | Start Bay | 31 | — | — |
| | ,, ,, 24 | 88 | ,, | 31 | 33 | — |
| | ,, July 9 | 144 | ,, | 35 | 38 | ♂ s. |
| | ,, ,, 14 | 123 | ,, | 28 | 30·5 | — |
| | ,, ,, 30 | 55 | ,, | 26 | 33 | — |
| | ,, Aug. 30 | 57 | ,, | 32·5 | 39·5 | — |
| | ,, Sept. 1 | 75 | ,, | 36 | 35·5 | — |
| | ,, Oct. 1 | 139 | ,, | 34 | 38 | — |
| | ,, ,, 2 | 10 | ,, | 35 | 40·5 | — |
| | 1903. Feb. 24 | 18 | 10 miles off Sidmouth | 35 | 43 | — |
| II. Oct. 11th, 1901.<br>6 Plaice (from haul 21).<br>Centre of Start Bay.<br>Labels: brass discs. | 1901. Dec. 8 | 260 | Torbay | 32 | — | — |
| III. Oct. 29th, 1901. | 1902. Mar. 27 | 145 | Spion Kop | 32·5 | 34 | ♀ s. |
| 54 Plaice (from special hauls)—35 between Redlap and Dartm. Fairway, 1½ m. from shore; remainder 1½ m. E. of Torcross. | ,, April 11 | 163 | ,, | 34 | 35·5 | — |
| Labels: bone buttons. | ,, ,, 26 | 159 | ,, | 33 | 35·5 | — |
| | ,, May 23 | 176 | Off Eddystone | 35 | 35 | ♂ s. |
| | ,, June 18 | 165 | 2 miles off Downend | 28 | — | — |
| | 1903. April 2 | 184* | 8 miles off Downend | 46 | 48 | — |
| | ,, July 28 | 155 | Start Bay | 26·5 | 39 | — |
| IV. Nov. 7th to 9th, 1901. | 1901. Nov. 14 | 299 | ,, | 36 | — | — |
| 108 Plaice (from hauls No. 7, 8, 9, and a special haul on Nov. 7th). | ,, ,, 19 | 205 | ,, | 21·5 | 21 | — |
| Inside Skerries, from off Torcross to Dartmouth Fairway. | ,, ,, 19 | 227 | ,, | 37 | — | — |
| Labels: bone buttons. | ,, ,, 20 | 279 | Teignmouth Bay | 33 | — | — |
| | ,, ,, 29 | 219 | Start Bay | 33·5 | 33·5 | — |
| | ,, Dec. 1 | 207 | 12 to 15 miles off Beer Hd. | 39 | 38 | — |
| | ,, ,, 1 | 276 | Start Bay | 34·5 | — | — |
| | ,, ,, 1 | 254 | ,, (+242 ?) | 27 | — | — |
| | ,, ,, 2 | 257 | 12 to 15 miles off Beer Hd. | 37·5 | 38 | — |
| | ,, ,, 5 | 218 | 2 to 5 miles off Berry Hd. | 34·5 | — | — |
| | ,, ,, 9 | 204 | Start Bay (?) | 33 | — | — |
| | 1902. Jan. 25 | 305 | In deep water off Beer Hd. | 37·5 | — | ♂ s. |
| | ,, Mar. 12 | 203 | Off Beer, in 20 fms. | 23·5 | — | ♂ s. |
| | ,, ,, 22 | 307 | Start Bay | 25·5 | 25·5 | — |
| | ,, April — | 210 | Off Bridport | 33·5 | — | — |
| | ,, ,, 2 | 217 | Spion Kop | 28·5 | 29·5 | ♂ s. |
| | ,, ,, 23 | 222 | Neighb'hood of Start Bay | 36 | 36 | ♂ s. |
| | ,, ,, 23 | 247 | ,, ,, | 28·5 | 29·5 | ♂ s. |
| | ,, May 10 | 202 | 4 miles off Dartmouth | 28 | 32 | — |
| | ,, ,, 17 | 287 | Offshore, off the Start | 36 | 37 (*sic*) | — |
| | ,, ,, 28 | 212 | 8 miles off Downend | 35·5 | 38 | — |
| | ,, July 18 | 268 | Back of New Ridge (3 miles off Downend) | 34·5 | 38·5 | — |
| | ,, Aug. 11 | 252 | Start Bay | 32 | 37 | — |
| | ,, ,, 11 | three | Locality unknown | ? ? ? | — | — |
| | ,, Sept. 13 | 308 | Salcombe Range | 33 | 38 | — |
| | ,, Oct. 17 | 29 (3 ?) | Torbay (3rd figure obscure) | 34 ? | 38 | — |
| | 1903. Feb. 6 | 277 | 20 miles S.W. of Start Pt. | 27·5 | 34 | — |

* Doubtful; see note p. 488.

## TORBAY.

| Particulars of Liberation. Date. No. of fish. Locality. | Particulars of Recovery. Date. | No. of fish. | Locality. | Initial size. | Ultimate size. | Sex. |
|---|---|---|---|---|---|---|
| Batch V. | | | | cm. | cm. | |
| Oct. 10th, 1901. | 1901. Dec. 1 | 287 | Torbay | 23 | — | — |
| 18 fish (from haul No. 11). | ,, ,, 1 | 289 | ,, | 27·5 | — | — |
| Torbay. | ,, ,, 1 | 294 | ,, | 30 | — | — |
| Labels: brass discs. | 1902. Oct. 16 | 298 | ,, | 33 | 38 | — |
| Batch VI. | | | | | | |
| Nov. 14th, 1901. | 1901. Dec. 1 | 325 | ,, | 31 | — | — |
| 7 fish (from haul No. 15). | 1902. May 6 | 327 | 12 miles off Start (latter bearing N.W. ?) | 30 | 30 (*sic*) | — |
| Torbay. | | | | | | |
| Labels: brass discs. | | | | | | |

## TEIGNMOUTH BAY.

| Particulars of Liberation. Date. No. of fish. Locality. | Particulars of Recovery. Date. | No. of fish. | Locality. | Initial size. | Ultimate size. | Sex. |
|---|---|---|---|---|---|---|
| Batch VII. | | | | cm. | cm. | |
| Oct. 9th, 1901. | 1901. Oct. 9 | 237 | Off Dawlish | 21 | — | — |
| 53 Plaice (from haul No. 7). | ,, ,, 12 | 254 | Teignmouth | 29 | — | — |
| Off Teignmouth. | ,, ,, 12 | 263 | Dawlish | 21·5 | — | — |
| Labels: brass discs. | ,, ,, 12 | 265 | Teignmouth | 24·5 | — | — |
| | ,, ,, 30 | 278 | Off Dawlish (caught with hook and line) | 28 | — | — |
| | 1902. Jan. 13 | 256 | Off Beer Head, in 20-25 fms. | 28 | — | — |
| | ,, Feb. 6 | 219 | Off Beer Head, in deep water | 23 | — | — |
| | ,, Apl. 7 | 258 | Teignmouth Bay, inside Ledge | 27 | 31 | — |
| | ,, May 15 | 225 | 6 miles off Beer Head | 20 | 23 | — |
| | ,, July 8 | 247 | 12 miles out from Torbay | 21·5 | — | — |
| | ,, Sept. 4 | 268 | Torbay | 23·5 | — | — |
| | ,, ,, 10 | 236 | Start Bay | 25 | 30·5 | — |
| | ,, Oct. 11 | 248 | Pole Sands, Teignmouth | 21 | 26·5 | — |
| | 1903. Mar. 5 | 244 | Spion Kop | 27·5 | 34·5 | — |
| | ,, ,, 14 | 246 | ,, | 27 | 37 | — |
| Batch VIII. | | | | | | |
| Nov. 13th, 1901. | 1902. Mar. — | 308 | Off Sidmouth and Teignmouth | 28 | — | — |
| 21 Plaice (7, and probably all, from hauls 11 and 12). | ,, Apl. 8 | 314 | Off the Start | 29·5 | — | — |
| Teignmouth Bay; liberated in three batches, off Minicombe, Dawlish, and Clerk Rock. | ,, ,, 11 | 312 | South of Beer Head, in 22 fms. | 28·5 | 32 | ♂ |
| | ,, ,, 23 | 320 | "The Corner" off Start Bay | 32 | — | — |
| | ,, July 10 | 313 | Start Bay | 31 | — | — |
| Labels: brass discs. | ,, Nov. 10 | 305 | Teignmouth Bay | 24 | 30·5 | — |
| Batch IX. | | | | | | |
| Nov. 29th, 1901. | 1901. Dec. 1 | 352 | Teignmouth | 35 | — | — |
| 28 Plaice (from special haul) | 1902. Jan. 24 | 337 | In deep water towards Portland (25 fms.) | 24 | — | — |
| Off Teignmouth 1 mile. | ,, Apl. 11 | 340 | South of Lyme | 31·5 | — | — |
| Labels: brass discs. | ,, ,, 28 | 343 | 7 miles off Exmouth | 23 | — | — |
| | ,, Apl. — | 333 | Off Teignmouth Bay | 25·5 | — | — |
| | ,, May 14 | 355 | 3 miles off Mausands | 23·5 | 27·5 | — |
| | ,, Oct. 11 | 335 | Pole Sands, Teignmouth | 24 | 26·5 | — |
| | ,, ,, 16 | 341 | Babbacombe | 25 | 30·5 | — |
| | 1903. Jan. 8 | 357 | 1 mile off Berry Head | 23 | 30·5 | — |
| | ,, Feb. 7 | 350 | Edge of Eastern Scruff | 34 | — | — |
| | ,, Mar. 5 | 338 | Spion Kop | 33 | 38 | — |
| | ,, ,, — | 339 (or 334 | ,, | 26 (or 29·5) | 35·5 | — |
| | ,, ,, 28 | 336 | ,, | 31·5 | 39·5 | — |

## OUTSIDE THE BAYS.

| Particulars of Liberation. | Particulars of Recovery. | | | | | |
|---|---|---|---|---|---|---|
| Date. No. of fish. Locality. | Date. | No. of fish. | Locality. | Initial size. | Ultimate size. | Sex. |
| Batch X. | | | | cm. | cm. | |
| April 12th and 14th, 1902. | 1902. Apl. 23 | 320 | Neighbourhood of Start Bay | 28 | 27 (*sic*) | ♂ s. ? |
| 11 Plaice. Two liberated 12 miles off Dartmouth (none recovered), and 9 liberated 6 miles S.S.E. from Dartmouth. | ,, May 6 | 315 | 8 miles E. by N. from the Start | 33 | — | — |
| | ,, July 19 | 314 | Start Bay | 35 | — | — |
| | ,, ,, 23 | 313 | ,, | 32 | — | — |
| Labels: bone buttons. | | | | | | |
| Batch XI. | | | | | | |
| May 29th, 1902. | 1902. June 5 | 354 | The Corner, 6 miles off Dartmouth | 32·5 | — | — |
| 62 Plaice. Liberated midway between Berry Head and Orestone. | ,, ,, 14 | 343 | 4 miles off Downend | 28 | 28 | — |
| | ,, ,, 21 | 360 | 10 miles off Downend | 29 | — | — |
| | ,, ,, 21 | 364 | 2 miles off Mausands | 27 | — | — |
| Labels: bone buttons. | ,, ,, 26 | 379 | Start Bay | 30·5 | — | — |
| | ,, July 8 | 369 | Off Berry Head, amongst "The Hitches" | 29·5 | 30 | — |
| | ,, ,, 10 | 322 | New Ridge (3 miles off Downend) | 23 | 24 | — |
| | ,, ,, 12 | 349 | Start Bay | 30 | — | — |
| | ,, ,, 17 | 338 | 2 miles off Downend | 28 | 28 | — |
| | ,, ,, 19 | 365 | Start Bay | 24·5 | 26·5 | — |
| | ,, Aug. 30 | 342 | ,, | 29 | 30 | — |
| | ,, Sept. 1 | 367 | ,, | 29·5 | 33 | — |
| | ,, ,, 12 | 329 | ,, | 25 | 27·5 | — |
| | ,, ,, 27 | 332 | ,, | 27 | 27·5 | — |
| | ,, Oct. 2 | 344 | ,, | 29 | 30·5 | — |
| | ,, 9 | 347 | Torbay | 29 | 35·5 | — |
| | ,, Nov. 16 | 373 | Off Eddystone (Plymouth trawler) | 30 | — | — |
| | 1903. Apl. 29 | 324 | Torbay, just inside Berry Head | 22 | 31·5 | — |
| | ,, May 1 | 328 (or 326) | Spion Kop | 25 (or 26·5) | 30 | — |
| | ,, ,, 27 | 336 | (No locality; found in fish store) | 28 | 30 | — |
| | ,, June 16 | 383 | 5 miles off Berry Head | 35 | 42 | — |
| | ,, July 27 | 361 | Start Bay | 29 | 37·5 | — |

In the above tables the letter "s" after the symbol of sex indicates "spawning" or "spent."

### 3. RATE OF GROWTH OF PLAICE.

By comparing the sizes of the marked plaice when recovered with their original size when liberated, it should be possible, if due precautions are taken, to obtain a fairly reliable measure of their rate of growth. Nearly seventy of the marked fishes described in the previous section were measured on recapture, partly by Mr. W. J. Sanders at Brixham and partly by Dr. Kyle. Mr. Sanders's measurements appear to have been taken in most cases to the nearest quarter-inch; Dr. Kyle's measurements—which, however, form the minority—were taken to the nearest half-centimetre. The original measurements of the fish at the time of liberation were all taken to the nearest half-centimetre.

In the following table the plaice, whose ultimate sizes were recorded, have been sorted out in order according to the number of days which elapsed between their liberation and recapture, and the increase in length of each fish has been given as recorded. It will be seen that the increments of growth for the same period vary considerably, and it is not certain that they are all reliable, especially in the case of fishes marked with bone buttons, the numbers on which were, in some cases, obscure. The increments of growth recorded cannot, therefore, be relied upon as an exact measure of the range in growth for any one period. The specimens have been further grouped according to the number of months between liberation and capture. The first month is taken to correspond with the period of thirty days from the sixteenth to the forty-fifth after liberation, the mean of the period being thus the thirtieth day. The second month covers the period from the forty-sixth to the seventy-fifth day, and so on. The fishes have been further sorted out, according to their original size, on liberation, into three groups: (1) fishes from 8 to 11 inches, inclusive (20 to 30 cm.); (2) fishes from 12 to 15 inches (30·5 to 40 cm.); and (3) fishes of 16 inches and upwards (40·5 cm. and upwards). Only one instance of the latter size, however, occurs, and it is a somewhat doubtful record. A distinction has also been drawn between the fishes liberated in the autumn of 1901 and those liberated in the spring of 1902, since the rate of growth in winter and summer is already known to differ considerably.

TABLE XXVI., *showing the Growth of marked Plaice, classified according to (1) season of liberation, (2) original size on liberation, and (3) period of growth in months of thirty days.*

| Liberated in October and November. | | | | | | | | Liberated on May 29th. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Length on liberation. | | | | | | | | Length on liberation. | | | |
| 20–30 cm. (=8″–11″). | | | | 30·5–40 cm. (=12″–15″). | | | | 20–30 cm. (=8″–11″). | | | |
| Month. | Label. | Days. | Increase (cm.) | Month. | Label. | Days. | Increase (cm.) | Month. | Label. | Days. | Increase (cm.) |
| [O] | 205 | 12 | — | [O] | 219 | 12 | — | I. | 343 | 16 | — |
| II. | 95 | 49 | 3·0 | I. | 207 | 24 | — | | 369 | 40 | 0·5 |
| IV. | 307 | 133 | — | | 257 | 24 | 0·5 | | 322 | 42 | 1·0 |
| V. | 217 | 146 | 1·0 | V. | 145 | 149 | 1·5 | II. | 338 | 49 | — |
| | 312 | 149 | 3·5 | | 163 | 164 | 1·5 | | 365 | 51 | 2·0 |
| VI. | 355 | 166 | 4·0 | VI. | 222 | 167 | — | III. | 342 | 93 | 1·0 |
| | 247 | 167 | 1·0 | | 159 | 179 | 2·5 | | 367 | 95 | 3·5 |
| | 130 | 167 | 1·5 | | 12 | 181 | 2·0 | IV. | 329 | 106 | 2·5 |
| | 135 | 169 | 1·5 | | 287‡ | 189 | 1·0 | | 332 | 121 | 0·5 |
| | 327 | 173 | — | VII. | 212 | 202 | 2·5 | | 344 | 126 | 1·5 |
| | 258 | 180 | 4·0 | | 87 | 202 | 2·0 | | 347 | 133 | 6·5 |
| | 202 | 184 | 4·0 | | 176 | 206 | — | | | — | — |
| VII. | 225 | 218 | 3·0 | VIII. | 88 | 234 | 2·0 | | | — | — |
| IX. | 123 | 284 | 2·5 | | 268 | 252 | 4·0 | | | — | — |
| X. | 55 | 301 | 7·0 | IX. | 252 | 276 | 5·0 | | | — | — |
| XI. | 335 | 316 | 2·5 | | 144 | 278 | 3·0 | | | — | — |
| | 341 | 321 | 5·5 | X. | 308 | 308 | 5·0 | | | — | — |
| | 236 | 336 | 5·5 | XI. | 57 | 332 | 7·0 | XI. | 324 | 334 | 9·5 |
| XII. | 305* | 362 | 6·5 | | 75 | 334 | — | XII. | 336 | 363 | 2·0 |
| | 248 | 367 | 5·5 | XII. | 139 | 362 | 4·0 | XIII. | 361 | 395 | 8·5 |
| XIII. | 357 | 405 | 7·5 | | 10 | 365 | 5·5 | | | | |
| XV. | 277 | 454 | 6·5 | | 298 | 371 | 5·0 | | | | |
| XVI. | 339† | 484 | 9·5 | XV. | 338 | 461 | 5·0 | | | | |
| XVII. | 244 | 512 | 7·0 | XVI. | 336 | 484 | 8·0 | | | | |
| | 246 | 521 | 10·0 | XVII. | 18 | 508 | 8·0 | | | | |
| XXI. | 155 | 637 | 13·0 | | | | | | | | |
| *Original length: 46 cm.* | | | | | | | | *Original length: 35 cm.* | | | |
| XVII. | 184§ | ? 520 | 2·0 | | | | | XIII. | 383 | 383 | 7·0 |

It will be seen from the table that for many of the months the number of records is too small to enable an accurate curve to be drawn representing the increase in size through each month of the year. A considerable number of fishes, however, were recaptured during the sixth month after liberation, and a fair number about the twelfth month. In the latter case, however, the records for the eleventh and thirteenth months may also be taken into consideration in order to enlarge the field from which the average for twelve months' growth may be derived. The following table, based on this method, shows the average increase in length for the plaice recovered after six months' and a full year's growth respectively.

* Brass label (Batch VIII.). ‡ Bone label (Batch IV.).

† Record doubtful, possibly 334, in which case the increment would be only 6·0 cm.

§ Record doubtful, the date of capture being given as April 4th, 1902, in one place, and April 4th, 1903, in another. The latter, from other evidence, appears to be correct.

TABLE XXVII., *showing average increase in length of marked Plaice, recorded in the preceding table.*

| Period of Growth. | Length when liberated. | |
|---|---|---|
| | 20 to 30 cm. | 30·5 to 40 cm. |
| Six months (Nov. to April) . . | 2·3 cm. (7 fish) | 1·4 cm. (4 fish) |
| Twelve months (XI. to XIII.) . . | 5·9 cm. (9 fish) | 4·8 cm. (6 fish) |
| ,, omitting Nos. 335, 75, and 336 | 6·9 cm. (7 fish) | 5·7 cm. (5 fish) |

In the above calculation, as regards the half-year's growth, it has only been possible to consider the fishes liberated in October and November; but for the full year's growth the records derived from the autumn and spring fish have been combined. The average increase in size during the first six months is seen to have been 2·3 cm. ($\frac{7}{8}$-inch) in the case of seven fish belonging to the smaller group, and 1·4 cm. ($\frac{1}{2}$-inch) in the case of four fishes belonging to the larger group. This growth, however, included the winter period, and a reference to the detailed table shows that during the summer months the rate of growth was considerably higher. In the case of the fish liberated on May 29th the average growth of two fishes in three months was 2·2 cm. ($\frac{7}{8}$-inch), and of four fishes in four months 2·7 cm. ($1\frac{1}{8}$ inches). These figures refer to the smaller group of fishes from 8 to 11 inches in original length. During the winter period, therefore, these fishes grow no more in six months than they attain in three months during the summer.

For the entire year's growth the average growth of nine fish of the smaller group was 5·9 cm. ($2\frac{1}{3}$ inches), and for six fishes of the larger group 4·8 cm. ($1\frac{7}{8}$ inches).

In each case it is seen that the larger fishes grow more slowly than the smaller fishes, a result which, indeed, is shown by the averages for almost every period specified in the detailed table.

As regards the full year's growth, however, it will be seen in the detailed table that several exceptionally low increases occur among the records, viz. Nos. 335 (2·5 cm.), 75 (0·0 cm.), and 336 (2·0 cm.). As the possibility of errors of measurement or identification has to be borne in mind, we may omit these specimens altogether in order to get an idea of the most usual growth for the twelve months' period. The averages then become 6·9 cm. ($2\frac{3}{4}$ inches) for seven fishes of the smaller group, and 5·7 cm. ($2\frac{1}{4}$ inches) for five fishes of the larger group. If allowance be made for shrinkage of the fish after death before remeasurement, the full year's growth would appear to have been about 3 and $2\frac{1}{2}$ inches in the case of the two groups respectively. The true average growth for plaice of the smaller size-group would probably, indeed, slightly exceed the figure assigned, since, as pointed out in the previous section, relatively few of the 8-inch fish were recovered, and we have seen in this section that the rate of growth was inversely proportional to the original size of the fish.

This experimental result agrees with the evidence of the trawling records. Station VII. in Teignmouth Bay is the chief rearing-ground for small plaice, and a representative haul on that station on October 9th (Table D, haul 7) shows that intervals of 4 inches and about $3\frac{1}{2}$ inches separated the sizes at which the plaice were most abundant, viz. 4 inches, 8 inches, and 11 or 12 inches. These sizes, according to Petersen's method, may be taken as the average sizes of plaice of successive yearly groups, and the intervals between them as the annual increments of growth (cf. also Torbay, same table, Station IV., hauls 1, 4, 8, and 34).

## Section III.

## The Reproduction of the Flat-Fishes.

By

**H. M. Kyle, M.A., D.Sc.**

### 1. SPAWNING PERIOD OF THE PLAICE.

"The spawning periods of the food-fishes have been fully ascertained for the east coast of Scotland by Dr. Fulton and other Scottish workers, and the present occasion afforded a good opportunity of determining the spawning time of the plaice on the south-west coast of England. Mr. Cunningham's work, published in previous numbers of this Journal, and in more compendious form in his book on *Marketable Marine Fishes*, covers the whole field of fishery investigation, and forms therefore an excellent basis for more definite and detailed research. The spawning period of the plaice, for example, is given as January, February, and March for the North Sea and English Channel, and in a general way this is quite correct, but it is somewhat vague. The plaice of the Bristol Channel also spawn during the months mentioned, but on the whole later than those of the English Channel. It is evident, therefore, that we must ascertain the periods at which most plaice are spawning or have spawned, in other words the maximum spawning period as it is generally called. The difficulties in the way of ascertaining this accurately arise from the facts that all fish do not spawn exactly at the same time, and that one fish may take two or more weeks in getting rid of all its spawn. We cannot, therefore, delimit the maximum spawning period to less than two to three weeks, and if we allow for fluctuations in different years, one month is the nearest approximation we can make.

"It is well known that the spawning period extends over a number of months, and isolated cases may occur much earlier and later than the usual period. Specimens examined during November seemed, especially the males, quite ready to spawn, but it was not until the middle of December that spawning was actually observed.

"The observations made during December, January, and February are summarised in the following table, the details with regard to sizes being given in Table XXIX. The various conditions which the reproductive organs may show are classified under three headings: (1) maturing, (2) spawning, (3) spawned. As there has always been some dubiety

TABLE XXVIII. *Spawning Period of the Plaice.*

| | December. | | January 15th. | | January 25th. | | February 10th. | |
|---|---|---|---|---|---|---|---|---|
| | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ |
| Maturing | 22 | 26 | 164 | 91 | — | 9 | — | 11 |
| *Percentage* | *88* | *93* | *71* | *65* | — | *32* | — | *16* |
| Spawning | 3 | 1 | 66 | 27 | 2 | 3 | 35 | 10 |
| *Percentage* | *12* | *3·5* | *29* | *19* | — | *11* | *100* | *14* |
| Spawned | — | 1 | — | 22 | — | 16 | — | 49 |
| *Percentage* | — | *3·5* | — | *16* | — | *57* | — | *70* |
| Total | 25 | 28 | 230 | 140 | 2 | 28 | 35 | 70 |

Total, 292 ♂ + 266 ♀ = 558.

with regard to the demarcation of these stages from one another and from the immature condition, a description may be given of the symptoms chosen as guides for the present work. During the period when the observations were made the difficulty of distinguishing the immature from the mature, whether male or female, is reduced to a minimum. In every case the reproductive organs and not merely the external appearance were examined, and during this period the males only give some trouble. When the testes are clearly developed, but no milt is running, the males are considered to be maturing; if milt comes freely or on slight compression, they are considered as spawning. If the testes are flaccid and a little milt can still be expressed, the males are put down as having spawned. Doubtful specimens are not entered on the list.

"It appears from the table that up to the 15th January the great majority of the males were still maturing, and that less than 30 per cent. could be considered as spawning. After that date all the specimens examined were spawning. The percentages for both sexes agree in showing that the maximum spawning period is later than the 15th of January.

"The females are grouped under the same three headings as the males. Maturing females mean those in which the ova are developing, as far as the stage where a few ova are clear, *i.e.* ripe, but have not yet made their way into the oviduct. Spawning females include all those which have ripe ova in the oviduct, no matter what stage the ovary may be in as regards depletion or emptiness. Spawned females are those in which the ovary is flaccid, and very few, if any, ripe ova still remain.

"The number of maturing females diminishes from 93 per cent. in December to 65 per cent. on the 15th of January, and lastly to 16 per cent. on the 10th of February. The spawning females are at no time numerous, the highest percentage being 19 on the 15th of January. The percentage of spawned females increases from 3·5 in December to 16 on the 15th, 57 on the 25th of January, and 70 on the 10th of February.

"The maximum spawning period may be said to have been reached when 50 per cent. of the specimens observed have spawned, and to have passed when 70 per cent. is attained. On the other hand, if more than 60 per cent. of the specimens have not yet begun to spawn it is evident that the maximum spawning period has not yet arrived. Consequently, the spawning of the plaice on the south-west coast of England is at its height during the third and fourth weeks of January. This holds good for the year under observation, viz. 1902, and if we allow one week on either side for probable fluctuations in other years, we conclude that the maximum spawning period lies between the third week of January and the second week in February.

"From the fact that a number of specimens had not yet begun to spawn on the 10th of February we may conclude that the spawning period is prolonged into March. No specimens were examined during the latter month, but all those seen during the first fortnight of April had finished spawning.

"The number of specimens examined during the present investigations is sufficiently large to test the suggestion made by Holt* that the largest fish of a species spawn the earliest as a rule. The single specimen which was found to have spawned in December was 40 cm. (16 inches), and of the numbers examined in January the small (from 11 to 15 inches) and the large (over 15 inches) are equally distributed amongst the maturing and spawning specimens, but the large clearly preponderate amongst the spawned. Holt's conclusion is justified only partly therefore, and the records for February point in the reverse direction, as the largest specimens examined, 53, 55, and 65 cm. (21 to 26 inches), have not yet begun to spawn. Here, as elsewhere, considerable variation occurs and definite conclusions are hard to find.

* *Journ. M. B. A.*, vol. ii. p. 370.

TABLE XXIX.

*Spawning Period of Plaice.*

| | MATURING. | | | | | | | | SPAWNING. | | | | | | | | SPAWNED. | | | | | | | | TOTAL MATURE. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DEC. | | JANUARY. 15th. | | JANUARY. 25th. | | FEB. 10th. | | DEC. | | JANUARY. 15th. | | JANUARY. 25th. | | FEB. 10th. | | DEC. | | JANUARY. 15th. | | JANUARY. 25th. | | FEB. 10th. | | | | |
| cms. | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ + ♀ |
| 22 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | 1 |
| 23 | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | 1 |
| 24 | — | — | 5 | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | 6 | — | 6 |
| 25 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | 1 |
| 26 | — | — | 3 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 3 | — | 3 |
| 27 | — | — | 3 | 1 | — | — | — | — | — | — | 1 | — | — | — | 1 | — | — | — | — | — | — | — | — | — | 5 | 1 | 6 |
| 28 | 1 | — | 12 | — | — | — | — | — | — | — | 1 | — | — | — | 2 | — | — | — | — | — | — | — | — | — | 16 | — | 16 |
| 29 | — | — | 9 | — | — | 1 | — | — | — | — | 4 | — | — | — | 6 | — | — | — | — | — | — | — | — | 2 | 19 | 3 | 22 |
| 30 | 3 | 1 | 11 | — | — | — | — | 1 | 2 | — | 5 | 1 | — | — | 5 | 1 | — | — | — | 1 | — | 1 | — | 1 | 26 | 7 | 33 |
| 31 | 1 | 2 | 12 | 2 | — | — | — | 1 | — | — | 2 | 1 | 1 | — | 3 | — | — | — | — | — | — | — | — | — | 19 | 6 | 25 |
| 32 | 5 | 1 | 23 | 2 | — | — | — | 1 | — | — | 6 | — | — | — | 3 | 1 | — | — | — | — | — | — | — | 1 | 37 | 6 | 43 |
| 33 | — | 1 | 11 | 1 | — | 1 | — | 1 | — | — | 9 | — | — | — | 3 | 1 | — | — | — | — | — | — | — | 5 | 23 | 10 | 33 |
| 34 | 2 | 3 | 13 | 3 | — | — | — | — | — | — | 6 | 1 | — | — | 4 | — | — | — | — | — | — | — | — | 7 | 25 | 14 | 39 |
| 35 | 5 | 2 | 19 | 4 | — | 1 | — | — | — | — | 5 | 2 | — | — | 2 | 1 | — | — | — | 3 | — | — | — | — | 31 | 13 | 44 |
| 36 | 1 | 4 | 13 | 4 | — | 1 | — | — | — | — | 6 | 1 | 1 | — | 3 | — | — | — | — | — | — | 1 | — | 2 | 24 | 13 | 37 |
| 37 | — | — | 12 | 6 | — | 1 | — | 2 | — | — | — | 1 | — | — | 3 | 2 | — | — | — | 1 | — | 1 | — | 1 | 15 | 15 | 30 |
| 38 | 2 | — | 6 | 1 | — | 1 | — | — | — | — | 5 | 2 | — | — | — | 2 | — | — | — | 1 | — | — | — | 5 | 13 | 12 | 25 |
| 39 | — | 2 | 2 | 11 | — | — | — | — | — | — | 5 | 3 | — | — | — | — | — | — | — | — | — | 1 | — | 3 | 7 | 20 | 27 |
| 40 | — | 2 | 3 | 5 | — | 1 | — | — | — | — | 3 | 3 | — | 2 | — | — | — | 1 | — | — | — | — | — | 4 | 6 | 18 | 24 |
| 41 | — | 1 | 3 | 6 | — | — | — | 1 | — | — | 2 | 1 | — | — | — | — | — | — | — | 2 | — | 1 | — | 4 | 5 | 16 | 21 |
| 42 | — | 1 | 2 | 4 | — | — | — | 1 | — | — | 1 | 1 | — | — | — | — | — | — | — | 1 | — | — | — | 2 | 3 | 10 | 13 |
| 43 | — | 2 | — | 4 | — | — | — | — | 1 | 1 | 4 | 3 | — | — | — | — | — | — | — | 1 | — | — | — | 1 | 5 | 12 | 17 |
| 44 | — | — | — | 8 | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | 2 | — | 1 | — | 13 | 13 |
| 45 | — | 1 | 1 | 6 | — | 1 | — | — | — | — | — | 1 | — | — | — | — | — | — | — | 3 | — | 1 | — | 3 | 1 | 16 | 17 |
| 46 | — | — | — | 6 | — | — | — | — | — | — | — | — | — | — | — | 2 | — | — | — | 1 | — | 1 | — | 1 | — | 11 | 11 |
| 47 | — | — | — | 1 | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | 1 | — | 3 | 3 |
| 48 | — | — | — | 1 | — | — | — | — | — | — | — | 1 | — | 1 | — | — | — | — | — | — | — | 1 | — | 1 | — | 5 | 5 |
| 49 | — | — | — | 4 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | 1 | — | — | — | 6 | 6 |
| 50 | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | 2 | — | 4 | 4 |
| 51 | — | — | — | 2 | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | 1 | — | 4 | 4 |
| 52 | — | — | — | 3 | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | 1 | — | 2 | — | — | — | 7 | 7 |
| 53 | — | 1 | — | 3 | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 5 | 5 |
| 54 | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | 2 | 2 |
| 55 | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | 2 | 2 |
| 56 | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | 1 | — | 1 | — | 4 | 4 |
| 57 | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | 1 | — | — | — | 3 | 3 |
| 58 | — | — | — | 1 | — | — | — | — | — | — | — | 2 | — | — | — | — | — | — | — | 1 | — | — | — | — | — | 4 | 4 |
| 59 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 60 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 61 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 62 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 63 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 64 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 65 | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 1 |
| Total | 22 | 26 | 164 | 91 | — | 9 | — | 11 | 3 | 1 | 66 | 27 | 2 | 3 | 35 | 10 | — | 1 | — | 22 | — | 16 | — | 49 | — | — | 558 |

## 2. SPAWNING GROUNDS.

"It has been pointed out, under the section describing the migration of the plaice, that the majority of the specimens of this species travel some distance from the inshore waters in order to spawn. The largest plaice spawn in 30 to 35 fathoms some 20 to 25 miles offshore, whilst the medium-sized spawn in 25 to 30 fathoms along the line from Start Point to Portland. Some, however, travel but a short distance from the bays, and a few seem actually to spawn within territorial waters.

"During December, 1901, a haul in the deep water (20 fathoms) off Dartmouth Fairway gave, amongst a number not yet ripe, two males with the milt running freely, one spawning female, and one already spawned. During January two similar males and two spawning females were obtained in 15 to 20 fathoms water, whilst eight females had already spawned. In February a score of spawned females was obtained about the same place.

"It is possible that the spawned specimens had migrated outward to the 25-fathom line and returned, but the presence of the spawning males and females at depths less than 20 fathoms renders it probable that all those obtained in Start Bay during January had spawned there. The number was not great. Very few plaice, small or large, are obtained in Start Bay during January.

"The number of spawning and spawned plaice found in Torbay and Teignmouth Bay was still smaller. The depth in these bays, it will be remembered, is under 12 fathoms, where one would not expect to meet spawning plaice. In Torbay, near Berry Head, one spawning male was obtained in December, and two large females (22 and 23 inches) which had already spawned in January. During the latter month, also, three large spawned females were got in Teignmouth Bay. It has been remarked by Fulton that large gravid females occur within territorial waters during the spawning season, and it is probable that the specimens found in Torbay and Teignmouth Bay were of that nature and had not migrated from the bays.

"Of the remaining species of food-fishes which the trawl captured in the bays, only two were found in the spawning condition. During March and April spawning and spawned dabs were found all over the area, within, but mostly without, the territorial waters, whilst towards the end of April two spawning brill (one male and one female) were obtained in Teignmouth Bay. No comment need be made on the dabs, as their ubiquitous nature and habits are well known. The occurrence of spawning brill in less than 12 fathoms of water is, however, quite exceptional, and it is interesting to note that Holt records the same phenomenon, also in Teignmouth Bay.

"The migratory round-fishes—herring, mackerel, and sprat—spawn in Torbay and Teignmouth Bay during the spring, summer, and autumn, but as these are captured by seines and not by trawls they do not concern us here.

## 3. AVERAGE SIZE AT FIRST MATURITY.

"The size at which fish become mature for the first time is of the greatest interest from the biological standpoint. It marks the stage where the species begins to reproduce its kind, and if for the moment we regard this as having been determined by natural selection, we may use the convenient terms of that theory in order to grasp the great significance of the line which divides the immature from the mature. It would be more correct to speak of age rather than size, but for present purposes the terms are interchangeable, whilst 'average size' conveys as yet more meaning to naturalists than 'average age.'

"We might say, then, that natural selection has regulated the size at which each species becomes mature for the first time, as it is of the greatest importance to the species under natural conditions that its individual components should reproduce as early as possible. If there is any risk of the species becoming exterminated, that is to say, if its enemies are many, then the sooner its individuals reproduce the greater will be the chances of the species surviving. Conversely, if its enemies beyond a certain size are comparatively few, so that the inevitable 'struggle' is *within* the species, then the later the stage of first maturity the stronger will be the individuals and the chances of extinction from ordinary causes practically nil. The latter seems to have been the condition of the plaice before man ventured on the deep-sea trawling, and even in these days the new fishing-grounds which are being opened up testify to the same thing. When man appears the conditions are slowly reversed, the large fish apparently grow scarcer, the average size of the race or species is consequently lowered, and a premium placed upon early reproduction. Is the species able, however, to adapt itself to the requirements of its new enemy? Would the average size at which the individuals reproduce for the first time —which size tends to be raised under natural conditions—become lower? In other words, would the individuals under the strain of the new conditions become mature in their third year, say, instead of their fourth as formerly?

"The circumstances which have given rise to the suggestion of this possibility are the following. Man's influence on the deep-sea fishing has gradually spread during the past century from the English Channel northwards, over the North Sea, and within the past twelve years on to Iceland. The average size* at which the female plaice of the southern portions of the North Sea reproduce for the first time is 13 to 14 inches, and the smallest mature female so far recorded is 9 inches.† The largest immature female has been 17 inches. In the northern portions of the North Sea the average size is 15 to 16, whilst the smallest mature and largest immature recorded are 12 and 17 inches respectively. The plaice of Iceland have not yet been closely examined, but they seem to have even larger proportions. The difference between the plaice of the southern and northern portions of the North Sea is just one year's growth. Further, the characters of the adults of the former group resemble those of the younger stages of the latter.

"These problems have already been discussed in a previous paper, and it was left an open question as to whether man's influence, or simply differences in the environment had brought about these differences between the southern and northern North Sea plaice. Further observations and records incline me to lay more stress on the selection exercised by man, whilst not forgetting the possibility that the environmental conditions may play some part. The new records‡ referred to are those of a group of small spawning plaice discovered during March, 1901, near the Borkum Reef in the German Bight. The sizes of the spawning females varied from 21·3 to 26·2 cm. (8·5 to 10·5 inches), and apparently a large number was obtained. If we consider the average size to be 9·5 inches, the difference between this average and that obtained for the southern portion of the North Sea during 1898–1899, viz. 12·5 inches, is again one year's growth.

"The observations are comparatively few in number, it must be admitted, but they point to the conclusion that man's influence may be causing a retrogression in the average size at which the plaice spawn for the first time. This would seem to lead to the further conclusion that the numbers of the species will be maintained at their former level by the earlier reproduction, even if the older and larger fish have been removed by man. This idea has indeed been expressed, though from a different standpoint, but unfortunately nature offers no great compensation, for the large plaice have over ten times more offspring than the small.

"In a former paper the view has been expressed that if we could

* *Eighteenth Rep. S. F. B.*, iii. p. 197.

† J. T. Cunningham, *Journ. M. B. A.*, vol. iv. pp. 17 and 99.

‡ I am indebted to my friend Prof. Ehrenbaum, of Heligoland, for permission to mention these records.

regard the average size at first maturity as a comparatively fixed point in the life-history of the plaice, we might therefrom, by comparison with the average size of the adults, obtain a measure of the increase or decrease in the numbers of the species, but the considerations presented above show that we can no more rely upon it than upon any other variable and varying stage. One important consequence is that we cannot accept, without repeated investigation, the results obtained in previous years, as a record of ten years ago may no longer hold true.

"The plaice on the south-west coast of England have been investigated at various times by Mr. Cunningham, and the results are given in vol. iii. p. 69 *et seq.* of this Journal. One hundred and nine specimens were examined during the winter, *i.e.* during the spawning season, and of these forty-two were males, sixty-seven females. The smallest mature male was 9 inches long, the largest immature 12 inches. The smallest mature female was likewise 9 inches, and the largest immature 14 inches long.

"During the present investigations a considerable number of plaice were examined from all quarters and at all sizes. The spawning months, from November to March, were deliberately chosen, and all doubtful males have been excluded from the list. The following tables show the numbers at the various sizes mentioned:—

TABLE XXX.—1. *Males.*

| Length in centimetres | 20, 21 | 22, 23 | 24, 25 | 26, 27 | 28, 29 | 30, 31 | 32, 33 | 34, 35 | 36, 37 | Total. |
|---|---|---|---|---|---|---|---|---|---|---|
| Immature . . | 13 | 11 | 17 | 3 | 5 | 2 | 2 | 1 | 0 | 54 |
| *Percentage* . | *81* | *61* | *63* | *25* | *14* | *5* | *4* | *2* | — | |
| Mature . . | 3 | 7 | 10 | 9 | 30 | 40 | 55 | 50 | 33 | 237 |
| *Percentage* . | *19* | *39* | *37* | *75* | *86* | *95* | *96* | *98* | *100* | |

2. *Females.*

| Length in centimetres | 26, 27 | 28, 29 | 30, 31 | 32, 33 | 34, 35 | 36, 37 | 38, 39 | 40, 41 | 42, 43 | Total. |
|---|---|---|---|---|---|---|---|---|---|---|
| Immature . . | 5 | 18 | 22 | 11 | 17 | 11 | 6 | 0 | 1 | 91 |
| *Percentage* . | *83* | *86* | *61* | *41* | *39* | *27* | *16* | — | *4* | |
| Mature . . | 1 | 3 | 14 | 16 | 27 | 29 | 32 | 34 | 22 | 178 |
| *Percentage* . | *17* | *14* | *39* | *59* | *61* | *73* | *84* | *100* | *96* | |

"It appears from these tables that the ranges of variation are greater than those detected by Cunningham. The smallest mature males were 21 cm. long ($8\frac{1}{4}$ inches), and a special search would, I think, discover even smaller mature specimens. The largest immature male was 34 cm. ($13\frac{1}{2}$ inches), or 13 cm. longer than the smallest mature. The smallest mature female was 26 cm. ($10\frac{1}{4}$ inches), and the largest immature 42 cm.

(16½ inches). The range of variation is therefore from 13 to 16 cm. (5 to 6 inches). For the North Sea specimens the same range was found to be 12 to 14 cm.

"According to Dr. Fulton,* all plaice probably spawn at the same age, and the difference in size is simply a difference in the rate of growth. I am inclined to think, however, that the range of variation (6 inches) is too great for the difference due to the rate of growth under natural conditions. The fact, also, that the difference in average size at first maturity of the southern and northern North Sea plaice is approximately equal to one year's growth speaks in favour of the same conclusion." * * * * *

The average size at which each sex matures for the first time being that at which 50 per cent. become mature, it may be concluded from these data that the average size for the females is 31·5 cm. (= 12·5 inches), and for the males about 25 cm. (= 10 inches). Dr. Kyle concludes:— "These values are a little less than those for the plaice of the southern parts of the North Sea. If we assume that the numbers of the males and females are approximately equal, then 28 cm. (11 inches) represents the average size at which all plaice of both sexes become mature for the first time."

## SECTION IV.

## General Summary and Conclusions.

By

**Walter Garstang, M.A., F.Z.S.**

The facts and experiments recorded in the preceding sections lead to the following main conclusions:—

(1) Plaice below 8 inches in length are practically confined to the inshore waters of the bays at all seasons of the year. They are especially abundant in Teignmouth Bay and Torbay, where they are caught with the usual trawl-mesh in numbers at least as great as those of all the larger sizes of plaice taken together. In Start Bay, on the other hand, these small plaice are far less numerous than the larger fish, which outnumber them by eighteen to one (Table II., p. 449).

In correlation with these facts the average size of all the plaice caught during 1901–2 was found to be 12·8 inches for Start Bay, 7·8 inches for Torbay, and 7·9 inches for Teignmouth Bay.

The actual percentages of small plaice caught in the bays were—Teignmouth Bay, 60 per cent.; Torbay, 50 per cent.; Start Bay, 4 per cent.

* *Twentieth Ann. Rep. S. F. B.*, iii. p 359.

(2) On attaining a length of 8 inches the plaice in Teignmouth Bay and Torbay tend to emigrate—in summer into Start Bay, and in winter over the offshore grounds. The special statistics appear to show that about 44 per cent. of the plaice caught offshore by the Brixham "Mumble Bees" are immature fish from 8 to 10 inches in length. These are doubtless derived for the most part from the two bays mentioned, although Sidmouth Bay and Lyme Bay probably contribute. Few of these fishes, however, are derivable from Start Bay; the marking experiments revealed a much slighter tendency for fishes of this size to emigrate from Start Bay than from the other two.

(3) Teignmouth Bay and Torbay are thus essentially nurseries or rearing grounds for the smallest plaice. They furnish the original stock from which Start Bay and the offshore grounds are annually recruited.

Start Bay, on the other hand, is not a nursery for plaice.

(4) Apart from seasonal changes in abundance caused by periodic migrations, the population of flat-fish in the bays is subject to considerable fluctuations from one year to another. These fluctuations are not traceable to the operation of the Committee's bye-laws, since fluctuations in both directions (viz. of increase and of decrease) have taken place at intervals during the period of closure. They appear to be attributable to the effects of good and bad spawning seasons, and especially to the direction of the winds during the period when the eggs and larvæ of the fish are drifting in the water prior to metamorphosis.

(5) The closure of the bays to trawlers appears to be useful only in so far as it protects the plaice from premature destruction. From this point of view the closure of Start Bay is ineffective, since the small fish are present in inappreciable numbers. Even the plaice below 12 inches in length in Start Bay did not amount, in 1901–2, to 30 per cent. of the total, which is considerably less than the percentage landed by the fishermen from the fishing grounds in general during 1902 (44 per cent.).

On the other hand, the closure of Teignmouth Bay and Torbay must be of great value for the upkeep of the fishery, since these bays furnish an important, and probably the chief, source of supply of young plaice for the trawling grounds in general.

(6) The closure of the bays does not protect the spawning fish to an appreciable extent, since the latter spawn mostly offshore.

(7) The closure of Teignmouth Bay (and probably of Torbay) defers the period of capture of a certain number of marketable fish, but does not cause any serious deprivation to the fishermen, since the same fish are available for capture after emigration from the bays when of larger

size and higher value. The marking experiments show that at least 41 per cent. of the marketable plaice marked in Teignmouth Bay were subsequently caught by the fishermen, viz. 31 per cent. during the first year, and 10 per cent. during the second.

On the other hand, the closure of Start Bay appears to deprive the small trawlers of a serious proportion of the large plaice which they would otherwise secure. Only 23½ per cent. of the marked plaice from Start Bay were recovered, viz. 21½ per cent. in the first year and 2 per cent. in the second. The difference between the percentages in the two experiments appears to indicate that about 10 per cent. of the large plaice in Start Bay annually migrate outside the area of the Mumble Bees altogether. It is impossible at present to say whether this migration materially affects the upkeep of the trawling grounds in the Channel, to which it undoubtedly contributes; but, regarding the matter merely from the standpoint of the Brixham fishery, it appears fairly certain that the closure of Start Bay altogether deprives the small trawlers of a considerable number of large plaice, against the capture of which no biological objections can be urged.

(8) In view of the facts ascertained by these investigations, and having regard to the permanent maintenance of the fishery, it would appear to be highly inadvisable to rescind the regulation which prohibits trawling in Teignmouth Bay and Torbay. On the other hand there are no biological reasons against the reopening of Start Bay, either as a whole or in its northern part alone, as suggested by Mr. Holt in his previous report.

In this connection it cannot be overlooked that the natural migrations of the fishes determine to a large extent the areas in a particular district which it is profitable or unprofitable for the trawlers to work over. There is no doubt that during the autumn months the plaice are concentrated in the bays, especially in Start Bay. At this season of the year the trawlers are limited by the closure of the bays to the soles and whiting on the offshore grounds (cf. Table A).

## Table A.

*Weekly number of Plaice, Soles, and Whiting captured by "Mumble Bees" during One Year (February 1st, 1902, to January 31st, 1903), with proportion of Small to Large.*

| | Plaice. | | | | | Soles. | Whiting. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1902. | No. of Trunks. | No. of Fish. | No. of Baskets. | No. of Fish. | Proportion %. | Pairs of. | No. of Trunks. | No. of Fish (Large). | No. of Fish (Medium). | No. of Baskets. | No. of Fish (Small) |
| Feb. 3–8 | 38 | 3,420 | 50 | 1,250 | — | 525 | 93 | 1,209 | 7,440 | 465 | 33,015 |
| ,, 10–15 | 81 | 7,290 | 56 | 1,400 | — | 1,560 | 276 | 3,588 | 22,080 | 880 | 79,980 |
| ,, 17–22 | 79 | 7,110 | 24 | 600 | — | 1,040 | 240 | 3,120 | 19,200 | 780 | 70,080 |
| ,, 24–Mar. 1 | 53 | 4,770 | 43 | 1,075 | — | 648 | 216 | 2,808 | 17,280 | 455 | 54,180 |
| Total. | 251 | 22,590 | 173 | 4,325 | 19 | 3,773 | 825 | 10,725 | 66,000 | 2,580 | 237,255 |
| March 3–8 | 100 | 9,000 | 110 | 2,750 | — | — | 60 | 780 | 4,800 | 200 | 17,700 |
| ,, 10–15 | 16 | 1,440 | — | — | — | — | 20 | 260 | 1,600 | 100 | 7,100 |
| ,, 17–22 | 40 | 3,600 | 12 | 300 | — | — | 50 | 650 | 4,000 | 150 | 14,150 |
| ,, 24–29 | 74 | 6,660 | 53 | 1,325 | — | — | 14 | 182 | 1,120 | 160 | 8,210 |
| Total. | 230 | 20,700 | 175 | 4,375 | 21 | — | 144 | 1,872 | 11,520 | 610 | 47,160 |
| Mar. 31–Ap. 5 | 98 | 8,820 | 76 | 1,900 | — | — | — | — | — | 200 | 7,200 |
| April 7–12 | 135 | 12,150 | 250 | 6,250 | — | — | — | — | — | 22 | 792 |
| ,, 14–19 | 56 | 5,040 | 90 | 2,250 | — | — | — | — | — | — | — |
| ,, 21–26 | 65 | 5,850 | 126 | 3,150 | — | — | — | — | — | — | — |
| ,, 28–May 3 | 200 | 18,000 | 250 | 6,250 | — | 350 | 19 | 247 | 1,520 | 65 | 5,665 |
| Total. | 554 | 49,860 | 792 | 19,800 | 40 | 350 | 19 | 247 | 1,520 | 287 | 13,657 |
| May 5–10 | 50 | 4,500 | 120 | 3,000 | — | 390 | 28 | 364 | 2,240 | 115 | 9,040 |
| ,, 12–17 | 32 | 2,880 | 30 | 750 | — | 675 | 28 | 364 | 2,240 | 100 | 8,500 |
| ,, 19–24 | 25 | 2,250 | 24 | 600 | — | 630 | 15 | 195 | 1,200 | 45 | 4,245 |
| ,, 26–31 | 31 | 2,790 | — | — | — | 650 | 39 | 507 | 3,120 | 130 | 11,505 |
| Total. | 138 | 12,420 | 174 | 4,350 | 35 | 2,345 | 110 | 1,430 | 8,800 | 390 | 33,290 |
| June 2–7 | 72 | 6,480 | 70 | 1,750 | — | 1,740 | 98 | 1,274 | 7,840 | 430 | 32,630 |
| ,, 9–14 | 50 | 4,500 | 110 | 2,750 | — | 864 | 114 | 1,482 | 9,120 | 378 | 33,558 |
| ,, 16–21 | 25 | 2,250 | 134 | 3,350 | — | 840 | 102 | 1,326 | 8,160 | 600 | 39,450 |
| ,, 23–28 | 17 | 1,530 | 40 | 1,000 | — | — | 75 | 975 | 6,000 | 500 | 31,125 |
| Total. | 164 | 14,760 | 354 | 8,850 | 60 | 3,444 | 389 | 5,057 | 31,120 | 1,908 | 136,763 |
| June 30–July 5 | 16 | 1,440 | 18 | 450 | — | 300 | 21 | 273 | 1,680 | 150 | 9,075 |
| July 7–12 | 40 | 3,600 | 50 | 1,250 | — | 1,139 | 135 | 1,755 | 10,800 | 750 | 50,625 |
| ,, 14–19 | 23 | 2,070 | 88 | 2,200 | — | 1,275 | 69 | 897 | 5,520 | 630 | 34,755 |
| ,, 21–26 | 24 | 2,160 | 80 | 2,000 | — | 1,200 | 228 | 2,964 | 18,240 | 1,470 | 92,820 |
| ,, 28–Aug. 2 | 16 | 1,440 | 150 | 3,750 | — | 1,800 | 320 | 4,160 | 25,600 | 1,500 | 110,000 |
| Total. | 119 | 10,710 | 386 | 9,650 | 90 | 5,714 | 773 | 10,049 | 61,840 | 4,500 | 297,275 |
| Aug. 4–9 | 5 | 450 | 182 | 4,550 | — | 1,425 | 128 | 1,664 | 10,240 | 1,310 | 69,560 |
| ,, 11–16 | 10 | 900 | 104 | 2,600 | — | 1,150 | 157 | 2,041 | 12,560 | 1,450 | 79,675 |
| ,, 18–23 | 8 | 720 | 88 | 2,200 | — | 1,800 | 240 | 3,120 | 19,200 | 1,400 | 92,400 |
| ,, 25–30 | 2 | 180 | 52 | 1,300 | — | 1,080 | 103 | 1,339 | 8,240 | 1,360 | 66,985 |
| Total. | 25 | 2,250 | 426 | 10,650 | 473 | 5,455 | 628 | 8,164 | 50,240 | 5,520 | 308,620 |

TABLE A—*continued.*

| | Plaice. | | | | | Soles. | Whiting. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1902. | No. of Trunks. | No. of Fish. | No. of Baskets. | No. of Fish. | Proportion %. | Pairs of. | No. of Trunks. | No. of Fish (Large). | No. of Fish (Medium). | No. of Baskets. | No. of Fish (Small). |
| Sept. 1–6 . | 1 | 90 | 50 | 1,250 | — | 1,430 | 123 | 1,599 | 9,840 | 1,400 | 71,925 |
| ,, 8–13 . | 2 | 180 | 72 | 1,800 | — | 2,310 | 228 | 2,964 | 18,240 | 1,900 | 108,300 |
| ,, 15–20 . | 3 | 270 | 80 | 2,000 | — | 2,145 | 239 | 3,107 | 19,120 | 1,410 | 92,585 |
| ,, 22–27 . | 8 | 720 | 60 | 1,500 | — | 1,425 | 180 | 2,340 | 14,400 | 1,410 | 82,260 |
| Total. . | 14 | 1,260 | 262 | 6,550 | 520 | 7,310 | 770 | 10,010 | 61,600 | 6,120 | 355,070 |
| Sept. 29–Oct. 4 | 2 | 180 | 50 | 1,250 | — | 2,316 | 295 | 3,835 | 23,600 | 2,700 | 148,825 |
| Oct. 6–11 . | 1 | 90 | 50 | 1,250 | — | 1,000 | 197 | 2,561 | 15,760 | 1,420 | 85,595 |
| ,, 13–18 . | 2 | 180 | 60 | 1,500 | — | 1,215 | 270 | 3,510 | 21,600 | 1,420 | 98,370 |
| ,, 20–25 . | — | — | 48 | 1,200 | — | 1,380 | 55 | 715 | 4,400 | 740 | 36,265 |
| ,, 27–Nov. 1 | — | — | 64 | 1,600 | — | 2,320 | 126 | 1,638 | 10,080 | 1,550 | 77,850 |
| Total. . | 5 | 450 | 272 | 6,800 | 1,511 | 8,231 | 943 | 12,259 | 75,440 | 7,830 | 446,905 |
| Nov. 3–8 . | — | — | 76 | 1,900 | — | 1,000 | 248 | 3,224 | 19,840 | 2,300 | 126,200 |
| ,, 10–15 . | 3 | 270 | 180 | 4,500 | — | 2,115 | 410 | 5,330 | 32,800 | 2,850 | 174,350 |
| ,, 17–22 . | 1 | 90 | 18 | 450 | — | 600 | 255 | 3,315 | 20,400 | 1,550 | 100,425 |
| ,, 24–29 . | — | — | 60 | 1,500 | — | 360 | 55 | 715 | 4,400 | 550 | 29,425 |
| Total. . | 4 | 360 | 334 | 8,350 | 2,319 | 4,075 | 968 | 12,584 | 77,440 | 7,250 | 430,400 |
| Dec. 1–6 . | 17 | 1,530 | 96 | 2,400 | — | 735 | 306 | 3,978 | 24,480 | 1,925 | 122,850 |
| ,, 8–13 . | 1 | 90 | 70 | 1,750 | — | 585 | 298 | 3,874 | 23,840 | 2,525 | 143,050 |
| ,, 15–20 . | 10 | 900 | 62 | 1,550 | — | 1,250 | 480 | 6,240 | 38,400 | 3,500 | 210,000 |
| ,, 22–31 . | 2 | 180 | 40 | 1,000 | — | 150 | 245 | 3,185 | 19,600 | 1,810 | 108,035 |
| Total. . | 30 | 2,700 | 268 | 6,700 | 248 | 2,720 | 1,329 | 17,277 | 106,320 | 9,760 | 583,935 |
| 1903. | | | | | | | | | | | |
| Jan. 1-8 . | 10 | 900 | 16 | 400 | — | 530 | 191 | 2,483 | 15,280 | 1,220 | 77,345 |
| ,, 5–10 . | 31 | 2,790 | 94 | 2,350 | — | — | 345 | 4,485 | 27,600 | 2,120 | 136,695 |
| ,, 12–17 . | 41 | 3,690 | 60 | 1,500 | — | 1,415 | 210 | 2,730 | 16,800 | 1,150 | 78,150 |
| ,, 19–24 . | 4 | 360 | 134 | 3,350 | — | 1,619 | 252 | 3,276 | 20,160 | 1,320 | 91,620 |
| ,, 26–31 . | 2 | 180 | 106 | 2,650 | — | 1,110 | 129 | 1,677 | 10,320 | 840 | 52,815 |
| Total. . | 88 | 7,920 | 410 | 10,250 | 129 | 4,674 | 1,127 | 14,651 | 90,160 | 6,650 | 436,625 |

## TABLE B.

# LIST OF TRAWLING STATIONS.

### START BAY.

| No. of Haul. | Date. | Locality and Course. | Station. | Hour Trawl Shot. | Duration of Haul. h. m. | Remarks. |
|---|---|---|---|---|---|---|
| | 1901. | | | | | |
| 1 | July 30 | Start Bay (inshore); two hauls combined. | II. | 8.45 a.m. | 2 35 | 18 Plaice marked (experimental). |
| 2 | ,, 30 | Start Bay (central part) . . | I. | 1 p.m. | 2 0 | 10 Plaice marked (experimental). |
| 3 | Aug. 7 | ,, ,, . . | I. | 11.30 a.m. | 2 0 | 12 Plaice marked (experimental). |
| 4 | ,, 8 | ,, N.E. part; depth 8–12 fms. | I. | Forenoon. | 1 10 | |
| 5 | ,, 9 | Haul close inshore from Torcross to Street Gate in 5–6 fms. | II. | — | 1 10 | 2 Plaice marked (experimental). |
| 6 | Sept. 6 | From inside Skerries Buoy to Hallsands. | III. | 1 p.m. | 2 0 | |
| 7 | ,, 7 | Shot farther to S.W. than on previous day, and continued farther down to off Hallsands, 1 mile from Start Point. | III. | 6.10 a.m. | 2 0 | 20 Plaice marked (experimental). |
| 8 | ,, 7 | From beginning of measured line above Torcross towards Street Head; direction N.E., then E.N.E., past Earlstone, towards East Blackstone until off Warren Point. | II. | 9.50 a.m. | 2 0 | |
| 9 | ,, 9 | Start Bay (centre of bay) . | I. | 6.35 a.m. | 1 55 | |
| 10 | ,, 9 | ,, (inshore); stopped off Street Point, trawling against tide. | II. | 9.40 a.m. | 2 0 | |
| 11 | ,, 9 | 3 miles off Torcross, heading N. in thick fog, hauled up just above Torcross, about a mile from shore. | I. | 5.30 p.m. | 1 5 | |
| 12 | ,, 10 | Round S.W. corner of Skerries | III. | 6 a.m. | 2 0 | |
| 13 | ,, 10 | Down centre of Start Bay, from off Royal Sands Hotel, towards Start Point, ending off Hallsands. | I. | 10.25 a.m. | 1 15 | |
| 14 | Oct. 1 | From near Skerries Buoy towards Start Point. | III. | 3.20 p.m. | 1 10 | |
| 15 | ,, 1 | Off Torcross towards Blackpool | II. | 5.40 p.m. | 2 0 | |
| 16 | ,, 2 | Began off Dartmouth Fairway, Southern Point. | I. | Noon. | 2 15 | 40 Plaice marked. |
| 17 | ,, 3 | Start Bay (central part) . . | I. | 4 a.m. | 1 30 | |
| 18 | ,, 3 | ,, ,, . . | I. | 1.15 p.m. | 2 0 | 38 Plaice marked. |
| 19 | ,, 3 | Inshore, along Slapton Sands, 7½ fms. and 8 later. | II. | 4.30 p.m. | 1 0 | 6 Plaice marked. |
| 20 | ,, 4 | Start Bay (central part) . . | I. | 12.40 p.m. | 1 10 | 15 Plaice marked. |
| 21 | ,, 11 | ,, ,, . . | I. | 1.50 p.m. | 2 0 | 6 Plaice marked. |
| 22 | Nov. 6 | ,, ,, . . | I. | 7.30 a.m. | 2 0 | |
| 23 | ,, 6 | On the Skerries . . . | III. | 10.50 a.m. | 1 0 | |
| 24 | ,, 7 | Start Bay (central part) . . | I. | 1.5 p.m. | 3 0 | 11 Plaice marked. |
| 25 | ,, 8 | Inshore from Straight Point, ½ mile from shore, hence out off Gully, keeping house at foot in line with two trees on top until Blackpool and Cod Rock in line, then to Cod. | II. | 12.30 p.m. | 1 50 | 26 Plaice marked. |

## Table B—*continued.*

### START BAY—*continued.*

| No. of Haul. | Date. | Locality and Course. | Station. | Hour Trawl Shot. | Duration of Haul. h. m. | Remarks. |
|---|---|---|---|---|---|---|
| | 1901. | | | | | |
| 26 | Nov. 9 | Northern portion of bay . . | I. | 3.45 a.m. | 3 0 | |
| 27 | ,, 9 | From Torcross to Straight Point, then out and turned back towards Torcross. | II. | 8.15 a.m. | 2 5 | 30 Plaice marked. |
| 28 | ,, 9 | Out round Oyster Bank to off Beesands. | II. | 11.50 a.m. | 1 0 | |
| 29 | ,, 15 | Start Bay (centre) . . . | I. | 2.10 p.m. | 2 30 | |
| 30 | ,, 16 | Start Point to Roughs . . | IIA. | 7.25 a.m. | 0 40 | |
| 31 | Dec. 17 | Start Bay (centre) . . . | I. | 8 a.m. | 3 0 | |
| 32 | ,, 17 | Along inside Skerries (1 h. 30 m.), and again as before, but towing to Start Point (1 h. 40 m.); two hauls combined. | III. | 12.20 p.m. | 3 10 | Trawl entangled in c or two crablines S.W. corner duri second haul. |
| 33 | ,, 17 | Start Bay (centre) . . . | I. | Night. | 3 0 | |
| 34 | ,, 18 | Northern portion, from Blackpool Sands to Skerries Buoy, in again to Slapton Sands, then out. | I. | 1.40 p.m. | 3 0 | |
| 35 | ,, 18 | Northern portion of bay, starting from off Mewstone, trawling south to 20 fms., then in towards Blackpool Sands, then out to Skerries Buoy, returning over same course. | I. | 7.10 p.m. | 3 0 | |
| 36 | ,, 19 | Northern portion, from Torcross, close inshore towards Mewstone, then off Blackpool towards eastwards to ½ mile from Buoy, then west to Torcross and out again. | I. | 2.30 p.m. | 3 0 | |
| 37 | ,, 19 | Start Bay, all over Bay . . | I. | 9.30 p.m. | 4 0 | Dabs and Gurnar not measured. |
| | 1902. | | | | | |
| 38 | Jan. 21 | N.E. portion, from Blackpool towards Bell Buoy, then down centre. | I. | 5.15 p.m. | 1 45 | |
| 39 | ,, 22 | Along inside Skerries . . | III. | 2.15 p.m. | 1 30 | |
| 40 | ,, 24 | From off Blackpool to off Hallsands, and return. | I. | 2 p.m. | 3 30 | |
| 41 | ,, 25 | Deep water from Mewstone to Skerries Buoy. | I. | — | 1 0 | |
| 42 | Feb. 4 | N.E. portion, Bell Buoy to Mewstone. | I. | 12.45 p.m. | 1 45 | |
| 43 | ,, 5 | N.E. corner, from Mewstone to Bell Buoy. | I. | 10.15 a.m. | 1 15 | |
| 44 | Apl. 8 | Start Bay, N.E. portion . . | I. | 6.25 p.m. | 0 40 | |
| 45 | ,, 14 | Mewstone to Skerries Buoy . | I. | 5.30 p.m. | 1 0 | |
| 46 | ,, 15 | On the Skerries . . . | III. | 7.50 a.m. | 1 0 | |
| 47 | ,, 15 | Start Bay (centre) . . . | I. | 9.30 a.m. | 2 30 | |
| 48 | ,, 15 | Inside Skerries . . . | III. | 2.50 p.m. | 2 0 | |
| 49 | May 22 | Start Bay, N.E. corner . . | I. | 8.25 a.m. | 2 0 | |
| 50 | ,, 22 | ,, (centre) . . . | I. | 11.10 a.m. | 2 0 | |
| 51 | ,, 22 | N.E. corner, Blackpool to Buoy, then to Fairway. | I. | 2.45 p.m. | 3 0 | |
| 52 | ,, 23 | Start Bay, N.E. corner . . | I. | 6.20 a.m. | 1 45 | |
| 53 | ,, 24 | ,, (centre) . . . | I. | 10.5 a.m. | 2 30 | |
| 54 | ,, 24 | Inshore, along Slapton Sands to off Oyster Bank. | II. | 1.45 p.m. | 1 0 | |

TABLE B—*continued.*

START BAY—*continued.*

| No. of Haul. | Date. | Locality and Course. | Station. | Hour Trawl Shot. | Duration of Haul. h. m. | Remarks. |
|---|---|---|---|---|---|---|
| | 1902. | | | | | |
| 55 | May 29 | Start Bay, N.E. corner . . | I. | Night. | 6 0 | Plaice alone measured. |
| 56 | June 19 | ,, ,, . . | I. | 11.30 a.m. | 1 0 | |
| 57 | ,, 26 | ,, ,, . . | I. | 4.15 p.m. | 1 0 | |
| 58 | ,, 27 | ,, (centre) . . | I. | 5.50 a.m. | 1 30 | |
| 59 | ,, 30 | ,, ,, Two hauls combined. | I. | 6.55 p.m. | 3 0 | |
| 60 | July 21 | Mewstone on Downend; shot rather outside marks, towed in towards Slapton Ley till marks were right, towed towards Redlap, hauled 1 mile off Blackpool. | I. | 3.10 p.m. | 2 25 | Homelyn and Blonde Rays not distinguished. |
| 61 | ,, 22 | Shot off E. end of Slapton Sands, hauled off Torcross. | II. | 10.10 a.m. | 0 50 | |
| 62 | ,, 22 | Shot off Fairway Buoy, Dartmouth, hauled off Torcross. | I. | 12.10 p.m. | 1 30 | Homelyn and Blonde Rays not distinguished. |
| 63 | ,, 25 | Centre of bay, Downend on Mewstone; towed towards Blackpool Sands, then out again towards 2 m. S.W. of Mewstone | I. | 8.25 a.m. | 1 45 | |
| 64 | Aug. 25 | Start Bay, N.E. corner . . | I. | 8.30 p.m. | 1 0 | |
| 65 | ,, 26 | ,, (centre) . . . | I. | 11.45 a.m. | 3 0 | |
| 66 | ,, 27 | Along Slapton Sands, starting from Street Point. | II. | 3.55 p.m. | 1 15 | |
| 67 | ,, 28 | Inshore, Slapton Sands, hauled up before passing Street Point. | II. | 11.55 a.m. | 0 30 | |
| 68 | ,, 28 | Start Bay, N.E. corner . . | I. | 1 p.m. | 2 0 | |
| 69 | ,, 28 | ,, (centre) . . . | I. | 3.40 p.m. | 3 0 | Plaice alone measured. |
| 70 | Oct. 6 | ,, (N.E. part) . . | I. | 9 a.m. | 1 30 | |

TABLE B—*continued.*

TORBAY.

| No. of Haul. | Date. | Locality and Course. | Station. | Hour Trawl Shot. | Duration of Haul. h. m. | Remarks. |
|---|---|---|---|---|---|---|
| | 1901. | | | | | |
| 1 | July 31 | Torbay, inshore . . . | IV. | 10.40 a.m. | 1 40 | |
| 2 | ,, 31 | ,, . . . . . . . | VI. | 4 p.m. | 1 10 | 8 Plaice marked. |
| 3 | Aug. 1 | ,, . . . . . . . | V. | 8.55 a.m. | 1 5 | 16 Plaice marked. |
| 4 | Sept. 11 | ,, hauled up beyond breakwater, Brixham. | IV. | 11.35 a.m. | 1 30 | |
| 5 | ,, 11 | Torbay, from Berry Head to Orestone. | VI. | 1.45 p.m. | 1 30 | |
| 6 | ,, 12 | From Goodrington Sands, along inside foul ground, ½ to ¾ mile from shore, as far as Fishcombe Cove. | IVA. | — | 1 0 | |
| 7 | ,, 12 | Diagonally across bay, from Berry Head to Torquay, ½ mile from shore, about ½ mile out from Torquay. | V. | 3.40 p.m. | 1 0 | |
| 8 | Oct. 7 | Torbay . . . . . . | IV. | 12.35 p.m. | 1 15 | |
| 9 | ,, 7 | ,, inside "Rough" . . | IVA. | 2.45 p.m. | 1 0 | |
| 10 | ,, 10 | From Paignton Pier towards Brixham, inside Rough. | IVA. | 7.15 a.m. | 1 0 | |
| 11 | ,, 10 | Torbay, trawling towards Brixham. | V. | 9.15 a.m. | 1 15 | 18 Plaice marked. |
| 12 | ,, 11 | Torbay, inside Rough . . | IVA. | — | 1 0 | |
| 13 | Nov. 11 | Ilsham to Brixham . . . | V. | 7.55 a.m. | 1 0 | |
| 14 | ,, 12 | Inside Rough . . . . . | IVA. | 8.25 a.m. | 0 50 | |
| 15 | ,, 14 | Hope's Nose to Berry Head, Torbay. | VI. | 1.50 p.m. | 1 0 | 7 Plaice marked. |
| 16 | ,, 15 | Torbay . . . . . . | V. | 5.40 a.m. | 1 0 | |
| 17 | ,, 15 | Inside Rough, hauled off Paignton Pier. | IVA. | 9 a.m. | 1 30 | |
| 18 | Dec. 12 | Torbay . . . . . . | IV. | 1.45 p.m. | 2 0 | |
| 19 | ,, 14 | Ilsham to Breakwater . . | V. | 9.30 a.m. | 0 45 | |
| | 1902. | | | | | |
| 20 | Jan. 28 | Torbay . . . . . . | IV. | 4.40 p.m. | 1 0 | |
| 21 | ,, 29 | ,, . . . . . . . | VI. | 3.30 p.m. | 0 45 | |
| 22 | April 17 | Inside Rough . . . . | IVA. | 7.55 a.m. | 1 30 | |
| 23 | ,, 17 | Torbay . . . . . . | V. | 10.55 a.m. | 1 15 | |
| 24 | ,, 19 | ,, . . . . . . . | VI. | 9.30 a.m. | 1 0 | |
| 25 | May 26 | ,, inside Rough . . | IVA. | 5.5 p.m. | 0 40 | |
| 26 | ,, 26 | ,, . . . . . . . | IV. | 6.30 p.m. | 1 0 | |
| 27 | July 2 | ,, inside Rough . . | IVA. | 2 p.m. | 1 0 | |
| 28 | ,, 2 | ,, . . . . . . . | IV. | 4.35 p.m. | 0 30 | |
| 29 | ,, 3 | ,, . . . . . . . | V. | 11.30 a.m. | 1 0 | |
| 30 | ,, 24 | Shot off Brixham, towed towards Kingston Valley. | V. | 10.40 a.m. | 1 30 | |
| 31 | ,, 24 | Inside Rough, towed towards Goodrington Head. | IVA. | 12.45 p.m. | 1 0 | |
| 32 | ,, 24 | Orestone to Berry Head . . | VI. | 3.50 p.m. | 1 0 | |
| 33 | Sept. 1 | Torbay, Ilsham to Breakwater . | V. | 9.15 a.m. | 0 45 | |
| 34 | ,, 1 | ,, Torquay to Paignton . | IV. | 11 a.m. | 1 0 | |
| 35 | ,, 1 | ,, inside Ledge . . | IVA. | 1.15 p.m. | 1 0 | |
| 36 | ,, 4 | ,, Berry Head to Orestone | VI. | 4.25 p.m. | 1 0 | |

TABLE B—*continued.*

TEIGNMOUTH BAY.

| No. of Haul. | Date. | Locality and Course. | Station. | Hour Trawl Shot. | Duration of Haul. h. m. | Remarks. |
|---|---|---|---|---|---|---|
| | 1901. | | | | | |
| 1 | Aug. 1 | Teignmouth Bay . . . | VII. | 11.20 a.m. | 1 0 | 15 Plaice marked. |
| 2 | ,, 1 | ,, ,, . . . . | IX. | 2 p.m. | 2 0 | |
| 3 | ,, 2 | ,, ,, . . . . | VIII. | 9.50 a.m. | 1 50 | 7 Plaice marked. |
| 4 | Sept. 13 | From Anstis Cove to the Ness (in about 8 fms.). | VII. | 8.10 a.m. | 1 30 | |
| 5 | ,, 13 | From off the Ness (4–5 fms.), along shore to Babbacombe. | VII. | 10.50 a.m. | 1 30 | |
| 6 | ,, 13 | Off Teignmouth Bar, ½ mile along shore N.E. direction, in 5–7 fms., hauled off Dawlish and from off Langstone Point along shore in 5 fms., ¾ mile from Fairway Buoy. | VIII. | 1.30 p.m. | 2 35 | |
| 7 | Oct. 9 | Teignmouth Bay . . . | VII. | 10.50 a.m. | 2 15 | 53 Plaice marked. Rays not measured. |
| 8 | ,, 9 | ,, ,, towards Pole Sands. | VIII. | 2.15 p.m. | 1 15 | Rays not measured. |
| 9 | ,, 11 | Teignmouth Bay . . . | VII. | 7.15 a.m. | 1 15 | Rays not measured. |
| 10 | Nov. 11 | ,, ,, off Babbacombe to the Ness. | VII. | 4.15 p.m. | 1 5 | |
| 11 | ,, 13 | Teignmouth, after a S.W. gale on previous day. | VII. | 9.50 a.m. | 1 30 | 19 Plaice marked.* |
| 12 | ,, 13 | Along Pole Sands (in 5 fms. water) | VIII. | 12.50 p.m. | 2 0 | 2 Plaice marked. |
| 13 | ,, 14 | From off Dawlish, along Pole Sands. | VIII. | 4.40 a.m. | 2 0 | Rays not measured. |
| 14 | Dec. 11 | Babbacombe to the Ness and back again. | VII. | 11.25 a.m. | 3 30 | |
| 15 | ,, 13 | Pole Sands, from Fairway Buoy to Langstone Point; course irregular, but mostly in 5 fms. | VIII. | 12.40 p.m. | 1 0 | |
| | 1902. | | | | | |
| 16 | Jan. 28 | Teignmouth Bay . . . | VII. | 7.15 a.m. | 1 30 | |
| 17 | ,, 28 | ,, ,, Pole Sands . | VIII. | 10.20 a.m. | 0 45 | |
| 18 | April 17 | ,, ,, . . . . | VII. | 3 p.m. | 1 30 | |
| 19 | ,, 17 | ,, ,, on the Ledge off Teignmouth on line Exmouth to Berry Head. | IX. | 5.15 p.m. | 1 0 | |
| 20 | ,, 18 | Teignmouth towards Dawlish, then to Fairway Buoy . . | VIII. | 1.45 p.m. | 3 0 | Net full of weed. |
| 21 | ,, 18 | Teignmouth . . . . | VII. | 9.30 p.m. | 2 0 | |
| 22 | May 27 | Teignmouth Bay . . . . | VII. | 9.45 a.m. | 1 45 | Trawl full of *ulva*. |
| 23 | ,, 27 | Pole Sands, and . . Pole Sands, outer part . (two short hauls combined) | VIII. | 1.30 p.m. | 1 45 | Not much weed. |
| 24 | ,, 27 | From Pole Sands towards Hope's Nose, 2 miles from shore. | IX. | 4.25 p.m. | 2 0 | |
| 25 | ,, 28 | Inside Ledge . . . . | IX. | 11.40 a.m. | 1 30 | |
| 26 | July 2 | On line Hope's Nose to Fairway Buoy, 2 miles off Teignmouth | IX. | 5.40 p.m. | 1 30 | |
| 27 | ,, 2 | Pole Sands . . . . | VIII. | 8.30 p.m. | 1 0 | |
| 28 | ,, 5 | Teignmouth Bay . . . . | VII. | 6.30 a.m. | 0 45 | |
| 29 | ,, 5 | ,, ,, inside Ledge . | IX. | 7.45 a.m. | 1 0 | |
| 30 | ,, 23 | Shot in 5 fms. just to N.E. of Parson and Clerk rocks; towed towards Fairway Buoy, Exmouth, and hauled ½ mile off. | VIII. | 9.30 a.m. | 1 40 | |
| 31 | Sept. 4 | Teignmouth Bay . . . | VII. | 6.30 p.m. | 0 45 | |
| 32 | ,, 4 | Dawlish, along Pole Sands . | VIII. | 8.15 p.m. | 1 30 | Rays not measured. |

* Haul 11.—The entries in the log-books render the allotment of 14 of these marked fish open to slight doubt.

## Table C.

*Records of Hauls of the Trawl made with s.s. "Oithona" in 1901–1902.*

START BAY.

| | Station. | II. | I. | I. | I. | II. | III. | III. | II. | I. | II. | I. | III. | I. | III. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Date. | 1901. July 30. | July 30. | Aug. 7. | Aug. 8. | Aug. 9. | Sept. 6. | Sept. 7. | Sept. 7. | Sept. 9. | Sept. 9. | Sept. 9. | Sept. 10. | Sept. 10. | Oct. 1. |
| | Haul. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| | Duration of Haul. | 2h. 35m. | 2 hours. | 2 hours. | 1h. 10m. | 1h. 10m. | 2 hours. | 2 hours. | 2 hours. | 1h. 55m. | 2 hours. | 1h. 5m. | 2 hours. | 1h. 15m. | 1h. 10m. |
| 1 | Dab (below 8 in.) | 24 | 8 | 5 | 14 | — | 1 | 1 | 39 | — | 7 | 1 | — | — | — |
| | *P. limanda*, L. (8 in. & above) | 21 | 4 | 3 | 14 | — | 43 | 8 | 45 | 9 | 39 | 24 | 8 | 6 | 1 |
| 2 | Flounder (below 8 in.) | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| | *P. flesus*, L. (8 in. & above) | — | — | — | — | 3 | — | — | — | — | — | — | — | — | — |
| 3 | Sole (below 8 in.) | 1 | 1 | — | — | — | — | — | — | — | — | — | — | — | — |
| | *S. vulgaris*, Quen. (8 in. & above) | 9 | 6 | 1 | 2 | 1 | 1 | — | 2 | — | 2 | 3 | — | 2 | — |
| 4 | Sand Sole (*S. lascaris*, Risso.) | — | 1 | — | — | — | 4 | 4 | — | 4 | — | — | 14 | 2 | — |
| 5 | Thickback (*S. variegata*, Flem.) | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — |
| 6 | Solenette (*S. lutea*, Bon.) | — | 4 | 10 | 7 | — | — | — | 2 | — | — | 3 | — | — | — |
| 7 | Lemon Sole (*P. microcephalus*, Don.) | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — |
| 8 | Plaice (below 8 in.) | 19 | 5 | 2 | 1 | — | — | — | 11 | — | 2 | — | — | — | — |
| | *P. platessa*, L. (8 in. & above) | 39 | 16 | 20 | 24 | 5 | 39 | 72 | 22 | 26 | 57 | 30 | 30 | 24 | 17 |
| 9 | Turbot (below 10 in.) | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| | *R. maximus*, Kl. (10 in. & above) | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 10 | Brill (below 10 in.) | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| | *R. lævis*, Kl. (10 in. & above) | — | — | — | — | — | 2 | 18 | 1 | 2 | — | — | 7 | — | 6 |
| 11 | Whiting (below 8 in.) | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| | *G. merlangus*, L. (8 in. & above) | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — |
| 12 | Bib (*G. luscus*, L.) | — | — | — | — | 7 | — | — | — | — | 1 | — | — | — | — |
| 13 | Poor Cod (*G. minutus*, L.) | — | — | — | — | 2 | — | — | — | — | — | — | — | — | — |
| 14 | Grey Gurnard (below 8 in.) | 49 | 21 | 6 | 29 | — | 3 | — | 6 | 4 | 9 | — | — | 2 | — |
| | *T. gurnardus*, L. (8 in. & above) | 3 | 3 | — | — | 2 | 12 | 4 | 10 | 4 | 4 | — | 4 | — | 2 |
| 15 | Tub (*T. lucerna*, Will.) | 16 | — | 2 | 6 | 1 | 1 | — | 10 | — | 7 | 5 | — | 1 | — |
| 16 | Red Gurnard (*T. pini*, Bl.) | — | — | 6 | 1 | — | 1 | 21 | — | 3 | — | — | 3 | — | 12 |
| 17 | Streaked Gurnard (*T. lineata*, L.) | — | — | 1 | 2 | — | 1 | — | — | — | — | — | — | — | — |
| 18 | Dory (below 8 in.) | 2 | 3 | 1 | 1 | — | 1 | 1 | — | — | 1 | — | 3 | — | — |
| | *Z. faber*, L. (8 in. & above) | — | — | — | — | — | 2 | 5 | 3 | 3 | 6 | 2 | 1 | — | 1 |
| 19 | Mullet (below 8 in.) | — | — | — | 1 | — | — | 1 | — | — | — | — | — | — | — |
| | *M. surmuletus*, L. (8 in. & above) | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — |
| 20 | Bream (*P. centrodontus*, C. et V.) | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 21 | Dragonet (*C. lyra*, L.) | 24 | 6 | 57 | 65 | 3 | 6 | 3 | 21 | 6 | — | — | 6 | 6 | — |
| 22 | Weever (*T. draco*, L.) | — | — | — | 2 | — | 4 | 8 | 3 | 10 | 8 | 6 | 5 | 1 | 1 |
| 23 | Thornback (below 12 in.) | 40 | 16 | 1 | — | — | — | — | 2 | — | — | — | — | — | — |
| | *R. clavata*, L. (12 in. & above) | 4 | 1 | — | — | — | — | — | — | — | — | — | — | — | — |
| 24 | Homelyn (below 12 in.) | 2 | — | — | 1 | — | 7 | 1 | 3 | 7 | 6 | 5 | — | — | — |
| | *R. maculata*, Mon. (12 in. & above) | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 25 | Blonde (below 12 in.) | — | — | — | — | — | 22 | 22 | 3 | 35 | — | 1 | 98 | 6 | 2 |
| | *R. blanda*, Holt (12 in. & above) | — | — | — | — | — | 15 | 75 | — | 44 | — | — | 33 | 2 | 11 |
| 26 | Painted Ray (below 12 in.) | — | — | — | — | — | 4 | — | — | — | 1 | 6 | — | — | — |
| | *R. microcellata*, Mon. (12 in. & above) | — | — | — | — | — | 3 | — | 1 | — | — | 2 | — | — | — |
| 27 | *S. canicula*, Cuv. | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 28 | *Acanthias vulgaris*, Risso. | 1 | 1 | — | — | — | — | — | 4 | — | 2 | — | — | — | 1 |
| 29 | Buffoon (*R. squatina*, Gün.) | 1 | 1 | 1 | — | — | — | — | 3 | — | — | 3 | — | — | — |
| 30 | Scaldback (*A. laterna*, Rond.) | 6 | 12 | 13 | 37 | — | 10 | 2 | 3 | 1 | 1 | 7 | 3 | — | — |
| 31 | Cod (*G. morrhua*, L.) | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 32 | White Skate (*R. alba*, Lac.) | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — |
| 33 | *Agonus cataphractus*, Bl. | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — |
| 34 | *Conger vulgaris*, Cuv. | — | — | — | — | — | — | — | — | — | — | — | — | — | — |

| | II. | I. | I. | I. | II. | I. | I. | I. | III. | I. | II. | I. | II. | II. | I. | IIA. | I. | III. | I. | I. | I. | I. | I. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Oct. 1. | Oct. 2. | Oct. 3. | Oct. 3. | Oct. 3. | Oct. 4. | Oct. 11. | Nov. 6. | Nov. 6. | Nov. 7. | Nov. 8. | Nov. 9. | Nov. 9. | Nov. 9. | Nov. 15. | Nov. 16. | Dec. 17. | Dec. 17. | Dec. 17. | Dec. 18. | Dec. 18. | Dec. 19. | Dec. 19. |
| | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 |
| | 2 hours. | 2h. 15m. | 1h. 30m. | 2 hours. | 1 hour. | 1h. 10m. | 2 hours. | 2 hours. | 1 hour. | 3 hours. | 1h. 50m. | 3 hours. | 2h. 5m. | 1 hour. | 2h. 30m. | 40 min. | 3 hours. | 3h. 10m. | 3 hours. | 3 hours. | 3 hours. | 3 hours. | 4 hours. |
| 1 | 10 | 17 | 3 | 18 | — | 6 | 8 | 11 | — | 7 | 4 | 21 | 2 | — | 1 | — | 3 | — | — | 2 | — | — | 12 |
| | 37 | 121 | 44 | 103 | 17 | 47 | 54 | 63 | 6 | 32 | 20 | 51 | 30 | 23 | 11 | 8 | 22 | 5 | 7 | 5 | 40 | 5 | |
| 2 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 3 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | 3 |
| | — | 1 | 3 | — | — | — | 2 | — | — | 2 | 4 | 5 | 5 | — | 1 | 1 | 4 | — | 5 | — | 1 | — | |
| 4 | — | 1 | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | 2 | — | — | — | 2 | — |
| 5 | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 6 | — | — | 1 | — | — | — | 1 | — | — | 3 | 2 | 2 | — | — | — | — | — | — | — | — | — | — | — |
| 7 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — |
| 8 | — | 2 | 1 | 1 | — | — | 2 | — | — | — | 2 | — | — | — | 1 | — | 1 | — | 1 | — | — | — | 2 |
| | 20 | 124 | 70 | 89 | 14 | 78 | 16 | 69 | 17 | 40 | 29 | 66 | 64 | 43 | 42 | 47 | 29 | 30 | 30 | 22 | 22 | 17 | 56 |
| 9 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | 1 | — | 2 | — | 1 | 1 | — | — | — | — | — | — | — | — | 2 | — |
| 10 | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | 1 | — | — | — | — |
| | — | — | — | — | — | — | 1 | — | 10 | — | — | — | — | 1 | — | 1 | — | 13 | 3 | 2 | 2 | — | — |
| 11 | 1 | — | — | — | — | — | — | 2 | — | — | — | — | — | — | — | — | 7 | — | — | — | 6 | — | 2 |
| | — | — | — | 1 | — | — | 2 | 4 | — | 2 | 1 | — | — | — | 3 | — | 5 | — | — | 1 | 22 | 1 | |
| 12 | — | — | — | — | 1 | — | — | — | — | — | 76 | — | — | — | — | — | — | — | — | — | — | — | — |
| 13 | — | — | 10 | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 14 | 40 | 41 | 2 | 29 | 7 | 22 | 36 | 37 | 1 | 8 | 23 | 20 | 29 | 11 | 5 | — | 20 | — | — | 7 | 4 | 1 | 20 |
| | 16 | 16 | 3 | 35 | 15 | 36 | 26 | 59 | 2 | 27 | 11 | 9 | 25 | 13 | 33 | 3 | 45 | — | — | 12 | 32 | 10 | |
| 15 | 2 | 2 | 2 | 2 | 1 | 4 | 5 | 6 | — | 2 | 6 | 3 | 2 | 1 | 1 | — | 3 | — | — | — | — | — | — |
| 16 | — | 1 | 1 | — | — | — | — | — | 3 | — | — | — | — | — | — | — | — | 2 | — | — | — | — | — |
| 17 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 18 | — | 2 | — | 1 | 1 | — | 1 | 2 | — | — | 1 | 1 | — | — | — | — | 1 | — | — | — | — | — | — |
| | 2 | 8 | — | 5 | 9 | 6 | 3 | 9 | 12 | 10 | 5 | — | 4 | 1 | 14 | 1 | — | — | — | — | — | — | — |
| 19 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — |
| | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 20 | — | — | — | — | — | — | — | 2 | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — |
| 21 | 7 | 12 | 12 | 12 | — | 20 | many | 40 | 12 | many | 12 | 20 | — | 12 | — | 2 | 12 | — | — | — | 6 | 6 | — |
| 22 | — | 10 | 3 | 4 | — | 14 | 2 | 1 | 3 | 1 | — | — | — | 3 | — | — | 1 | 2 | — | — | 2 | 5 | — |
| 23 | — | — | — | — | 3 | — | 3 | — | — | — | 3 | — | — | — | — | 4 | 1 | 1 | ? | — | — | — | — |
| | — | — | — | — | 1 | — | — | — | — | — | 1 | — | — | 1 | 2 | 3 | — | — | | — | — | — | — |
| 24 | — | — | 7 | 1 | — | — | 3 | — | — | 3 | 2 | 1 | 3 | 1 | — | 5 | — | — | ? | — | — | — | — |
| | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | | — | — | — | — |
| 25 | — | — | — | — | — | 1 | — | — | 17 | — | — | — | — | — | — | — | — | 19 | ? | — | 12 | 8 | — |
| | — | — | 5 | — | — | — | — | — | 20 | — | — | — | — | — | — | 1 | — | 18 | | 6 | 1 | — | — |
| 26 | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 1 | — | — | 2 | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | — | — | 1 | — | — | — | 2 | — | 1 | 3 | — | — | — | 2 | — | — |
| 27 | 1 | 3 | — | — | 1 | — | 1 | 1 | — | 5 | — | — | — | — | — | — | 1 | — | — | — | — | — | — |
| 28 | 60 | 20 | — | — | 2 | 5 | 2 | 40 | ? | very many | 1 | — | — | — | 20 | — | 12 | — | — | — | 2 | — | — |
| 29 | — | 2 | — | — | 4 | — | — | 1 | 1 | — | 1 | — | — | 1 | — | 1 | — | — | — | — | — | — | — |
| 30 | 3 | 13 | 3 | 3 | 1 | 5 | few | 5 | 1 | 5 | 5 | 5 | — | 5 | — | — | — | — | — | — | 3 | — | — |
| 31 | — | — | — | — | — | — | — | — | — | — | — | 2 | — | — | — | — | — | — | — | — | — | — | — |
| 32 | — | — | — | — | 1 | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — |
| 33 | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — |
| 34 | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | 1 | — | — | 1 | — | — |

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START BAY—*continued.*

| | Station. | I. | III. | I. | I. | I. | I. | I. | I. | III. | I. | III. |
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| | Date. 1902. | Jan. 21. | Jan. 22. | Jan. 24. | Jan. 25. | Feb. 4. | Feb. 5. | April 8. | April 14. | April 15. | April 15. | April 15. |
| | Haul. | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 |
| | Duration of Haul. | 1h. 45m. | 1h. 30m. | 3h. 30m. | 1 hour. | 1h. 45m. | 1h. 15m. | 40 min. | 1 hour. | 1 hour. | 2h. 30m. | 2 hours. |
| 1 | Dab (below 8 in.) | 3 | — | 10 | 5 | 10 | — | — | 3 | — | 5 | — |
| | *P. limanda*, L. (8 in. & above) | 6 | 3 | 14 | 16 | 5 | 5 | 1 | 2 | — | 4 | — |
| 2 | Flounder (below 8 in.) | — | — | — | — | — | — | — | — | — | — | — |
| | *P. flesus*, L. (8 in. & above) | — | — | 2 | 1 | — | — | — | — | — | — | — |
| 3 | Sole (below 8 in.) | — | — | — | — | — | — | — | — | — | — | — |
| | *S. vulgaris*, Quen. (8 in. & above) | 1 | — | 1 | 1 | 1 | 3 | — | — | — | — | — |
| 4 | Sand Sole (*S. lascaris*, Risso.) | — | 1 | — | — | — | — | — | — | — | — | — |
| 5 | Thickback (*S. variegata*, Flem.) | 2 | — | — | — | — | — | — | — | — | — | — |
| 6 | Solenette (*S. lutea*, Bon.) | — | — | — | — | — | — | — | — | — | — | — |
| 7 | Lemon Sole (*P. microcephalus*, Don.) | — | — | — | — | — | — | — | — | — | — | — |
| 8 | Plaice (below 8 in.) | — | — | 3 | 1 | 7 | 1 | 2 | 1 | — | 3 | 7 |
| | *P. platessa*, L. (8 in. & above) | 3 | 2 | 33 | 17 | 31 | 17 | 1 | 16 | 3 | 33 | 9 |
| 9 | Turbot (below 10 in.) | — | — | — | — | — | — | — | — | — | — | — |
| | *R. maximus*, Kl. (10 in. & above) | — | — | — | — | — | 1 | — | — | — | — | — |
| 10 | Brill (below 10 in.) | — | — | — | — | — | — | — | — | — | — | — |
| | *R. lævis*, Kl. (10 in. & above) | 2 | 9 | 2 | — | 1 | — | — | — | — | — | 2 |
| 11 | Whiting (below 8 in.) | — | — | — | — | 4 | — | — | — | — | — | — |
| | *G. merlangus*, L. (8 in. & above) | 2 | — | 9 | 10 | 1 | 1 | — | — | — | — | — |
| 12 | Bib (*G. luscus*, L.) | — | — | — | — | 5 | — | — | — | — | — | — |
| 13 | Poor Cod (*G. minutus*, L.) | — | — | — | — | — | — | — | — | — | — | — |
| 14 | Grey Gurnard (below 8 in.) | — | — | 7 | 6 | 1 | — | — | — | — | 1 | — |
| | *T. gurnardus*, L. (8 in. & above) | 4 | 6 | 17 | 15 | — | — | — | — | — | — | — |
| 15 | Tub (*T. lucerna*, Will.) | 1 | — | — | 1 | 2 | — | — | — | — | — | — |
| 16 | Red Gurnard (*T. pini*, Bl.) | — | — | — | — | — | — | — | — | — | — | — |
| 17 | Streaked Gurnard (*T. lineata*, L.) | — | — | — | — | — | — | — | — | — | — | — |
| 18 | Dory (below 8 in.) | — | — | — | — | — | — | — | — | — | — | — |
| | *Z. faber*, L. (8 in. & above) | — | — | 1 | — | — | — | — | — | — | — | — |
| 19 | Mullet (below 8 in.) | 1 | — | 1 | 2 | — | — | — | — | — | — | — |
| | *M. surmuletus*, L. (8 in. & above) | — | — | — | — | — | — | — | — | — | — | — |
| 20 | Bream (*P. centrodontus*, C. et V.) | — | — | — | — | — | — | — | — | — | — | — |
| 21 | Dragonet (*C. lyra*, L.) | — | — | — | — | 3 | — | — | — | — | — | — |
| 22 | Weever (*T. draco*, L.) | — | 2 | — | — | — | — | — | — | — | — | 3 |
| 23 | Thornback (below 12 in.) | — | — | — | — | 3 | 1 | — | 1 | — | — | — |
| | *R. clavata*, L. (12 in. & above) | — | — | — | — | 4 | — | — | — | — | — | — |
| 24 | Homelyn (below 12 in.) | — | — | 1 | — | — | — | — | 1 | — | — | — |
| | *R. maculata*, Mon. (12 in. & above) | — | — | — | — | — | — | — | — | — | — | — |
| 25 | Blonde (below 12 in.) | — | 19 | 3 | 4 | 1 | — | — | — | 2 | 4 | 7 |
| | *R. blanda*, Holt (12 in. & above) | — | 6 | — | — | — | — | — | — | 1 | — | 2 |
| 26 | Painted Ray (below 12 in.) | — | — | — | — | — | — | — | — | — | — | — |
| | *R. microcellata*, Mon. (12 in. & above) | — | 1 | 2 | — | — | — | — | — | — | — | — |
| 27 | *S. canicula*, Cuv. | — | — | — | — | 1 | — | — | — | — | — | — |
| 28 | *Acanthias vulgaris*, Risso. | — | — | — | — | — | — | — | — | — | — | — |
| 29 | Buffoon (*R. squatina*, Gün.) | — | 2 | — | — | — | — | — | — | — | 3 | — |
| 30 | Scaldback (*A. laterna*, Rond.) | — | — | — | — | — | — | — | — | — | — | 3 |
| 31 | Cod (*G. morrhua*, L.) | — | — | — | — | — | — | — | — | — | — | — |
| 32 | White Skate (*R. alba*, Lac.) | — | — | — | — | — | — | — | — | — | 1 | — |
| 33 | *Agonus cataphractus*, Bl. | — | — | — | — | 1 | — | — | — | — | — | — |
| 34 | *Conger vulgaris*, Cuv. | — | — | — | — | — | — | — | — | — | — | — |

| | I. | I. | I. | I. | I. | II. | I. | I. | I. | I. | I. | II. | I. | I. | I. | I. | II. | II. | I. | I. |
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| | May 22. | May 22. | May 22. | May 23. | May 24. | May 24. | June 19. | June 26. | June 27. | June 30. | July 21. | July 22. | July 22. | July 25. | Aug. 25. | Aug. 26. | Aug. 27. | Aug. 28. | Aug. 28. | Oct. 6. |
| | 49 | 50 | 51 | 52 | 53 | 54 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 70 |
| | 2 hours. | 2 hours. | 3 hours. | 1h. 45m. | 2h. 30m. | 1 hour. | 1 hour. | 1 hour. | 1h. 30m. | 3 hours. | 2h. 25m. | 50 min. | 1h. 30m. | 1h. 45m. | 1 hour. | 3 hours. | 1h. 15m. | 30 min. | 2 hours. | 1h. 30m. |
| 1 | — | — | — | 2 | — | — | 29 | 59 | 129 | 122 | 32 | — | 30 | 9 | 175 | 111 | 279 | 52 | 260 | 67 |
| | 7 | 12 | 12 | 12 | 8 | 8 | 11 | 10 | 14 | 22 | 3 | — | 5 | 4 | 44 | 24 | 18 | 8 | 23 | 2 |
| 2 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
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| 4 | — | — | — | — | — | — | — | — | — | 2 | 1 | — | — | — | — | — | — | — | — | — |
| 5 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 6 | — | 1 | — | — | — | — | — | — | — | 2 | — | — | — | — | — | 6 | 1 | — | — | — |
| 7 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 8 | — | — | — | — | — | — | — | 1 | 1 | 5 | 1 | — | — | — | 1 | — | 5 | 1 | 1 | — |
| | 35 | 42 | 74 | 57 | 54 | 7 | 10 | 38 | 25 | 94 | 26 | 4 | 23 | 5 | 46 | 78 | 71 | 23 | 61 | 16 |
| 9 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
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| | — | — | — | — | — | — | 1 | 18 | 50 | 74 | 2 | — | 1 | — | — | — | — | — | 1 | 6 |
| 12 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 13 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 14 | — | — | — | — | 3 | — | — | 12 | 14 | 45 | 7 | — | 1 | — | 34 | 6 | 16 | 5 | 15 | 4 |
| | — | 1 | — | — | 1 | — | — | 1 | 1 | 4 | — | — | — | — | — | 5 | 2 | 1 | 6 | 12 |
| 15 | — | — | — | 1 | 1 | — | — | — | — | 5 | 1 | — | — | — | 1 | 7 | 11 | 6 | 1 | 3 |
| 16 | — | — | — | — | — | — | — | — | 2 | 13 | — | — | — | — | 4 | 2 | — | — | 2 | — |
| 17 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 18 | — | 2 | 4 | 3 | 2 | 1 | 8 | 1 | 7 | 7 | 1 | — | 1 | 2 | — | 1 | 4 | 1 | 1 | — |
| | — | 4 | 13 | 1 | 1 | — | — | — | 2 | — | 1 | — | — | — | — | — | 7 | 1 | 1 | 7 |
| 19 | — | — | — | — | — | — | — | 2 | 14 | — | 3 | — | — | — | — | — | — | 3 | — | — |
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| 20 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 21 | — | — | — | — | — | — | — | — | 6 | 6 | 5 | — | — | — | — | — | 3 | 2 | — | 1 |
| 22 | — | 1 | — | — | — | — | — | — | 1 | 5 | — | — | — | — | 5 | 7 | — | — | — | — |
| 23 | 1 | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | 6 | 4 | 9 | — |
| | 1 | — | — | — | — | — | — | — | 1 | — | — | — | — | 1 | — | — | 2 | 1 | 1 | — |
| 24 | 1 | 1 | 1 | — | 1 | — | 1 | — | — | 6 | 3(?) | — | 1(?) | — | — | 1 | — | — | 2 | — |
| | — | — | 1 | — | — | — | — | — | — | — | 8(?) | — | — | — | — | — | — | — | — | — |
| 25 | — | 2 | 5 | — | 5 | — | — | — | — | 2 | 4(?) | — | 1(?) | — | 1 | — | — | 1 | 2 | — |
| | — | — | 2 | — | — | — | — | — | — | 13 | 13(?) | — | — | — | — | 1 | — | — | — | — |
| 26 | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — |
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| 27 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| 28 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 29 | 1 | — | 1 | — | — | — | — | — | — | — | 1 | 2 | — | — | — | — | 1 | 1 | — | — |
| 30 | — | — | — | — | — | — | 2 | — | 3 | — | — | — | — | — | — | — | 2 | — | — | 1 |
| 31 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 32 | — | 1 | 1 | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 33 | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 34 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |

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TORBAY.

| STATION. | IV. | VI. | V. | IV. | VI. | IVA. | V. | IV. | IVA. | IVA. | V. | IVA. | V. | IVA. | VI. |
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| DATE. 1901. | July 31. | July 31. | Aug. 1. | Sept. 11. | Sept. 11. | Sept. 12. | Sept. 12. | Oct. 7. | Oct. 7. | Oct. 10. | Oct. 10. | Oct. 11. | Nov. 11. | Nov. 12. | Nov. 14. |
| HAUL. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| DURATION OF HAUL. | 1h. 40m. | 1h. 10m. | 1h. 5m. | 1h. 30m. | 1h. 30m. | 1 hour. | 1 hour. | 1h. 15m. | 1 hour. | 1 hour. | 1h. 15m. | 1 hour. | 1 hour. | 50 min. | 1 hour. |
| 1 Dab (below 8 in.) | 117 | 10 | 58 | 265 | 12 | 28 | 66 | 145 | 7 | — | 98 | 2 | 67 | — | 5 |
| *P. limanda*, L. (8 in. & above) | 3 | 14 | 4 | 17 | 20 | 2 | 25 | 7 | 3 | 2 | 12 | — | 10 | 2 | 15 |
| 2 Flounder (below 8 in.) | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| *P. flesus*, L. (8 in. and above) | 8 | — | — | 12 | — | 4 | — | 3 | 4 | 1 | — | 1 | — | 1 | — |
| 3 Sole (below 8 in.) | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — |
| *S. vulgaris*, Quen. (8 in. & above) | 3 | 1 | 1 | 4 | 2 | 3 | 1 | 1 | — | 1 | 1 | — | — | — | 1 |
| 4 Sand Sole (*S. lascaris*, Risso.) | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 5 Thickback (*S. variegata*, Flem.) | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 6 Solenette (*S. lutea*, Bon.) | 29 | 1 | 5 | 7 | — | — | — | many | — | — | — | — | 1 | — | 1 |
| 7 Lemon Sole (*P. microcephalus*, Don.) | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 8 Plaice (below 8 in.) | 40 | 3 | 7 | 135 | 1 | 5 | 2 | 96 | 14 | 4 | 8 | 8 | 1 | — | — |
| *P. platessa*, L. (8 in. & above) | 39 | 11 | 22 | 71 | 7 | 32 | 33 | 35 | 20 | 20 | 39 | 18 | 20 | 11 | 7 |
| 9 Turbot (below 10 in.) | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| *R. maximus*, Kl. (10 in. & above) | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 10 Brill (below 10 in.) | — | — | — | — | — | — | — | 1 | 1 | — | — | — | — | — | — |
| *R. lævis*, Kl. (10 in. and above) | — | 1 | — | — | — | — | — | — | 1 | — | — | — | — | — | — |
| 11 Whiting (below 8 in.) | 2 | 1 | 4 | 1 | 1 | — | — | 3 | — | — | 1 | — | 7 | — | 2 |
| *G. merlangus*, L. (8 in. & above) | — | — | — | — | — | — | — | — | — | — | — | — | 3 | — | — |
| 12 Bib (*G. luscus*, L.) | — | — | — | — | 3 | 103 | — | — | — | — | — | — | — | — | — |
| 13 Poor Cod (*G. minutus*, L.) | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 14 Grey Gurnard (below 8 in.) | 31 | 7 | 38 | 2 | — | — | — | — | — | — | — | 1 | 3 | — | 3 |
| *T. gurnardus*, L. (8 in. & above) | 1 | — | — | — | 1 | 1 | — | — | — | — | — | — | 1 | — | — |
| 15 Tub (*T. lucerna*, Will.) | 14 | — | — | 2 | — | 1 | — | 4 | 3 | — | 2 | 4 | 2 | — | — |
| 16 Red Gurnard (*T. pini*, Bl.) | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 17 Streaked Gurnard (*T. lineata*, L.) | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 18 Dory (below 8 in.) | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| *Z. faber*, L. (8 in. and above) | — | — | — | 1 | — | 2 | — | — | — | — | — | 2 | — | — | — |
| 19 Mullet (below 8 in.) | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| *M. surmuletus*, L. (8 in. & above) | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 20 Bream (*P. centrodontus*, C. et V.) | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 21 Dragonet (*C. lyra*, L.) | 24 | 22 | 24 | 30 | — | — | — | 6 | — | — | — | — | 6 | — | 12 |
| 22 Weever (*T. draco*, L.) | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — |
| 23 Thornback (below 12 in.) | 32 | 88 | 20 | 9 | 7 | — | 2 | 26 | 5 | 1 | 9 | 6 | — | — | 15 |
| *R. clavata*, L. (12 in. & above) | — | 6 | 3 | — | 1 | — | — | — | — | — | — | — | — | — | — |
| 24 Homelyn (below 12 in.) | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| *R. maculata*, Mon. (12 in. and above) | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 25 Blonde (below 12 in.) | — | — | — | 3 | — | — | — | — | — | — | — | — | — | — | — |
| *R. blanda*, Holt (12 in. & above) | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 26 Painted Ray (below 12 in.) | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| *R. microcellata*, Mon. (12 in. and above) | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 27 *S. canicula*, Cuv. | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — |
| 28 *Acanthias vulgaris*, Risso. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 29 Buffoon (*R. squatina*, Gün.) | 6 | 1 | — | 4 | 5 | 4 | — | — | 1 | — | — | — | 1 | 1 | — |
| 30 Scaldback (*A. laterna*, Rond.) | 25 | 8 | 9 | 30 | 4 | 6 | 10 | few | few | — | many | 3 | few | — | 2 |
| 31 Cod (*G. morrhua*, L.) | — | — | — | — | — | 1 | — | — | — | 1 | — | — | — | — | — |
| 32 White Skate (*R. alba*, Lac.) | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 33 *Agonus cataphractus*, Bl. | 2 | 2 | — | 1 | 1 | — | — | 3 | — | — | — | — | — | — | — |
| 34 *Conger vulgaris*, Cuv. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |

| | V. | IVA. | IV. | V. | IV. | VI. | IVA. | V. | VI. | IVA. | IV. | IVA. | IV. | V. | V. | IVA. | VI. | V. | IV. | IVA. | VI. |
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| | Nov. 15. | Nov. 15. | Dec. 12. | Dec. 14. | 1902. Jan. 28. | Jan. 29. | April 17. | April 17. | April 19. | May 26. | May 26. | July 2. | July 2. | July 3. | July 24. | July 24. | July 24. | Sept. 1. | Sept. 1. | Sept. 1. | Sept. 4. |
| | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 |
| | 1 hour. | 1h. 30m. | 2 hours. | 45 min. | 1 hour. | 45 min. | 1h. 30m. | 1h. 15m. | 1 hour. | 40 min. | 1 hour. | 1 hour. | 30 min. | 1 hour. | 1h. 30m. | 1 hour. | 1 hour. | 45 min. | 1 hour. | 1 hour. | 1 hour. |
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### Table C—*continued.*

#### TEIGNMOUTH BAY.

| Station. | VII. | IX. | VIII. | VII. | VII. | VIII. | VII. | VIII. | VII. | VII. | VII. | VIII. |
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| Date. | 1901. Aug. 1. | Aug. 1. | Aug. 2. | Sept. 13. | Sept. 13. | Sept. 13. | Oct. 9. | Oct. 9. | Oct. 11. | Nov. 11. | Nov. 13. | Nov. 13. |
| Haul. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Duration of Haul. | 1 hour. | 2 hours. | 1h. 50m. | 1h. 30m. | 1h. 30m. | 2h. 35m. | 2h. 15m. | 1h. 15m. | 1h. 15m. | 1h. 5m. | 1h. 30m. | 2 hours. |
| 1 { Dab (below 8 in.) | 21 | — | 2 | 40 | 19 | 8 | 57 | — | 2 | 12 | 42 | 14 |
| { *P. limanda*, L. (8 in. and above) | 13 | — | 3 | 5 | 6 | 10 | 28 | 2 | 1 | 9 | 44 | 14 |
| 2 { Flounder (below 8 in.) | — | — | — | — | — | — | — | — | — | — | — | — |
| { *P. flesus*, L. (8 in. and above) | — | — | 1 | — | — | — | — | — | — | — | — | — |
| 3 { Sole (below 8 in.) | — | 1 | — | — | — | 1 | — | — | — | — | 1 | 2 |
| { *S. vulgaris*, Quen. (8 in. and above) | — | 8 | 6 | 1 | — | 8 | 3 | — | 1 | 3 | 9 | 26 |
| 4 Sand Sole (*S. lascaris*, Risso.) | — | — | — | — | — | — | — | — | — | — | — | — |
| 5 Thickback (*S. variegata*, Flem.) | — | — | — | — | — | — | — | — | — | — | — | — |
| 6 Solenette (*S. lutea*, Bon.) | 1 | 2 | 1 | 31 | 2 | 6 | 6 | — | — | 1 | 60 | 6 |
| 7 Lemon Sole (*P. microcephalus*, Don.) | — | — | — | 1 | — | 2 | — | — | — | — | — | — |
| 8 { Plaice (below 8 in.) | 27 | — | 10 | 7 | 43 | 55 | 212 | 30 | 133 | 144 | 10 | — |
| { *P. platessa*, L. (8 in. and above) | 22 | 2 | 7 | 29 | 42 | 85 | 112 | 29 | 32 | 86 | 52 | 11 |
| 9 { Turbot (below 10 in.) | — | — | — | — | — | — | — | — | — | — | — | — |
| { *R. maximus*, Kl. (10 in. and above) | — | — | — | — | — | — | — | 1 | 1 | — | — | 1 |
| 10 { Brill (below 10 in.) | — | — | 1 | — | — | 4 | 1 | 1 | 3 | 3 | 1 | 1 |
| { *R. lævis*, Kl. (10 in. and above) | — | 3 | 1 | — | — | 1 | — | 1 | — | — | — | — |
| 11 { Whiting (below 8 in.) | — | — | 1 | 1 | — | — | — | 1 | — | — | 116 | 5 |
| { *G. merlangus*, L. (8 in. and above) | — | — | — | — | — | — | — | — | — | — | 38 | 58 |
| 12 Bib (*G. luscus*, L.) | — | — | — | 1 | 275 | 2 | — | — | — | — | 11 | 29 |
| 13 Poor Cod (*G. minutus*, L.) | — | — | — | — | — | — | — | — | — | — | — | 3 |
| 14 { Grey Gurnard (below 8 in.) | — | 12 | 3 | 1 | — | 1 | 3 | 1 | — | 23 | 5 | 4 |
| { *T. gurnardus*, L. (8 in. and above) | — | 3 | — | — | — | — | — | — | — | — | — | — |
| 15 Tub (*T. lucerna*, Will.) | 10 | — | 6 | 1 | 3 | 28 | 15 | 8 | 6 | 1 | — | — |
| 16 Red Gurnard (*T. pini*, Bl.) | — | — | — | — | — | — | — | — | — | — | — | — |
| 17 Streaked Gurnard (*T. lineata*, L.) | — | — | — | — | — | — | — | — | — | — | — | — |
| 18 { Dory (below 8 in.) | — | — | 2 | — | — | — | — | — | — | — | 1 | — |
| { *Z. faber*, L. (8 in. and above) | — | — | 1 | 1 | 1 | — | — | — | — | 1 | — | 3 |
| 19 { Mullet (below 8 in.) | — | — | — | — | — | — | — | — | — | — | — | — |
| { *M. surmuletus*, L. (8 in. and above) | — | — | — | — | — | — | — | — | — | — | — | 3 |
| 20 Bream (*P. centrodontus*, C. et V.) | — | — | — | — | — | 2 | — | — | — | — | — | — |
| 21 Dragonet (*C. lyra*, L.) | 11 | 60 | 4 | 12 | 7 | 50 | — | few | few | 7 | few | 6 |
| 22 Weever (*T. draco*, L.) | — | — | — | — | — | — | — | — | — | — | — | — |
| 23 { Thornback (below 12 in.) | — | 17 | 4 | 37 | 7 | 19 } | 63 | 1 | { — | 31 | 59 | 36 |
| { *R. clavata*, L. (12 in. and above) | 8 | 11 | 5 | 3 | 8 | 26 } | | | { — | 3 | 6 | 25 |
| 24 { Homelyn (below 12 in.) | — | — | — | — | — | 2 } | 2 | { — | — | — | — | 3 |
| { *R. maculata*, Mon. (12 in. and above) | — | — | — | — | — | — } | | { — | — | — | — | — |
| 25 { Blonde (below 12 in.) | — | — | — | — | — | 3 | — } | 8 | { — | 1 | — | — |
| { *R. blanda*, Holt (12 in. and above) | — | — | — | — | — | 6 | — } | | { — | — | — | 9 |
| 26 { Painted Ray (below 12 in.) | — | — | — | — | — | — | — } | 3 | 1 | { — | — | — |
| { *R. microcellata*, Mon. (12 in. and above) | — | — | — | — | — | 19 | — } | | | { — | — | 1 |
| 27 *S. canicula*, Cuv. | — | 16 | 1 | 3 | — | — | — | — | — | 1 | — | many |
| 28 *Acanthias vulgaris*, Risso. | — | — | — | — | — | — | — | — | — | — | — | — |
| 29 Buffoon (*R. squatina*, Gün.) | 35 | — | 2 | 3 | 44 | 12 | many | 12 | many | — | few | — |
| 30 Scaldback (*A. laterna*, Rond.) | 8 | 10 | 5 | 12 | 2 | 21 | 30 | — | 1 | — | few | 6 |
| 31 Cod (*G. morrhua*, L.) | — | — | — | — | — | 1 | — | — | — | — | 1 | — |
| 32 White Skate (*R. alba*, Lac.) | 1 | — | — | — | — | — | — | — | — | — | 1 | — |
| 33 *Agonus cataphractus*, Bl. | — | — | — | 1 | — | — | — | — | — | — | 2 | — |
| 34 *Conger vulgaris*, Cuv. | — | — | — | — | — | — | — | — | — | — | — | — |

| | VIII. | VII. | VIII. | VII. | VIII. | VII. | IX. | VIII. | VII. | VII. | VIII. | IX'. | IX. | IX. | VIII. | VII. | IX. | VIII. | VII. | VIII. |
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| | Nov. 14. | Dec. 11. | Dec. 13. | 1902. Jan. 28. | Jan. 28. | April 17. | April 17. | April 18. | April 18. | May 27. | May 27. | May 27. | May 28. | July 2. | July 2. | July 5. | July 5. | July 23. | Sept. 4. | Sept. 4. |
| | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
| | 2 hours. | 3h. 30m. | 1 hour. | 1h. 30m. | 45 min. | 1h. 30m. | 1 hour. | 3 hours. | 2 hours. | 1h. 45m. | 1h. 45m. | 2 hours. | 1h. 30m. | 1h. 30m. | 1 hour. | 45 min. | 1 hour. | 1h. 40m. | 45 min. | 1h. 30m. |
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| 31 | 4 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 32 | 1 | — | 1 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 33 | 1 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 34 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |

## Table D.

*Record of Plaice caught.*

### I. START BAY.

| No. of haul. | Year. | Month. | Day. | Station. | Duration of haul h. | m. | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | (Inches.) | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 1901 | July | 30 | II. | 2 | 35 | – | 1 | 3 | 15 | 6 | 2 | 2 | 2 | 2 | 10 | 7 | 2 | 2 | – | 1 | 1 | 2 | – | – | – | – | – | 58 |
| 2 | ,, | ,, | ,, | I. | 2 | 0 | – | 1 | 1 | 3 | 1 | – | 1 | 2 | — | 6 | 4 | 2 | — | – | – | – | – | – | – | – | – | – | 21 |
| 3 | ,, | Aug. | 7 | I. | 2 | 0 | – | 1 | – | 1 | 1 | – | 1 | 1 | 7 | 4 | 5 | 1 | — | – | – | – | – | – | – | – | – | – | 22 |
| 4 | ,, | ,, | 8 | I. | 1 | 10 | – | – | – | 1 | 1 | 2 | 1 | 5 | 7 | 2 | 5 | 1 | — | – | – | – | – | – | – | – | – | – | 25 |
| 5 | ,, | ,, | 9 | II. | 1 | 10 | – | – | – | — | – | – | – | – | — | — | — | 1 | 1 | 2 | 1 | – | – | – | – | – | – | – | 5 |
| 6 | ,, | Sept. | 6 | III. | 2 | 0 | – | – | – | — | 2 | 1 | 3 | 4 | 4 | 7 | 7 | 2 | 5 | 3 | – | 1 | – | – | – | – | – | – | 39 |
| 7 | ,, | ,, | 7 | III. | 2 | 0 | – | – | – | — | – | – | – | – | 5 | 12 | 18 | 20 | 10 | 3 | 4 | – | – | – | – | – | – | – | 72 |
| 8 | ,, | ,, | ,, | II. | 2 | 0 | – | – | – | 11 | – | 1 | – | 1 | 3 | 4 | 5 | 2 | 1 | – | 3 | 1 | 1 | – | – | – | – | – | 33 |
| 9 | ,, | ,, | 9 | I. | 1 | 55 | – | – | – | — | 1 | – | – | – | 4 | 7 | 2 | 7 | — | 3 | 2 | – | – | – | – | – | – | – | 26 |
| 10 | ,, | ,, | ,, | II. | 2 | 0 | – | – | – | 2 | 5 | 4 | 7 | 5 | 5 | 11 | 5 | 6 | 5 | 1 | 2 | 1 | – | – | – | – | – | – | 59 |
| 11 | ,, | ,, | ,, | I. | 1 | 5 | – | – | – | — | – | 6 | 3 | 2 | 3 | 7 | 5 | 3 | 1 | – | – | – | – | – | – | – | – | – | 30 |
| 12 | ,, | ,, | 10 | III. | 2 | 0 | – | – | – | — | – | – | – | – | 1 | 6 | 5 | 10 | 5 | 3 | – | – | – | – | – | – | – | – | 30 |
| 13 | ,, | ,, | ,, | I. | 1 | 15 | – | – | – | — | – | 1 | 2 | 1 | 2 | 4 | 6 | 5 | 2 | 1 | – | – | – | – | – | – | – | – | 24 |
| 14 | ,, | Oct. | 1 | III. | 1 | 10 | – | – | – | — | – | – | – | – | — | — | 5 | 5 | 3 | 1 | – | 3 | – | – | – | – | – | – | 17 |
| 15 | ,, | ,, | ,, | II. | 2 | 0 | – | – | – | — | 1 | 1 | 1 | – | 3 | 1 | 6 | 2 | 3 | – | – | – | – | – | 2 | – | – | – | 20 |
| 16 | ,, | ,, | 2 | I. | 2 | 15 | – | 1 | – | 1 | – | 8 | 8 | 8 | 19 | 18 | 33 | 21 | 6 | 2 | 1 | – | – | – | – | – | – | – | 126 |
| 17 | ,, | ,, | 3 | I. | 1 | 30 | – | – | – | 1 | 2 | 8 | 2 | 6 | 14 | 18 | 8 | 7 | 4 | 1 | – | – | – | – | – | – | – | – | 71 |
| 18 | ,, | ,, | ,, | I. | 2 | 0 | – | – | – | 1 | 1 | 5 | 4 | 3 | 10 | 16 | 19 | 15 | 8 | 6 | 2 | – | – | – | – | – | – | – | 90 |
| 19 | ,, | ,, | ,, | II. | 1 | 0 | – | – | – | — | – | 1 | 1 | 3 | — | — | — | – | 1 | 2 | 2 | – | – | 1 | 2 | – | – | 1 | 14 |
| 20 | ,, | ,, | 4 | I. | 1 | 10 | – | – | – | — | 5 | 2 | 6 | 7 | 9 | 14 | 14 | 11 | 9 | 1 | – | – | – | – | – | – | – | – | 78 |
| 21 | ,, | ,, | 11 | I. | 2 | 0 | – | – | – | 2 | – | 2 | 1 | 1 | 2 | — | 1 | 5 | 2 | 2 | – | – | – | – | – | – | – | – | 18 |
| 22 | ,, | Nov. | 6 | I. | 2 | 0 | – | – | – | — | 2 | 5 | 3 | 4 | 7 | 22 | 14 | 7 | 4 | 1 | – | – | – | – | – | – | – | – | 69 |
| 23 | ,, | ,, | ,, | III. | 1 | 0 | – | – | – | — | – | – | – | – | — | 3 | 1 | 6 | 5 | 2 | – | – | – | – | – | – | – | – | 17 |
| 24 | ,, | ,, | 7 | I. | 3 | 0 | – | – | – | — | 1 | – | – | 4 | 6 | 1 | 12 | 8 | 6 | 1 | 1 | – | – | – | – | – | – | – | 40 |
| 25 | ,, | ,, | 8 | II. | 1 | 50 | – | – | – | 2 | 2 | 6 | 1 | 4 | 3 | 3 | 3 | 4 | – | – | – | – | 2 | 1 | – | – | – | – | 31 |
| 26 | ,, | ,, | 9 | I. | 3 | 0 | – | – | – | — | 1 | 1 | 1 | 3 | 4 | 4 | 17 | 15 | 10 | 5 | 3 | – | – | 1 | 1 | – | – | – | 66 |
| 27 | ,, | ,, | ,, | II. | 2 | 5 | – | – | – | — | – | – | 1 | 2 | 5 | 12 | 15 | 23 | 3 | 1 | – | – | 1 | – | 1 | – | – | – | 64 |
| 28 | ,, | ,, | ,, | II. | 1 | 0 | – | – | – | — | 1 | 1 | 2 | 4 | 6 | 5 | 11 | 6 | 4 | – | 1 | – | – | 2 | – | – | – | – | 43 |
| 29 | ,, | ,, | 15 | I. | 2 | 30 | – | – | 1 | — | 1 | 1 | 1 | – | 5 | 2 | 10 | 10 | 5 | 4 | – | 1 | 2 | – | – | – | – | – | 43 |
| 30 | ,, | ,, | 16 | II*a*. | 0 | 40 | – | – | – | — | – | 1 | 2 | 5 | 5 | 9 | 10 | 11 | 1 | – | 1 | – | 2 | – | – | – | – | – | 47 |
| 31 | ,, | Dec. | 17 | I. | 3 | 0 | – | 1 | – | — | – | – | – | 2 | 5 | 5 | 5 | 7 | 3 | 2 | – | – | – | – | – | – | – | – | 30 |
| 32 | ,, | ,, | ,, | III. | 3 | 10 | – | – | – | — | – | 1 | 3 | 1 | 7 | 7 | 5 | 2 | 2 | 1 | 1 | – | – | – | – | – | – | – | 30 |
| 33 | ,, | ,, | ,, | I. | 3 | 0 | – | – | – | 1 | – | 3 | 3 | 3 | 4 | 10 | 1 | 3 | 1 | 1 | – | – | 1 | – | – | – | – | – | 31 |
| 34 | ,, | ,, | 18 | I. | 3 | 0 | – | – | – | — | 1 | – | – | 2 | 1 | 3 | 3 | 4 | 2 | 2 | 3 | – | – | – | 1 | – | – | – | 22 |
| 35 | ,, | ,, | ,, | I. | 3 | 0 | – | – | – | — | 1 | – | – | 1 | 4 | 3 | 3 | 4 | 2 | 1 | 2 | – | 1 | – | – | – | – | – | 22 |
| 36 | ,, | ,, | 19 | I. | 3 | 0 | – | – | – | — | – | – | 1 | 3 | 1 | — | 3 | 5 | 1 | 1 | 1 | 1 | – | – | – | – | – | – | 17 |
| 37 | ,, | ,, | ,, | I. | 4 | 0 | – | – | 1 | 1 | 1 | 1 | 6 | 5 | 8 | 9 | 10 | 6 | 3 | 4 | – | – | 1 | 1 | 1 | – | – | – | 58 |
| | | | | | | | | | | | | | | | | | | Total, 1901 | | | | | | | | | | . . . | 1508 |

TABLE D—*continued.*

*Record of Plaice caught.*

I. START BAY—*continued.*

| No. of haul. | Year. | Month. | Day. | Station. | Duration of haul. | | (Inches.) | | | | | | | | | | | | | | | | | | | | | | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | h. | m. | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | |
| 38 | 1902 | Jan. | 21 | I. | 1 | 45 | - | - | - | - | — | — | — | — | 1 | 2 | — | — | — | - | - | - | - | - | - | - | - | - | 3 |
| 39 | ,, | ,, | 22 | III. | 1 | 30 | - | - | - | - | — | — | — | — | — | — | 1 | — | 1 | - | - | - | - | - | - | - | - | - | 2 |
| 40 | ,, | ,, | 24 | I. | 3 | 30 | - | - | 1 | 2 | 3 | 2 | 2 | 5 | 5 | 6 | 5 | 2 | 2 | - | 1 | - | - | - | - | - | - | - | 36 |
| 41 | ,, | ,, | 25 | I. | 1 | 0 | - | 1 | - | - | 1 | — | 2 | — | 2 | 2 | 3 | 2 | 1 | 1 | 1 | 2 | - | - | - | - | - | - | 18 |
| 42 | ,, | Feb. | 4 | I. | 1 | 45 | 3 | 2 | 2 | - | 5 | — | 9 | 6 | 2 | 1 | 3 | 3 | 1 | - | - | - | - | - | 1 | - | - | - | 38 |
| 43 | ,, | ,, | 5 | I. | 1 | 15 | - | - | - | 1 | 3 | — | — | 3 | 2 | 2 | — | 1 | 4 | - | 2 | - | - | - | - | - | - | - | 18 |
| 44 | ,, | Apr. | 8 | I. | 0 | 40 | - | 1 | 1 | - | — | — | — | — | — | — | 1 | — | — | - | - | - | - | - | - | - | - | - | 3 |
| 45 | ,, | ,, | 14 | I. | 1 | 0 | - | - | - | 1 | — | 2 | 4 | 4 | 3 | — | 1 | 1 | 1 | - | - | - | - | - | - | - | - | - | 17 |
| 46 | ,, | ,, | 15 | III. | 1 | 0 | - | - | - | - | — | — | — | — | — | — | — | — | 1 | - | 1 | - | - | - | 1 | - | - | - | 3 |
| 47 | ,, | ,, | ,, | I. | 2 | 30 | - | 2 | 1 | - | — | — | 1 | 2 | 8 | 4 | 6 | 3 | 6 | 3 | - | - | - | - | - | - | - | - | 36 |
| 48 | ,, | ,, | ,, | III. | 2 | 0 | 3 | 3 | 1 | - | — | — | — | — | — | 2 | 3 | 3 | — | - | 1 | - | - | - | - | - | - | - | 16 |
| 49 | ,, | May | 22 | I. | 2 | 0 | - | - | - | - | — | — | 1 | 3 | 3 | 4 | 10 | 4 | 7 | 1 | - | - | - | 1 | 1 | - | - | - | 35 |
| 50 | ,, | ,, | ,, | I. | 2 | 0 | - | - | - | - | — | 1 | 2 | 3 | 6 | 5 | 8 | 5 | 5 | 6 | - | - | - | - | 1 | - | - | - | 42 |
| 51 | ,, | ,, | ,, | I. | 3 | 0 | - | - | - | - | — | 1 | 9 | 7 | 14 | 11 | 13 | 7 | 4 | 4 | 2 | 1 | - | - | - | - | 1 | - | 74 |
| 52 | ,, | ,, | 23 | I. | 1 | 45 | - | - | - | - | — | 2 | 3 | 6 | 10 | 7 | 10 | 8 | 7 | 1 | - | 3 | - | - | - | - | - | - | 57 |
| 53 | ,, | ,, | 24 | I. | 2 | 30 | - | - | - | - | — | 1 | 2 | 4 | 10 | 6 | 8 | 9 | 11 | 1 | - | 1 | - | - | 2 | - | - | - | 54 |
| 54 | ,, | ,, | ,, | II. | 1 | 0 | - | - | - | - | — | — | — | 5 | 1 | — | — | 1 | — | - | - | - | - | - | - | - | - | - | 7 |
| 55 | ,, | ,, | 29 | I. | 6 | 0 | - | - | - | - | — | — | 3 | 8 | 6 | 12 | 7 | 4 | 4 | 1 | 6 | 1 | - | - | - | - | - | - | 52 |
| 56 | ,, | June | 19 | I. | 1 | 0 | - | - | - | - | 3 | — | 1 | 1 | 3 | 2 | — | — | — | - | - | - | - | - | - | - | - | - | 10 |
| 57 | ,, | ,, | 26 | I. | 1 | 0 | - | - | 1 | - | 2 | — | 3 | 9 | 4 | 4 | 7 | 3 | 4 | 2 | - | - | - | - | - | - | - | - | 39 |
| 58 | ,, | ,, | 27 | I. | 1 | 30 | - | - | - | 1 | — | — | 3 | 2 | 4 | 8 | 3 | 3 | — | - | 1 | 1 | - | - | - | - | - | - | 26 |
| 59 | ,, | ,, | 30 | I. | 3 | 0 | - | - | 2 | 3 | 3 | 3 | 11 | 15 | 14 | 17 | 13 | 4 | 4 | 4 | 2 | 1 | 1 | - | - | - | 1 | 1 | 99 |
| 60 | ,, | July | 21 | I. | 2 | 25 | - | - | - | 1 | 3 | — | 2 | 2 | 6 | 4 | 3 | 1 | 3 | - | - | - | 1 | - | 1 | - | - | - | 27 |
| 61 | ,, | ,, | 22 | II. | 1 | 50 | - | - | - | - | — | — | 1 | — | 3 | — | — | — | — | - | - | - | - | - | - | - | - | - | 4 |
| 62 | ,, | ,, | ,, | I. | 1 | 30 | - | - | - | - | — | 1 | 6 | 5 | 5 | 3 | 2 | 1 | — | - | - | - | - | - | - | - | - | - | 23 |
| 63 | ,, | ,, | 25 | I. | 1 | 45 | - | - | - | - | — | — | — | 2 | 2 | 1 | — | — | — | - | - | - | - | - | - | - | - | - | 5 |
| 64 | ,, | Aug. | 25 | I. | 1 | 0 | - | - | 1 | - | 6 | 2 | 4 | 7 | 4 | 8 | 7 | 5 | 1 | 1 | - | 1 | - | - | - | - | - | - | 47 |
| 65 | ,, | ,, | 26 | I. | 3 | 0 | - | - | - | - | 10 | 11 | 6 | 10 | 5 | 7 | 9 | 11 | 4 | 2 | 2 | - | - | 1 | - | - | - | - | 78 |
| 66 | ,, | ,, | 27 | II. | 1 | 15 | - | - | - | 5 | 10 | 17 | 9 | 15 | 11 | 5 | 2 | — | — | 1 | - | 1 | - | - | - | - | - | - | 76 |
| 67 | ,, | ,, | 28 | II. | 0 | 30 | - | - | - | 1 | 5 | 4 | 1 | 3 | 5 | 2 | — | 2 | — | - | - | - | - | 1 | - | - | - | - | 24 |
| 68 | ,, | ,, | ,, | I. | 2 | 0 | - | - | - | 1 | 4 | 7 | 7 | 10 | 12 | 7 | 4 | 4 | 3 | 1 | 1 | 1 | - | - | - | - | - | - | 62 |
| 69 | ,, | ,, | ,, | I. | 3 | 0 | - | - | - | 2 | 4 | 3 | 8 | 6 | 6 | 6 | 12 | 4 | 6 | - | - | - | - | - | - | - | - | - | 57 |
| 70 | ,, | Oct. | 6 | I. | 1 | 30 | - | - | - | - | 1 | 3 | 2 | 2 | 4 | — | — | — | 2 | - | - | 1 | - | 1 | - | - | - | - | 16 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | Total, 1902 . | 1104 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | ,, 1901 . | 1508 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | Grand total . | 2612 |

TABLE D—*continued.*

*Record of Plaice caught.*

II. TORBAY.

| No. of haul. | Year. | Month. | Day. | Station. | Duration of haul. h. m. | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | (Inches.) | | | | | | | | | | | | | | | | | | | | | |
| 1 | 1901 | July | 31 | IV. | 1 40 | 8 | 7 | 1 | 8 | 16 | 12 | 2 | 2 | 5 | 3 | 4 | 9 | 2 | – | – | – | – | – | – | – | – | 79 |
| 2 | ,, | ,, | ,, | VI. | 1 10 | – | — | — | — | 3 | 2 | 2 | 2 | – | 1 | – | 3 | 1 | – | – | – | – | – | – | – | – | 14 |
| 3 | ,, | Aug. | 1 | V. | 1 5 | 1 | — | — | 2 | 4 | 1 | 1 | — | 4 | 7 | 4 | 1 | 2 | 2 | – | – | – | – | – | – | – | 29 |
| 4 | ,, | Sept. | 11 | IV. | 1 30 | 5 | 103 | 17 | 5 | 5 | 13 | 14 | 3 | 9 | 9 | 10 | 7 | 5 | – | – | 1 | – | – | – | – | – | 206 |
| 5 | ,, | ,, | ,, | VI. | 1 30 | – | 1 | — | — | — | 1 | 3 | 1 | – | – | 1 | 1 | – | – | – | – | – | – | – | – | – | 8 |
| 6 | ,, | ,, | 12 | IVA. | 1 0 | – | 1 | 2 | — | 2 | 9 | 5 | 1 | – | 1 | 2 | 5 | 3 | 1 | – | 2 | – | 2 | – | 1 | – | 37 |
| 7 | ,, | ,, | ,, | V. | 1 0 | – | — | — | — | 2 | 9 | 2 | 5 | 3 | 7 | 2 | 4 | 1 | – | – | – | – | – | – | – | – | 35 |
| 8 | ,, | Oct. | 7 | IV. | 1 15 | 7 | 62 | 23 | — | 4 | 9 | 8 | 4 | 1 | 5 | 6 | – | – | – | 1 | – | 1 | – | – | – | – | 131 |
| 9 | ,, | ,, | ,, | IVA. | 1 0 | 1 | 8 | 3 | — | 2 | 3 | 4 | — | 1 | 1 | 2 | 1 | 1 | – | 2 | 2 | 2 | 1 | – | – | – | 34 |
| 10 | ,, | ,, | 10 | IVA. | 1 0 | – | 1 | 1 | 2 | — | 5 | 3 | — | – | – | 1 | 3 | 4 | 1 | – | 1 | 1 | – | – | – | 1 | 24 |
| 11 | ,, | ,, | ,, | V. | 1 15 | – | 2 | — | 2 | 4 | 3 | 2 | — | 8 | 8 | 5 | 6 | 4 | 1 | 2 | – | – | – | – | – | – | 47 |
| 12 | ,, | ,, | 11 | IVA. | 1 0 | – | 3 | 4 | — | 1 | 6 | 5 | 2 | – | – | 2 | – | 1 | 1 | – | 1 | – | – | – | – | – | 26 |
| 13 | ,, | Nov. | 11 | V. | 1 0 | – | — | — | — | 1 | 2 | 1 | 1 | 4 | 9 | 3 | – | – | – | – | – | – | – | – | – | – | 21 |
| 14 | ,, | ,, | 12 | IVA. | 0 50 | – | — | — | — | — | 2 | 1 | 2 | – | – | 2 | 2 | – | 1 | – | – | – | – | – | – | 1 | 11 |
| 15 | ,, | ,, | 14 | VI. | 1 0 | – | — | — | — | — | — | 1 | — | – | 2 | 1 | 1 | – | 2 | – | – | – | – | – | – | – | 7 |
| 16 | ,, | ,, | 15 | V. | 1 0 | – | 64 | 57 | 2 | — | 2 | 2 | 2 | – | 3 | 2 | 1 | 1 | – | 1 | – | – | 1 | – | – | – | 138 |
| 17 | ,, | ,, | ,, | IVA. | 1 30 | 2 | 15 | 10 | 1 | 2 | 7 | — | 2 | – | – | 1 | – | – | 1 | – | – | 4 | 1 | – | 1 | – | 47 |
| 18 | ,, | Dec. | 12 | IV. | 2 0 | – | 1 | 1 | 2 | — | — | 1 | 1 | 1 | 2 | 1 | 1 | – | – | – | – | – | – | – | – | – | 11 |
| 19 | ,, | ,, | 14 | V. | 0 45 | – | — | — | — | — | — | — | — | – | 5 | 1 | – | 3 | 1 | – | – | – | – | – | – | – | 10 |
| | | | | | | | | | | | | | | | | | | | | Total, 1901 | | | | | | . | 915 |
| 20 | 1902 | Jan. | 28 | IV. | 1 0 | 1 | 8 | 17 | 4 | — | — | — | 3 | – | 1 | 1 | 1 | – | – | – | – | – | – | 1 | 1 | – | 38 |
| 21 | ,, | ,, | 29 | VI. | 0 45 | – | 2 | 3 | 2 | — | 1 | — | — | – | – | 2 | – | – | – | – | – | – | – | – | – | – | 10 |
| 22 | ,, | April | 17 | IVA. | 1 30 | 1 | 15 | 16 | 5 | 2 | — | 1 | 1 | – | 2 | – | – | – | – | – | – | – | 1 | – | – | – | 44 |
| 23 | ,, | ,, | ,, | V. | 1 15 | 1 | 6 | 16 | 14 | 1 | 5 | 4 | 3 | 1 | 1 | 6 | 1 | 1 | 1 | 1 | – | – | – | – | – | – | 62 |
| 24 | ,, | ,, | 19 | VI. | 1 0 | – | 1 | 3 | 6 | 1 | 3 | — | 1 | – | 1 | 1 | 1 | – | – | – | – | 1 | – | – | – | – | 19 |
| 25 | ,, | May | 26 | IVA. | 0 40 | – | — | — | — | — | — | — | — | 1 | 1 | – | – | – | 2 | – | – | – | – | – | – | – | 4 |
| 26 | ,, | ,, | ,, | IV. | 1 0 | – | — | — | — | — | — | — | — | 1 | 3 | – | – | – | – | – | – | – | – | – | – | – | 4 |
| 27 | ,, | July | 2 | IVA. | 1 0 | – | 1 | — | 4 | 2 | 4 | 1 | 1 | – | 1 | – | – | – | 1 | – | 1 | – | – | – | – | – | 16 |
| 28 | ,, | ,, | ,, | IV. | 0 30 | – | — | 1 | 6 | 6 | 3 | — | — | – | – | 1 | 1 | – | – | – | 1 | – | – | 1 | – | – | 20 |
| 29 | ,, | ,, | 3 | V. | 1 0 | – | — | 4 | 30 | 13 | 7 | 1 | 8 | 3 | 1 | 1 | 3 | – | 3 | – | – | 1 | – | – | – | – | 75 |
| 30 | ,, | ,, | 24 | V. | 1 30 | – | — | — | — | — | 1 | — | — | 1 | 2 | – | 1 | 1 | – | – | – | – | – | – | – | – | 6 |
| 31 | ,, | ,, | ,, | IVA. | 1 0 | 1 | — | — | 3 | 3 | 2 | 3 | — | – | – | – | – | – | – | – | – | – | – | – | – | – | 12 |
| 32 | ,, | ,, | ,, | VI. | 1 0 | – | — | — | 1 | — | 1 | 1 | — | – | – | 1 | – | – | – | – | 1 | – | – | – | – | – | 5 |
| 33 | ,, | Sept. | 1 | V. | 0 45 | – | 1 | — | — | 9 | 6 | 4 | — | 5 | 1 | 1 | 3 | 1 | – | – | 1 | – | – | – | – | – | 32 |
| 34 | ,, | ,, | ,, | IV. | 1 0 | 2 | 9 | 1 | 3 | 21 | 53 | 34 | 16 | 2 | 2 | 2 | 2 | – | 2 | – | – | – | – | 1 | – | – | 150 |
| 35 | ,, | ,, | ,, | IVA. | 1 0 | – | 3 | — | 4 | 11 | 24 | 17 | 10 | 3 | 3 | 2 | – | – | 1 | – | – | 1 | – | 3 | – | 1 | 83 |
| 36 | ,, | ,, | 4 | VI. | 1 0 | – | — | — | — | 2 | 1 | — | — | 1 | – | – | – | – | – | – | – | 1 | – | – | – | – | 5 |
| | | | | | | | | | | | | | | | | | | | | Total, 1902 | | | | | | . | 585 |
| | | | | | | | | | | | | | | | | | | | | ,, 1901 | | | | | | . | 915 |
| | | | | | | | | | | | | | | | | | | | | Grand Total | | | | | | . | 1500 |

TABLE D—*continued.*

*Record of Plaice caught.*

III. TEIGNMOUTH BAY.

| No. of haul. | Year. | Month. | Day. | Station. | Duration of haul. h. | m. | (Inches.) 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1901 | Aug. | 1 | VII. | 1 | 0 | 2 | — | — | 18 | 7 | 5 | 1 | — | 2 | 2 | 4 | 3 | 1 | 1 | 1 | 2 | — | — | — | — | — | — | — | 49 |
| 2 | ,, | ,, | ,, | IX. | 2 | 0 | — | — | — | — | — | 1 | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 |
| 3 | ,, | ,, | 2 | VIII. | 1 | 50 | 1 | — | 4 | 3 | 2 | — | — | 1 | — | 2 | 1 | 1 | — | — | 1 | — | 1 | — | — | — | — | — | — | 17 |
| 4 | ,, | Sept. | 13 | VII. | 1 | 30 | 1 | 1 | — | 1 | 4 | 6 | 4 | 1 | 5 | 5 | 2 | 3 | 1 | — | 2 | — | — | — | — | — | — | — | — | 36 |
| 5 | ,, | ,, | ,, | VII. | 1 | 30 | — | 18 | 3 | 6 | 16 | 6 | 1 | 4 | 3 | 2 | 4 | 5 | 5 | 2 | 3 | 5 | 1 | — | — | 1 | — | — | — | 85 |
| 6 | ,, | ,, | ,, | VIII. | 2 | 35 | 1 | 4 | 6 | 27 | 17 | 10 | 3 | 8 | 10 | 4 | 7 | 17 | 10 | 4 | 5 | 7 | — | — | — | — | — | — | — | 140 |
| 7 | ,, | Oct. | 9 | VII. | 2 | 15 | 8 | 124 | 56 | 5 | 19 | 38 | 13 | 9 | 13 | 12 | 9 | 6 | 4 | 7 | — | — | 1 | — | — | — | — | — | — | 324 |
| 8 | ,, | ,, | ,, | VIII. | 1 | 15 | — | 5 | 2 | 8 | 15 | 6 | 1 | 4 | — | 1 | 2 | — | 6 | 3 | — | 4 | — | 1 | — | — | 1 | — | — | 59 |
| 9 | ,, | ,, | 11 | VII. | 1 | 15 | 2 | 77 | 46 | 5 | 3 | 2 | 1 | 1 | 4 | 6 | 8 | 5 | 1 | 2 | — | — | — | 1 | — | — | — | — | 1 | 165 |
| 10 | ,, | Nov. | 11 | VII. | 1 | 5 | — | 52 | 77 | 10 | 5 | 12 | 9 | 11 | 14 | 11 | 10 | 9 | 2 | 3 | 3 | — | 1 | 1 | — | — | — | — | — | 230 |
| 11 | ,, | ,, | 13 | VII. | 1 | 30 | — | 2 | 8 | — | — | 6 | 2 | 4 | 6 | 10 | 8 | 5 | 6 | — | 2 | — | 3 | — | — | — | — | — | — | 62 |
| 12 | ,, | ,, | ,, | VIII. | 2 | 0 | — | — | — | — | — | 3 | 1 | 1 | 1 | 1 | 1 | — | — | 1 | — | — | 1 | 1 | — | — | — | — | — | 11 |
| 13 | ,, | ,, | 14 | VIII. | 2 | 0 | — | 1 | 1 | — | — | 1 | — | 1 | 3 | — | 1 | 2 | — | — | — | 1 | — | — | — | — | — | — | — | 11 |
| 14 | ,, | Dec. | 11 | VII. | 3 | 30 | 1 | 29 | 54 | 4 | 1 | 1 | 3 | 1 | 1 | — | 2 | 1 | 2 | — | — | 1 | — | — | — | — | — | — | — | 101 |
| 15 | ,, | ,, | 13 | VIII. | 1 | 0 | — | 1 | 4 | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 6 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1298 |
| 16 | 1902 | Jan. | 28 | VII. | 1 | 30 | 5 | 47 | 18 | 3 | 1 | — | 1 | — | 2 | 1 | 2 | — | 1 | — | — | — | — | 2 | — | — | — | — | — | 83 |
| 17 | ,, | ,, | ,, | VIII. | 0 | 45 | — | 1 | 2 | 1 | — | — | — | — | — | — | — | 1 | — | — | — | 1 | — | — | — | — | — | — | — | 6 |
| 18 | ,, | April | 17 | VII. | 1 | 30 | 2 | 44 | 30 | 7 | 1 | — | — | 2 | 2 | 2 | 2 | 1 | 2 | 3 | 4 | — | 1 | — | — | — | — | — | — | 103 |
| 19 | ,, | ,, | ,, | IX. | 1 | 0 | — | — | — | — | — | 1 | — | 1 | 1 | — | 2 | — | — | 1 | 2 | — | — | — | — | — | — | — | — | 8 |
| 20 | ,, | ,, | 18 | VIII. | 3 | 0 | — | 33 | 24 | 9 | 1 | 3 | 3 | — | 3 | 3 | — | 3 | 2 | 2 | 2 | 1 | 2 | — | — | — | — | — | — | 91 |
| 21 | ,, | ,, | ,, | VII. | 2 | 0 | — | 18 | 18 | 3 | — | — | 1 | 1 | 1 | — | — | 2 | — | 1 | — | — | — | — | — | — | — | — | — | 45 |
| 22 | ,, | May | 27 | VII. | 1 | 45 | — | — | — | — | — | — | 1 | — | — | — | — | 1 | 1 | 1 | — | 1 | — | — | — | — | — | — | — | 5 |
| 23 | ,, | ,, | ,, | VIII. | 1 | 45 | — | — | — | — | — | — | 1 | — | — | 3 | — | — | — | — | — | — | — | 1 | — | — | — | — | — | 5 |
| 24 | ,, | ,, | ,, | IX. | 2 | 0 | — | — | — | — | 1 | — | 4 | 2 | 4 | 1 | 1 | 4 | 1 | 2 | — | — | — | — | — | — | — | — | — | 20 |
| 25 | ,, | ,, | 28 | IX. | 1 | 30 | — | — | — | — | — | — | 1 | 5 | 3 | — | 4 | 2 | — | — | — | — | — | — | — | — | — | — | — | 15 |
| 26 | ,, | July | 2 | IX. | 1 | 30 | — | — | — | 2 | 1 | 2 | 1 | 2 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 8 |
| 27 | ,, | ,, | ,, | VIII. | 1 | 0 | — | — | — | 4 | 1 | 3 | — | 2 | — | — | 2 | 1 | 1 | — | — | 1 | — | — | — | — | — | — | — | 15 |
| 28 | ,, | ,, | 5 | VII. | 0 | 45 | — | 1 | 9 | 3 | 5 | 3 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 21 |
| 29 | ,, | ,, | ,, | IX. | 1 | 0 | — | — | 11 | 48 | 19 | 21 | 4 | 4 | 8 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | 116 |
| 30 | ,, | ,, | 23 | VIII. | 1 | 40 | — | — | 2 | 2 | 4 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 9 |
| 31 | ,, | Sept. | 4 | VII, | 0 | 45 | — | 1 | 2 | 18 | 5 | 11 | 6 | 6 | 5 | 2 | 1 | 1 | — | — | — | — | — | — | — | 1 | — | — | — | 59 |
| 32 | ,, | ,, | ,, | VIII. | 1 | 30 | — | — | 1 | 9 | 11 | 11 | 2 | 7 | 3 | 4 | 4 | 8 | 1 | 3 | 1 | 2 | 1 | 2 | — | — | — | — | — | 70 |

| | |
|---|---|
| Total, 1902 . | 679 |
| ,, 1901 . | 1298 |
| Grand Total . | 1977 |

## TABLE E.

Showing for each month—

(1) The total Plaice caught in each bay separately, distinguishing the four size-groups.

(2) The average size of Plaice caught (expressed in centimetres, with approximate equivalents in inches).

(3) The number of hours fishing.

(4) The catch of Plaice per hour's fishing.

### I. START BAY.

| Year. | Month. | No. of fish caught. | | | | Total. | Average size. | | No. of hours. | | Catch per Hour. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0″–7″ | 8″–11″ | 12″–14″ | 15″+ | | cms. | ins. | hrs. | min. | 0″–7″ | 8″–11″ | 12″–14″ | 15″+ | Total. |
| 1901 | July | 24 | 16 | 29 | 10 | 79 | 28·5 | 11¼ | 4 | 35 | 5·2 | 3·5 | 6·3 | 2·2 | 17·2 |
| | Aug. | 3 | 12 | 30 | 7 | 52 | 32·8 | 13 | 4 | 20 | 0·7 | 2·8 | 6·9 | 1·6 | 12·0 |
| | Sept. | 13 | 49 | 138 | 113 | 313 | 34·4 | 13½ | 14 | 15 | 0·9 | 3·4 | 9·7 | 7·9 | 21·9 |
| | Oct. | 6 | 87 | 210 | 131 | 434 | 34·2 | 13½ | 13 | 5 | 0·5 | 6·6 | 16·0 | 10·0 | 33·0 |
| | Nov. | 3 | 60 | 195 | 162 | 420 | 35·6 | 14 | 17 | 5 | 0·2 | 3·5 | 11·3 | 9·4 | 24·4 |
| | Dec. | 4 | 38 | 97 | 71 | 210 | 34·7 | 13¾ | 22 | 10 | 0·2 | 1·7 | 4·4 | 3·2 | 9·5 |
| 1902 | Jan. | 4 | 15 | 27 | 13 | 59 | 31·7 | 12½ | 7 | 45 | 0·5 | 1·9 | 3·5 | 1·7 | 7·6 |
| | Feb. | 8 | 26 | 10 | 12 | 56 | 28·8 | 11½ | 3 | — | 2·7 | 8·7 | 3·3 | 4·0 | 18·6 |
| | April | 13 | 13 | 28 | 21 | 75 | 31·1 | 12¼ | 7 | 10 | 1·8 | 1·8 | 3·9 | 2·9 | 10·5 |
| | May | — | 61 | 151 | 109 | 321 | 34·3 | 13½ | 18 | 15 | — | 3·3 | 8·3 | 6·0 | 17·6 |
| | June | 7 | 56 | 79 | 32 | 174 | 32·3 | 12½ | 6 | 30 | 1·1 | 8·6 | 12·2 | 4·9 | 26·8 |
| | July | 1 | 22 | 29 | 7 | 59 | 31·4 | 12½ | 6 | 30 | 0·1 | 3·4 | 4·4 | 1·1 | 9·0 |
| | Aug. | 10 | 169 | 112 | 53 | 344 | 30·0 | 11¾ | 10 | 45 | 0·9 | 15·7 | 10·4 | 4·9 | 32·0 |
| | Oct. | — | 8 | 4 | 4 | 16 | 31·8 | 12½ | 1 | 30 | — | 5·3 | 2·7 | 2·7 | 10·7 |
| Totals | . | 96 | 632 | 1139 | 745 | 2612 | — | — | 136 | 55 | 14·8 | 70·2 | 103·3 | 62·5 | 250·8 |
| Means (14 months) | | 6·8 | 45·1 | 81·3 | 53·2 | 186·57 | 32·24 | 12½ | 9 | 46 | 1·0 | 5·0 | 7·4 | 4·5 | 17·9 |
| General averages | | — | — | — | — | — | 32·17 | 12½ | — | — | 0·7 | 4·6 | 8 3 | 5·4 | 19·0 |

## Table E—*continued.*

### II. TORBAY.

| Year. | Month. | No. of fish caught. | | | | Total. | Average size. | | No. of hours. | | Catch per Hour. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0″–7″ | 8″–11″ | 12″–14″ | 15″+ | | cms. | ins. | hrs. | min. | 0″–7″ | 8″–11″ | 12″–14″ | 15″+ | Total. |
| 1901 | July | 43 | 27 | 20 | 3 | 93 | 22·3 | $8\frac{3}{4}$ | 2 | 50 | 15·2 | 9·5 | 7·0 | 1·0 | 32·9 |
| | Aug. | 7 | 6 | 12 | 4 | 29 | 27·3 | $10\frac{3}{4}$ | 1 | 5 | 6·5 | 5·5 | 11·1 | 3·7 | 26·9 |
| | Sept. | 143 | 78 | 49 | 16 | 286 | 20·4 | 8 | 5 | — | 28·6 | 15·7 | 9·8 | 3·2 | 57·2 |
| | Oct. | 130 | 64 | 40 | 28 | 262 | 21·5 | $8\frac{1}{2}$ | 5 | 30 | 23·6 | 11·6 | 7·3 | 5·0 | 47·6 |
| | Nov. | 154 | 29 | 27 | 14 | 224 | 17·0 | $6\frac{3}{4}$ | 5 | 20 | 28·9 | 5·4 | 5·0 | 2·6 | 42·0 |
| | Dec. | 4 | 3 | 10 | 4 | 21 | 28·8 | $11\frac{1}{2}$ | 2 | 45 | 1·0 | 1·5 | 3·6 | 1·5 | 7·6 |
| 1902 | Jan. | 37 | 4 | 5 | 2 | 48 | 18·0 | 7 | 1 | 45 | 21·1 | 2·3 | 2·8 | 1·1 | 27·4 |
| | April | 88 | 19 | 13 | 5 | 125 | 18·4 | $7\frac{1}{4}$ | 3 | 45 | 23·5 | 5·0 | 3·5 | 1·3 | 33·3 |
| | May | — | 2 | 4 | 2 | 8 | 33·1 | 13 | 1 | 40 | — | 1·2 | 2·4 | 1·2 | 4·8 |
| | July | 75 | 37 | 12 | 10 | 134 | 22·0 | $8\frac{3}{4}$ | 6 | — | 12·5 | 6·2 | 2·0 | 1·6 | 22·3 |
| | Sept. | 66 | 176 | 16 | 12 | 270 | 23·8 | $9\frac{1}{2}$ | 3 | 45 | 17·6 | 46·9 | 4·2 | 3·2 | 72·0 |
| Totals . | | 747 | 445 | 208 | 100 | 1500 | — | — | 39 | 25 | 178·5 | 110·8 | 58·7 | 25·4 | 374·0 |
| Means (11 months) | | 67·9 | 40·4 | 18·9 | 9·09 | 136·36 | 23·0 | 9 | 3 | 35 | 16·22 | 10·07 | 5·33 | 2·31 | 34·0 |
| General averages | | — | — | — | — | — | 19·95 | $7\frac{3}{4}$ | — | — | 18·95 | 11·28 | 5·27 | 2·58 | 38·01 |

### III. TEIGNMOUTH BAY.

| Year. | Month. | No. of fish caught. | | | | Total. | Average size. | | No. of hours. | | Catch per Hour. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0″–7″ | 8″–11″ | 12″–14″ | 15″+ | | cms. | ins. | hrs. | min. | 0″–7″ | 8″–11″ | 12″–14″ | 15″+ | Total. |
| 1901 | Aug. | 37 | 11 | 13 | 7 | 68 | 23·1 | 9 | 4 | 50 | 7·6 | 2·3 | 2·6 | 1·4 | 14·0 |
| | Sept. | 105 | 61 | 49 | 46 | 261 | 25·8 | $10\frac{1}{4}$ | 5 | 35 | 18·8 | 10·9 | 8·7 | 8·2 | 46·7 |
| | Oct. | 375 | 92 | 49 | 32 | 548 | 17·9 | 7 | 4 | 45 | 78·9 | 19·3 | 10·3 | 6·7 | 115·3 |
| | Nov. | 156 | 75 | 58 | 25 | 314 | 21·8 | $8\frac{1}{2}$ | 6 | 35 | 23·7 | 11·3 | 8·8 | 3·8 | 47·7 |
| | Dec. | 94 | 7 | 3 | 3 | 107 | 14·8 | $5\frac{3}{4}$ | 4 | 30 | 20·9 | 1·5 | ·6 | ·6 | 23·7 |
| 1902 | Jan. | 78 | 3 | 4 | 4 | 89 | 14·8 | $5\frac{1}{4}$ | 2 | 15 | 34·7 | 1·3 | 1·7 | 1·7 | 39·5 |
| | April | 190 | 19 | 15 | 23 | 247 | 17·6 | 7 | 7 | 30 | 25·3 | 2·5 | 2·0 | 3·0 | 32·9 |
| | May | 1 | 21 | 16 | 7 | 45 | 31·1 | $12\frac{1}{4}$ | 7 | — | — | 3·0 | 2·3 | 1·0 | 6·4 |
| | July | 112 | 51 | 4 | 2 | 169 | 19·0 | $7\frac{1}{2}$ | 5 | 55 | 18·9 | 8·7 | ·6 | ·3 | 28·5 |
| | Sept. | 47 | 51 | 20 | 11 | 129 | 24·6 | $9\frac{1}{2}$ | 2 | 15 | 20·9 | 22·6 | 8·8 | 4·9 | 57·3 |
| Totals . | | 1195 | 391 | 231 | 160 | 1977 | — | — | 51 | 10 | 249·7 | 83·4 | 46·4 | 31·6 | 412·0 |
| Means (10 months) | | 119·5 | 39·1 | 23·1 | 16·0 | 197·7 | 21·07 | $8\frac{1}{4}$ | 5 | 7 | 24·97 | 8·34 | 4·64 | 3·16 | 41·2 |
| General averages | | — | — | — | — | — | 20·14 | 8 | — | — | 23·35 | 7·64 | 4·51 | 3·12 | 38·6 |

# APPENDIX I.

## Preliminary Report on the Trawling Experiments in the Bays on the South Coast of Devon.

THE investigation of the trawling grounds in Start Bay, Torbay, and Teignmouth Bay, which had been previously investigated in 1895–8 by Messrs. Stead and Holt, was resumed by the Marine Biological Associaton in 1901. The new investigations were placed in the hands of Dr. H. M. Kyle, Assistant Naturalist to the Association, and were carried out by him at nearly regular monthly intervals from the end of July, 1901, to the beginning of September, 1902, by means of the Association's s.s. *Oithona.*

In addition to the trawling investigations, Dr. Kyle arranged for the collection of special statistics dealing with the Brixham fisheries. These covered the period from the beginning of February, 1902, to the end of January of the current year.

The manuscript of Dr. Kyle's report was received in March, but the work of revision has been attended with considerable difficulty, owing to Dr. Kyle's removal to Copenhagen and the necessity of considerable correspondence. When it is mentioned that his report includes an analysis of nearly a hundred and fifty hauls of the trawl, in which every fish was counted and measured, and that elaborate calculations have been made from these data from a variety of points of view, it will be understood that the Council of the Association have felt the necessity of subjecting the work to a careful revision before transmitting a formal detailed report. As, however, there has already been some considerable delay, it is thought that the Devon Sea Fisheries Committee may be glad to receive a preliminary summary of the chief results of the investigation.

This summary is limited to questions affecting the plaice, except where otherwise stated.

### Trawling Experiments in the Bays.

The new investigations confirm Mr. Holt's previous report on the following points:—

(1) Start Bay is not a nursery for small flat fish. Only 4 per cent. of the plaice caught were below 8 inches in length, while 71 per cent. of the plaice were 12 inches in length and over. This species matures at 11 inches.

(2) Teignmouth Bay and Torbay are nurseries for small plaice. In the former 61 per cent., and in the latter 50 per cent., were less than 8 inches in length. Three-quarters of the plaice in these bays were immature, and only 20 per cent. attained a length of 12 inches and over.

During the last year the preponderance of large fish over small in Start Bay, and of small fish over large in the other bays, was thus even more marked than during the previous investigations five years ago.

A remarkable feature of the bays last year, to which Dr. Kyle draws attention, was the relative scarcity of medium-sized plaice between 8 and 12 inches, as compared with the period covered by Mr. Holt's investigations. A discussion of the probable explanation of this feature must be reserved for the detailed report.

As was explained at the time of the commencement of the present investigations, no attempt could be made as a result of these experiments to provide a direct answer to any question as to the absolute increase or decrease in the abundance of fish on the grounds. The information provided by this report nevertheless points to distinct conclusions as to the probable effect of closure of the bays on the maintenance of the fishery as a whole.

### Statistics of Fish landed.

Daily returns of the fish landed at Brixham by the small trawlers (Mumble Bees) have been provided by Mr. Will Sanders, the number of trunks being distinguished from the number of baskets. Dr. Kyle reports that the fishermen are accustomed to land their larger fish in the trunks and the small fish in the baskets. He considers that, generally speaking, the plaice above 11 inches are placed in the trunks, and those below that size in the baskets. He further estimates the average number of plaice in the trunks at about 90, and the average number of plaice in the baskets at about 25. From the returns provided by Mr. Sanders he has thus been able to obtain an approximate measure of the numbers of plaice above and below the limit of

11 inches landed by the Brixham smacks during the past year. He reports the total number of "large" plaice landed during the year as about 180,000. "Of this number more than half were captured during February, March, and April, when the plaice were spawning in the deep water, or returning to the inshore grounds after having spawned. The months when the larger fish are least abundant offshore are September, October, and November. It is worthy of remark that the numbers for the months rise from 360 in November to 49,860 in April, and descend again to 450 in October in an almost uniform manner."

"The number of small fish landed for the year is a little over 143,000. The total number of plaice, large and small, is about 323,000, and of these the small plaice amount to 44 per cent."

Dr. Kyle's comments on these figures may be here given. He says: "The most remarkable fact which this table reveals is the large number of small plaice which are captured in the deep water, not only in one month or season, but throughout the year. The largest number—that recorded in April—is 19,800, but those for the other months vary between 4,000 and 10,000."

It should be added that the fishing grounds from which these fish are derived lie almost entirely within the area Start Point to Portland, and that the landings are almost confined to those of the small trawlers (Mumble Bees), which are the chief fishing-boats on the grounds in question.

### Experiments on Migration.

In order to trace the seasonal migrations of the plaice to and from the closed waters of the bays, Dr. Kyle marked nearly 500 fish with numbered labels of brass or bone, and liberated these partly in the inshore waters of each of the bays in October and November, 1901, and partly outside Torbay and Start Bay in April and May of the following year. A reward was offered and paid for every marked fish returned, and the greatest care was taken to obtain correct returns of the places where the fish were recaptured. The Association is again very greatly indebted to Messrs. Sanders for the efficient and friendly assistance which they rendered to Dr. Kyle in this respect. Thanks to their arrangements and to the friendly co-operation of the fishermen, more than 25 per cent. of the fish have been returned with reliable particulars of capture.

The results of the experiments show in a convincing manner that in November and December the great majority of the mature fish leave Start Bay for the deeper offshore waters in Lyme Bay, the larger fish taking a more or less direct course to the eastward, and the smaller ones a less direct course along the shallower gradients to the north-eastward, their general destination being towards the "Biscuit Dust" ground in the first case, and the so-called "Spion Kop" ground in the second.

From Teignmouth Bay the winter migration of the fish above 8 inches was also directed towards the northern of these areas, *i.e.* off Beer Head in about 20 fathoms; but the fish below 8 inches in length were found to remain for the most part in the bays until the following summer.

In March and April the Start Bay fish were found to be returning towards the bay from the distant grounds, where they had spawned, and were recovered within the limits in considerable numbers from July to October. They were recruited on their return journey by a majority of the fish liberated off the northern end of Torbay in May, which also tended to set into Start Bay during the autumn months.

As Dr. Kyle points out, these experiments confirm the view that Start Bay is essentially a summer and autumn "feeding ground" for the large plaice. It is neither a nursery for the small fish nor a spawning ground for the large ones, since the latter almost entirely desert the bay in winter on the approach of spawning time, and do not return until the spawning is over.

## The Protection afforded by Closure of the Bays.

From the three classes of evidence briefly summarised above, it is clear that the closure of Start Bay to trawlers cannot materially protect the small fish (since the latter are present there in inappreciable numbers), nor can it furnish a sanctuary for the spawning fish, since the latter spawn mostly offshore. Its closure is therefore ineffective as a remedial measure, and merely delays the capture of the large fish a month or two longer than would otherwise be the case.

The closure of Torbay and Teignmouth Bay appears, on the other hand, to be advantageous so far as trawling is concerned, since these bays, especially the latter, contain the chief nurseries of small fish known within the entire area from Start Point to Portland, and the closure is not rendered ineffective by any natural tendency of the fish to emigrate in their earliest stages of growth. The extent, however, to which the prosecution of seine-fishing limits the efficiency of closure has not been further investigated.

WALTER GARSTANG,
*Naturalist in Charge of Fishery Investigations.*

PLYMOUTH, *July 7th*, 1903.

# APPENDIX II.

## Preliminary Report on Trawling Experiments in the Bays of South Devon.

### SUMMARY TABLES (PLAICE).

SUBMITTED FOR THE INFORMATION OF THE DEVON SEA FISHERIES COMMITTEE.

TABLE I., *showing the Average Yearly Percentage Frequency of Plaice of different sizes in each of the Bays* (i.) *for* 1901–2, *and* (ii.) *for* 1895–8.

| | Percentages. | | | | Number Measured. |
|---|---|---|---|---|---|
| | 0–7″ | 8–11″ | 12–14″ | 15″+ | |
| *Start Bay.* | | | | | |
| 1901 to 1902 | 4 | 24 | **44** | 28 | 2,612 |
| 1894 to 1898 | 12 | **41** | 38 | 9 | 1,636 |
| *Torbay.* | | | | | |
| 1901 to 1902 | **50** | 30 | 14 | 6 | 1,500 |
| 1895 to 1898 | **39** | 35 | 23 | 3 | 1,040 |
| *Teignmouth Bay.* | | | | | |
| 1901 to 1902 | **60** | 20 | 12 | 8 | 1,977 |
| 1895 to 1898 | 32 | **56** | 10 | 2 | 2,791 |

TABLE II., *showing the Average Quarterly Catch per Hour of Plaice of different sizes in each of the Bays* (*s.y.* "*Oithona*") *compared with the same for July*, 1895–8 (*s.y.* "*Busy Bee*").

#### A.—START BAY.

| Season | Catch per Hour. | | | | | Percentages. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total. | 0–7″ | 8–11″ | 12–14″ | 15″+ | 0–7″ | 8–11″ | 12–14″ | 15″+ |
| July to Sept., 1901 | 18 | 2 | 4 | 8 | 4 | 13 | 22 | 44 | 21 |
| Oct. to Dec. ,, | 20 | 0·2 | 3 | 10 | 7 | 1 | 18 | 47 | 34 |
| Jan. to Feb., 1902 | 11 | 1 | 4 | 4 | 2 | 10 | 36 | 32 | 22 |
| April to June ,, | 18 | 1 | 4 | 8 | 5 | 4 | 23 | 45 | 28 |
| July to Aug. ,, | 28 | 1 | 15 | 9 | 3 | 4 | 53 | 32 | 11 |
| July, 1895–8, *Busy Bee* | 15 | 4 | 8 | 2 | 1 | 29 | 50 | 14 | 7 |

## SUMMARY TABLES (PLAICE)—*continued.*

### B.—TORBAY.

| Season. | Catch per Hour. Total. | 0–7″ | 8–11″ | 12–14″ | 15″+ | Percentages. 0–7″ | 8–11″ | 12–14″ | 15″+ |
|---|---|---|---|---|---|---|---|---|---|
| July to Sept., 1901 | 45 | 15 | 14 | 11 | 5 | 33 | 32 | 24 | 11 |
| Oct. to Dec. „ | 37 | 21 | 7 | 6 | 3 | 57 | 19 | 15 | 9 |
| January, 1902 | 27 | 21 | 2 | 3 | 1 | 77 | 8 | 11 | 4 |
| April to May „ | 25 | 17 | 4 | 3 | 1 | 66 | 16 | 13 | 5 |
| July to Sept. „ | 51 | 18 | 27 | 3 | 3 | 35 | 53 | 7 | 5 |
| July, 1895–8, *Busy Bee* | 45 | 11 | 28 | 4 | 2 | 24 | 63 | 9 | 4 |

### C.—TEIGNMOUTH BAY.

| Season. | Catch per Hour. Total. | 0–7″ | 8–11″ | 12–14″ | 15″+ | Percentages. 0–7″ | 8–11″ | 12–14″ | 15″+ |
|---|---|---|---|---|---|---|---|---|---|
| July to Sept., 1901 | 28 | 12 | 6 | 5 | 5 | 42 | 22 | 19 | 17 |
| Oct. to Dec. „ | 61 | 39 | 11 | 7 | 4 | 65 | 18 | 11 | 6 |
| January, 1902 | 40 | 35 | 1 | 2 | 2 | 88 | 3 | 5 | 4 |
| April to June „ | 20 | 13 | 3 | 2 | 2 | 65 | 14 | 11 | 10 |
| July to Sept. „ | 36 | 19 | 12 | 3 | 2 | 54 | 34 | 8 | 4 |
| June, 1895–8, *Busy Bee* | | | | | | 69 | 17 | 8 | 6 |

TABLE III., *showing Average Size of all Plaice caught during the Trawling Experiments in each Bay during* 1901–2.

| | |
|---|---|
| Start Bay ... ... ... ... ... | 12·8 inches. |
| Torbay ... ... ... ... ... | 7·8 „ |
| Teignmouth Bay ... ... ... ... | 7·9 „ |

TABLE IV., *showing Percentage of Marked Plaice* (*exceeding* 8 *inches*) *recovered in the case of Teignmouth Bay and Start Bay Experiments.*

| Liberated. Locality. | Number. | Recovered. Altogether. | After 1 Year. |
|---|---|---|---|
| Teignmouth Bay | 70 | 41 % | 10 % |
| Start Bay | 258 | 23·5 % | 1·5 % |
| Difference | | 17·5 % | 8·5 % |

NOTE.—The difference (17·5 per cent.) appears to represent approximately the proportion of Start Bay Plaice (large) which migrated outside the Brixham trawling grounds altogether.—W. G.

LOWESTOFT, *October* 5*th*, 1903.

# Notes on the Physical Conditions existing within the Line from Start Point to Portland.

By

**H. M. Kyle, D.Sc.**

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During the trawling work of the past year within and around the bays on the south coast of Devon, my attention was drawn to the peculiar phenomena displayed by the tides and currents in Start Bay, and a subsequent endeavour to trace their connections and consequences led to a wider survey of the region within the line from Start to Portland. The bottom samples brought up by the trawl and lead afforded excellent opportunities of ascertaining the nature and distribution of the different soils, and thus of tracing out their changes during the seasons. My own observations, moreover, were supplemented by those of the friendly Brixham fishermen, who had many years' experiences behind them. Their theories, it is true, were somewhat numerous and divergent, as becomes such an energetic and independent race, but the phenomena were described with a wonderful definiteness and unanimity. Knowledge of the bottom-soil—its changes through the month and year—and of the tidal phenomena is absolutely essential to the fisherman because his living depends upon it, so that one need not be surprised at, though appreciating, the great accuracy with which they can tell where they are and what they should catch in their trawls from a brief examination of the soil brought up by the lead.

In addition to the records of the trawl and lead, dredgings were taken in the usual manner by means of a canvas bag laced inside the ordinary dredge, but these were comparatively few in number. The region under investigation is an awkward one as regards weather even in the best of years, and the weather of the past year was exceptional in its severity. The result was that the limited time at our disposal was shortened on every occasion throughout the year, and the offshore grounds were only partially investigated. I am obliged, therefore, to rely on the Admiralty charts for the areas not investigated, but of the relations between tides and bottom-soil they, of course, give no account, and it is with these the present paper will deal.

In the various pilot guides to the English Channel a great amount of information is given with regard to the tides in the different regions, and much light is thrown on the circulation of the water within the line from Start Point to Portland and its relation to the tides at the mouth of the Channel; but here, again, the inshore currents are barely mentioned, and the relation of the currents generally to the formation and changes of the bottom-soil not at all.

Several papers contributed by Mr. H. N. Dickson to this Journal (vol. ii.) deal with the distribution of surface temperatures in the English Channel. Comparatively few records were taken within the area here considered, but during the summer of 1891 it was found that in Start Bay,* so called, a warm upper stratum of water was superposed upon a cold lower layer nearer the bottom. In other respects than temperature the two strata were alike. Special emphasis was laid by Dickson upon this discovery, even though observations made in the succeeding winter failed to corroborate it. It showed that the colder waters from west of the Start were able to penetrate under the almost stagnant upper layers within the Great West Bay.

With regard to the action of waves and currents on the shore a great deal of literature exists, but it is unnecessary to enter into this aspect in any detail. Reference need only be made to the paper of Vaughan Cornish on the famous Chesil Beach near Portland, and to the recent work of Wheeler on the *Sea Coast: Its Destruction and Protection*. In the former the much-disputed origin of the Chesil Beach is discussed, and a theory stated which seems to accord well with the phenomena observed. As will be shown later, this theory is accepted here and applied to phenomena very similar, though on a smaller scale, at the other extreme of the area, namely, Slapton Sands in Start Bay. In the latter work an interesting account is given of the actual condition of the shores and the littoral drift on the south coast. Reference will be made to it later.

The Great West Bay is 48 miles across from Start Point to Portland, and extends 20 miles inwards. Its area is about 650 square miles. It opens to the south-west, so that its easterly arm towards Portland

* Considerable doubt exists as to the right name to apply to the region within the line from Start Point to Portland. Dickson refers to it as Start Bay, but this is obviously incorrect. Wheeler calls it Lyme Bay, but Lyme Bay is more usually restricted to the northern portion from Hope's Nose or Straight Point to Portland. It seems advisable to have a distinct name, however, because Start Point and Portland form the natural boundaries to a compact series of phenomena, and the name Great West Bay, used by Mr. A. R. Hunt (*The Evidence of the Skerries Shoal on the Wearing of Fine Sand by Waves*, 1897), has been adopted in this paper.

is fully exposed to the southerly and westerly gales, but sheltered from the easterly. Conversely, the arm which extends out to the Start is sheltered from the westerly gales, and only the easterly and south-easterly winds affect it strongly.

It has long been known as a good fishing-ground, and at the present day from seventy to eighty of the Brixham boats trawl over it regularly throughout the year. From the point of view of the fisheries this area is of great interest, for it displays within comparatively narrow limits all the important biological problems in connection with the life histories of food-fishes, as well as the physical conditions with which those life histories are so closely related.

## Tides and Currents.

The movements of the tides in the English Channel are complicated by the numerous bays and inlets of the French and English coasts. In the centre of the Channel the periodic ebb and flow is fairly regular, but even there the cross currents caused by in-draughts into the various bays on both coasts produce a rotary motion at the changes of the tides, which is only approximately constant as regards direction and duration. Without entering too far into the details which may be found in Channel pilot books, the tidal currents and their strengths may be referred to so far as they concern the Great West Bay.

The Channel is divided into three main regions: the first lies to the west of the Lizard in Cornwall; the second from the Lizard to Start Point; and the third from Start Point to Beachy Head. In the first division the state of the tides is always the reverse of that in the third, *i.e.* with regard to ebb and flood; in the second region it is "intermediate," agreeing for one half of the tidal period with the outside main tidal stream, and for the other half with the "true Channel stream" between Start Point and Beachy Head. There is no definite line of demarcation, however; what happens is that whilst the "true Channel stream" is flowing, the condition intermediate between ebb and flood, *i.e.* slack water, is gradually passing from the Lizard to the Start until it reaches the latter point two hours before high water at Dover. To the west of Start Point, therefore, the ebb is going to the west for one hour whilst the flood to the east of Start Point is still travelling to the east. The "true Channel stream," as is well known, suddenly changes after high water at Dover throughout the third region and ebbs to the west. For the short space of one hour the direction of the tidal current is the same throughout the entire Channel, *i.e.* to the west, then the flood begins to make at the western end, and for the next four hours the second region is the centre of opposing forces. In the western end of the Channel the flood is deflected to the north for one hour, and then flows steadily to the east; in the centre of the second region the antagonistic forces produce a definite spell of slack water when they meet, but in the eastern end near Start Point the oncoming flood is deflected to the south and south-east for two hours before it is able to overcome the opposing ebb current. During the same period the ebb to the east of the Start is deflected first of all to the south of west, then to the north, and there is no period of slack water. During the last part of the ebb, therefore, the tidal current is setting directly into the Great West Bay.

It thus appears that the Great West Bay participates in the effects of the conflict between the "true Channel stream," and the "intermediate stream," and these effects are such that a definite spell of slack water occurs on the last of the flood,* and that there is an inset on the last of the ebb.† It is evident, therefore, that these conflicting currents tend on the whole to weaken the tides in the Great West Bay, and the peculiar disposition of the bottom-soil there is in part due to this cause.

The strength of the tidal currents is manifested by the rate. Whilst the rate outside is over two knots per hour at springs, within the Great West Bay, off Berry Head, it is less than one knot. The centre of this region, in fact, is almost at rest so far as the tides are concerned, and farther in towards the land, off Beer Head, the currents move definitely round a complete circle during the tidal period.

At the two extreme corners the currents rush in and out with great velocity. The latter phenomenon is associated with, and partly the result of, the heaping up of the waters within a confined area. When the flood-tide passes round the Start it has to contend against not merely the rising ground, but also a sheet of water which will stand compression only to a limited extent. The main stream is consequently deflected away from the bay towards Portland. For the first three hours of flood the water-level steadily rises all over the area, and the trend of the current all along the shore is towards the east. When high water is reached the current is still eastward outside and in the easterly portion of Lyme Bay, but as we pass in towards the land of the westerly portion, the current gradually gets slower, until it ceases altogether, and finally changes its direction and flows to the west. The waters heaped up at the head of the bay by the rising tide must find some outlet after high water, and whilst the eastward current outside has still some three hours to run. As we pass,

* Except, perhaps, to the east of the bay, near Portland.

† The direction of the surface currents here, as elsewhere in the English Channel, is greatly determined by the prevailing winds. Cf. W. Garstang, *Journ. M. B. A.*, v. p. 199.

on the one hand, from Beer towards Portland, the stream gradually increases from almost nothing in strength to over five knots per hour. As we pass backward along shore from Beer towards the Start we pass through Teignmouth Bay, where the current is scarcely felt, Torbay, where it is uncertain and variable in direction, until we come to Berry Head and Mudstone Ledge, where the current is setting to the westward.

On the shore of the western half of the area there is, therefore, a backward eddy during the latter half of the flood-tide. Wheeler, in describing this peculiar phenomenon for Start Bay, imagined that the flood-tide was deflected from the cliffs forming the north-eastern boundary of Start Bay, and thus entered the bay from its north-eastern aspect. Apart from the inherent improbability of such a thing, this explanation leaves out of count the presence of the backward eddy over Mudstone Ledge close to Berry Head.

Along Slapton Sands, in Start Bay, the current sets towards Start Point the last half of the flood and the whole of the ebb, *i.e.* for nine hours out of the twelve. Along Chesil Beach, at the other corner, the current sets towards Portland also for nine hours out of twelve, but there it is during the last part of the ebb and the whole of the flood.

The tidal phenomena close to Portland repeat what has already been described as occurring off Beer Head. Two miles west of Portland Bill the direction of the currents turns round a complete circle, so that after three hours of ebb-tide the current sets northerly into the bay, and to counterbalance this inset there is an outward eddy along Chesil Beach. This northerly set of the current is probably due to the fact that the flood is already making to the west of Start Point. To the west of Portland Bill, therefore, there is a circular motion of the waters during the last part of the ebb.

The comparison of the currents at the two extreme ends of the area may be carried still farther. At the eastern end the stream passing round Portland Bill meets with an opposing ebb and eddy from beyond, and thus helps to form the "race," which passes on to and over the great sandbank known as the Shambles. At the western extremity the eddy issuing from Start Bay also forms a race with the opposing flood-tide coming from the west, and this race extends obliquely from the shore for nearly a mile in a south-westerly direction. The outgoing eddy, however, is weak in comparison with that at Portland, so that the race is not a strong one, and the sandbank, instead of being in the direct line of the race, lies farther to the north-east on the line of the flood-tide.

The conditions, so far described, obtain generally throughout the year, but are more particularly marked during spring-tides. During neaps, the water is almost stagnant over the whole western area, and the currents along shore are feeble and uncertain in direction. In Teignmouth

Bay there is practically no current one mile from the shore. The tide sets directly on to the beach in its northerly portion, and the only currents along shore are caused by projecting headlands, *e.g.* Clerk Point, sending off the incoming tide on each side in different directions. At the southern end of the bay the incoming tide sets along the projecting headland of Hope's Nose, and there is thus a slight current along shore.* In Torbay the central portions are even more stagnant than in Teignmouth Bay, but on the beach we have the same phenomenon of currents acting in opposite directions. Paignton Head, in the centre of the bay, divides up the incoming tide, and there is a current on each side of it—the one tending across Brixham breakwater to Berry Head, the other towards Torquay and Hope's Nose.

Sometimes, as the result of storms either within the area or beyond in the Channel, these currents may be reversed, but in general they are well marked.

Within Start Bay during neaps there is very little current in the centre of the bay, and the eddy along shore is not so strong as during spring-tides. During the latter periods the eddy rushes out round the Start at a rate exceeding two knots per hour. This eddy extends about a mile from the shore off Torcross, and during the ebb the current sets straight across the Skerries in a south-south-easterly direction.

## Depths and Bottom-soil.

The region under consideration lies mostly within the thirty-fathom line. At Start Point the water deepens rapidly, so that within two miles of the shore thirty fathoms is reached. From there the thirty-fathom line runs in an easterly direction until the centre of the bay is reached, when it inclines to the south of east and passes Portland about eight miles off. Within this line the water gradually shoals, and twenty fathoms is reached on a line from Berry Head to Portland. The twenty-fathom line is also concave, with the concavity more marked towards Portland. The ten-fathom line follows roughly across the outlying headlands of the numerous bays and indentations round the coast, being nowhere more than three miles from the shore, and in some places approaching it to within a few yards.

The general rise in the bottom-level is fairly uniform and regular, except along the western side, where important modifications occur. Within half a mile of Start Point, to the north-east, the water shoals rapidly from nine fathoms to four, and a little farther to only two.

* According to Mr. Taverner, the Fisheries Inspector of the Devon Sea Fisheries Committee, the general trend of the current here is from Babbacombe towards Hope's Nose; that is to say, that the eddy which makes itself so evident in Start Bay is already felt in Teignmouth Bay.

From thence the sandbanks of the Skerries extend in a north-easterly direction for three miles. The tops of the banks lie from two to five fathoms below the surface, but between them the water deepens to nine or more fathoms. On the outer side the slope of the banks is very steep, and more so toward the end away from the Start. In some places it descends from five fathoms to eighteen within a hundred yards. On the inner side the slope is more gradual, but when from four to five fathoms are reached there is a sudden dip down to about seven. This is caused by the central channel of the bay, which narrows as it approaches the Start, and is generally about nine fathoms deep. Half a mile off Hallsands, in June, 1902, a depth of fifteen fathoms was obtained by the lead, and according to the Brixham fishermen this part is "full of pits."

At the other extremity of the Skerries Bank there is a sudden dip to fourteen fathoms at the Bell Buoy, and from there across to the Mewstone, on the far side of Dartmouth fairway, the depth approaches twenty fathoms. Beyond the east Blackstone, half a mile to the east of the Mewstone, there is a bank of sand well known to the Brixham men, but not clearly indicated on the charts. It begins on the southerly aspect of the Blackstone, and runs in a north-easterly direction for nearly a mile. The depth of water over it varies from ten to fifteen fathoms, but, like the Skerries, there are depressions at various places. Immediately inside it the depth varies from thirteen to eighteen fathoms. The presence of this bank is of great interest, and the water over it almost always displays some disturbance.

As we pass towards Berry Head we find a deep channel within half a mile from the shore. On one occasion during May, 1902, a depth of thirty fathoms was recorded a quarter of a mile off the Cod Rock. The greatest depth given by any chart for this place is twenty-eight fathoms, and the Admiralty charts give only twenty-three. Outside the channel the depth of water is but seventeen to nineteen fathoms. Apart from these exceptions, the depths given by the Admiralty charts were found to agree fairly well with the records.

The soil in the Great West Bay varies from rough gravel and stones to fine sand and mud. Along the thirty-fathom line we find for the most part gravel and coarse sand, except at the two extremes. Five to six miles off the Start in an easterly direction, with Prawle Point on a line with the Start, there are banks of fine sand, which in the beginning of summer are covered by mud. This region is called the "Corner" by the Brixham fishermen, and, it will be noticed, lies straight off Dartmouth fairway. The depth over these banks is about thirty fathoms, and they are surrounded by water one to two fathoms deeper.*

* These banks are not to be confounded with Start Bank, which lies to the south of Start Point. See chart.

As we pass along the thirty-fathom line and come to a point east by south of Berry Head, and south-west of Portland, we meet with a long bank or ridge of gravel, shells, and stones, which extends on to the rocks off Portland. This ridge is not shown on the smaller charts, but on the large chart of the Channel by Laurie it is significantly marked as "rotten ground," "coarse," and "sand and small stones." The first designation probably refers to the oyster and pecten shells which abound there in great quantities. The Brixham men call the ridge the "Scruff," and state that there used to be a western scruff of similar material in the Corner off the Start. The western limit of the Scruff is not clearly defined, but there is a break between it and what are called the "Clumps," the rough ground about fifteen to twenty miles off the Start. The Scruff and the Clumps are, however, of similar nature, and if we continue the same line westward we come upon the rough stony tract which forms the centre of the Channel.

The breadth of the Scruff seems to be about a quarter of a mile. Its outer boundary is parallel and close to the line followed by steamers passing up and down Channel from Portland to the Start. Within the line of the Scruff there is a broad band of bright yellow sand of medium to coarse quality, which the trawlers call "biscuit dust." This extends as far as the twenty-five-fathom line, where it changes to fine sand of a brown colour. This continues all round Lyme Bay until fifteen to sixteen fathoms are reached, when it gives place to rocky ground with intermediate patches of sand.

The western side of the Great West Bay is just the reverse of the eastern. Outside the Skerries we find gravel and coarse sand, but from there onward to off Teignmouth Bay the offshore grounds consist of fine sand and mud. This, in fact, is the peculiarity of the western part, that its central region, from twenty-seven fathoms right into Torbay, consists of mud (Tables I. and II., p. 540, Sample x.). There is no place in the English Channel, nor, so far as I can discover, round the British coasts, where mud—non-estuarine in character—has accumulated to such an extent as off Berry Head.

Within Start Bay, and along a narrow strip from Berry Head to the Mewstone off Dartmouth, the bottom-soil is quite different. Gravel and coarse to medium sand are found between the rocks off Downend, and on the bank off the East Blackstone. There is a tract of mud across the mouth of the Dart until we come to the centre of Start Bay off Torcross. The mud then gives place to fine yellow sand, and this, towards the shore on the one hand and the Skerries on the other, grades into coarse sand. Along the beach from Blackpool to Start Point the soil gradually changes from medium sand, through mixed sand and stones on Slapton beach, to a fairly uniform spread of gravel and pebbles at Hallsands.

A dredging obtained off Blackpool, where the beach is of sand, showed that other materials were present in the deeper waters. It is well known that the sand of the beach rests on a clay bottom, which is frequently uncovered by storms. At the eastern corner, in five fathoms of water, this clay was found free of sand, but contained small pebbles similar to those on the beach at Hallsands. These pebbles were well rounded, showing that they must have travelled about a good deal until trapped in the clay.

Apart from the beach the coarsest sand in Start Bay is to be found along the margins of the Skerries Bank. Samples obtained there after a gale from the east on the 4th February, 1902, showed that the material varied from coarse gravel to fine sand, stones being absent, and silt practically so (Tables I. and II., Samples ii.–vi.).* Of five samples taken the coarsest was 4·760 on the average, or between coarse sand and fine gravel, whilst the finest was 6·049, *i.e.* medium sand. The finest material obtained on that date was 6·86 on the average, *i.e.* almost entirely fine sand (Sample vii.), and this was got, not on the Skerries Bank, but half a mile from the shore between Hallsands and Beesands. In the summer and autumn, however, the fine sand is found on the top of the Skerries Bank, and the easterly gale is responsible for its having been found within the bay near the shore.

Off Teignmouth Bay, again, we find a peculiar distribution of the bottom-soil. From Hope's Nose to off Teignmouth there is a stretch of hard ground on which oysters are fairly abundant. As showing the trend of the current in Teignmouth Bay, it may be mentioned that the empty shells congregate in masses behind the Orestone on the Torbay side. Outside this hard though muddy ground, there is a long shelving bank, which the Brixham fishermen call the "Ledge." This extends out in an easterly direction, and has several patches of rocks and coarse gravel. On the inner side of the oyster ground lies a stretch of muddy ground, which, within six fathoms, gives place to sand. The ground on the northern portion of the bay is very variable throughout the year. When first worked over during the autumn of 1901, it was a stretch of uniform sand from off Teignmouth to the fairway buoy off Exmouth; but in the spring of 1902 the sand was swept away, and a bed of large stones running out from Clerk Rock to over a mile from the shore was laid bare. This bed was still uncovered in July, 1902.

It only remains now to consider the relations between the tides and currents on the one hand, and the bottom-soil on the other. The effect of storms is to disturb the actual condition of things, but with fairly regular currents the tendency of soil is to take up a state of

* The grading of the soil is as given by E. J. Allen, "On the Fauna and Bottom-deposits near the Thirty-fathom Line from the Eddystone to Start Point" (*Jour. M. B. A.*, vol. v. p. 378).

equilibrium so that one kind is present at one place and others at another. Looking at the matter broadly, we may say that wherever a current is running we find stones, but where there is comparative calm we find sand or mud.

It has been shown that the Great West Bay is the centre of reciprocating currents in the Channel; further, that the main tidal stream does not penetrate far into the bay, and consequently that the current inside is less than one knot per hour at full and change of moon, whereas outside it is over two. These causes combined bring about a state of comparative calm within the bay, more especially to the westward side and in the centre, and it is there we find the finest bottom-soil of the whole region.

At the head of the bay, *i.e.* off Beer Head, it was pointed out that the tides set round a complete circle within the twelve hours, and the tendency of the currents, therefore, is to carry away from this centre whatever material may be movable. We thus find that along the northern shore the ascent to the beach is comparatively rapid, *i.e.* deep water approaches close to the shore, and, secondly, that the ground is mostly hard and rocky, with a few patches of mud and sand between the rocks.

As we pass from the head of the bay along its two arms, it has been shown that we meet with two currents, which gradually increase in velocity and strength as they approach and finally pass round the two extreme points. On the one hand, at Portland this current is made up of the flood-tide and an eddy from the ebb, and is of great velocity—greater than the outside main tidal stream; on the other hand, at Start Point the current arises from the ebb-tide and an eddy from the flood, and is comparatively weak. Both these currents flow in their respective directions nine hours out of the twelve, and their constancy and duration are considered to be due to the heaping up of the waters by the tide at the head of the bay.

On the eastern arm towards Portland there can be little doubt that the east-going stream has considerable influence in keeping the bottom clear of sand and mud, and thus leaves the rocks bare and uncovered. Along this arm the rocks of the coast project outwards as far as the fifteen-fathom line. The seas raised by the gales from the south and south-west break heavily on this eastern arm, but their influence is mostly destructive, and the sand and mud would tend to return to their former position were it not for the steady, though at the beginning slow, current which is in reality the effective agent in the transference of sand from west to east. It is to the excess of the easterly-going current over that going to the west that Vaughan Cornish * ascribes

* "The Grading of the Chesil Beach Shingle" (*Proc. Dorset Nat. Hist. Field Club*, 1898).

the peculiar formation of the famous Chesil Beach. As is well known, this beach begins near Bridport with fine sand and extends a distance of sixteen miles towards Portland, the sand gradually changing to gravel and pebbles and thence to stones. The grading is so nice that fishermen are said to be able to tell where they are, even in the dark, by merely examining the materials of the beach. According to Cornish, the east-going current of nine hours' duration is able to carry along materials to a greater distance than the west-going current of only three hours. Consequently the heavy stones are steadily being carried to the eastward, until they are trapped by the projecting "island" of Portland, which acts as a natural groyne. The lighter materials remain longer in suspension and are carried onwards beyond the Bill to the Shambles. The west-going stream may carry the suspended sand backwards towards Bridport, but on the whole the drift is easterly.*

It has been mentioned that a returning eddy makes its appearance in Start Bay after high water by the shore, and though this eddy has not been definitely traced farther back than Berry Head, there are indications of its presence even in Teignmouth Bay. In the centre of the latter bay the tides are scarcely felt, and the trend of the currents on the shore is in opposite directions at Teignmouth and Exmouth. The former seems to be due to the returning eddy, which, though weak, tends to deaden the flood-tide, whilst the latter is due in part to the conjoined currents setting directly on to the shore. At the lower end of the bay we have clearer evidence of the eddy in the strong current which rushes through between the Orestone and the mainland on the ebb, and in the accumulation of material from Teignmouth Bay on the Torbay side of the Orestone.† In Torbay itself the only evidence I have found for the presence of the eddy is that the trend of objects from the Brixham side of the bay is past the breakwater and on to Berry Head. Off Berry Head we have the deep, though narrow, channel close in to land, which seems unmistakable evidence of a strong eddy, and over Mudstone Ledge the eddy definitely makes it appearance. Off Downend, again, we find a sandbank separated from the land by a deeper channel, which has probably been formed by the conflict of the flood-tide flowing easterly on the outside with the eddy going to the west on the inside. Lastly, the whole appearance of Start Bay is evidence of the presence and great influence of the eddy.

On the chart it will be noticed that the depth contour lines in Start

* According to Wheeler (*loc. cit.*) there is also a distinct northerly current flowing along the island, and this accounts for the greater accumulation of material at Chesilton, which lies at the bend where the island begins to separate from Chesil Beach.

† See foot-note, p. 533.

Bay are just the reverse of those in other parts, *i.e.* they are opposed to the direction of the flood-tide. The opening into the bay lies between the Skerries Buoy and the Mewstone, whilst its head is at Hallsands. This shows that the currents in the bay tend in the main to go from the Dartmouth end towards the Start. The presence of the Skerries Bank undoubtedly has a great deal to do with the opening of the bay from the north-east, but it seems clear that this bank must itself have been formed under the influence of the eddy. Since the latter is running down through Start Bay for nine hours out of twelve, it follows that for three hours out of twelve it is opposing the on-coming flood-tide off the Start, and the materials it is carrying down in suspension eventually come to rest either on the beach or along the line of demarcation. This seems to explain clearly enough why the Skerries Bank is present off Start Bay, and also why it is broader near the Start than at the other end near the buoy. The tendency is for the sand to accumulate more and more at the south-west corner, because it is there that the opposing currents meet and are most in conflict, causing the water to be comparatively calm, and it is only the deep channel cut out by the eddy between the bank and the land which prevents the south-west corner from being filled up by sand.

Along the beach from Slapton to Hallsands we have the Chesil Beach reproduced on a smaller scale. The finer sand mixed with stones and gravel is found on Slapton Sands, whereas at Hallsands there is practically nothing but pebbles. The theory of Cornish seems to apply equally well here. The eddy and the ebb together being in excess of the flood, carry all materials down the bay. The heavier stuff comes to rest sooner under the lee of the projecting promontory of Start Point, and is thus deposited on the beach at Hallsands, whilst the lighter sand is carried onwards and deposited on the Skerries.

In conclusion, the comparison between Chesil Beach and the beach in Start Bay may be recapitulated. In both cases we have currents flowing for nine hours one way and three hours the other, a projecting promontory at each which acts as a natural groyne, a grading of the beach materials from fine to coarse in the direction of the more prolonged current, and the presence of a large sandbank offshore. Further, both beaches have been raised in great part, if not entirely, by the action of these currents, and a stretch of water has thereby been enclosed—in the one case Slapton Ley, behind Slapton Sands, in Start Bay; in the other case the Fleet, near Portland.

When more samples of the bottom-soil have been obtained it will be possible to push the comparison still farther.

## I. SAMPLES OF THE BOTTOM-SOIL, SHOWING THE PROPORTIONS OF THE DIFFERENT KINDS OF SAND.

| | SAMPLES. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| GRADE. | I. | II. | III. | IV. | V. | VI. | VII. | VIII. | IX. | X. |
| I. Stones . . | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| II. Coarse Gravel . | ... | 0·50 | 0·58 | 0·70 | 4·30 | 0·37 | 0·25 | trace | 3·20 | ... |
| III. Medium Gravel | 1·35 | 2·60 | 3·10 | 2·40 | 15·60 | 2·71 | 0·10 | 0·42 | 5·50 | 1·4 |
| IV. Fine Gravel . | 3·50 | 4·00 | 7·92 | 4·50 | 21·00 | 4·61 | 0·20 | 1·65 | 11·20 | ·68 |
| V. Coarse Sand . | 4·45 | 5·80 | 10·25 | 5·30 | 19·20 | 6·30 | 0·25 | 2·37 | 12·30 | ·78 |
| VI. Medium Sand . | 59·70 | 80·30 | 71·85 | 70·50 | 38·20 | 56·00 | 11·05 | 61·14 | 50·50 | 16·0 |
| VII. Fine Sand . | ... | 6·80 | 6·30 | 16·60 | 1·70 | 30·01 | 87·80 | 34·41 | 17·30 | 74·0 |
| VIII. Silt . . | ... | trace | ... | ... | trace | trace | 0·35 | trace | trace | 7·2 |

NOTE.—I am much indebted to Mr. R. H. Worth for kindly working out Samples II. to VIII.

## II. GROUND WHERE SAMPLES WERE OBTAINED AND AVERAGE CONDITION OF SAMPLES.

| No. | Ground, Depth, and Date. | Average. |
|---|---|---|
| I. | Close to Skerries Buoy on inner side; 11½ fathoms; January 30, 1902 . . . . . . . | 6·22 |
| II. | Close to Skerries Buoy on inner side, after easterly gale; 12¾ fathoms; February 4, 1902 . . . . . . | 5·83 |
| III. | Close to Skerries Buoy on outer side; 15 fathoms; February 4, 1902 | 5·686 |
| IV. | On line Skerries Buoy to Start Lighthouse (½ mile); 10 fathoms; February 4, 1902 . . . . . . . | 5·923 |
| V. | On line Skerries Buoy to Lighthouse (half-way); 10 fathoms; February 4, 1902 . . . . . . . | 4·760 |
| VI. | South-west corner of Skerries Bank, opposite Hallsands, on line Buoy to Lighthouse; 10 fathoms; February 4, 1902 . . | 6·049 |
| VII. | Midway between Hallsands and Beesands (½ mile offshore); 9½ fathoms; February 4, 1902 . . . . . . | 6·86 |
| VIII. | Off Torcross (2 miles); 7½ fathoms; February 4, 1902 . . . | 6·274 |
| IX. | On line Skerries Buoy to Lighthouse (¾ mile); 16 fathoms; February 4, 1902 . . . . . . | 5·513 |
| X. | Four miles off Berry Head (E. ½ S.); 24 fathoms; April 16, 1902 . | 6·82 |

# Notes on the Invertebrate Fauna and Fish-food of the Bays between the Start and Exmouth.

By

**R. A. Todd, B.Sc.**

## Introduction.

THE following records are based on notes taken on board the *Oithona* when engaged in fishing in the bays. Whilst the primary object of the work was the distribution of fish, it was thought that something would be gained if the distribution of the invertebrates in the same area were known. The time at our disposal, however, did not allow of hauls with the dredge and shrimp trawl, so that the records are based, in all but one case, on the invertebrates caught in an otter trawl, the exception being on the Limpet Rocks off Torcross, where one haul with the dredge was taken. This is accountable for the fact that many of the smaller invertebrates were not caught at all, whilst some are only recorded because they were found in fish stomachs. The almost total absence in the records of Tunicata, Polyzoa, and small species of the other groups is due to the fact that only those were recorded which could be identified on board. The records themselves, however, incomplete as they are, are fairly representative of the distribution of the species recorded.

For a description of the bottom-deposits and the positions of the stations worked over, the reader is referred to the Report to the Devon Committee in the present number of this Journal, pp. 451, 460, 467.

## I. Records of Invertebrates.

### START BAY.

#### STATION I.

This ground was characterised by the presence in moderate numbers of *Chætopterus variopedatus* and *Atelecyclus heterodon*, the latter of which occurred on only one other ground, "the Corner," where it was common. *Maia squinado*, *Corystes cassivelaunus*, and *Solen ensis*, the latter in Plaice stomachs, were more common on this ground than elsewhere.

Other common species were *Eupagurus Bernhardus* and *E. Prideauxii*, with their attendant anemones *Sagartia parasitica* and *Adamsia palliata*, these being especially abundant, and also *Astropecten irregularis*, *Asterias rubens*, *Portunus depurator*, *Pecten opercularis*, *Solen pellucidus*, and *Syndosmya alba*, the two latter being taken in Plaice and Dab stomachs.

Soil, fine sand and mud; depth, 9–20 fathoms.

**List of Species.***

HYDROZOA.

Hydractinia echinata. Not uncommon.
Obelia longissima. Dead; taken once.
Campanularia verticillata. Taken once.
Sertularella Gayi. Taken once.
„ polyzonias. Taken once.
Sertularia operculata. Taken once.
Sertularia abietina. Common.
Hydrallmania falcata. Moderately common.
Antennularia antennina. Taken once.
„ ramosa. Occasionally taken.

ACTINOZOA.

Alcyonium digitatum. Occasional.
Sagartia parasitica. Common with E. Bernhardus.
Adamsia palliata. Common with E. Prideauxii.

ECHINODERMA.

Astropecten irregularis. Common.
Asterias rubens. Common.
Ophiura ciliaris. Taken occasionally.
Echinus miliaris. Taken occasionally.
Spatangus purpureus. Fragment only.
Echinocardium cordatum. Occasionally.

POLYCHÆTA.

Aphrodite aculeata (*Linn.*). Not uncommon.
Acholöe astericola (*Clpd.*). Taken once.
Chætopterus variopedatus (*Clpd.*). Not uncommon.

CRUSTACEA

Maia squinado. Very common.
Eurynome aspera. Taken once.
Cancer pagurus. Taken occasionally.
Portunus puber. Taken once.
„ depurator. Common.
„ holsatus. Occasionally.
Polybius Henslowii. One ♂ taken.
Gonoplax angulatum. One taken from Thornback stomach.
Atelecyclus heterodon. Moderately common.
Corystes cassivelaunus. Common.
Eupagurus Bernhardus. Very common.
„ Prideauxii. Very common.
Porcellana longicornis.
Palinurus vulgaris. One.
Homarus vulgaris. One.

* The following is the nomenclature used throughout:—

Hydrozoa. Hincks, *British Hydroid Zoophytes.*
Actinozoa. Gosse, *The British Sea-anemones and Corals.*
Echinoderma. Bell, *Catalogue of British Echinoderms in the British Museum.*
Crustacea. Bell, *British Stalk-eyed Crustacea.*
Mollusca. Forbes and Hanley, *British Mollusca.*
Polyzoa. Hincks, *British Marine Polyzoa.*
Tunicata. Herdman, *A Revised Classification of the Tunicata.* Linn. Soc. Jour., xxiii.

MOLLUSCA.

Corbula gibba. One in Plaice stomach.
Solen ensis. Moderately common in Sole and Plaice stomachs.
Solen pellucidus. Moderately common in Sole and Plaice stomachs.
Syndosmya alba. Common in Dab and occasionally in Plaice stomachs.
Mactra solida. In Dab stomachs.
Lutraria elliptica. Shells only.
Cardium aculeatum. Shells only.
Pecten opercularis. Common in Dab stomachs.
Natica monilifera. Shells very common; two alive.
Natica nitida. Occasional.
Buccinum undatum. Occasional.
Philine aperta. Occasional.
Loligo media. Moderately common.
Sepia officinalis. Moderately common.
„ elegans. Occasional.

### Station II.

This ground was not particularly rich, *Portunus depurator* being the only species which was at all common. *Peachia triphylla,* of which two specimens were taken, deserves mention on account of its rarity.

Soil, coarse sand; depth, 5–7 fathoms.

#### List of Species.

HYDROZOA.

Sertularella polyzonias. Occasionally.
Sertularia abietina. Occasionally.
Hydrallmania falcata. Occasionally.

ACTINOZOA.

Peachia triphylla. Two only.
Sagartia parasitica. Not uncommon.
Adamsia palliata. Not uncommon.

ECHINODERMA.

Astropecten irregularis. Moderately common.
Asterias rubens. Moderately common.

POLYCHÆTA.

Aphrodite aculeata. Not uncommon.

CRUSTACEA.

Maia squinado. Not uncommon.
Portunus depurator. Common.
„ holsatus. Not uncommon.
Eupagurus Bernhardus. Not uncommon.
Eupagurus Prideauxii. Not uncommon.
Solen pellucidus. In fish stomachs.
Syndosmya alba. In fish stomachs.

MOLLUSCA.

Mactra solida. In stomachs of *Callionymus.*
Cardium aculeatum. Shells only.
Nucula nitida. In stomachs of *Callionymus.*
Pecten opercularis. Occasionally.
Rissoa parva. Taken once.
Natica monilifera. Shells only.
Nassa incrassata. In stomach of *Callionymus.*
Buccinum undatum. Not uncommon.
Philine aperta. Taken once.

### Station III.

The Skerries Bank, scoured as it is by strong currents and disturbed by the heavy seas which sweep over it during gales from the N.E. round by S. to S.W., has a fauna which is not well represented in catches made with an otter-trawl. In fact, some hauls made on it did not give more than two or three invertebrates altogether. Echinoderms, other than *Echinocyamus pusillus,* which was taken from the stomachs of Plaice caught on the bank, were altogether absent, and the only living molluscs taken were *Dendronotus arborescens* and *Æolis papillosa*, both of which were found on an old crab-pot. It, however, is one of the chief grounds on which the edible crab, *Cancer pagurus*, is taken in the neighbourhood. Besides *Cancer*, the only other common species are *Portunus depurator* and *Maia squinado. Gastrosaccus spinifer* was, however, very common in the stomachs of *Raia blanda,* but no living specimens were taken in the trawl, due doubtless to the size of the mesh, and this is probably accountable for the absence in the records of such forms as shrimps, pandalids, etc.

Soil, coarse sand; depth, 3–18 fathoms.

#### List of Species.

ACTINOZOA.

Sagartia parasitica. Occasional.
„ viduata. A dozen on an old crab-pot.
Adamsia palliata. Occasionally.

ECHINODERMA.

Echinocyamus pusillus. Common in Dab stomachs.

HIRUDINEA.

Pontobdella muricata (*Linn.*).

CRUSTACEA.

Maia squinado. Common.
Cancer pagurus. Common.
Portunus depurator. Moderately common.
„ holsatus. One in stomach of *Acanthias.*
Eupagurus Bernhardus. Occasionally.
„ Prideauxii. Occasionally.
Gastrosaccus spinifer. Very common in stomachs of *Raia blanda.*

PYCNOGONIDA.

Pycnogonum littorale. Two on an old crab-pot.

MOLLUSCA.

Mactra solida. In stomach of *Callionymus.*
Natica monilifera. Shells.
Dendronotus arborescens. A dozen on an old crab-pot.
Æolis papillosa. Two or three on an old crab-pot.

POLYZOA.

Cellaria fistulosa. Taken once.

## LIMPET ROCKS OFF TORCROSS.

A haul of the dredge was taken on this ground. Of the fifty-seven species recorded, twenty-six, all mollusca, were represented by dead shells only. *Corbula nucleus, Solen pellucidus, Syndosmya alba,* and *Nucula nitida* were each represented by two living specimens, these being the only living specimens of those species which we obtained. Shells of *Mactra stultorum* were common, although it was not found alive, nor in the stomachs of any fish captured in the bays. It was found, however, in spawning Plaice caught in the deep water off Portland. Of the other species recorded only few specimens were taken.

Soil, coarse sand and rocks.

### List of Species.

PORIFERA.

Clione celata. One colony.

HYDROZOA.

Sertularella polyzonias.
Sertularia abietina.
Hydrallmania falcata.
Antennularia antennina.

ACTINOZOA.

Alcyonium digitatum. Several colonies on shale.
Adamsia palliata. Several.

ECHINODERMA.

Astropecten irregularis. One or two.
Asterias rubens. Two.
Ophiura ciliaris. Several.
Ophiothrix fragilis. One.
Echinus miliaris. One.

GEPHYREA.

Phascolion strombi (*Mont.*). One.

POLYCHÆTA.

Acholöe astericola. One.
Pectinaria sp.? Fragment of tube.
Lanice conchilega (*Pallas*).
Sabellaria spinulosa (*Leuck.*). Several on stones, shells, etc.
Serpula sp.?

CRUSTACEA.

Stenorhynchus phalangium. One.
Eupagurus Prideauxii. Several.
Anapagurus lævis. Three.
Porcellana longicornis. Several.

MOLLUSCA.

(Shells only, unless otherwise stated.)

Saxicava rugosa. A few.
Mya truncata. One.
Corbula nucleus. Two alive.
Solen ensis. A few.
" siliqua. A few.
" pellucidus. Two alive.
Syndosmya alba. Two alive.
Mactra stultorum. Common.
" solida. A few.
Lutraria elliptica. A few.
Psammobia ferröensis. A few.
Tapes virginea. One.

MOLLUSCA—*continued.*

Venus striatula. A few.
Artemis exoleta. One.
Lucinopsis undata. A few.
Cardium aculeatum. One.
Cardium echinatum. A few.
Nucula nitida. Two alive.
Pecten pusio. A few.
„ opercularis. A few.
„ varius. A few.
Ostræa edule. A few.
Turritella communis. A few.
Natica monilifera. A few.
„ nitida. A few.
Murex erinaceus. One.
Aporrhais pes-pelecani. One.
Nassa reticulata. One alive.
„ incrassata. Several.
Buccinum undatum. One.
Fusus gracilis. One.

POLYZOA.

Bugula turbinata. One colony.
Cellaria sinuosa. One colony.

TUNICATA.

Ciona intestinalis. Two.
Ascidiella aspersa. Two.

## TORBAY.

### Station IV.

Although not a rich ground, as far as species are concerned, some of those which did occur were very common, notably *Asterias rubens*, *Ophiura ciliaris*, *Eupagurus Bernhardus* with the anemone *Sagartia parasitica*, *Portunus depurator*, and *Philine aperta*. *Syndosmya alba* was very common in the stomachs of Dabs.

Soil, fine sand to mud; depth, 4–5 fathoms.

**List of Species.**

ACTINOZOA.

Sagartia parasitica. Very common.
Actinoloba dianthus. Taken once.

ECHINODERMA.

Asterias rubens. Very common.
Ophiura ciliaris. Very common.

CRUSTACEA.

Maia squinado. Occasional.
Portunus puber. Occasional.
„ depurator. Very common.
Portunus holsatus. From stomach of Dab.
Eupagurus Bernhardus. Very common.

MOLLUSCA.

Solen siliqua. Shells.
„ pellucidus. In Plaice stomachs.
Syndosmya alba. In Plaice stomachs. Very common.
Mactra solida. In Plaice stomachs. Common.
Lutraria elliptica. Shells.

MOLLUSCA—*continued.*

Lucinopsis undata. Shells.
Cardium aculeatum. Shells common ; one alive.
Mytilus edulis. Taken once.
Nucula nitida. In Plaice stomachs.
Natica monilifera. Not uncommon alive.
Nassa reticulata. Occasionally.
Buccinum undatum. Occasionally.
Philine aperta. Very common.
Sepia officinalis. Occasionally.

### Station IVa.

*Portunus depurator* and *Philine aperta* were the only species at all common. *Cardium aculeatum* was taken alive in moderate numbers, and one or two specimens of *Portunus arcuatus* and *Homarus vulgaris* were also taken.

Soil, sand and *Zostera* ; depth, 3–5 fathoms.

#### List of Species.

ECHINODERMA.

Asterias rubens. Not common.

CRUSTACEA.

Maia squinado. Occasional.
Portunus puber. Taken once.
„ depurator. Common.
„ arcuatus. Taken once.
Corystes cassivelaunus. Occasional.
Eupagurus Bernhardus. Rare.
Porcellana longicornis. Rare.
Palinurus vulgaris. Taken once.
Homarus vulgaris. Taken once.
Crangon vulgaris. Rare.

MOLLUSCA.

Cardium aculeatum. Not uncommon alive.
Mytilus edulis. Taken once.
Philine aperta. Very common.
Loligo Forbesii. Occasionally.
Sepia officinalis. Occasionally.

### Station V.

This ground was characterised chiefly by its foulness, caused by the presence of old baskets, boxes, rope, etc. *Sertularia abietina*, *Asterias rubens*, *Portunus depurator*, and *Philine aperta* were the commonest species.

Soil, mud ; depth, 6 fathoms.

#### List of Species.

HYDROZOA.

Hydractinia echinata. Not uncommon.
Sertularella polyzonias.
Diphasia pinnata.
Sertularia abietina. Common.
Sertularia operculata.
„ cupressina.
Hydrallmania falcata.

ACTINOZOA.

Alcyonium digitatum. Taken once.
Sagartia parasitica. Moderately common.
Actinoloba dianthus. Moderately common.

ECHINODERMA.

Astropecten irregularias. Moderately common.
Solaster papposus. Taken once.
Asterias rubens. Small, common.
Ophiura ciliaris. Occasional.
Echinocardium cordatum. Taken once.

POLYCHÆTA.

Aphrodite aculeata. Not uncommon.
Acholöe astericola. Taken once.

CRUSTACEA.

Maia squinado. Not uncommon.
Portunus depurator. Very common.
Eupagurus Bernhardus. Moderately common.
Porcellana longicornis. Not uncommon.
Homarus vulgaris. Taken once.

MOLLUSCA.

Solen vagina. In Plaice stomachs.
„ pellucidus. In Plaice stomachs.
Syndosmya alba. In Plaice stomachs.
Mactra solida. In Plaice stomachs.
Cardium aculeatum. Shells.
Pecten opercularis. Not uncommon.
Ostræa edule. Two.
Buccinum undatum. Not uncommon.
Philine aperta. Common.
Loligo media. (?) Not uncommon.
Sepia officinalis. Not uncommon.

STATION VI.

This ground was remarkable for the large number of swimming crabs, *Portunus depurator*, which were taken on it. *Eupagurus Bernhardus*, *Porcellana longicornis*, and *Philine aperta* were also present in quantity, but not quite so common as *Portunus*. *Gonoplax angulatum* and *Turritella communis*, two mud-haunting species, were moderately common, whilst *Tritonia Hombergii*, a mollusc, which in the Plymouth neighbourhood is generally taken in 30 fathoms, is an interesting record. *Antedon bifida* was present on the rough ground at the Berry Head end of the station.

Soil, mud; depth, 8–10 fathoms.

**List of Species.**

HYDROZOA.

Sertularia abietina. Not uncommon.

ACTINOZOA.

Alcyonium digitatum. Not uncommon.
Sagartia parasitica. Common.
Adamsia palliata. Not uncommon.
Actinoloba dianthus. Not uncommon.

ECHINODERMA.

Antedon bifida. Taken once.
Astropecten irregularis. Moderately common.
Solaster papposus. Occasional.
Asterias rubens. Common.
Ophiothrix fragilis. Not uncommon.
Echinus miliaris. Not uncommon.

POLYCHÆTA.

Aphrodite aculeata. Not uncommon.
Acholoe astericola. Taken once.
Dasychone bombyx (*Dal.*). Occasional.
Serpula sp. ? Common.

CRUSTACEA.

Maia squinado. Occasional.
Cancer pagurus. Occasional.
Portunus depurator. Extremely common.
Gonoplax angulatum. Not uncommon.
Corystes cassivelaunus. Fairly common.
Eupagurus Bernhardus. Very common.
Eupagurus Prideauxii. Occasional.
Porcellana longicornis. Very common.

MOLLUSCA.

Saxicava arctica. Taken once.
Thracia pubescens. Shells.
Solen siliqua. Shells.
Syndosmya alba. In fish stomachs.
Lutraria elliptica. Shells.
Venus striatula. Shells.
Cardium aculeatum. Shells.
Pinna pectinata. Shells.
Pecten opercularis. Occasional.
" maximus. Shells.
Pecten varius. Taken once.
Ostræa edule. Occasionally.
Trochus zizyphinus. Common.
Turritella communis. Not uncommon.
Buccinum undatum. Not uncommon.
Philine aperta. Very common.
Tritonia Hombergii. Three.
Loligo Forbesii. Taken once.
" media (?). Taken once.

POLYZOA.

Cellaria fistulosa.
Lepralia foliacea.

TUNICATA.

Phallusia mammillata. One.
Ciona intestinalis. One.

## TEIGNMOUTH BAY.

### Station VII.

*Philine aperta*, *Portunus depurator*, and *Aphrodite aculeata* were the only common species. *Pinnotheres pisum* was present in nearly all the specimens of *Mytilus edule* taken, but *Mytilus* itself was not common. *Polybius Henslowii* was taken occasionally.

Soil, coarse sand; depth, 5–6 fathoms.

**List of Species.**

ACTINOZOA.

Sagartia parasitica. Not uncommon.
Actinoloba dianthus. Not uncommon.

### ECHINODERMA.

Astropecten irregularis. Taken once.
Asterias rubens. Not common.
Ophiura ciliaris. Not common.

### HIRUDINEA.

Pontobdella muricata. Occasional.

### GEPHYREA.

Phascolion strombi. Taken once.

### POLYCHÆTA.

Aphrodite aculeata. Fairly common.
Lanice conchilega. In Sole stomachs.

### CRUSTACEA.

Maia squinado. Occasionally.
Carcinus mænas. Taken once.
Portunus depurator. Common.
Polybius Henslowii. Occasionally.
Pinnotheres pisum. Common in *Mytilus.*
Eupagurus Bernhardus. Not uncommon.
Nika edulis. In stomach of *Scyllium.*

### MOLLUSCA.

Solen ensis. Shells.
„ siliqua. Shells.
„ vagina. Shells.
„ pellucidus. In Sole stomachs.
Syndosmya alba. In Sole stomachs.
Mactra solida. Common in Plaice stomachs.
Lucinopsis undata. Shells.
Cardium aculeatum. Shells.
„ echinatum. Shells.

Mytilus edulis. Not uncommon.
Nucula nitida. In Sole stomachs.
Pecten opercularis. Occasional.
„ maximus. Once only.
Ostræa edule. Not common.
Buccinum undatum. Occasional.
Philine aperta. Common.
Loligo Forbesii. Occasional.
„ media. (?) Not uncommon.
Sepia officinalis. Not uncommon.

## Station VIII.

*Serpula sp.?*, *Portunus depurator*, and *Pecten opercularis* were the commonest species on this ground. *Pinnotheres pisum*, as in Station VII., was present in nearly all the mussels taken.

Soil, coarse sand; depth, 4–6 fathoms.

### List of Species.

Sagartia parasitica. Fairly common.
Adamsia palliata. Not common.

Actinoloba dianthus. Moderately common.

### ECHINODERMA.

Asterias rubens. Moderately common.
Echinus miliaris. Rare.

HIRUDINEA.

Pontobdella muricata. Occasional.

POLYCHÆTA.

Serpula sp. ? Common.
Nereis fucata (*Sav.*). In shell with Hermit-crab.

CRUSTACEA.

Maia squinado. Not uncommon.
Carcinus mænas. Few; small.
Portunus depurator. Common.
Pinnotheres pisum. Occasionally.
Eupagurus Bernhardus. Fairly common.
„ Prideauxii. Taken once.
Homarus vulgaris. Taken once.
Galathea strigosa. Taken once.

MOLLUSCA.

Mytilus edulis. Occasionally.
Pecten opercularis. Common; small.
Ostræa edule. Not uncommon.
Buccinum undatum. Occasionally.
Cypræa Europæa. Not uncommon.
Philine aperta. Not uncommon.
Aplysia punctata. Not uncommon.
Loligo Forbesii. Occasional.
„ media (?). Occasional.
Sepia officinalis. Moderately common.

TUNICATA.

Phallusia mammillata. Occasional.
Ciona intestinalis. Occasional.

### Station IX.

This was the richest ground investigated, the commonest species being *Actinoloba dianthus, Echinus miliaris, Serpula sp., Gammarus locusta,* and *Ostræa edule,* the last species being sufficiently common to make oyster-dredging a profitable occupation. Both *Serpula* and *Actinoloba* were generally attached to shells, notably the inside of a *Cyprina* valve, and to stones. Among the less common species which were not taken alive elsewhere were *Synapta digitata, Ophiactis Balli, Henricia sanguinolenta, Galathea squamifera, Protula tubularia, Kellia suborbicularis, Cardium echinatum,* and *Aporrhais pes-pelecani.*

Soil, fine sand, mud, and stones; depth, 11–12 fathoms.

**List of Species.**

PORIFERA.

Suberites domuncula. Occasional.

HYDROZOA.

Sertularella polyzonias.
Sertularia abietina.
Hydrallmania falcata.

ACTINOZOA.

Alcyonium digitatum. Occasional.
Sagartia parasitica. Common.
Adamsia palliata. Not uncommon.
Actinoloba dianthus. Very common.

## ECHINODERMA.

Synapta digitata. Fragment.
Astropecten irregularis. Not uncommon.
Solaster papposus. Taken once.
Asterias glacialis. Taken once.
„ rubens. Common.
Henricia sanguinolenta. Occasional.
Ophiura ciliaris. Not uncommon.
Ophiothrix fragilis. Occasional.
Ophiactis Balli. Occasional.
Echinus miliaris. Very common.
„ esculentus. Occasional.

## GEPHYREA.

Phascolion strombi. Common.

## HIRUDINEA.

Pontobdella muricata. Occasional.

## POLYCHÆTA.

Aphrodite aculeata. Very common.
Chætopterus variopedatus. Not uncommon.
Polymnia nebulosa (*Mont.*). Taken once.
Protula tubularia (*Mont.*). Not uncommon.
Serpula sp. ? Very common.

## CRUSTACEA.

Stenorhynchus longirostris. Occasional.
Inachus dorsettensis. Occasional.
„ dorynchus. Occasional.
Maia squinado. Common.
Portunus puber. Common.
„ depurator. Common.
Gonoplax angulatum. Occasional.
Pinnotheres pisum.
Eupagurus Bernhardus. Common.
„ Prideauxii. Not uncommon.
„ cuanensis. Occasional.
Porcellana longicornis.
Galathea squamifera.
„ dispersa.
Gammarus locusta. Abundant.

## MOLLUSCA.

Solen ensis. Shells.
„ siliqua. Shells.
„ vagina. Shells.
Mactra solida. Shells.
Venus striatula. Shells.
Lucinopsis undatum. Shells
Cyprina islandica. One alive and shells.
Cardium aculeatum. Shells.
„ echinatum. Not uncommon.
Kellia suborbicularis. Two.
Mytilus edulis. Not uncommon.
Pinna pectinata. Shell.
Pecten maximus. Not uncommon.
„ opercularis. Moderately common.
Ostræa edule. Common.
Trochus zizyphinus. Common.
„ magus. Shell.
Turritella communis. Common.
Aporrhais pes-pelecani. Taken once.
Natica monilifera. Shells, common.
Purpura lapillus. Taken once.
Buccinum undatum. Not uncommon.
Loligo Forbesii. Occasional.
„ media (?). Occasional.

## POLYZOA.

Cellaria fistulosa. Occasional.
„ sinuosa. Occasional.
Lepralia foliacea. Not uncommon.

## TUNICATA.

Phallusia mammillata. Occasional.
Ciona intestinalis. Occasional.
Ascidiella aspersa. Occasional.

## THE "CORNER."

This ground was characterised by the large quantity of hydroids which were present, notably *Obelia longissima*, *Campanularia verticillata*, *Halecium halecinum*, *Sertularella polyzonias*, *Sertularia abietina*, *Hydrallmania falcata*, and *Antennularia antennina*. *Atelecyclus heterodon* was also present in moderate numbers. Several of the smaller crustacea were taken, *Hyas coarctatus*, *Galathea dispersa*, *Crangon vulgaris*, and *C. spinosus*, due possibly to the hydroids filling up the meshes of the trawl.

*Turritella communis*, which was common, especially in the muddy part of the ground, generally had hydroids attached to the shell. A large species of *Botryllus*, the "pork" of the Plymouth trawlers, was not uncommon.

Soil, mud, fine sand, and coarse sand; depth, 30 fathoms.

### List of Species.

PORIFERA.

Suberites domuncula. Occasional.

HYDROZOA.

Hydractinia echinata. Occasional.
Obelia longissima. Common.
Campanularia verticillata. Common.
Laföea dumosa. Occasional.
Halecium halecinum. Common.
Sertularella Gayi. Not uncommon.
" polyzonias. Common.
Sertularia abietina. Common.
Hydrallmania falcata. Very common.
Antennularia antennina. Common.
" ramosum. Not uncommon.
Aglaophenia myriophyllum. Not uncommon.

ACTINOZOA.

Alcyonium digitatum. Occasional.
Sagartia parasitica. Common.
Adamsia palliata. Not uncommon.

ECHINODERMA.

Astropecten irregularis. Not uncommon.
Asterias rubens. Common; small.
" glacialis. Two taken.
Ophiothrix fragilis. Not uncommon.
Echinus miliaris. Not uncommon.
Spatangus purpureus. Fragment only.

GEPHYREA.

Phascolion strombi. One.

POLYCHÆTA.

Aphrodite aculeata. Not common.
Gattyana cirrosa (*Pall.*). One.
Acholöe astericola. Two.
Chætopterus variopedatus. Occasional.
Sabellaria spinulosa. Occasional.
Sabella pavonina. Occasional.

CRUSTACEA.

Stenorhynchus longirostris. Common.
Inachus dorsettensis. Not uncommon.
Hyas coarctatus. One.
Maia squinado. Occasional.
Cancer pagurus. Occasional.
Portunus depurator. Very common.
Atelecyclus heterodon. Common.
Corystes cassivelaunus. Not uncommon.
Eupagurus Bernhardus. Common.
„ Prideauxii. Not uncommon.
„ cuanensis. Occasional.
Porcellana longicornis. Common.
Galathea dispersa. Common.
Crangon vulgaris. Occasional.
„ spinosus. Two.
Scalpellum vulgare. Few.

MOLLUSCA.

Syndosmya alba. Shells.
Mactra solida. Shells.
Venus striatula. Shells.
Lucinopsis undata. Shells.
Cyprina islandica. Shells.
Cardium echinatum. Shells.
Pinna pectinata. Shells.
Pecten opercularis. Few alive.
Ostræa edule. Shells.
Dentalium entale. Shells.
Trochus zizyphinus. Shells.
„ granulatus. Shells.
Turritella communis. Common alive.
Natica monilifera. Shells.
Buccinum undatum. Few alive.
Philine aperta. Few alive.
Loligo Forbesii. Occasional.
„ media (?). Occasional.
Sepia officinalis. Occasional.
„ elegans. Occasional.

TUNICATA.

Botryllus sp.? Few colonies.

## SUMMARY.

### HYDROZOA.

Hydroids were commonest in the "Corner," *Campanularia verticillata*, *Sertularella polyzonias*, *Halecium halecinum*, and *Hydrallmania falcata* being the most frequent. Station I. also gave about the same number of species, but not in any quantity, *Sertularia abietina* being the only common form.

### ACTINOZOA.

*Sagartia parasitica* was common on Stations I., IV., VI., IX., and the Corner; absent from Limpet Rocks and Station IVA. *Adamsia palliata* was commonest at Station I. and the Corner. *Actinoloba dianthus*, very common on Station IX., not uncommon Stations V., VI., VII., VIII., but absent from Start Bay and Stations IV. and IVA. in Torbay. *Peachia triphylla* and *Sagartia viduata* were recorded once from Stations II. and III. respectively.

### ECHINODERMA.

Excepting for the presence of *Echinocyamus pusillus* in the stomachs of Plaice, the Skerries Bank was quite devoid of Echinoderms. *Astropecten irregularis*, *Asterias rubens*, *Ophiura ciliaris* were more or less common in all the bays, chiefly on fine sand and mud. *Asterias glacialis*, of which the previous most easterly record was Salcombe, was taken in Teignmouth Bay (Station IX.); the Corner; one and a half miles off Berry Head; and in Brixham Harbour, but only one or two specimens from each locality. *Echinus miliaris* was common only on Station IX., whilst the following were found there and not elsewhere: *Synapta digitata, Henricia sanguinolenta, Ophiactis Balli,* and *Echinus esculentus.*

### POLYCHÆTA.

*Aphrodite aculeata* was present in all the bays, but common at Station IX. only. *Acholöe astericola,* although not always recorded, was probably present on all stations on which *Astropecten irregularis* was commonly taken. *Chætopterus variopedatus* was characteristic of Stations I. and IX. and the Corner; whilst *Serpula* sp.? was abundant on Station IX. and common on Stations VI. and VIII. *Polymnia nebulosa* and *Protula tubularia* were taken on Station IX. only. *Nereis fucata* is recorded only from Station VIII., but it was probably present on nearly all the grounds with *Eupagurus Bernhardus.*

### CRUSTACEA.

*Maia squinado* was common only on Stations I., III., and IX. *Cancer pagurus* was common on the Skerries (Station III.), but only a few specimens were taken on the other grounds. *Carcinus mænas* was only taken in Teignmouth Bay, whilst *Portunus depurator* was common on all grounds excepting the Limpet Rocks, especially so on Stations VI., IV., V., and the Corner. *Pinnotheres pisum* (the "poison crab") was present only in Teignmouth Bay, but there nearly every mussel examined had one or more—one had three, all males. *Gonoplax angulatum* was taken alive on Stations VI. and IX. only; whilst *Atelecyclus heterodon* was common on Station I. and the Corner and absent from the rest. *Corystes cassivelaunus* was common only on Stations I. and VI. *Eupagurus Bernhardus* was more or less common on all the grounds, being especially so on Stations I., IV., and VI. *E. Prideauxii* was common only on Station I. and the Corner. *Porcellana longicornis,* common only on Station VI.

### MOLLUSCA.

Chiefly represented by shells. Living specimens of the following were taken:—*Solen pellucidus, Nucula nitida, Corbula gibba, Syndosmya alba* on the Limpet Rocks; *Cardium aculeatum,* Station IVA.; *C. echinatum,* Station IX.; *Mytilus edulis* from Stations IV., VII., VIII., and IX. *Pecten opercularis* and *Ostræa edule* were commonest in Teignmouth Bay. *Turritella communis,* common only on Stations VI., IX., and the Corner, generally with hydroids (the Corner) or *Alcyoni-*

*dium* sp. ? (Stations VI. and IX.) growing on the shell. *Natica monilifera* was taken alive on Stations I. and IV. only, but shells were common on most grounds. *Buccinum undatum* was common only on Station VI.; *Philine aperta*, common in Torbay and Station VII. of Teignmouth Bay. The following were taken alive on one station only, and generally in very small numbers:—*Aplysia punctata* (Station VIII. not uncommon), *Tritonia Hombergii* (Station VI.), *Dendronotus arborescens* (Station III.), *Æolis papillosa* (Station III.).

Of the Cephalopoda, *Loligo Forbesii* occurred in Torbay, Teignmouth Bay, and the Corner; *L. media* (?) in all the bays and the Corner; *Sepia officinalis* in all the bays; whilst *S. elegans* is recorded from Station I. and the Corner.

As summary to the foregoing pages, a few remarks may be made on the comparative abundance of some of the common forms on the various grounds in the bays, as shown in the following table:—

*List of Identified Species regarded as distinctive of the Grounds named.*

× = present. c = common. cc = very common.

| Species. | Start Bay. | | | Torbay. | | | | Teignmouth Bay. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | I. | II. | III. | IV. | IVa. | V. | VI. | VII. | VIII. | IX. |
| Actinoloba dianthus | — | — | — | — | — | × | × | × | × | cc |
| Echinus miliaris | — | — | — | — | — | — | c | — | — | cc |
| Aphrodite aculeata | × | × | — | — | — | × | × | c | — | cc |
| Chætopterus variopedatus | × | — | — | — | — | — | — | — | — | × |
| Protula tubularia | — | — | — | — | — | — | — | — | — | c |
| Serpulids | — | — | — | — | — | — | c | — | × | cc |
| Maia squinado | cc | × | c | × | × | × | × | × | × | cc |
| Portunus puber | — | — | — | — | — | — | — | — | — | c |
| „ depurator | c | c | × | cc | c | cc | cc | c | c | c |
| Corystes cassivelaunus | c | — | — | — | × | — | × | — | — | — |
| Atelecyclus heterodon | × | — | — | — | — | — | — | — | — | — |
| Pinnotheres pisum | — | — | — | — | — | — | — | × | × | × |
| Gonoplax angulata | × | — | — | — | — | — | c | — | — | × |
| Eupagurus Bernhardus | cc | × | × | cc | × | c | cc | × | c | c |
| „ Prideauxii | cc | × | × | — | — | — | × | — | × | c |
| Mactra solida | × | — | — | c | — | c | — | c | — | × |
| Syndosmya alba | — | × | — | cc | — | c | c | c | — | — |
| Solen pellucidus | — | c | — | × | — | × | — | × | — | — |
| Mytilus edulis | — | — | — | — | × | — | — | × | × | × |
| Ostræa edule | — | — | — | — | — | × | × | × | × | cc |
| Trochus zizyphinus | — | — | — | — | — | — | c | — | — | c |
| Turritella communis | — | — | — | — | — | — | × | — | — | c |

It is of interest to note that there is a considerable difference in the size of some of the species in the different bays. *Mactra solida*, for example, in Torbay and Teignmouth Bay is represented by small specimens only; whilst in Start Bay those obtained were much larger. It is possible that such a distribution of the invertebrate fauna has a considerable, if not a predominant, influence on the distribution of the small and large fish. In Torbay and Teignmouth Bay, for example, the Plaice are, on the whole, much smaller than in Start Bay.

## II. Food of Fishes.

The contents of the stomachs of various fish were examined, with the following result:—

### PLAICE.

(*Pleuronectes platessa.*)

START BAY.—Nine fish examined, 7 to 20 inches in length.

ECHINODERMA.

*Ophiura ciliaris.* In one.
*Echinocyamus pusillus.* In two, one of which was full.

POLYCHÆTA.

*Nephthys* sp.? In two.
*Sabella pavonina.* In one.

CRUSTACEA.

*Eupagurus* sp.? In one.

MOLLUSCA.

*Corbula gibba.* In one.
*Solen pellucidus.* In two.
„ *ensis.* In two.
*Syndosmya alba.* In three, all of which were full.

TORBAY.—Sixty-three fish, of which twenty-four were 12 inches and more in length.

ECHINODERMA.

*Ophiura ciliaris.* Arms only in five.

POLYCHÆTA.

*Nephthys* sp.? In eight.
Unidentified. In twenty.

CRUSTACEA.

*Corystes cassivelaunus.* In three.
Crab fragments. In one.
Amphipod. In one.

MOLLUSCA.

*Solen ensis.* In one.
„ *vagina.* Siphons only in five.
„ *pellucidus.* In two.
*Syndosmya alba.* In eleven.
*Mactra solida.* In thirty. In fifteen of the plaice under 12 inches this mollusc constituted the sole food.
*Nucula nitida.* In one.
*Philine aperta.* The sole food in three or four of the larger Plaice.
Lamellibranch fragments. In three.

TEIGNMOUTH BAY.—Twelve fish examined, eight being over 12 inches in length.

POLYCHÆTA.

Remains in one.

MOLLUSCA.

*Solen siliqua.* Fragments in one.
*Mactra solida.* In nine, constituting the sole food.
*Syndosmya alba.* In one.

In the eighty-four fish examined, the following occurred in 10 % and over of the stomachs:—*Mactra solida* (46 %), Polychæte remains unidentified (25 %), *Syndosmya alba* (17 %), *Nephthys* sp.? (12 %).

## DABS.

(*Pleuronectes limanda.*)

START BAY.—Ten fish were examined, of which five were over 8 inches in length.

POLYCHÆTA.

Fragments in one.

ECHINODERMA.

*Ophiura ciliaris.* In four.

CRUSTACEA.

*Eupagurus* sp.? In three.
*Portunus* sp.? In four.
Crab fragments. In one.

MOLLUSCA.

*Syndosmya alba.* In one.
*Mactra solida.* In one.
*Pecten opercularis.* In two.
Lamellibranch fragments. In one.
*Philine aperta.* In one.
*Loligo media* (?). In one.

PISCES.

*Ammodytes* sp.? In one.

TORBAY.—Seventeen fish examined, ten of which were under 8 inches in length.

ECHINODERMA.

*Ophiura ciliaris.* In two.
*Echinus* sp.? Fragments in one.

POLYCHÆTA.

*Nephthys* sp.? In one.
*Sabella pavonina.* In one.
Fragments in two.

CRUSTACEA.

*Eupagurus* sp.? In one.
*Portunus holsatus.* In one.
*Portunus* sp.? In one.
Amphipod. In one.

MOLLUSCA.

*Solen* sp.? In two.
*Syndosmya alba.* In one.
*Cardium* sp.? In one.
*Philine aperta.* In one.

"HITCHES" OFF TORBAY.—Eight fish examined $7\frac{1}{2}$ to 10 inches in length.

CŒLENTERATA.

*Sagartia?* sp.? Six of the dabs examined had been feeding on a small anemone, somewhat resembling *Sagartia viduata*, but they were too much digested to identify with any certainty. As many as fifty were counted in one stomach.

POLYCHÆTA.

*Nephthys* sp.? In one.
Fragments. In one.

CRUSTACEA.

*Eupagurus* sp.? In two.
*Portunus* sp.? In two.

MOLLUSCA.

*Philine aperta.* In one.
*Turritella communis.* Shell in one.
*Æolis* sp.? In one.

In the thirty-five fish examined, the following were present in 10 % or more of the stomachs:—*Portunus* sp. var. (22 %), *Sagartia?* sp.? (16 %), *Ophiura ciliaris* (16 %), *Eupagurus* sp.? (16 %), Polychæte remains (11 %).

## SOLES.

START BAY.—Fifteen fish examined.

POLYCHÆTA.

Remains in four.

MOLLUSCA.

*Solen ensis.* In six.
,, *pellucidus.* In three.
*Turritella communis.* In one.

TEIGNMOUTH BAY.—Four fish.

POLYCHÆTA.

*Nereis* sp.? In one.
*Lanice conchilega.* In one.

MOLLUSCA.

*Solen pellucidus.* In three.
*Syndosmya alba.* In all.
*Nucula nitida.* In two.

## BRILL.

START BAY.—Forty-nine fish examined.

PISCES.

*Clupea sprattus.* In one.
*Gadus merlangus?* In one.
*Ammodytes tobianus.* In thirty or more.
,, *lanceolatus.* In thirty or more.

TORBAY.—One brill of 8 inches was examined, and found to contain a single *Gobius minutus.*

TEIGNMOUTH BAY.—Three fish were examined, of which one was empty and the others contained respectively a sand-eel (*Ammodytes*) and fish remains.

## TURBOT.

(*Rhombus maximus.*)

START BAY.—Three fish were examined, and contained respectively: Sandeels, Grey Gurnard, and *Portunus holsatus.*

## DRAGONET.

(*Callionymus lyra.*)

START BAY.—Fourteen fish were examined.

ECHINODERMA.

*Ophiura ciliaris.* In two.

CRUSTACEA.

*Eupagurus* sp.? In one.

MOLLUSCA.

*Solen* sp.? Fragments in two.
*Mactra solida.* In six.
*Tapes* sp.? In one.
*Nucula nitida.* Many in one.
*Philine aperta.* In one.
Lamellibranch fragments. In two.

### GREATER WEEVER.

(*Trachinus draco.*)

START BAY.—Several fish examined.

CRUSTACEA.

*Pandalus* sp. ? In three.

PISCES.

*Ammodytes* sp. ? In one.
*Gadus* sp. ? probably *pollachius*. In the remainder.

### PIKED DOG-FISH.

(*Acanthias vulgaris.*)

START BAY.—Seven fish examined.

POLYCHÆTA.

Polynoid remains. In one.

CRUSTACEA.

*Eupagurus* sp. ? In one.
*Portunus holsatus*. In two.

PISCES.

*Ammodytes tobianus*. In two.
*Clupea sprattus*. In two.
*Gobius* sp. ? In one.

### ROUGH DOG.

(*Scyllium canicula.*)

TEIGNMOUTH BAY. Two fish.

GEPHYREA.

*Phascolion strombi*. In one.

POLYCHÆTA.

Remains. In one.

CRUSTACEA.

*Nika edulis*. In one.
*Eupagurus* sp. ? In one.

MOLLUSCA.

*Buccinum undatum*. Operculum only.
*Loligo media*. (?) Several in one.

### ANGEL.

(*Rhina squatina.*)

TEIGNMOUTH BAY.—Two fish examined, each of which contained one *Portunus depurator* and many *Loligo media*. (?)

### THORNBACK.

(*Raia maculata.*)

START BAY.—The only fish examined contained one each of the following Crustacea:—

*Eupagurus* sp. ?
*Stenorhynchus* sp. ?
*Corystes cassivelaunus*.
*Portunus depurator*.
*Gonoplax angulatum*.

### BLONDE.

(*Raia blanda.*)

START BAY.—Eight fish examined.

CRUSTACEA.

*Gastrosaccus spinifer.* Common in six.

PISCES.

| | |
|---|---|
| *Ammodytes* sp. ? Common in six. | *Pagellus* sp. In two. |

*Trachinus vipera.* In two.

### DORY.

(*Zeus faber.*)

START BAY.—All those examined contained numbers of small Gadoids, probably *Gadus pollachius.*

Although the number of fish stomachs examined is too small to draw any definite conclusion, the results tend to confirm the observations of Petersen,* Herdman,† and the Scottish Fishery Board,‡ which show that the dab may not be a serious competitor with the plaice in the matter of food. Both species appear to feed at times on the same organisms; but the plaice, on the grounds examined, confined themselves chiefly to Mollusca and Polychæta, whereas the dab did not specialise in any one group. The dab, therefore, could only become a serious competitor with the plaice if it largely predominated in numbers. The presence of *Sagartia ?* in such numbers in the stomachs of dabs from the "Hitches" is an interesting record. It is probable that the anemone was attached to *Turritella* or other gastropod shells, as one or two were found in that position.

* Petersen, "Biology of our Flatfishes," 1893, p. 30.

† Herdman and Scott, *Trans. Liverpool Biological Society*, vol. ix., 1895, pp. 107–30.

‡ *Report S. F.B.*, x. pp. 211–31 ; xx. pp. 486–538.

# Fishing Nets, with Special Reference to the Otter-trawl.

By

H. M. Kyle, M.A., D.Sc.

(With Plates I. and II.)

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The increased attention which has been paid within recent years to fishery statistics has revealed, amongst other troublesome things, that the instruments employed play an important part both as to quantity and quality in the result. It is not necessary to discuss whether any of the instruments as now used give a fair sample of the contents of the water or ground, but it certainly is the case that different apparatus will give different samples. Let a beam-trawl and an otter-trawl work for a year over the same ground alongside drift-nets and fixed trammel-nets or gill-nets, and we can guarantee that the results will differ from one another. In the case of the drift-nets we should have a few forms probably in large quantity, in the others a great variety of forms, but in different proportions in each. And again, those obtained by the drift-nets would be practically absent from the trawls. It thus behoves the naturalist to make every kind of fishing apparatus subservient to his use, if he desires to obtain even an approximate measure of fish-life in the sea.

Up to the present time the fishing gear employed by naturalists has been that of the practical fishermen, and rightly too. For a naturalist to devise a new and better type of fishing apparatus than exists, he must serve an apprenticeship in the making and working of the old, so that he may share with the practical men the experience of many generations. The danger then arises, however, of his becoming too much enamoured of the one or two special types he himself has had experience of and losing sight of the others. It would be impossible to find a more careful or better description of a trawl and the working of that trawl than the one given by Dr. Petersen for what he calls the "otter drag-seine"; yet an essential portion of the trawl was omitted, and the realisation of his ideas consequently has fallen far short of the ordinary *beam-* or *otter-trawl.*

The latter, it must be remembered, are the consummation of the experience not of one or two types of fishing apparatus, but of all. They are the successful and highly developed forms of a long series, so that every little part and detail has come at some time under the searching eye of experience. To realise their full worth, one must hark back to the more primitive forms and retrace their development. It is interesting to note that this is just what Dr. Petersen has done. His so-called "otter drag-seine" and its subsequent alterations repeat, to a certain extent, the history of the real *otter-trawl,* and in his latest work he has attained to the appreciation of the latter in all its parts.

I have not the slightest doubt that Dr. Petersen, with his admirable command of the English language, would be able to give a good account of the English otter-trawl now that he has one in his possession, but his distance from England, where the right names and the relative importance of the various parts might be explained to him, constitute a great difficulty. It seems more appropriate, therefore, that a detailed description should come from the English side.

As stated above, the *otter-trawl* is the last of a long series of successful and unsuccessful experiments with fishing gear. I think it advisable, therefore, to preface its description with a brief reference to past history and to the various forms of apparatus used in this and in other countries. Not knowing these, one would be unable to appreciate the finer details of the *otter-trawl* and the advance it has made from the more primitive types.

The numerous forms of fishing apparatus may be classified according to the mode of working them—*fixed nets,* if they are moored to the beach, or at the bottom of the sea; *movable nets,* if they are dragged through the water.

The simplest form of the fixed nets is a dam of stones or rushes between tide-marks leading down into a simple "pound" also made of rushes. More advanced forms are seen in the eel-traps of Holland,* the "fyke-nets" and "weirs" of America,† and the salmon stake-nets of Scotland. In all, the principle is the same. A "leader" of network, in some cases two, is placed across the direction in which the fish are supposed to travel, and guides them into a cunningly constructed labyrinth, from which they cannot escape. In rocky parts the leader is removed, and the "pound" simply moored off the rocks in deep water. It may seem strange that the openings, which are of good size, cannot be used by the fish for exit as well as entry,

* The inshore fishing apparatus of the Netherlands. *Mededeel over Visscherij,* 1899.

† "Fyke-nets," *Bull. U.S. Fish Commission,* xii., 1892.

but the difficulties of a wasp which has entered a room through a slightly open window are very small in comparison with those of a fish when it is once in the "heart" of the pound.

These nets are only useful for the capture of inshore fish or fish which enter rivers, but there are two forms of *fixed* nets, probably derived from the "leader" of the pound-net, which are of great importance in sea fishing. These are the *gill-net* and the *trammel*. In the former, as the name denotes, the fish are caught by the gills; in the latter they are entrapped in a bag or pocket of their own making.

Though *gill-nets* are extensively used in this country, it is mostly in the form of *drift-nets* for fish swimming near the surface, such as mackerel or herring. The net is made fast—at one end only—to the boat, and boat and net drift together. Sometimes the head-line is sunk below the surface by extra leads on the foot-rope when the fish are swimming deep, and they frequently catch fish—for example, whiting—which keep near the bottom as a rule. In one or two places these nets are moored in fishing for herring, and quite within the last few years the old method of sinking the net to the bottom has been revived on the east coast of Scotland.*

In the United States,† however, *gill-nets* are, as a rule, *fixed nets*, and only occasionally *drift-nets*. The enormous part they play in the American fisheries may be judged from this, that each boat is said to have an outfit of gill-nets which would extend twenty to thirty miles, if set at one time.

The *trammel*‡ is a compound net usually in three layers, of which the two outer are of wide mesh stretched out taut, whilst the middle layer is of very small mesh with plenty of slack. Consequently, if a fish strike the net on either side it will pass through the first layer and drive the second through the third, and thus becomes entrapped in a pocket of its own making. These nets are employed on the south-west coast of England and round the Channel Islands for the capture of red mullet, though they catch all kinds of fish—soles, plaice, dories, and even crabs and lobsters. Like the gill-net, the trammel is moored upright to the bottom by means of lead on the foot-rope and corks on the head-rope, and like it also is very useful on rough or rocky ground. The advantage which the *trammel* has over the *gill-net* consists in its

* The result of this is said to have been a greatly increased catch, amongst other fish, of haddock, on grounds which were supposed to have been cleaned out by the trawlers. *Gill-nets* were formerly used also for the capture of crabs and lobsters on the south coast of England.

† Augur, *Bull. U.S. Fish Commission*, xiii., 1893, p. 381.

‡ Wilcocks, *The Sea Fisherman*, London, 1875, p. 244; Holdsworth, *Deep Sea Fishing and Fishing Boats*, London, 1874, p. 175.

ability to catch different sizes and, therefore, a greater variety of fish.*

The utility of these two forms of nets as complementary to trawls can hardly be overestimated. They reach ground the trawl cannot touch, and might be used in any part of the North Sea. Incidentally, it may be mentioned that the United States Fish Commission steamer *Albatross* had twelve different kinds of *gill-nets* and two *trammels* as part of its fishing apparatus.†

There are various other forms of *fixed nets,* such as the *stow-net* ‡ ("Ankerkuilen" of Holland) for sprats and whitebaits, which are used in tidal waters or streams. They are not likely to be of any service in deep-sea fishing, so that further mention of them is unnecessary.

The peculiarity of the preceding nets is that they are, for the most part, stationary, so that the responsibility for being caught rests with the fish themselves. The traps laid are exceedingly subtle, and are the result of generations of experience of the habits, habitat, and even the structure of the fish; but when the traps are once laid man retires, and the fish do the rest. In the case of *movable* nets man does not wait for the fish to come to him, and, not content with devising ingenious instruments for their capture, pursues them with all his might and drags them in by main force. The two methods of fishing are therefore strongly antagonistic, and cannot both be pursued on the same ground at one and the same time.

It is by means of *movable nets* that naturalists—in Europe at any rate—have done their work in the past, and the tendency at the present time is to continue doing so. This is founded on the notion that *movable nets* may be made to give a quantitative measure of the fish in the sea.

The principle of the *movable net* is simply that of collecting together all the fish within a certain compass and dragging them to land or into a boat. Both these methods seem to have been pursued in the earliest times of which we have definite records by Phœnicians and Greeks. It is from the latter, indeed, that we derive our modern word *seine* or *sean,*

* The *gill-net* is made like an ordinary drift-net. The *trammel* is usually from 30 to 50 fathoms (60 to 100 m.) long and 1 to 2 fathoms deep. The middle layer is just double this when stretched out. The meshes of the outer layers are from 4 to 5 inches from knot to knot, and those of the middle layer about 1 inch. The foot-rope is weighted according to depth and strength of tide. The price varies according to material used and length. A *trammel* of 50 fathoms made of *cotton* and finished completely costs £12. If the inner wall only is of cotton and the two outer of hemp, about £8. These may be obtained from the well-known Bridport makers (South Dorset), Messrs. Hounsell or Messrs. Gundry.

† Tanner, *Bull. U.S. Fish Commission*, xvi., 1896.

‡ See Wilcocks, *loc. cit.*; Holdsworth, *loc. cit.*; Hoek, *Verslag Staat Ned. Zeevisch*, 1896.

and it is suggested that the Phœnicians, in the course of their wanderings, taught the use of this net to the men of Cornwall.* However this may have been, it is interesting to note that in passing from the shores of the Mediterranean to the coasts of Great Britain we can mark out every stage in the evolution of the beam- and otter-trawls from the primitive ground- or long haul-seine. The word *seine* is thus generic, and on historical grounds Dr. Petersen is quite entitled to call his *otter-trawl* a *seine*, but so many forms of nets are already included under this term that it is advisable to limit its applicability. In England *seine* is applied only to those nets which are hauled in on the shore, and so strict is the usage that one and the same net may have different names. When hauled in on the shore it is a *seine ;* when hauled in on a boat it is a *tuck-net.* Rightly speaking, *trawls* are therefore *tuck-nets,* but as these latter are only used from small boats in shallow water, and the term has arisen from the peculiar method of hauling in the net, the word *trawl* is more strictly applied to the apparatus for deep-sea fishing. Though the fields denoted by these three terms overlap to a slight extent, they are quite distinct, and it prevents confusion to limit the use of the terms correspondingly.

In its simplest form the *seine* is simply a weighted ground-rope and buoyed head-rope, between which hangs the net. The mode of working is likewise simple. A boat pays out the net some little distance to sea, the ropes attached to each end are brought ashore at a suitable spot, and the whole net is then gradually drawn to the beach.

The changes rung on this simple form are almost too numerous to mention. The length and depth vary, the mesh may be large or small, the size of mesh is different in different parts, the " wings " may be of great length, it may have a " bunt " or " bag " in the centre, and so on. Each kind of net has its distinct uses, and each has its distinct name, as a rule, according to the fish sought after. Usually each net has two sizes of mesh, often three or even four, those in the centre or bunt being smaller than those in the wings, in order to entrap but not mesh the fish. In this form the *ground-* or *long haul-seine* is in use in almost all countries of Europe,† but in none is it employed to such an extent as in the United States. All the aids that modern invention can give, a steamer for shooting the net, and steam winches for hauling it in, are there employed.

* See Couch, *Fishes of the British Islands,* vol. ii. pp. 91–6. σαγηνη was transformed through the Latin Vulgate *sagena* into the Anglo-Saxon *segne,* and this has become the English and French *seine* or *sean,* the Dutch *zegen.*

† It is the *Tratta* or *Sciabica* of Italy, the *Bourgin* or *Seine* of France, the *Zegen* of Holland. The sight of the swarthy, half-naked fishermen hauling in their long seine on the beach at Posilipo, near Naples, is one of the things which cling to one's memory of that famous city.

On the south coast of England probably the best-known forms of this kind of net are the *sweep-nets* for mackerel and pilchard. These are used to surround a shoal of these fish; and a second smaller net—the *stop-net*—is employed to close the opening in the circle which the large seine is making round the shoal. When the circle is completed the *stop-net* is removed, and the whole concern is dragged towards the shore if possible. If the fish are exceedingly numerous, another net—the *tuck-net*—is shot inside the seine, and the fish are removed in batches.*

In the United States † the *tuck-net* is largely employed, and it may be used any distance from land and over any depth of water. When a shoal of fish has been surrounded the different portions of the lower part of the net are pulled tight together by means of a long "purse-string" passed through rings on the foot-rope. The net is thus "pursed" or "tucked," and the fish cannot escape underneath. The slack of the net is then hauled in until all the fish are collected in the bunt, when the steamer comes alongside, and the fish are ladled on board by means of a bucket.

As already mentioned, the central portion or bunt of these seines has usually a much smaller mesh than the outlying portions or wings. It is also somewhat deeper. In those used for small fish the centre may even be of canvas or calico, as in the sand-eel seines. In Plate I. Fig. 1, a sketch is given of a form of seine which has been much used by members of the Association, especially for small flat-fish.‡ The

* For fuller description see Holdsworth, *loc. cit.* † Augur, *loc. cit.*

‡ DIMENSIONS OF *DRAG-SEINE* OR *TUCK-NET.*

| | | | |
|---|---|---|---|
| Length of wing (from A to D, Fig. 1), | 10 fathoms | (20 m.). |
| ,, wide-meshed portion (A to B), | 2 fathoms | (4 m.). |
| ,, intermediate portion (B to C), | 5 fathoms | (10 m.). |
| ,, small-meshed portion (C to D), | 3 fathoms | (6 m.). |
| ,, "bunt" (E to E′), | 3 fathoms | (6 m.). |

| | | |
|---|---|---|
| Number of meshes in portion from A to B, | 30 to the yard | (31 to metre). |
| ,, ,, ,, B to C, | 36 ,, ,, | (37 ,, ). |
| ,, ,, in "bunt" and from C to D, | 42 ,, ,, | (43 ,, ). |

Cod-end at E′ may or may not have a short piece of still finer netting *sewed* on.

| | |
|---|---|
| Number of meshes deep at D and D′ . . | 80. |
| ,, ,, ,, A . . . | 60. |
| ,, ,, across "bunt" from D to D′ | 80. |

The mode of "setting-up" the net on to the foot-rope is shown in Fig. 2, and to the head-rope in the central portion of Fig. 3. Across the "bunt" and in the fine portion of the net there are four meshes to every "setting." There are therefore twenty "settings" across the "bunt." Across the "bunt" the "settings" are stretched tighter on the head-rope than on the foot-rope, so as to allow more slack in the net underneath. Towards the outer end of the wings the number of meshes on each setting is gradually reduced to three. Small pieces of sheet-lead are fastened to the foot-rope every three to four settings, and small pieces of cork are attached to the head-rope at corresponding distances, but more lead and corks are placed on the "bunt" than on the wings.

The net as a whole is made of 21-ply cotton; the head-rope is of 3-strand hemp, and advantage of this net is its handiness: it may be packed into small compass, and can be worked by two men. It may be used either from the shore or as a *tuck-net* from a boat. The method of working it as a *tuck-net* is the same as that employed by the Danes for their so-called plaice-seines. The boat is moored some distance from the shore, and the net carried round by rowing and the help of the tide in a semicircle—in Denmark a second boat may aid in shooting it—then the net is dragged over the ground by hauling on the anchor-rope. When the boat is close over the anchor, the net is quickly hauled in, care being taken to keep the foot-rope tight and the head-rope slack, *i.e.* to "tuck" the net.

The Danish "tuck-net" and plaice-seines are probably the same as the above, but the lack of any description of them prevents certainty on the point. It is very similar to Petersen's otter-trawl, but has no "funnel" in the bunt. This is an advantage rather than the reverse, because the mesh is already so small that any additional impediment would prevent the water passing freely through the "bunt," and thus inhibit its fishing capability. Pockets are only of use when the apparatus having them is working for some time—an hour or more. In these fine nets for shallow water they are unnecessary as well as an impediment, because the gear is hauled in at short intervals.

Since the ground covered by these *ground-seines*, *plaice-seines*, or *tuck-nets* is necessarily limited, we may endeavour to increase it in two ways—by fixing otter-boards to the end of the wings, or by towing the net between two boats. The former method was adopted some twenty years ago by the Danish fishermen, and will be referred to more particularly later. The latter seems to be an ancient method, and, as it displays the historical development of our modern English trawls, may be briefly described here. It is the ordinary method of deep-sea fishing on the southern shores of Italy (the *cocchia*); * of France (*filets de bœuf*); * and of Spain (*parejas*).

In the *filets de bœuf* the spread of the net is about 80 feet (25 m.); and, since the boats in towing separate as widely from one

the foot-rope of 4-strand hemp. At the end of each wing both head-rope and foot-rope are continued out one foot, "hitched" round a pole six feet high, and meet together ten to twelve feet further in an "eye." The drag-ropes, thirty to fifty fathoms long, are fastened to each "eye." A heavy piece of sheet-lead is fastened round each pole just *above* where the foot-rope is hitched on (L).

The complete net as above described costs £5. A larger net of same make, 100 meshes in the "bunt" and twelve fathoms in the wings, costs a little over £6.

* Faber, *The Fisheries of the Adriatic;* Gourret, *Les Pêcheries et les Poissons de la Mediterranée*, Paris, 1894.

In the Italian trawls there is a series of four to five hoops, probably of bamboo, which help to support the main body of the long net.

another as possible, these nets may have as wide a spread as our otter-trawls. The wings are somewhat smaller than those of the drag-seine above mentioned, but the bag is of enormous dimensions. From the centre of the head-line to the end of the sac (*culignon*) it measures at least 90 feet (28 m.). As in the drag-seine, the meshes are very small—1 in. at the greatest—and there are no pockets; instead, the *culignon* has the form of a triangle whose apex joins the main body of the net. The base of the triangle, *i.e.* the end of the net, expands at each side into two ears (*anses*), and from the centre of the base two stout cords—one below, the other above—run up through the net to join the foot-rope and head-line respectively. The object of this evidently is to press the fish into the ears and keep them there. There is thus no need for flapper or pockets. The whole contrivance is, however, very clumsy in comparison with the ordinary beam- or otter-trawls.

In the *tartana* fishing of Italy and the *gangui à la voile* of France there is only one boat for each net. The nets differ considerably; in the *gangui* it is similar to the *filet de bœuf;* in the *tartana* it is much simpler, without wings or pockets. Both are alike, however, in having a long pole of wood fixed some little distance in front of the net in order to keep the mouth open. The boat which drags the net drifts with the wind and tide, as is the case with the eel-drift boats of Denmark. In the latter, however, the net has no beam or pole, but the bridles are carried directly to the boat, the one forward to the end of the bowsprit, the other aft to the mizzen boom.

From these somewhat primitive types to the modern English *beam-trawl* * there is a considerable gap, but the beam-trawl is highly specialised, and the early stages are quite lost. It differs from the previous forms in having the top of the net fastened directly on to the beam, which again rests on triangular pieces of iron, called the iron-heads. The honour of introducing this change has been claimed by the fishermen of Barking on the Thames, and Brixham in South Devon. For the later developments, however, the lengthening of the square and introduction of pockets and flapper, the Brixham men seem responsible. Since the description given by Holdsworth leaves nothing to be desired, it is unnecessary to enter into any details of its structure.†

We come lastly to the otter-trawl, the most recent and most efficient

* For an excellent description of the structure and working of the beam-trawl see Holdsworth, *loc. cit.*

† The size of mesh used in the beam-trawl varies according to the kind of fishing. For whiting the mesh in the square is $2\frac{1}{2}$ in. to $2\frac{1}{4}$ in. from knot to knot, and this decreases to $1\frac{1}{2}$ in. and then to $1\frac{1}{4}$ in. towards the cod-end. For ordinary fishing the size of mesh is as in the otter-trawl.

of all trawls. Its introduction is of so recent a date that changes and experiments are still being made—on the boards, the size and shape of the net, ground-rope, and so on, so that it seems as if the final form had not yet been attained.

The principle of this trawl, as is well known, is that of the kite, the net representing the "tail," the boards the body of the kite, and the warp the string. When a current of air strikes on the kite it tends to drive the kite as a whole away from the string, but the lower portion, being the larger, tends to go away from the string more than the upper. Hence the head of the kite tends to incline towards the string, and consequently the kite, as a whole, moves upward until it has reached such an angle to the direction of the wind that the forces acting above and below the line of the string are in equilibrium. The otter-boards act in a similar fashion when drawn through the water.

Though the principle of the otter-board had been long known, and in use for carrying out a line from the beach or the side of a boat, it was not until between 1860 and 1870 that experiments were made with it on trawls. The earliest mention I can find is that made by Holdsworth (*loc. cit.*) in 1874, and the invention is there ascribed to a Mr. Musgrave. From other evidence it appears, however, that Musgrave merely introduced the otter-trawl to the notice of Irish fishermen, and that Mr. Hearder, an electrician and inventor of considerable repute, was really the inventor.

One can see from the figure given by Holdsworth that the original otter-trawl invented by Hearder differed from the modern trawls in that the ground-rope was very little behind the head-rope. The boards, however, were fixed up in a similar fashion to those later patented by Scott. These trawls were much used by amateurs, especially from steam yachts, but it was not till some years later that professional fishermen adopted them.

According to Spillmann,* the captain of an English steam trawler was the first to experiment with them in 1885, but he does not seem to have met with success. In 1886 one Thurlow took out a patent for a peculiar kind of board resting on a small trolley, but this also does not seem to have worked well. In the *Mittheilungen* for 1888, p. 153, a figure is given of an otter-board which is fixed up essentially the same as those now used. It was employed by the Danish sailing craft from Frederikshaven when fishing on the west coast of Jutland. If the wind was suitable they fastened these otter-boards to their long drag-seines (or plaice-seines, see *ante*), and towed the net over the ground ("snurrevaaden"). As the fishing seems to have been success-

* *Mitt. Deut. Seefisch. Vereins*, August, 1896, p. 153.

ful,* we may ascribe to the Danish fishermen the honour of first using, professionally, the *otter-trawl* from sailing boats.

It was not, however, until 1894 that the *otter-trawl* began to make distinct headway amongst professional fishermen. In that year Scott of Granton, who had been experimenting for several years with the otter-boards, became at last convinced of their utility and took out a patent for boards of his own design. He then fitted up several steamers on his own account and caused them to fish from different English ports in succession. The transformation effected thereby in the fishing apparatus of the English, and later the foreign, steamers was both rapid and extensive; within a few years the old beam-trawls had quite disappeared, except in the sailing craft.† The advantages claimed for the otter-trawl over the beam-trawl were mainly that it had a greater spread, and that its head-line was higher from the ground, so that it should catch more fish and in greater variety.‡ Recent investigations have cast some doubt on the first claim, but the second seems to be well substantiated by the greater catches of round fish which the otter-trawl brings in.

From the figure of Scott's patent otter-boards given by Cunningham in this Journal (*loc. cit.*) it appears that, as originally designed, the ground-rope and head-line met together in a ring at the centre of the hind margin. In all the boards used at the present day they are fastened separately, the former near the foot of the board, the latter near the top. In the present-day boards also, there are three transverse iron bars running across the otherwise smooth front face and bolted through to similar bars on the back. On the latter, one frequently sees two long iron bars placed diagonally across the board. These are used on the boards with chains in place of the patent triangles.

The boards are made of deal wood and are 9 ft. to 10 ft. long by 4 ft. 5 in. to 4 ft. 6 in. high, and 4 in. to 5 in. thick.§ The first iron bar is placed 2 ft. 4 in. to 2 ft. 6 in. from the anterior border and supports the base of the first triangle or "bracket" (see Cunningham's figure). The second bar comes 18 in. further back and supports the second and longer triangle. In working, the two triangles meet about

* Petersen, *Report from the Danish Biological Station*, iii., 1892, p. 36. *Mitt. Deut. Seefisch. Vereins*, 1888.

† According to Spillmann, *loc. cit.* (quoted by Petersen, *loc. cit.*, 1898), Capt. Nielsen, a Dane, was the first to make the otter-boards a success in 1895. As Scott and probably many others had been successful during 1894, it would have been more correct to say that Nielsen was *one* of the first successful fishermen. It appears further from Spillmann's account that Nielsen was one of the first, if not the first, to avoid Scott's patent by using chains instead of "brackets" on the boards.

‡ Cunningham, "North Sea Investigations," *Journ. M. B. A.*, iv. pp. 114–121.

§ According to Spillmann the boards used in Germany are shorter (7 ft.) and lighter (7 cwt.), but in proportion higher (4 ft.). The English boards are about 9 cwt.

9 in. to 1 ft. from the board and nearer the base of the anterior triangle than that of the posterior. The third iron bar is placed near the posterior margin of the board, a little in front of the two holes above and below for the end of the head-line and the shackle of the foot-rope respectively. Round the apices of the triangles a ring or shackle is passed, which, when the boards are working, is fastened to the last of a series of iron links, six to ten in number, forming the continuation of the warp. The second last link of this chain is replaced by a swivel which serves to take the "turns" out of the warp. In the non-patent boards chains are used in place of the brackets, and they are fastened to the boards nearer to the posterior end, as well as wider apart. The reason for this is that the solid iron brackets of Scott's patent are able to steady the board, though they act on only a small surface. The chains are loose and must, in order to steady the board, be attached as near the corners as possible.

Other forms of boards have been tried, but these are the ones most used. The great difficulty with them all is that when the boat stops towing, or if the warps get slack for any reason, the boards fall flat on the ground. When the strain comes on the warps again the boards, instead of rising to their previous position, may turn right over, and thus put a double turn on the net.

To try to obviate this an otter-board of peculiar shape was patented in Germany in 1897. In this, two large wheels joined by an axle were employed, and in the centre of the axle two oar-shaped spars were fixed—one above, the other below. These spars were inclined at an angle away from the axle, so that the upper should catch the water as the ordinary otter-boards do, and the lower the ground in similar fashion. From the sides of the axle two iron bars extended forward to the inner side, and to the ends the warp was attached. Two other similar bars extended backward to the toe-chain of the foot-rope, and from a little distance along them two chains passed upward and backward to support the pole which held up the head of the net.

Whether these have been successful or joined the majority of patents, I cannot say.

It is still an open question whether the large size of boards used by the trawlers is really necessary. The great resistance they offer to the water and their great weight add considerably to the pull of the net on the warps, and consequently demand more power and steaming on the part of the steamer. Further, the volume of water displaced causes a strong current to rush back against the wings. If this water passed down into the net it would be an advantage, but it is found that even with double meshes on the head of the wings it is necessary to leave a gap between the boards and the net. It might be thought, therefore, that if an opening were made in the centre of the board—which plays little or no part in the rotating motion already described—then the same purpose would be served, and if they had sufficiently large surfaces in front and behind the line of action of the trawl warp, they would act just as well as the ordinary boards. Such boards have been used for some months on the trawl of the Association's steamer *Oithona*, and so far as one can judge, give as good a spread, and are easier to work with than if they were solid throughout.

The *net* of the otter-trawl has gone through several changes since first introduced, and even now there are many differences in detail in different companies' trawls. In comparison with that of the beam-trawl, it has a shorter "square," but this is compensated for by an additional pair of wings on the top, or rather in front. In other words, the beam-trawl net has only one pair of wings—the bottom pair; the otter-trawl net has two. The "bag" of the net is identically the same in both.

The "head-line" is formed of a single rope, which passes from board to board along the front of the net above. It is 3 in. to 3½ in. in circumference, and is usually from 90 to 100 feet long. Before use it must be well soaked in water for some time, stretched, then soaked again. This prevents the rope from twisting itself up or "kinking," as it is called. The best thing for a head-line is a half-used warp or a rope which has seen some service and had the "kinks" taken out of it.

The "square" is the central portion of the net which overhangs the ground in front of and above the ground-rope in trawling. It is so-called, I imagine, because it is the nearest approach to a square piece in the whole net. The "top of the square," *i.e.* the portion immediately behind the head-line and the "top-wings," has 300 meshes across (sometimes as many as 330). The "bottom of the square," the portion immediately above the inner edge of the "ground-rope," has 200 meshes across, and down each side there are from 100 to 120 meshes, according as one has a square of 34 or 40 feet long. The size of the mesh is the same throughout, namely, 3 in. from knot to knot, or "four fingers' breadth," as the fishermen say.

The "top-wings" are the outlying portions of the net which extend forward from the square on each side to the top part of the boards. They are of a peculiar triangular shape, with a broad base of 100 meshes joined on to the head of the square, and an apex of only 6 to 12 meshes at the boards. Each may be from 31 to 35 feet long, according to the fancy of the fisherman for a long or a short square. These parts are made to suit one another and the lower portion of the net. As the latter seldom varies, it follows that the top-wings must vary inversely as regards the square. The mesh of the top-wings is usually the same as that of the square, viz. 3 in., but sometimes it is only $2\frac{1}{2}$ in.

Measuring along the side, the top-wing and the square taken together are 65 to 70 feet in length, and this consequently is the length of each "bottom-wing."* These form the lower portions of the trawl-mouth. In front, they are fixed to the ground-rope; at the sides, to the square and top-wings; and behind, to the head of the belly. In shape, they are long, comparatively narrow strips, which are about twice as broad (or deep) at the lower or hind end as they are at the upper or forward end. Where they join on to the head of the belly they measure 50 to 55 meshes across; at the forward end next the boards they are from 25 to 40 meshes. Some men prefer a deep lower wing with 40 meshes in front; others like it narrower. The size of mesh is again 3 in. from knot to knot.

When we come to the "bag" of the net we find that the upper and lower portions are exactly alike, so that as they come ready-made from the makers, it is impossible to distinguish them; and one may be used for the other. Formerly, ten more meshes were allowed in the head of the top portion than in the lower, as is always the case in the beam-trawls; but nowadays the nets are shaped and fixed differently, and the ten meshes are unnecessary. The upper and lower portions are thus alike, and each is divisible into two. The first part, where the number and size of the meshes are being reduced, is called the "batings" when above, "belly and batings" below; and the second part, which is the end of the net, is the "cod-end" or "cod."

The "batings" start with 200 meshes across where they join on to the foot of the square and work down to 60. The size of the mesh to begin with is 3 in. from knot to knot, and this is reduced to $1\frac{1}{2}$ in. The distance between the 200 mesh and the head of the 60 is 34 to 36 feet measured along the side; and the "cod-end," which is uniformly of 60 meshes across, is 12 to 18 feet long. The length of the "bag" is thus from 46 to 50 feet.

In the "batings" the reduction of the size of the mesh and of the number of meshes across is made as gradual as possible. For the first 8 feet the mesh is still 3 in. from knot to knot, but "batings"†

* This is the length of the bottom-wing when fixed to the square and top-wing. In reality, it is some 4 to 6 feet longer. See p. 578.

† A "bating," *i.e.* reduction, is where two meshes of the preceding row are taken into one mesh. A "creasing" is where an extra mesh is inserted. "Braiding" is the process of making a net. To braid one "round" is to go once across the net. This closes the half-meshes of the preceding "round." Therefore two rounds are required to make one "row" of meshes. The "batings" and "creasings" constitute the puzzle and the artfulness of the net.

are made on each side, so as to reduce their number. At the end of 8 feet the mesh is reduced in size through 2 feet to $2\frac{1}{2}$ in. The batings continue with two knots between each, and the mesh is also gradually reduced until at 18 feet from the foot of the square we have 120 meshes of 2 in. across. This marks the "head of the pockets." The size of mesh is now reduced to $1\frac{1}{2}$ in., and the batings continued until the "cod" of 60 meshes across is reached. The "cod" is open at the end across the whole 60 meshes. A loose double mesh is braided on at the end, through which a rope is passed. When the cod-end is fastened, this rope is pulled tight at both ends and then fastened in a peculiar and handy knot, which only the true trawler knows. The "flapper" is a short tongue of netting of $1\frac{1}{2}$ in. mesh, 40 to 50 meshes at the top down to 20 or 22 meshes at the bottom.

The different parts of the net have now been described. It remains to show how they are "fixed" or put together. The "fixing" is the secret of the successful working of the net. By diverse signs one learns to know that the net is too tightly pinched at one part or too slack at another. After a new net is placed in the water it may shrink unevenly—and usually does—and the net will not fish properly. In all cases, when from some sign one suspects the fixing to be wrong, it is better to take the net to pieces and set it up afresh. There is nothing more tantalising than a badly fixed net.

As it comes from the makers the net is in separate bundles, viz. a pair of top-wings, a pair of bottom-wings, the square, a pair of batings and a pair of cod-ends. Unrolling the top-wings and the square, these are braided together, as shown in Plate I. At the side, it is usual to join them by double twine so as to strengthen the corner of the net. The lines of junction of the top-wings to the square are called the "top-quarters" (Plate II.).

The foot of the square is then braided on to the head of one of the batings, and one of the cod-ends to the foot of the latter. The flapper is now taken and *laced* on to the lower part of the batings where the latter is 90 meshes across. The top part of the net is now ready for fixing on to the lower part. As sent out from the makers the bottom-wings are joined together at their broadest part by three to four rows of meshes of double twine. There should be 100 meshes across from wing to wing, and these form what is called the "bosom." The bosom in the centre and the wings at the sides are to be braided on to the head of the belly or batings, and on the lower end of these is braided the remaining cod-end.

The two halves of the net are now prepared for lacing. This is done by hitching them up to a post, or an eye on the bulwarks, and stretching them out parallel to one another—the flapper on the inside, of course—so that the meshes along the side—"selvage," it is called—correspond above and below. In lacing it is better to begin at the cod-end and work along to the wings, because the "bag" must be uniformly alike above and below, whereas a little slack, which may show itself in the lacing, does not matter in the wings. The selvage is of double twine both above and below, and the lacing strings, also double, should take in two to six extra rows of meshes. There should be little chance, therefore, of the net breaking away in the selvage.*

When both sides of the net are laced up, the lower portion should be stretched out flat and the pockets put in. This is done by getting hold of the net where it is 120 meshes across, and lacing the top to the bottom part across the first three meshes on each side, then down some ten feet along a line of the network. As the lacing proceeds, the first two meshes of the sides of the flapper are taken up and laced in between the bottom and top part of the net. At 90 the pockets end, but the flapper is laced down to the belly some two feet further along the same line of network. About six rows of the flapper are left free at the end. By lacing the flapper down to the belly a free space is left above, between the flapper and the top batings, so that when fish get behind the flapper and try to strike back they will enter this space first of all, and thence be guided into the pockets.

When the trawl is laced up the last operations consist in fixing on the head-line and foot-rope. The "foot-rope" or "ground-rope" is a very large and expensive structure in the modern trawls. It has a central core of "$2\frac{1}{2}$" in. wire covered by old netting from mackerel or herring nets, and this is rounded with old manilla trawl warps. When complete it measures about 10 in. in circumference and 120 to 138 ft. long.

In order to fix on the ground-rope, the centre of the bosom should be found and hitched up on a pole as before; the wings are then stretched parallel to one another and their ends hitched up to another pole. The "balch" or "balch-line," or rope $1\frac{1}{2}$ in. in circumference which comes between the ground-rope and the net, is then hitched up at its centre to the first pole and both sides stretched out parallel to some distance over the parallel wings. The bosom of the net is then "marled" on (Fig. 3) directly to the balch. The wings, however, have what is called the "flying-mesh" along the inner side (Fig. 3), and the balch is fixed on differently. A "wing-line" of the ordinary net-twine, but doubled, is passed through each flying-mesh, as shown in the figure, and then marled on to the balch-line. The flying-mesh for the wings is an ingenious contrivance. The part most liable to injury from stones or "ross" on rough ground, is the first two to three

* When heavy "bags" are experienced, a 2-in. rope is laced in with the selvage.

rows immediately behind the foot-rope. The more yielding or "give" the meshes in these rows have, the more likely are they to jump the obstacle or break it off. This greater elasticity is provided for by the flying-mesh. It is specially useful in the wings, because any obstacle that catches the net will there strike the mesh on the side, *i.e.* at its weakest part, and might break *across* a long series of meshes. Such a tear is about the most awkward to mend the fisherman can have. With the flying-mesh the tear tends to be *along* the mesh, *i.e.* the course of braiding, and it is soon mended. It is evident further that in the bosom the flying-mesh is unnecessary. The ground-rope is next made fast and stretched out as was done to the net and balch, and the balch is then fastened or "balched on" to it. As a rule 10 to 20 ft. of bosom are allowed on the foot-rope, so that the 100 meshes are to be gathered together, in threes, and their balch-line distributed uniformly over the 10 to 20 ft. The fisherman is guided by the turns in the rounding of the ground-rope where to fix the "setting." It is generally every third turn for the balching of the bosom. In balching the wings the foot-rope is often marked by chalk-lines where the settings have to go. Experienced hands, however, are guided by the turns in the ground-rope, about every seventh to begin with, until they see how much slack they have, and then fix according to their liking. Three to four of the "staplings" on the balch-line are included in a setting, and the settings are wider apart near the end of the wings than at the quarters.

The head-line and the top part of the net are set up for balching in a similar fashion, but there are no flying-meshes * nor balch-line. The square and the top-wings are marled on directly to the head-line with double twine. The square has very little slack given it; the slack is put into the wings. The result of this is that when the trawl is moving through the water the wings are greatly distended at each side, thus tending to keep the mouth of the bag open wide. If the slack were put into the head of the square, the head-line would dip in the centre from the weight of the net behind.

When the net has been fixed in the fashion described, attention has to be paid constantly, when fishing, to the condition of things at the quarters. These are where the square and top-wings (or belly and bottom-wings) meet on the head-line (or ground-rope). These are made specially strong with double meshes, as already described; and if the net has been badly fixed or shrinks unequally, they soon show it. If the square is too much stretched, it will break away from the head-rope at the quarters; the top-wing has then to be unlaced from

* The flying-mesh may also be present in the top-wings.

the bottom-wing on the side where the break occurs, more slack given to the square at the quarters, and the whole laced up again.

Some of the finer details in the structure and fixing of the net may now be pointed out. It will first of all be noticed that whilst the head-rope is only 90 feet long, the length of the wings and head of the square which fix on to the head-rope is more than 105 feet, that is to say, 15 feet of slack must be distributed along the two wings. This means that the square is stretched out in the centre as far as it can stretch. The batings are consequently stretched out in the centre, and likewise the cod-end. If we turn to the under part of the net we find the same thing. The ground-rope is 120 feet long, but the length of net to be attached to it is over 160 feet. This means that the centre of the belly must be pulled up, even though plenty of slack is allowed. Consequently, there is a strain down the centre of the net, both above and below, from the front to the cod-end; and this does away with the necessity for having guy-ropes leading from the head-line and foot-rope to the cod-end, which are present, as mentioned before, in the *filets de bœuf*.

On the other hand, the bag-formation at the sides, which the Frenchmen obtained by means of these ropes and the ears (*anses*) in the "cod-end" (*culignon*), is given in the otter-trawl by a careful distribution of the slack along the sides. The top-wing and square measured along the side are about 70 feet long; the bottom-wing to which they are laced is 5 feet longer. This 5 feet of slack must be put in somewhere, and as it is usual to allow the square two or three of slack in order to relieve the strain on the net and put it on the head-rope, we must distribute the 8 feet of slack on the bottom-wing along the selvage of the top-wing. It would seem, therefore, as if the meshes of the top-wing ought to be stretched, but, as already pointed out, it has about 8 feet of slack along the head-line. The bottom-wing, relatively to the head-rope, has consequently about 16 feet of slack net, and relatively to the foot-rope it has more than 20 feet. The result is that the net must bulge out to the side and also backward, and this is the case with the under part of the net more than with the upper.

As we follow the lines of the bag of the net from the 120 mesh towards the cod-end, it will be noticed that the inner sides of the pockets really continue the sides of the net, and the opening under the flapper is the termination. The remaining portions, formed by the pockets and cod-end, are just as if they had been tacked on separately. When the net is fishing, therefore, there is nothing at the sides to stop the flow of water or cause an eddy, but a smooth passage right down into the cod-end. The rush of water into the latter must be of considerable force, and as it enters it must divide into two streams—one to the right, the other to the left, because it cannot pass through the knot by which the end is tied.

The water in the cod-end tending to escape at the sides and above, forms an eddy in the direction of the pockets. That this eddy must be fairly strong is shown by the practice of the fishermen in having a long cod-end. If the cod-end is short and dirt gets in, the fishermen get no fish, and ascribe this to the dead-water or back-wash which gets above the flapper and closes it. And as evidence of this one may find some dirt or weed hanging above the flapper.

With respect to the cod-end, it should be mentioned that rubbers are laced to it underneath to prevent the net being chafed on the ground. They are made from old net cut into strips two to four feet long, and the breadth of the cod-end. They vary in number from four to eight, according as the ground is smooth or rough. On smooth ground, indeed, they are not necessary.

It has been shown above that there is a strain upon the meshes of the net along the central line both above and below. One result of this is that the meshes of the square must be wide open; and since the meshes there are large in size, many fish must escape through them. By Dr. Fulton's experiments * with cod-ends of various sizes of mesh it has been shown that more fish escaped than were captured with the ordinary cod-end mesh of $1\frac{1}{2}$ in., and when a mesh of $2\frac{1}{2}$ in. was used all except the very largest got through. A few years ago, also, it occurred to the men of the smaller Brixham trawlers that many fish, especially whiting, must escape through the top of the net, which at that time had a mesh of $2\frac{1}{2}$ in. in the square and head of the batings. To test the point they laced a portion of a herring net over the square and batings, and found, just as they expected, that they caught more fish in the herring net than in the trawl. They consequently reduced the mesh to $2\frac{1}{4}$ in. and 2 in. in the square, and 2 in. in the batings. Even with this size they find that a great number of intermediate size of whiting—9 to 10 in.—are meshed in the batings whilst trying to escape.

It follows from these experiments of Dr. Fulton and the Brixham men that only a very small proportion—less than 10 per cent.—of the round fish are taken by the otter-trawl from the water which it passes through. Some might wonder why the fishermen use such a mesh in the top part of the net as will allow the largest haddock to escape, but the large mesh is really a necessity in the trawls as now constructed. It is different for a beam-trawl, where the mesh can be suited by the speed; but with the otter-trawl the smaller speed which

* *Rep. Scot. Fish. Board*, xix., for 1900, part iii. p. 62.

is demanded by the smaller mesh would mean that the otter-boards would not spread out satisfactorily, and the net consequently would not fish well, if at all. On the other hand, if the meshes of the square are open to their fullest extent, it is different with the meshes in the wings. As a result of the "slack" at the sides, the meshes there will be extended lengthwise and not so fully open as in the square. The result is that the main rush of water down into the bag is along the sides, and this should be the path the majority of the fish caught in the net will travel.

The greatest difficulty in the working of the otter-trawl is to ensure that the head-line is well off the bottom. If it tends to sag in the centre, the results of the fishing will show that for one thing, and if it bends so far as to touch the ground the rope will be frayed or have some dirt on it. If the mesh in the square were smaller the force of the water when it passed *under* the head-line would tend to raise the net, but the objections to the smaller mesh are twofold: firstly, if the head-line sagged in any part the pressure of the water would act on the net *above* the head-line and thus drive it down; and secondly, the smaller the mesh the greater the resistance to the water, and the greater, therefore, the "wave" in front of the net. In neither case would the fishing be a success.

Various patents have from time to time appeared with the intention of overcoming this difficulty. In Epton's patent two large air-bladders, with coating of rubber and surrounded by netting, are fastened one to each top-quarter. In another patent an air-bladder of similar material, but tubular in shape and some 6 to 10 ft. long, is attached to the net over the centre of the head-line. It is said by some, however, that the resistance these offer to the water is appreciable. Tanner's idea,* which has been adopted by Petersen and Hjort, to fix glass spheres enclosed in netting round the head-line, would hardly do for professional fishermen. The most recent patent, and one which seems most likely to be successful of any yet tried, is to attach two small otter-boards to the top-quarters and to the main otter-boards in such a way that they would tend to rise in the water, and therefore pull up the head-line.

Another difficulty lies in the choice of the right size of ground-rope to use, though it has been more experienced by naturalists and sailing trawlers than the steamers. In the sailing trawlers the wind may be so light that the boat cannot pull the ground-rope over the bottom fast enough, and mud or stones getting into the net may tear it to pieces. Sometimes also, even with a good breeze, the trawl may come upon a bank of sand or mud which reaches higher than the beam and means

* *Bull. U.S. Fish Commission*, xvi. 1896.

ruin to the trawl. Similar difficulties and experiences have been encountered in the use of Petersen's trawl, but, as will be shown presently, these arise in this case from the nature of the trawl, which, as constructed, courts disaster on soft ground.

Hjort (*loc. cit.*) has endeavoured to overcome this difficulty in the latter by fixing a stone to the under part of the ground-rope in the centre and counterbalancing it by means of a glass globe above, the idea being, that if the weight of the stone is taken off by rising ground, then the glass globe will lift the ground-rope out of harm's way. Though one would imagine that the stone, by sticking in the mud, would drag the rope down into it likewise, Hjort seems to have found the method successful. Petersen suggests that a thick coir rope should be fastened on the foot-rope when trawling on soft ground, and indeed, the only thing that can be done with Petersen's trawl, if one wishes to use it on soft, muddy ground, is to make the ground-rope as light as possible and as large round as possible, then tow over the ground as fast as the trawl will permit. Such is the method of the steam trawlers. They have no special fear of muddy ground, but take care to increase the speed of the vessel.

The otter-trawl, by the large meshes of the net, the thick ground-rope, and the high speed it must be towed at, is well adapted for soft ground. A greater difficulty is met with on hard or stony ground. It is essential for good fishing that the ground-rope should grip the ground to some extent, and in order to do this on hard ground all trawlers, whether sailing or steam, reduce speed and at the same time shorten the warps. To do this successfully demands great skill and experience, and in the latter respect the beam-trawlers are many years ahead. It is said, indeed, that they work constantly on rough ground, which the steam trawler avoids after one or two trials. The reason is not far to seek. On rough ground, the roughness is caused not merely by stones, but also by the animal life present, as *Lepralia* ("Ross"), *Alcyonium* ("Dead Men's Fingers") on Oysters, Pectens, and such like. The ground-rope of the otter-trawl is quite able to get over these, but their sharp points tear the meshes of the net. The sailing trawlers and the steamers have different devices for overcoming this difficulty. In the former a series of iron rings is suspended all along the ground-rope, and between each ring hangs a short iron chain. There is thus a series of festoons hanging underneath the ground-rope which, at one and the same time, helps the rope to bite into the ground and to break up the material which causes the roughness. To my knowledge, this device has not been adopted, though it may have been tried, on any of the steam trawlers; probably because the great weight the chains add to the foot-rope would cause the otter-boards to approach one another, and thus effectually spoil the fishing. Instead, they use a series of "bobbins" or rollers in place of the ordinary bosom of the ground-rope. These are of two sorts—a large, about 15 in. in length by 12 in. in diameter, and a small, about 6 in. by 4 in. The small rollers alternate with the large, and serve for the fixing of the settings of the bosom. Each roller has an iron "bush," *i.e.* a hollow tube through the centre, and through this is threaded the iron wire which forms the core of the ground-rope. Since these bobbins are not always in use, it is necessary to have some arrangement by which they can be readily shipped and unshipped, and this is done in the following manner. The ground-rope is made in three pieces, and the central part, about 20 ft. long, is shackled on to the wings. When the bobbins are to be used, it is a simple matter to unshackle the ordinary bosom of the ground-rope, and shackle on the wire rope with the bobbins.

These add very little, if anything, to the weight of the ground-rope, and are better able to surmount obstacles and break up the hard material on rough ground.

Having thus described the structure of the otter-trawl in detail, it may be of interest to compare it more particularly with other forms of trawls, so as to display wherein its advantages and its limitations lie. It has been shown that the otter-trawl and the beam-trawl are alike in the structure of the bag, batings, pocket, and cod-end, and in having a large square projecting in front. In these particulars they differ from all other forms, and show a distinct improvement. The advantage of the square is that the fish which are feeding on the bottom fauna are well into the net before being disturbed by the ground-rope. If the latter is in advance of the head-line or on a level with it, as in the *filets de bœuf* and Petersen's trawl, for example, very few of the swifter forms will be captured. Such has been our experience during the past year. The first trawl employed on the Association's steamer *Oithona* had a square only 8 ft. long, and whilst it was an excellent instrument for catching plaice and soles, it was useless, comparatively speaking, for whiting. They were caught, but in no great quantity. Later, when a 24-foot square was used, the whiting were well represented. As pointed out by Dr. Fulton,* the presence of long wings, and, I may add, the absence of a square, is one of the serious defects of Petersen's trawl.

The advantage of the flapper and pockets, and of the mode of fixing the net which makes them functional, is that once the fish are in the bag of the trawl they cannot escape. In the *filets de bœuf* and similar nets of the Mediterranean, the bag is exceedingly long, and

* *Ann. Report Scot. Fishery Board*, xx. p. iii. p. 329.

contracts about 10 ft. from the end, like the old-fashioned silk purses, and then expands into the *culignon*. A great length of bag is here necessary in order to make the net contract and retain the fish. Another method, formerly used in the beam-trawls of this country, was to make several pockets up each side of the net, without a flapper. A further method is that used in the shrimp-trawls of the scientific expeditions of the United States, and adopted more recently by Petersen. It consists of a cone, or funnel, which is laced at its broad end near the front part of the bag, the narrower end hanging open and free towards the cod-end. The under part of this funnel is obviously of doubtful use. It must lie on the belly of the net when trawling and is consequently of no service. If the sides of the funnel were laced along the belly, as described here for the otter-trawl, the under part could be done away with. It is probable, however, that Petersen's trawl would fish just as well without the funnel as with it.

Of the various methods for retaining the fish within the bag, that used in the beam- and otter-trawls seems by far the simplest and most efficient. If the net is properly constructed and properly fixed the fish should have no difficulty in getting into the cod-end, and once there their natural and well-known tendency to strike upward raises them above the flapper, and they thus cannot escape back into the net. The short bag that is necessary is also a great advantage, as it saves a great deal in the making and repairing of the nets.

The otter-trawl and beam-trawl differ from one another so little that the one may be converted into the other. Remove the beam and iron-heads from the latter, braid on a pair of top-wings to the square, and extend the lower wings correspondingly, and we should have a fairly good otter-trawl. The few differences are of minor importance and are concerned with the kind and manner of fishing. It follows from thence that the results of the fishing depend upon the shape and size of the mouth of the trawl. In the beam-trawl the mouth is rectangular—30 to 40 ft. broad or more, and 3 to 4 ft. high. In the otter-trawl both the height and breadth are still uncertain. According to the experiments made by Fulton * the breadth from board to board varies between one-half and two-thirds of the possible spread, *i.e.* a trawl with 90-foot head-line will have a breadth of mouth between 45 and 60 ft. In this respect, therefore, the otter-trawl has only a slight advantage over the largest beam-trawls in use. With regard to the height of the centre of the head-line we have no data on which to base a calculation. If the trawl-mouth is open properly it may vary between 5 and 15 ft., and the fisherman's estimate of 10 ft. is probably near the mark. This seems to accord with the opinion

* *Loc. cit.*, pp. 120, 121.

generally held by trawlers, and indicated by the calculations of Garstang* and Fulton,† that the otter-trawl catches about 30 per cent. more round fish than the beam-trawl, but the same amount of flat fish. Whatever reliance may be placed on these conclusions, and they are admittedly based on indirect evidence, it is certain that the otter-trawl is not so adaptable for catching flat-fish as the beam-trawl. The high rate of speed which is necessary in the former case in order to keep the mouth of the net open, detracts from its power of catching flat-fish. If the speed is reduced the spread of the mouth will fall below that of the beam-trawl, and the same thing would occur if any extra weight, such as an iron chain or dangles, were attached to the foot-rope as in the beam-trawl, in order to stir up the fish. With respect to size of mesh, also, the otter-trawl is at a great disadvantage in comparison with the beam-trawl. A smaller mesh means less speed, and this, as shown, distinctly affects the fishing capacity of the former, and that adversely, whereas if it affects the beam-trawl it is favourably. The head of the net in the latter is always a fixed height from the ground, and the reduced speed that the smaller mesh demands does not affect the spread.

There can be no doubt, therefore, that for certain purposes the beam-trawl is preferable to the otter, and more especially for small flat-fish. Petersen's trawl, for example, is exceedingly well adapted for this purpose, but it would fish better, I think, and with less trouble, if a beam were attached to it. Its utmost spread appears to be 16 ft., but in practice it is probably less, whereas if it were converted into a beam-trawl its spread would be constant and assured. The small size of its mesh—less than 1 in.—makes it comparable, not to an otter-trawl or ordinary beam-trawl, but to the well-known shrimp-trawl. In the latter the beam may be of any length between 8 ft. and 24 ft., and its height from 15 in. to 2½ ft. The size of mesh varies from 1 in. down to ¼ in., and in formation the net may be exactly as the ordinary beam-trawl. In place of a wooden beam, however, a hollow iron pipe is better. For deep-sea work in depths greater than 20 fathoms Agassiz' modification of the shrimp-trawl is very useful, because it is immaterial which side it falls on.‡

The average speed at which the otter-trawl is towed over the ground is 2½ knots per hour, the beam-trawl 2 knots, and the shrimp-trawl

* *Journ. M. B. A.*, vol. vi. p. 50. † *Loc. cit.*, pp. 122–5.

‡ *Bull. U.S. Fish Commission*, xvi., 1896, p. 357. Petersen (*loc. cit.*, p. 6) would have it that the Americans are inclined to return to the single form of shrimp-trawl, but this does not seem warranted. Petersen has slightly misquoted the words of Tanner in the Bulletin cited. According to Tanner, "experts" are able to land the ordinary shrimp-trawl right side up in deep water; Petersen has it "investigators." There is here a distinction as well as a difference.

1 mile; it varies according to the ground, the size of mesh, and the length of warp. On hard ground or with smaller mesh or shorter warps it is less than stated, but may be greater with larger mesh and greater length of warp, especially on soft ground.

The dimensions of the commercial trawl-net may be summarised in more compact form :—

*Square:* 34–40 feet long, 300 meshes down to 200; mesh 3 in.
*Top-wings:* 31–35 feet long, 100 meshes down to 6 or 12; mesh 3 in.
*Bottom-wings:* 68–78 feet long, 50–55 meshes down to 25–32; mesh 3 in.
*Batings:* 200 meshes down to 60; length, 34 to 36 feet (18 feet to "head of pockets," 10–12 feet of pockets, 6 feet 90 meshes down to 60).
*Belly and Batings:* like the Batings.
*Cod-end:* 60 meshes across; $1\frac{1}{2}$ in. mesh; 12 to 18 feet.
*Head-rope:* 90–100 feet.
*Ground-rope:* 120–130 feet.

Inasmuch as the ordinary commercial otter-trawls are often too large for the steamers at the service of naturalists, it may be of use to give the dimensions of a trawl with 64 feet head-line such as used on the *Oithona*:—

*Square:* 26 feet long, 280 meshes down to 180; mesh $2\frac{1}{2}$ in.
*Top-wings:* 25 feet long, 80 meshes down to 10; $2\frac{1}{2}$ in. mesh.
*Bottom-wings:* 54 feet long, 50 meshes down to 30; $2\frac{1}{2}$ in. mesh.
*Batings;* 180 meshes down to 60; 24 feet (first 10 feet to the head of the pockets, 10 feet of pockets, 4 feet 90 meshes down to 60); the size of mesh is graded as in the big trawls.
*Belly and Batings:* 170 meshes down to 60; the details otherwise being the same as above.
*Cod-end:* 60 meshes across in its whole length; 1 in. or $1\frac{1}{2}$ in. mesh; 8 feet long.
*Head-rope:* 64 feet.
*Ground-rope:* 90 feet.

The fixing is just the same as in the large trawls, the square being balched tight to the single head-rope, and 7 to 10 feet of bosom allowed. The ground-rope is 7 in. in diameter, and has a central core of iron wire except in the centre of the bosom.

The best method of curing or preserving a net made of manilla twine is to soak it in coal-tar, but if the net is of cotton this makes it unnecessarily heavy, and either cutch alone should be used or cutch once or twice, and then light green oil, *i.e.* creosote oil. The heavy oil of tar, commonly called green oil, is also useful. For hemp nets, cutch and coal-tar seem the best methods. Manilla is employed where rough work has to be done, as in the otter-trawls and larger beam-trawls; cotton and hemp in the smaller beam-trawls and shrimp-trawls.

In the paper referred to,* Dr. Fulton discusses the probability of pelagic fishing with trawls, and concludes that the ideal should have two pairs of otter-boards, so that the mouth and net itself is square-shaped. The practical men, however, seem to have dissuaded him from trying this. As a matter of fact, such a net was experimented with in the North Sea a little more than two years ago with some measure of success.

## DESCRIPTION OF DRAWINGS.

*Plate* I. Fig. 1.—Drag-seine or Tuck-net, see footnote, p. 567.

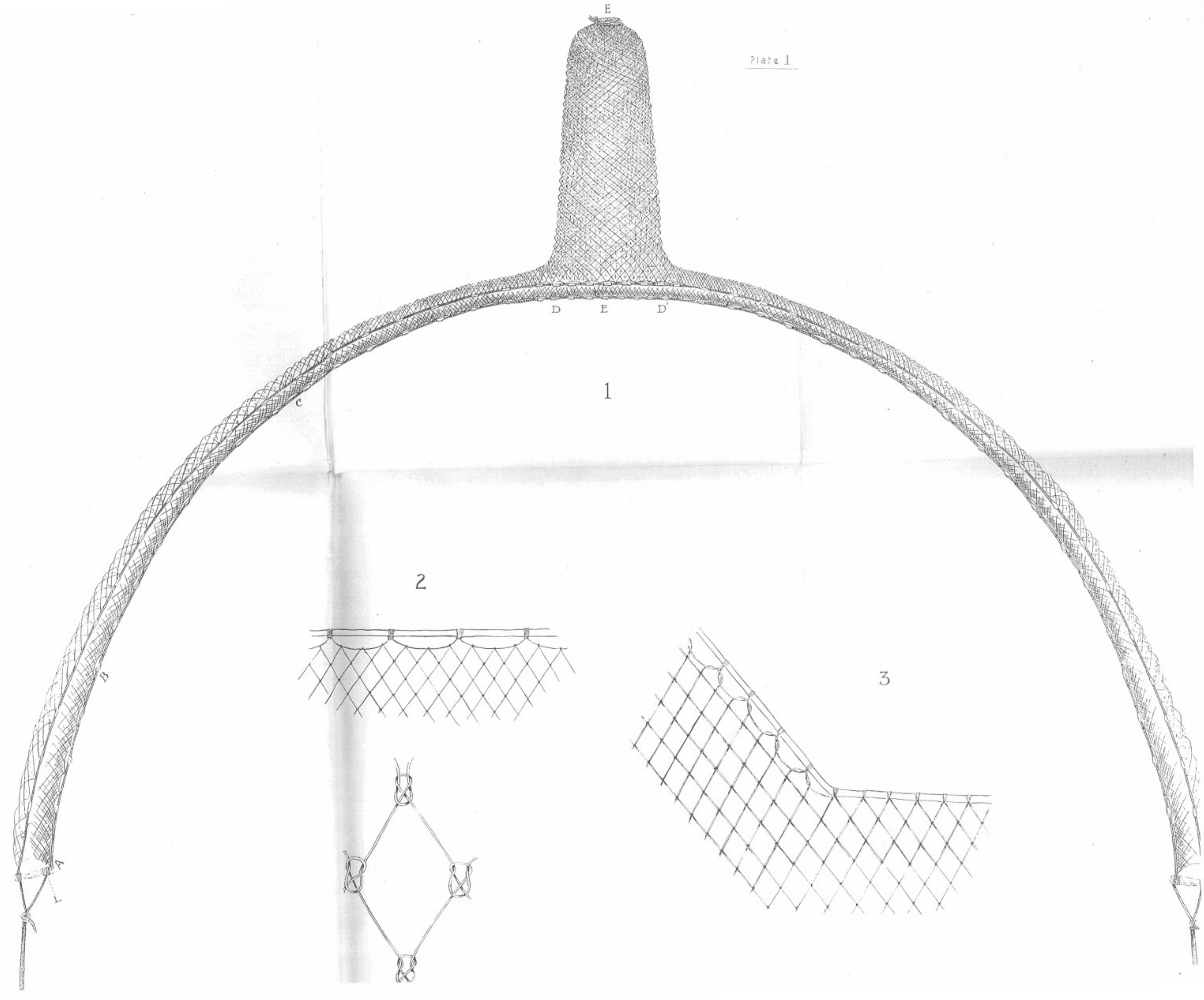
Fig. 2.—The method of fixing (balching) a balch-line (*b*) by means of settings (*s*) on to a head-line or ground-rope.

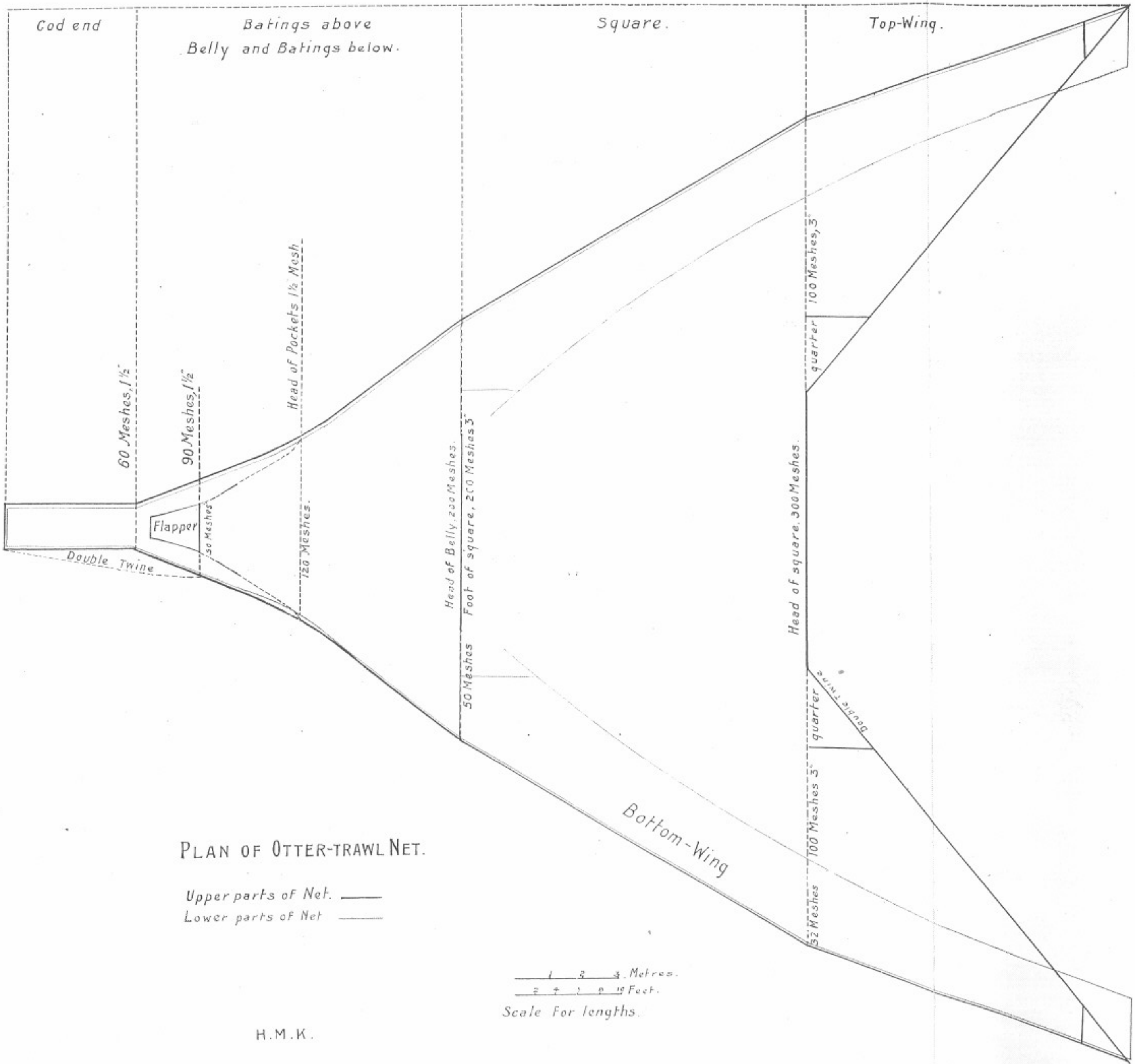
Fig. 3.—The method of fixing (marling) the head of the square on to the head-line, and the "flying mesh" in the wings.

*Plate* II.—Ground-plan of Otter-trawl.

* *Twentieth Report*, pp. 329 and 330.

Plate 1






PLAN OF OTTER-TRAWL NET.

# What is Over-fishing? *

By

**Dr. C. G. Joh. Petersen, Copenhagen.**

(With one Diagram.)

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For the sake of argument I will suppose:

I. That in a biologically self-contained area, *e.g.* in the North Sea, statistics show that the value of the total yearly catch of a certain species of fish is decreasing year by year;

II. That the catching power and the prices are not reduced;

III. That the physical conditions have not changed in an unfavourable manner.

The decrease must then be ascribed to organic factors, either to man or to other organisms.

If the decrease must be ascribed to man solely, or in some degree, over-fishing has taken place.

It will be understood that over-fishing cannot easily be proved with regard to many species of fishes, *e.g.* for true migratory fishes. For example, in the case of the herring and the cod statistics have always shown great fluctuations. For this reason it is necessary that statistics in the case of such fishes should extend over a very long time to prove any decrease beyond the ordinary fluctuations. In dealing with other fishes, *e.g.* the plaice, the statistics do not fluctuate so much because the plaice is not so migratory. However, if we had statistics alone to depend upon, the problem concerning the influence of man would never be solved. Any decrease might always be ascribed to some or other imagined reasons. Fortunately we can get more than statistical data to rely upon.

It is not my intention here to discuss all problems about over-fishing, this being impossible. I only wish to give an example in

* This analysis of the problems of over-fishing was prepared to meet a desire expressed by several members of the International Committee on Over-fishing during the last meeting of the International Council at Copenhagen.—W. G.

order to throw light upon some of the principal ideas concerning this matter.

Accordingly I take the case of an imaginary fish, species "P," which exhibits the following features:—

1. It does not migrate out of the North Sea.
2. It takes three years to grow up to maturity (see Diagram).
3. It is nearly in every respect closely allied to the plaice.

The stock of this fish "P" has, during recent years, been reduced in the Kattegat and in the North Sea to such an extent that statistics prove that the weight of "P" annually caught is not at present so great as formerly, in spite of the catching power being highly augmented. Had not the prices per kilo increased during the same period, nearly all "P" fishing would have been stopped, at least in the Kattegat.

Now somebody may say, "Well, you have had to do with a stock of 'P' accumulated during many years. The III Group (Diagram, IIIa) was accumulated and included all 'P' of three years and above, possibly up to twenty years, the maximum possible age of a 'P.' In the very beginning you were catching these old III individuals, but this cannot be done every year, since a larger stock will grow up in twenty years than in one. This fact is the explanation of your decreasing statistics."

This *status quo* may occur in Norwegian fjords, where the areas in which the I or II Groups live are very limited, and where the number of individuals in these groups is consequently small compared with those in the III Group. The individuals of the I and II Groups are very fond of shallow, sandy beaches, but those of the III Group live in much deeper water. Fishery investigations in such fjords have proved that the III Group is really much easier to catch in numbers than are the I and II Groups, and that the average size of the individuals of the III Group is thirteen to fourteen inches (Diagram, IIIa). This example of an annually decreasing catch is not strictly an example of over-fishing, at any rate it is only an exceptional kind of over-fishing, which is inevitable, and to some degree desirable.

An explanation of this kind, however, cannot be used to account for what has happened in the North Sea and in the Kattegat during recent years, since the fishery of "P" in this area is no longer based upon the III Group, but upon the II Group. If we consider numbers instead of weight, the greater part of the total annual catch is now, and has been for many years, made up of individuals of the II Group with comparatively few of the III Group. The average size of the III "P" has, moreover, during the same time gone down from thirteen or fourteen to ten inches (Diagram, IIIb), and statistics show a decreasing value year by year in the North Sea taken as a whole, the North Sea being a biologically well-defined area for the "P." *

This being the fact, what can be the reason or the reasons for the declining statistics and for the reduced average size of the "P" in this area? The catching power has been much enlarged, the prices have risen, and the physical conditions have not undergone any unfavourable change; so the decrease in value of the total yearly catch must be ascribed to organic factors, *i.e.* to man or to other organisms.

Has the bottom been injured by trawling in such a way that the food of the "P" has been destroyed?

This view was held in former times, but has never been proved or set forth in such a way as to make it probable. If the "P's" food was destroyed, we might suppose that the "P" in consequence would look very lean, or not be able to grow, as the case is in the Baltic. Marking experiments, nevertheless, prove that the "P" grows fast when not too abundant in a narrow space. Overcrowding may perhaps be found on certain grounds, this being actually the case in the Western Lim Fjord; but in other parts of the Lim Fjord the "P" grows very fast where it is scarce. Experiments of mine specially directed to this point have shown that the small invertebrates are still as numerous per square foot in the western part as in many other places in the Lim Fjord. Speaking generally, we cannot consider that food is wanting in the North Sea, at any rate not to a greater extent than formerly; but in the present state of our knowledge is it possible to suppose that other invertebrates, *e.g.* the star-fish *Asterias rubens*, eat the small bivalves which are the best "P" food, and that *Asterias* is more numerous at the present time because the large "P" individuals have disappeared from many fishing grounds? Investigations on the actual rate of growth of the "P" in such localities may solve this problem—at any rate, they may prove how fast that "P" is growing, which is the

* I am extremely familiar with this kind of fishing upon the II Group, since the plaice lives in the Lim Fjord, but does not propagate there, perhaps because all plaice are fished out there every autumn when they have grown some few inches during the spring and the summer. The young ones immigrate in numbers every year from the North Sea. In the Lim Fjord we have no true stock at all. What must, then, be thought of the Lim Fjord fishery? Is it "destruction of immature fish," since all are fished out before they reach maturity, and almost entirely fished out every year? The Lim Fjord, however, is not a biologically self-contained area for the plaice, and this question accordingly forms only a part of the whole over-fishing problem. The fjord gets its young plaice from the North Sea every spring, and we in Denmark have only the two things to do: (1) To help into the fjord as many as there is room for, and this is limited, and (2) to leave them in peace during the summer to grow up to a saleable size, like carps in a carp pond. As we get our young plaice every spring for nothing, or almost for nothing, and as they reach a good size for sale during the six to eight months, they ought to be fished out every autumn and winter.

essential point in the matter. I do not think it necessary further to discuss it here.

When the "P" grows fast, we might take predatory animals into consideration as a cause of the reduction in the average size of the "P." It will then have to be investigated which predatory animals attack the big "P" more severely than smaller ones. I think it is not very probable that such animals exist. At all events, I do not know of such animals, and have never heard of any.

Other organic factors (diseases) may, perhaps, be mentioned as capable of reducing the average size of the "P." We do not, however, know anything about this; but from our investigations (1) we know the quick rate of growth of the marked "P," and (2) we see that their mortality, except by fishing, is not great in the North Sea. And this is sufficient.

The first immediate influence of fishing is beyond doubt the reduction in number of the "P."* The second influence of fishing is that it prevents the "P" from being as old, and therefore as big, as in places where no fishing is going on. It is in this latter fact, I think, that we have to look for the reduction of the average size of the "P" in the North Sea and in the Kattegat. When admitted that we have not to do with an accumulated stock of "P" in the North Sea, but only with a stock of the II, and a small part of the III Group of "P" highly reduced by fishing and growing up again every year nearly, but not quite, to the same point as the year before, it will be understood that the average size has been slowly reduced year by year. Somebody might already regard this reduction of the average size as over-fishing, yet it is not absolutely so. We suppose that the mature fish, Group III, have been greatly reduced in numbers, but are still capable of yielding sufficient eggs to keep the stock up to date. According to the custom of nature, it is probable that in former times eggs and young fishes were produced in overcrowding multitudes, and that a very high percentage consequently died out. The mature "P" may undoubtedly become so scarce that they cannot supply the stock sufficiently with eggs. If this be so, we have to do with one kind of over-fishing of the mature "P" which reduces the number of "P." I do not, however, suppose this to be the case, but rather that there is a sufficient supply

* It is possible to imagine that reduction of the III Group by fishing may afterwards allow the II Group to spread over a larger area, and consequently procure more favourable conditions for the individuals of this group: (1) they will grow quicker, and (2) the mortality will perhaps be reduced, and the total number of all "P" will thereby in a twelvemonth be larger than before the fishing was carried out. This would be a peculiar result of over-fishing. Whether it really is over-fishing depends upon two things: (1) the amount of reduction of the average size, and the price of the fish at this reduced size; (2) the extent of the increase of the numbers and rate of growth of the II Group. Statistics must solve this problem.

of eggs, and that it is only Group III which has been reduced in average size, and is less numerous than before.

Then there is the possibility that the two other groups, I and II, are growing faster now than before because they have more room, and each of them consequently more food. Group II still consists of saleable fish, and they grow up a year quicker than Group III; not so many of them die or are eaten by animals, because they are only two years old. For these reasons it is very likely that it would pay better to base the fishery for the greater part on this group and not on the III Group.

This problem depends upon the value of the fish in Group II compared with that of the fish in Group III, and upon the mortality in the third year. If we only knew the rate of growth, the mortality during this year, and the price of the fish, the question might be exactly solved by mathematics. In the third year we know that the "P" increases its value four times by growing. If the mortality is as high as one-half during this year, which is not probable, it would pay to prevent all fishing for the II Group. Failure to prevent all fishing for this group would then involve the "destruction of undersized fish." A size limit for the fish would, under these circumstances, be desirable. Studies on the rate of growth, and of predatory animals feeding on the "P," would greatly add to our knowledge on this point.

So far I have dealt with the following three cases:—

I. Over-fishing of an accumulated stock.

II. Over-fishing of the mature fish to so great an extent that they cannot render a sufficient number of eggs to supply the stock with young fishes.

III. Reduction of the average size of the fish to such an extent that they are not sufficiently saleable. This case we may name the "relative destruction of immature fish."

It is, nevertheless, possible to imagine another kind of over-fishing, viz.:—

IV. The Group I of the "P" is living in certain very restricted areas close to the shore where shrimp-trawling is going on. It is possible that shrimp-trawling can destroy too many young ones. This I Group has no value in the market at all, and if such individuals are killed by fishing for shrimps or by other methods, it may, in the true sense of the word, be called "destruction of immature fish."

It is again possible, *e.g.* in the Kattegat, that the stock of "P" is reduced a good deal by fishing, while other allied species, *e.g.* the dab (*Pleuronectes limanda*), are less affected. If this be the case, the last-named fish may then increase its stock and take its food in areas where the "P" was formerly the dominant fish. This only means that the equilibrium of nature has been disturbed by man. We may in many cases expect other organisms to augment the disturbance by retarding the rate of growth of the "P" and by augmenting its mortality, but this has nothing immediately to do with over-fishing.

How is it possible to recognise in nature which of the four kinds of over-fishing we have to deal with in a particular case?

We suppose the "P" to be the most important fish in the North Sea, and the fishing on the whole to be based upon it. We know that the value of the total catch is going down year by year, and that the prices per kilo of the various sizes have been constant or perhaps rising. We know still further that the average size of "P" in the market has gone down. We know the "P" of Group I to be living close to the shore in shallow water, while Group II is living at greater depths, and Group III in the greatest depths of the North Sea. We, furthermore, are acquainted with the facts that no accumulated stock of "P" exists here, that the weight of a II Group "P" on an average is one-quarter kilo, and the price of each fish ten öre (three halfpence), while the "P" of the relatively scarce III Group has a weight of one-half kilo, and the price of it is forty öre (sixpence).

Perhaps we shall never be able to prove in a purely scientific and statistical manner, without experiments by preventive laws, which kind of over-fishing, as set forth in II, III, and IV, actually has damaged the stock of the "P" most seriously in the North Sea—whether over-fishing of the mature III "P," relative destruction of the immature II "P," or the destruction of the I Group. However, we cannot ignore the fact that over-fishing is taking place, and that we must do something if the fisherman is not to starve and the North Sea become a barren "P" fishing ground. What must be done? We must do something that at the same time will help us in all the three kinds of over-fishing. The remedy may be a suitable size limit for saleable "P." If the size limit be sufficiently high, it will, in the markets as well as in the sea, augment the average length of the "P," and, therefore, the number of eggs. It must be high enough to prevent saleable fish of too small a size being admitted to the market. It must further be provided that shrimp-trawling does not destroy too many young "P," as we have perhaps here an essential factor in the problem of over-fishing. In applying this method, all three kinds of over-fishing will be dealt with at the same time.

How to legislate here I do not wish to discuss, nor shall I propose any particular size limit, since the most economical size limit can only be shown by investigations all over the North Sea.

A suitable size limit will be able, in some cases, (1) to augment the average size of the II and especially of the III Groups; (2) to increase the numbers of the III Group, and thereby the number of eggs.

A low size limit may be without any effect at all, while a too high limit may cause an excessive number of "P" to die out or to be eaten before they are fished. I imagine the best size limit will be found in the neighbourhood of the upper part of the II Group, or perhaps in the lowest part of the III Group, since the "P" at this point is growing fast, and increases its value four to five times in one year's growth, and since the "P" at this size obtains the highest price per kilo which on the whole is paid for this species of fish at any size.

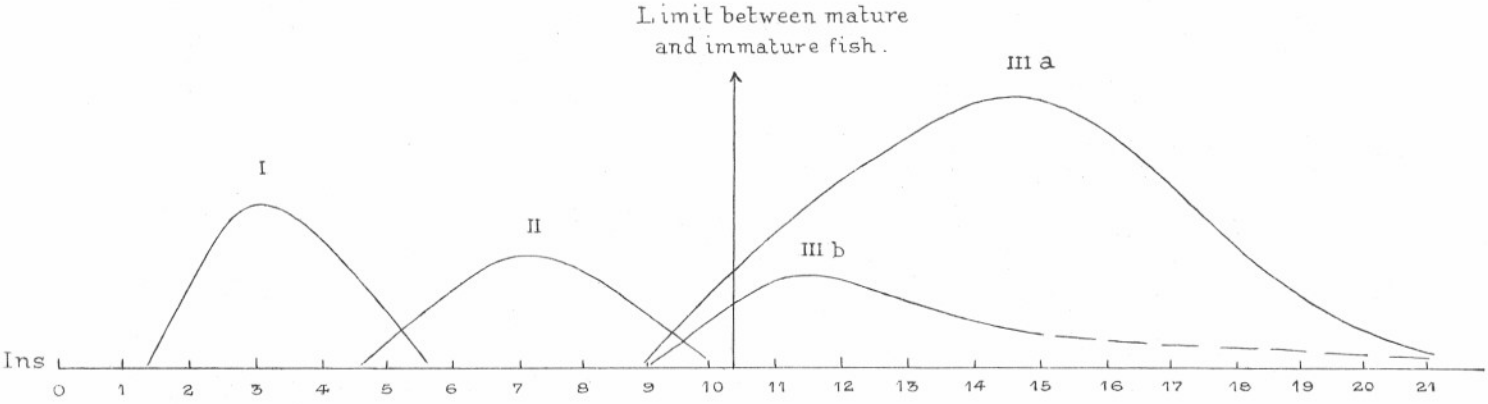
The North Sea is, with regard to the "P," a well-limited area from a biological point of view, but this is not so from all fishermen's points of view. The interests of the shore-fishing vessels are not the same as of the sea-going; and over-fishing is, perhaps, not carried out in all parts of the North Sea, but only in this area taken as a whole. I feel inclined to think that the decrease of the total yearly catch of "P" is essentially due to reduction of the III Group, and, consequently, that the process of over-fishing takes place in the areas inhabited by the fishes of this group, viz. in the open sea. If the shore-fishing vessels do not affect the yield of the large open areas in the North Sea by killing the young "P" on the shore, they should still be left in peace; but if they are now interfering with greater interests, it may be necessary that they, at least to some degree, should give way to the interests of the commonwealth.

It has been proposed by means of artificial hatching, and by artificial fertilisation of eggs, to increase the stock of "P." At present we know, however, that this remedy can only meet one kind of over-fishing. It has also been suggested to fix a size limit simply from a biological point of view, viz. one which should allow fish to spawn once before being caught. This also does not deal with more than one part of the problem; but we have to consider all parts of the problem at the same time as far as we are able. Which of these parts is the most essential can only be ascertained through experience. Artificial hatching would, *e.g.* probably in the Lim Fjord, be of no consequence because the water is so dirty. I also consider all natural hatching here impossible for the "P." In this place a new stock of "P" can only be produced every year by immigration from the North Sea. We know, however, that this immigration does not reach all parts of the fjord to the extent that is desirable, so we help it artificially by transplanting. Such transplantation would, I think, also be useful in larger seas, *e.g.* in the North Sea. It would be a profit to the whole stock if multitudes of small "P" were taken from the overcrowded shallow grounds where they are slowly growing, and transplanted to areas where the III "P" is fished out, and where there is, consequently, enough room and food, —just as young cabbages are planted out every spring. I, for my part, have much more belief in such work than in artificial hatching. By marking the transplanted "P," it is possible to get an idea about their growth, mortality, and augmented value, while we do not know what becomes of the newly-hatched young larval fishes when liberated in the sea.

It has been set forth in former years that "the question of immature fish" was itself an immature question. This charge may have been a just one. Possibly the question when first urged was an immature one; but in a few more years we may hope that the fishes, as well as the questions, will approach maturity more and more, *i.e.* if the fishes are not caught too soon and the questions not forgotten. It is my wish that the question, What is over-fishing? should not be forgotten, but discussed and investigated in every possible way.

*Postscript.*—To prevent misunderstanding, Dr. Petersen wishes to repeat here that the diagram is not intended to represent the stock of *plaice*, but the stock of a hypothetical species of fish approaching the plaice in habits and conditions of existence. A small number of "annual groups" has been purposely assigned to the hypothetical fish, in order to facilitate simplicity of treatment of the general problem.

*Diagram representing the stock of "P" in the North Sea in spring.*




Group I. = the one-year-old "P," from c. 1–6 ins.
,, II. = the two-year-old "P," from c. 4–10 ins.
,, IIIa. = the original stock of all "P" three years old and upwards.
,, IIIb. = the reduced stock of the same (for the most part only three years old).

# The Larvæ of Certain British Crangonidæ.

By
Robert Gurney, B.A. (Oxon.).

In the present paper I propose to give a brief account of the larvæ of two species of Crangonidæ—*Cheraphilus trispinosus* and *Ægeon fasciatus.* I shall not do more than describe the most characteristic features of the larva, as I hope soon to publish a more complete account of the development, with illustrations.*

The larvæ of Decapod Crustacea are a conspicuous feature of the plankton during the greater part of the year, and their identification being usually impossible without their complete metamorphosis being known, it seems to me to be worth while giving, not only a description of the above-mentioned larvæ, but also a diagnostic table for the distinction of all those Crangonid larvæ at present known.

In drawing up the table given I have depended largely on the paper of G. O. Sars,† but I have been able to confirm his description of the larvæ of *Crangon vulgaris, Cheraphilus nanus,* and *Pontophilus spinosus.*

Of our commoner British species there remains only *Ægeon sculptus* to be investigated. I have found no larva in the tow-net collections during the present year not referable to one or other of the species named, and have only seen a single specimen of the adult. Its larva must therefore remain for the present unknown.

### The Larva of Cheraphilus trispinosus (Hailstone).

An abundant supply of zoæas was obtained by keeping berried females in the laboratory tank till the hatching of the eggs. Unfortunately it was found impossible to keep the zoæas alive beyond the first moult, and in spite of the commonness of the adult, very few larvæ have been found in the tow-nets.

The first larva varies in length from 1·8 to 2·0 mm., not including

* [This account has now appeared. See R. Gurney, "Metamorphoses of the Decapod Crustaceans *Ægeon* (*Crangon*) *fasciatus* (Risso) and *Ægeon* (*Crangon*) *trispinosis* (Hailstone)," *Proceed. Zool. Soc.*, London, 1903, vol. ii. p. 24. E. J. A.]

† "Bidrag til Kundskaben om Decapodernes Forvandlinger, III. fam. Crangonidæ." *Arch. f. Mathem. oy Naturvid.*, xiv. (1890).

the length of the rostrum; the average of twenty-five specimens being 1·9 mm. The body is somewhat transparent and of a light greenish yellow colour, with a conspicuous, large chromatophore dorsally in the middle of the thorax. In general form it resembles closely the zoæa of *Cheraphilus nanus*, the thorax being not conspicuously broader than the first segments of the abdomen, which tapers gradually backwards.

The rostrum is short and pointed, but in later stages it is broad at its base and contracted sharply towards the apex, as is the case also in *C. nanus.* The ventral edge of the carapace is smooth though ending in front in a single short spinous prolongation. The abdominal segments are usually quite smooth, but the fifth segment may in some cases have a pair of short lateral spines. The tail plate is of the usual Crangonid type, with seven strong ciliated setæ on either side.

The inner flagellum of the first antenna is closely ciliated as in *C. echinulatus.* In *C. nanus* there are a few minute spines in addition to the cilia. The scale of the second antenna is narrow and elongated, with seven internal setæ and two setæ and a small spine apically. Externally there are two small setæ. The second antenna agrees closely with that of *C. nanus*, but differs from that of *C. echinulatus* in the narrowness of the scale.

The remaining appendages show no very characteristic features. The larva of *C. trispinosus* may be distinguished by its small size, and by the absence of teeth on the lower edge of the carapace and of spines on the third and fourth abdominal segments.

### **The Larva of Ægeon fasciatus** (Risso).

The length of the larva when just hatched varies from 1·8 to 2·05 mm., the average being 2·0 mm. for twenty-four specimens. This measurement is exclusive of the rostrum, which is about ·17 mm. long at this stage. In general form of body the zoæa is not unlike that of *C. trispinosus*, but it is easily distinguishable. The thorax is not much broader than the first abdominal segment, and the carapace is prolonged forward into a long pointed rostrum. In later stages the rostrum is broad at the base and sharply contracted distally. The lower edge of the carapace is arched and without teeth, ending in front in a small blunt process.

The abdomen tapers but little, though the characteristically expanded epimera of the second segment make it appear considerably broader than the others. The third segment has a pair of backwardly directed dorsal spines; the fourth a pair of small knobs on the posterior dorsal edge, while the fifth segment has on either side a long, downwardly-curved blunt process, which in later stages has the form of a long hooked spine. The tail plate is of the usual form. The first antennæ are very long—about two-thirds of the length of the carapace. The inner flagellum is bluntly pointed and ciliated in the first stage. The scale of the second antenna is long and very narrow, with only six internal setæ, two setæ and a spine terminally, and two short external setæ. The palp of the first maxilla is two-jointed. The remaining appendages I will here leave undescribed.

The larva of *Ægeon fasciatus* can be at once distinguished by the length of the antennæ and the spines of the abdominal segments, the two lateral spines of the fifth segment with their terminal hook being very conspicuous, especially in the later stages.

## TABLE FOR THE DISCRIMINATION OF SPECIES HITHERTO DESCRIBED.

| | | |
|---|---|---|
| 1.* | Palp of first maxilla one-jointed . . . . | 2. |
| | Palp of first maxilla two-jointed . . . . | 3. |
| 2. | Third abdominal segment with a dorsal spine . | *Crangon vulgaris.* |
| | Third abdominal segment without a dorsal spine | *C. allmanni.* |
| 3. | Abdomen more than twice as long as thorax . | 4. |
| | Abdomen less than twice as long as thorax . | 5. |
| 4. | Telson deeply incised; posterior dorsal margin of abdominal segments smooth . . | *Pontophilus spinosus.* |
| | Telson not deeply incised; posterior dorsal margin of abdominal segments with many small spines . . . . | *P. norvegicus.* |
| 5. | Telson with more than sixteen spines . . | 6. |
| | Telson with fourteen to sixteen spines . . | 7. |
| 6. | No dorsal spines on abdominal segments . . | *Sabinea septemcarinata.* |
| 7. | Spines of fifth abdominal segment long, curved downwards at the end . . . | *Ægeon fasciatus.* |
| | Spines of fifth abdominal segment short and pointed, or absent . . . . | 8. |
| 8. | Third abdominal segment with no dorsal spine | *C. trispinosus.* |
| | Third abdominal segment with two dorsal spines | 9. |
| 9.† | Inner flagellum of first antenna with cilia only | *C. echinulatus.* |
| | Inner flagellum of the first antenna with cilia and small spines . . . . | *C. nanus.* |

* The mysis stage of Crangon differs from that of the other genera in having exopodites on the first four thoracic appendages only, instead of on the first five pairs.

† In the first larva only. In later stages the larvæ must be distinguished by size, *e.g.* last stage: *C. echinulatus*, 4·80 mm.; *C. nanus*, 3·30 (Sars).

# Report on the Eggs and Larvæ of Teleostean Fishes observed at Plymouth in the Spring of 1902.

By

**Frank Balfour Browne, M.A. (Oxon.).**

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In the following pages I have attempted, at Mr. Garstang's suggestion, to record the results of the examination of tow-net stages of Teleostean fishes, as it seemed important to determine to what extent the record for 1897, published by Holt and Scott (*Journal M. B. A.*, v., N.S., p. 156), was representative of the conditions usually prevailing in the Plymouth district.

The work was begun in February, and the present paper deals with material taken up to the end of April, the collections being made, as a rule, at intervals of two or three days. So far, some interesting differences in the date of the first occurrence of several of the species from what was recorded in 1897 have been observed.

The first egg of *Pleuronectes flesus* was taken this year on February 21st, while in the 1897 record the date of the first capture of this egg was March 30th. It should be noted, however, that Holt and Scott record no observations between March 1st and 30th, so that the difference in date of appearance in this case (as in some others connected with the same period) may be more apparent than real.

*P. microcephalus,* first taken this year on February 21st, was found in 1897 on January 29th. This species has only occurred occasionally, usually one egg at a time, through the season, and appears to have been as seldom taken in 1897.

There is no record in 1897 of the occurrence of the eggs of *P. limanda.* One was taken this year on April 14th, which produced a larva 2·63 mm. in length, with pale yellow pigment, and a larva was also taken on April 21st 3.08 mm. in length, showing the same colour.

*Solea vulgaris* has appeared this year two months earlier, and *S. variegata,* of which I have now had two eggs, three months earlier than in 1897.

The eggs of *Ctenolabrus rupestris*, which Holt and Scott first record on April 27th, have only just made their appearance at the time of writing (May 23rd to 25th), and then in large numbers; while *Trachinus vipera*, which in 1897 did not occur until June 9th, is recorded this year on April 9th. I have only had one egg of this species, but I think there can be little doubt as to its identity. It measured 1·43 mm. in diameter, being larger than the extreme limit given by Holt (*Trans. Roy. Dubl. Soc.*, iv. (1891), p. 437), who gives the limits of variation as 1·25–1·37 mm. It had, however, about fifteen pale green oil globules scattered over the yolk, and the embryo and yolk immediately surrounding it was speckled with pigment which appeared dull yellow by reflected light.

No eggs have appeared this year up to the present corresponding with those recorded as *Trigla gurnardus* on March 30th, 1897.

In other respects my record agrees more or less closely with that of Holt and Scott.

I append a table showing the different times of appearance in the two years of the eggs above referred to.

| Species. | First occurrence recorded in 1897. | | First occurrence recorded in 1902. |
|---|---|---|---|
| *Pleuronectes flesus* . . . | Mar. 30th | ... | Feb. 21st. |
| *P. microcephalus* . . . | Jan. 29th | ... | Feb. 21st. |
| *P. limanda* . . . . | not recorded | ... | Apr. 14th. |
| *Solea vulgaris* . . . | Apr. 22nd | ... | Feb. 27th. |
| *S. variegata* . . . . | July 27th | ... | Apr. 21st. |
| *Topknot* (with larger oil globule) . | Feb. 15th | ... | Mar. 3rd. |
| *Topknot* (with smaller oil globule) . | Mar. 30th | ... | Mar. 15th. |
| *Gadus merlangus* . . . | Mar. 30th | ... | Feb. 25th. |
| *Ctenolabrus rupestris* . . . | Apr. 27th | ... | (May 23rd.) |
| *Trachinus vipera* . . . | June 3rd | ... | Apr. 9th. |
| *Trigla gurnardus* . . . | Mar. 30th | ... | not yet recorded. |

Careful coloured drawings have been made of many of the eggs and larvæ recorded, and will, I hope, be useful for future reference.

Before discussing some of the more interesting points which have arisen in connection with the work, I wish to thank Mr. Garstang and Dr. Kyle for help and suggestions on many occasions.

## Callionymus.

I obtained eggs of *C. lyra* first on February 14th, almost as soon as I commenced to examine the contents of the tow-nets.

The eggs measured varied in diameter between ·78 and ·93 mm.:—

| Millimetres. | ·78 | ·79 | ·80 | ·82 | ·83 | ·84 | ·85 | ·86 | ·87 | ·88 | ·89 | ·90 | ·91 | ·92 | ·93 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of eggs . | 1 | 3 | 2 | 5 | 2 | 6 | 2 | 3 | 4 | 7 | 1 | 1 | 2 | 2 | 2 |

Twenty-three larvæ, measured within thirty-six hours of hatching, varied in length between 1·82 and 2·83 mm.

I found most of these larvæ of the type figured by Holt in his paper in the *Trans. Roy. Dubl. Soc.*, iv. (1891), Pl. LI., Fig. 41, but, at least in most cases, black pigment was present in addition to the yellow, as he has since recorded in this Journal (vol. v. (1897), p. 111).

I also hatched five larvæ from these eggs, which seemed to me to be of a different type from that referred to, but I am not prepared at present to give a final opinion.

## The Topknots—Zeugopterus and Phrynorhombus.

In his paper in the *M. B. A. Journal*, v. p. 129, Holt, after discussing the facts then known as to the eggs and larvæ of the three British Topknots, concludes that his three Species x., xi. and xii., described in the *Trans. Roy. Dubl. Soc.*, v. (1893), pp. 96, 99, and 101, had been separated on insufficient grounds.

I have had little material upon which to base conclusions, but such as I have had seems to fall conveniently into two series depending upon the size of the oil globule, as will be seen from the following table :—

| Millimetres. | ·82 | ·85 | ·86 | ·87 | ·88 | ·90 | ·91 | ·95 | ·97 |
|---|---|---|---|---|---|---|---|---|---|
| Number of eggs. . | 4 | 1 | 1 | 1 | 2 | 5 | 1 | 1 | 1 |
| Size of oil globule. | ·13–·15 | ·14 | ·12 | ·12 | ·12–·125 | ·13–·14 | ·14 | ·18 | ·14 |
| Larvæ hatched, length in mm. . | 2·46 | — | 2·36 | 2·42 | — | 3·37<br>3·1<br>3·0 | 3·18 | 3·39 | 2·65 |

| Millimetres. | ·99 | 1·02 | 1·03 | 1·04 | 1·05 | 1·06 | 1·07 | 1·09 |
|---|---|---|---|---|---|---|---|---|
| Number of eggs. . | 1 | 6 | 6 | 3 | 2 | 1 | 2 | 1 |
| Size of oil globule. . | ·175 | ·175–·19 | ·18 | ·19–·21 | ·18–·185 | ·195 | ·18–·185 | ·18 |
| Larvæ hatched, length in mm. . | — | 3·57 | — | — | 2·88 | — | — | — |

Thus there seems to be a clear separation between eggs having an oil globule varying between ·12 and ·15 and others having an oil globule varying between ·175 and ·21, though the sizes of the eggs themselves give no clear line of demarcation.

The larvæ hatched from the eggs with the oil globule varying between ·12 and ·15 exactly resembled Species F of M'Intosh and Prince (*Trans. Roy. Soc. Edinb.*, xxxv., Pl. XVII., Fig. 4) and Holt's Species xii. (*Trans. Roy. Dubl. Soc.*, v. (1893), Pl. VIII., Figs. 67 and 68). I did not, however, find any specimens which showed an imperforate anus, as in Holt's figure.

Of the larvæ hatched from the eggs showing the larger oil globule (·175 to ·21) I can only find reference to three in my notes, though many more were hatched. Referring to these three, they certainly did not resemble those hatched from the other series of eggs, though it seemed to me that they might have been very well represented by the figures of either of Holt's Species x. or xi. (*loc. cit.*, Pl. II., Figs. 19–21, Pl. VIII., Fig. 64), according as the light through the microscope was manipulated.

The eggs with the larger oil globule appeared in the tow-nets nearly a fortnight earlier than those with the smaller, the actual dates of their first occurrence being March 3rd for the former and March 15th for the latter. However, on March 7th a female *Zeugopterus norvegicus* was dredged up from which eggs were obtained by slight pressure. These eggs appeared to be ripe, and floated in the sea-water, and were quite translucent. Those measured varied between ·85 and ·90 mm. and the oil globule between ·13 and ·14 mm.

My facts are perhaps too few to permit a definite conclusion, but at least they suggest that the eggs with the smaller oil globule (Mr. Holt's Species xii.) are distinct from those with the larger globule (Mr. Holt's Species x. and xi.), and that the former eggs belong to the smallest topknot, *Z. norvegicus.*

## Gadus.

The descriptions given by the various authors of the eggs of the different species of the genus are up to the present insufficient for separating those of several of the commoner kinds, such as *G. luscus, minutus.* and *pollachius.* and possibly also some of those of *G. merlangus.*

In the first place certain eggs varying in diameter between 1·2 and 1·28 mm. seemed to separate out clearly as those of **G. merlangus.** Yellow pigment became early visible in the developing embryo, and the larvæ when hatched showed conspicuous yellow chromatophores all over the head, body, yolk sac, and dorsal and ventral fins. These eggs I have referred to in the record as those of *G. merlangus.* Twenty-two larvæ from these eggs were measured within thirty-six hours of hatching, and their length varied between 3·24 and 3·98 mm., the commonest length being about 3·65 mm.

About 115 **other Gadus eggs** were obtained, those measured varying in size between ·90 and 1·19 mm., as follows:—

| Size in millimetres. | ·90 | ·93 | ·94 | ·95 | ·96 | ·97 | ·98 | ·99 | 1·0 | 1·01 | 1·02 | 1·03 | 1·05 | 1·06 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of eggs. . | 1 | 3 | 2 | 6 | 1 | 7 | 9 | 3 | 14 | 2 | 4 | 2 | 1 | 1 |

| Size in millimetres. | 1·07 | 1·08 | 1·09 | 1·1 | 1·11 | 1·12 | 1·13 | 1·14 | 1·16 | 1·17 | 1·18 | 1·19 | 1·2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of eggs. . | 2 | 2 | 1 | 3 | 1 | 1 | 3 | 1 | 1 | 2 | 2 | 1 | 2 |

I hatched many of these eggs, the larvæ varying as follows:—

| Size in mm. | ·95 | ·96 | ·97 | ·98 | ·99 | 1·0 | 1·01 | 1·02 | 1·08 | 1·09 | 1·1 | 1·2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Length of larvæ in millimetres. | 3·26 | 2·3 | 2·35 | 3·0 | 3·07 | 3·36 | 3·1 | 2·87 | 3·6 | 3·2 | 2·7 | 3.2 |
| | — | — | 3·0 | 3·07 | 3·12 | 3·1 | — | 3·0 | 3·38 | — | 3·49 | 3·15 |
| | — | — | — | 3·27 | — | 3·07 | — | 3·64 | — | — | — | 3·5 |
| | — | — | — | 2·75 | — | 3·1 | — | — | — | — | — | — |
| | — | — | — | 3·2 | — | 3·27 | — | — | — | — | — | — |
| | — | — | — | — | — | 3·05 | — | — | — | — | — | — |

These measurements were taken within thirty-six hours of the larva hatching. The total number of larvæ hatched and measured was forty-four, and their sizes varied between 2·3 and 3·76, but in all other cases than those given in the above table the larvæ could not be referred to particular eggs.

In most of the eggs when they reached their final stages a yellowish tinge was distinctly visible, and in some cases faint yellow pigment spots could be seen, and in *all* the larvæ produced either a yellowish tinge could be detected or yellow spots were visible just as in the larvæ hatched from eggs attributed to *G. merlangus*, but very faint. The degree of yellowness, however, was not the same in all cases, and in some the pigment spots only became visible when the larvæ were moribund, where before there had only been a faint yellow tinge. In these cases the spots were discernible all along the body and on the head, and in a few cases several spots could be made out on the yolk sac and at the extreme anterior end of the dorsal fin.

With regard to those larvæ which when healthy showed pale pigment dispersed as in *G. merlangus*, I did not have enough to ascertain certainly whether they only arose from the larger eggs. I find one record of an egg 1·09 which produced such a larva 3·2 mm., and I had other such larvæ 3·12, 3·12, 3·12, 3·45, 3·2, 3·2 mm. in length. I kept four of these larvæ on April 12th, hatched from eggs taken on the 9th, and also one larva of *G. merlangus*; and on April 14th the *merlangus* larva still showed strong yellow pigment spots, whereas the other three larvæ (one had died) had lost their distinct chromatophores and only showed a yellow tinge. It is on account of these larvæ that I said that possibly some of the eggs of *G. merlangus* were indistinguishable, and though from the size of the one egg given and from the different appearance of the larvæ they may be some other species than the whiting, there is, of course, nothing at present to draw conclusions from.

Heincke and Ehrenbaum (*Eier und Larven von Fischen der deutschen Bucht*, 1900, pp. 120 and 170) describe the pigmentation of the embryo **pollack** as being similar to that of *G. æglefinus* and possessing black pigment only, arranged in a line down each side to the tail, and they distinguish *G. luscus* from *G. pollachius* by the presence of yellow pigment in the former. Now the pollack is an extremely abundant fish in the neighbourhood of Plymouth, and it would be strange indeed had I not obtained a few eggs at least of this species. Yet the only Gadus egg I have had which showed no trace of yellow was the egg of *G. morrhua*.

Of course, it must be borne in mind that the tow-nets examined have all, or nearly all, been taken within three or four miles of the shore, and in most cases much closer in, so that I may perhaps not have been on the right ground.

Holt (*M. B. A. Journal*, v., p. 141) refers to the eggs of pollack as being 1·4 to 1·45 mm. in diameter and the larva hatched from one of these eggs as being 4·2 mm. in length, and having "a single lateral row of stellate black chromatophores extending from the head to about midway along the tail." I have had no Gadus egg, except that of the cod, so large as those referred to by Holt, and in that case the larva resembled exactly the figure given by Masterman (M'Intosh and Masterman, Plate IX., Fig. 1) for a *G. morrhua*, and also agreed with Holt's description of the larva of that species (*Trans. Roy. Dubl. Soc.*).

Heincke and Ehrenbaum give the limits of size for *G. pollachius* eggs as 1·10 to 1.30 (perhaps 1·45), so that as far as size is concerned many of my eggs could quite well be those of this species. As to the arrangement of pigment in a single row along each side, many of my larvæ showed this when healthy; but when the black pigment spots became very dendritic, after a larva had been on the stage of the microscope for a few minutes, the regularity of the rows was far from obvious, and the pigment spots under these circumstances generally appeared to increase in number. As to the existence of the yellow tinge in my larvæ, I must admit that I was not always sure of its presence immediately the larva was placed under the microscope, but in such cases when it became obvious the larva was not necessarily at the point of death, as I often kept such specimens alive for hours afterwards.

As to the other two species, **G. luscus** and **minutus,** they both occur apparently commonly in the neighbourhood, and from descriptions the larvæ of both show yellow either diffuse or as spots. Holt suggests a later spawning period for the latter species, but I have had no opportunity for investigating this point.

The sizes of eggs taken in February varied between ·98 and 1·09, in March between ·93 and 1·17 (one egg ·90), and in April between ·93 and 1·19.

It was perhaps rather strange finding a single egg of **G. morrhua** on March 15th in the West Channel. The egg was advanced in development, the free caudal portion just appearing. The larva escaped on the 16th or 17th, and on the latter date measured 4·71 mm., the preanal region being 1·83 mm. in length.

The larva exhibited the characteristic barred appearance, and the pigment was arranged precisely as in Masterman's figure referred to above.

As this was the only example I found, and as the egg was already far advanced in development when taken, it had probably drifted a considerable distance from the spawning grounds of the species and evidently out of the usual currents.

### **Motella.**—The Rocklings.

I have had very many eggs which are certainly referable to species of this genus, but they have shown no distinguishable specific characters unless differences in the colour of the oil globules can be considered as such.

From the commencement of the work in February I found eggs with a colourless oil globule common in the tow-nets, and they continued to occur in numbers all through March and the first half of April, after which they gradually became scarcer, until at the end of the month they only appeared now and again.

On March 15th I first obtained a Motella egg with a greenish-yellow globule; and eggs with this character gradually became commoner as those with the colourless one began to diminish, until they took their place as the commonest egg in the tow-nets. These latter eggs were still quite common at the end of April, the point at which the present record ceases.

Only three times did I find eggs with a copper-coloured oil globule. On March 3rd they first appeared in numbers, this date happening to be one on which the egg with a colourless globule was also particularly abundant. I obtained on that date something over one hundred Motella eggs, those with the coloured globule being about equal in number with those having the colourless one.

Though the latter eggs were in all stages of development, none of those with the coloured globule had begun to segment. Of these latter eggs the majority had several small oil globules, many having five, and some even nine.

I reserved a batch of each variety of egg for hatching, placing them in similar vessels containing sea-water. As development proceeded the coloured globules in the one batch gradually became paler, until at the end of three days the colour could, in most cases, only be described as a smoky white. The globules had also generally reduced in number in each egg, one being present in the majority. None of this batch of eggs hatched, although nearly all the batch with colourless globules, about fifteen in number, hatched normally.

On March 11th I again obtained among eggs with the colourless globule a few with the coloured one, and I again endeavoured to hatch them. The colour of the oil globule gradually disappeared as before, but after developing to about the end of Stage II. the eggs again all died.

On March 19th I again obtained a single egg with copper-coloured globule, but it also failed to hatch.

Holt obtained eggs with colourless, "and some few with distinctly cupreous globules," from one specimen of *M. mustela,* so that the colour, not being present in all the eggs, is evidently not characteristic; and from the fact that out of perhaps twenty-five eggs with this distinction I could not get one to hatch it occurred to me that the colour might be indicative of some pathogenic condition. Unfortunately material did not suffice to make further investigations on this point.

The eggs with the green oil globule always developed normally, producing a larva with the same character but otherwise quite similar to larvæ hatched from eggs with the colourless globule. This was as Holt found.

On several occasions I have come across eggs with a large number of colourless oil globules of various sizes, the eggs having a perivitelline space, but never showing any signs of development. The globules in many cases ran together in the course of a few days, but the eggs were infertile. Holt also found these eggs and obtained them directly from a female *Motella mustela.*

On April 9th a ripe female Motella 19 cms. long was brought to me, which proved to be a specimen of *M. fusca* (Moreau), a description of which will be found on another page. Large numbers of eggs had been extruded in the handkerchief in which the fish was carried, and many more were obtained from the fish by slight pressure. These eggs exactly agreed with the infertile eggs above referred to. The size varied between ·69 and ·82 mm. diameter, the majority of those measured, however, being about ·72 to ·74 mm.; and the oil globules, in a few in which only one was present, measured ·13 to ·14 mm.

Brook gives the size of fertilised eggs of *M. mustela* as ·65 to ·73 longer axis, and ·64 to ·716 shorter axis with an oil globule of about ·11. The eggs of *M. fusca,* therefore, appear to be slightly larger, with a larger oil globule than those of the former species, but there is probably not sufficient difference to distinguish between tow-net eggs.

Holt found the size of the eggs with a greenish globule, which he mentions in his Irish papers (*Trans. Roy. Dubl. Soc.,* ii. (1891), p. 464, and v. (1893), p. 95) as ·66, with o.g. ·14, and ·72, o.g. ·17, and I find that those I have obtained this year here vary between ·69 and ·82, o.g.'s ·14 and ·20. The eggs with the colourless globule vary from ·70 to ·87, o.g. ·12 to ·19.

Unless, therefore, the green oil globule can be taken as a specific distinction, there is no evidence at present upon which to identify any of the tow-net eggs with any particular species.

I append tables of the number of eggs at the different sizes which I have obtained, of which I have actual measurement. In many cases I had only recorded that the sizes of a batch obtained varied between two limits, so that these are not included in the tables.

*Motella. Table showing number of eggs measured and sizes.*

I. Eggs with Colourless and Copper-coloured Oil Globules.

| Millimetres. | ·70 | ·71 | ·72 | ·73 | ·74 | ·75 | ·76 | ·77 | ·78 | ·79 | ·80 | ·81 | ·82 | ·83 | ·86 | ·87 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of eggs. | 1 | 1 | 7 | 8 | 5 | 10 | 9 | 12 | 10 | 5 | 9 | 3 | 5 | 3 | 1 | 1 |

II. Eggs with Green or Greenish-yellow Globules.

| Millimetres. | ·69 | ·70 | ·71 | ·72 | ·73 | ·74 | ·75 | ·76 | ·78 | ·80 | ·82 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of eggs. | 2 | 3 | 2 | 10 | 6 | 1 | 9 | 3 | 2 | 1 | 1 |

# JOURNAL OF OBSERVATIONS,

## February to April (Inclusive), 1902.

Abbreviations employed: sev. = several; m. = many; v.m. = very many; o.g. = oil globule.

For convenience of tabulation the different stages of development have been divided into three groups: Stage I. = if fertilised, stages up to the outgrowth of the eyes; II. = from I. up to the appearance of the caudal rudiment; III. = from II. up to hatching.

Since the ova were not always examined immediately after their capture, it was necessary in many cases to compute the stage exhibited at that time. The divisions indicated above being fairly broad, the results set forth below are probably near the mark. Confusion is most liable to have occurred between Stages II. and III. All dimensions are given in millimetres.

| Date. | Locality. | Position of Net. | EGGS. | | | | | LARVÆ. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Species. | No. | Diam. of Egg. | Diam. of Oil Globule. | Stage of Development. | Species. | No. | Length. |
| | | | | | mm. | mm. | | | | mm. |
| Feb. 6. | 2 miles S. of Mew- | Surface. | Motella sp.? o.g. colourless. | 3 | ·75–·78 | ·16 | I. | Clupea harengus. | sev. | ? |
| | stone. | ... | *Clupea sprattus.* | 6 | 1·0–1·1 | ... | I., III. | C. sprattus. | sev. | ? |
| | ... | ... | Gadus sp.? | 3 | 1·0–1·05 | ... | I., II. | | | |
| | Cawsand Bay. | Surface. | Eggs not examined. | ... | ... | ... | ... | Agonus cataphractus. | 1 | 7·0 |
| ,, 11. | 4 miles off Rame Head. | Surface, midwater and bottom. | Motella sp.? o.g. colourless. | 7 | ·72–·78 | ·14–·16 | I. | Unrecognisable. | 3 | |
| | | | C. sprattus. | 3 | 1·0 | ... | I., II. | | | |
| ,, 12. | ½ mile S. of Mew-stone. | Surface. | *Pleuronectes platessa.* | 1 | 1·82 | ... | II. | | | |
| ,, 14. | 4 miles W. of Rame | Surface. | C. sprattus. | sev. | 1·0–1·03 | ... | I., III. | C. harengus. | sev. | ? |
| | Head. | Surface. | ... | ... | ... | ... | ... | C. sprattus. | sev. | ? |
| | ... | Midwater. | C. sprattus. | m. | ·95–1·1 | ... | I., III. | Motella sp.? | 2 | 2·6, 2·75 |
| | ... | ... | Gadus sp.? | 4 | 1·0 | ... | I. | Species ? | 1 | 2·34 |
| | ... | ... | *Callionymus lyra.* | 2 | .80, ·93 | ... | II., III. | C. harengus. | sev. | ? |
| | ... | ... | ... | ... | ... | ... | ... | C. sprattus. | sev. | ? |
| | ... | ... | ... | ... | ... | ... | ... | Unrecognisable. | 6 | |
| | | Bottom. | Callionymus lyra. | 4 | ·85–·90 | ... | I., II. | | | |
| | | ... | C. sprattus. | m. | 1·0–1·03 | ... | II., III. | Motella ? | 1 | 2·53 |

| Date. | Locality. | Position of Net. | EGGS. Species. | No. | Diam. of Egg. | Diam. of Oil Globule. | Stage of Development. | LARVÆ. Species. | No. | Length. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | mm. | mm. | | | | |
| Feb. 19. | 1 mile S. of Break- | Surface. | Motella sp.? o.g. colourless. | 4 | ·72–·78 | ·14–·16 | I. | | | |
| | water Fort. | Midwater. | Motella sp.? o.g. colourless. | m. | ·72–·78 | ? | I. | Unrecognisable. | 2 | |
| | ... | ... | Gadus sp.? | 5 | 1·0–1·06 | ... | I., II. | | | |
| ,, 21. | 1 mile S. of Break- | Surface. | Clupea sprattus. | sev. | ? | ... | I., III. | C. harengus. | sev. | ? |
| | water Light. | | Motella sp.? o.g. colourless | sev. | ? | ? | II., III. | C. sprattus. | sev. | ? |
| | ... | Midwater. | C. sprattus. | 1 | 1·0 | ... | I. | Gadus sp.? | 1 | 5·8 |
| | ... | ... | Motella sp.? o.g. colourless | 3 | ·72–·75 | ? | II. | Unidentified. | 1 | 5·5 |
| | ... | ... | Gadus sp.? | 6 | ·98–1·2 | ... | II., III. | C. harengus. | sev. | |
| | ... | ... | *Pleuronectes microcephalus* | 1 | 1·4 | ... | I. | | | |
| | ... | ... | *P. flesus.* | 1 | 1·0 | ... | III. | | | |
| | ... | Bottom. | Clupea sprattus. | m. | ? | ... | II., III. | | | |
| | ... | ... | Motella sp.? o.g. colourless. | m. | ? | ? | I., III. | | | |
| | ... | ... | Gadus sp.? | 2 | ·97, 1·05 | ... | II., III. | | | |
| ,, 25. | Off the Shagstone, | Surface. | Not examined. | | | | | | | |
| | East Channel. | Midwater. | *Gadus merlangus.* | 1 | 1·25 | ... | III. | Unrecognisable. | 3 | |
| | ... | ... | Motella sp.? o.g. colourless. | m. | ·72–·76 | ? | I., II. | | | |
| | ... | ... | C. sprattus. | v.m. | ? | ... | II., III. | | | |
| | ... | Bottom. | Not examined. | | | | | | | |
| ,, 27. | West Channel, off | Surface. | Clupea sprattus. | sev. | 1·05, 1.07, etc. | ... | I., III. | C. sprattus. | 1 | ? |
| | Breakwater Light. | ... | Motella sp.? o.g. colourless. | 2 | ·79, ·72 | ? | III. | C. harengus. | sev. | ? |
| | ... | ... | Pleuronectes microcephalus | 1 | 1·55 | ... | I. | | | |
| | ... | ... | Callionymus lyra. | 1 | ·92 | ... | II. | | | |
| | ... | ... | Gadus merlangus. | 3 | 1·25–1·28 | ... | II., III. | | | |
| | ... | ... | Gadus sp.? | 5 | ·97–1·08 | ... | II., III. | | | |
| | ... | Midwater. | Clupea sprattus. | v.m. | ? | ... | I., III. | Unidentified. | 2 | 3·1, 3·05 |
| | ... | ... | Motella sp.? o.g. colourless. | v.m. | ? | ? | II., III. | | | |
| | ... | ... | Gadus merlangus. | 7 | 1·25 | ... | II., III. | | | |
| | ... | ... | Gadus sp.? | sev. | ·98–1·09 | ... | I., II., III. | | | |
| | ... | ... | Callionymus lyra. | 1 | ·89 | ... | III. | | | |
| | ... | ... | *Solea vulgaris.* | 1 | 1·48 | ... | II. or III. | | | |
| | ... | ... | Pl. microcephalus. | 1 | 1·43 | ... | II. | | | |
| | ... | ... | P. flesus. | 2 | ·99, 1·0 | ... | II., III. | | | |

| Date. | Locality. | Position of Net. | EGGS. Species. | No. | Diam. of Egg. | Diam. of Oil Globule. | Stage of Development. | LARVÆ. Species. | No. | Length. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | mm. | mm. | | | | |
| Feb. 27. | West Channel, off Breakwater Light. | Bottom. | Clupea sprattus. | v.m. | ? | ... | II., III. | Callionymus lyra. | 1 | 1·9 |
| | | ... | Motella sp.? o.g. colourless. | m. | ? | ? | II., III. | C. sprattus. | 2 | ? |
| | ... | ... | Gadus merlangus. | 1 | 1·25 ? | ... | III. | C. harengus. | 1 | ? |
| | ... | ... | Gadus sp.? | 1 | 1·0 | ... | II. | | | |
| | ... | ... | Gadus sp.? | 6 | ? | ... | III. | | | |
| | ... | ... | Callionymus lyra. | 1 | ·90 | ... | III. | | | |
| Mar. 3. | West Channel. | Surface. | Motella sp.? o.g. colourless. | v.m. | ·72–·78 and others. | ·14–·16 | I., II., III. | | | |
| | ... | ... | Motella, o.g. copper. | v.m. | ·72–·78 and others. | ·13–·16 (2 measured). | I. | | | |
| | ... | ... | Gadus merlangus. | 1 | 1·27 | ... | I. | | | |
| | ... | ... | Gadus sp.? | 9 | ·93–1·02 | ... | I., II., III. | | | |
| | ... | Midwater. | Motella sp.? (unfertilised). | 3 | ·82, ·80, ·73 | many. | ... | Unidentified. | 1 | 5·55 |
| | ... | ... | Motella sp.? o.g. colourless. | v.m. | ·72–·81 | ? | I., II., III. | | | |
| | ... | ... | Motella sp.? o.g. copper. | v.m. | ? | ? | I., II., III. | | | |
| | ... | ... | Gadus merlangus. | 3 | 1·25–1·27 | ... | III. | | | |
| | ... | ... | Gadus sp.? | 7 | ·90–1·15 | ... | II., III. | | | |
| | ... | Bottom. | Callionymus lyra. | 1 | ·84 | ... | III. | C. harengus. | 1 | ? |
| | ... | ... | Clupea sprattus. | m. | ? | ... | II., III. | | | |
| | ... | ... | Motella sp.? o.g. colourless. | m. | ·75, ·80, etc. | ? | II., III. | | | |
| | ... | ... | Motella sp.? (unfertilised). | 1 | ·74 | several. | ... | | | |
| | ... | ... | Gadus sp.? | 5 | ·99–1·03 | ... | II., III. | | | |
| | ... | ... | *Topknot.* | 1 | 1·03 | ·18 | I. | | | |
| ,, 7. | ½ mile S. of Mewstone. | Surface. | Clupea sprattus. | m. | ·97–1·05 | ... | I., III. | | | |
| | | ... | Motella sp.? o.g. colourless. | m. | ? | ? | I., II., III. | | | |
| | ... | ... | Gadus sp.? | 2 | ·96, ·97 | ... | I., II. | | | |
| | ... | Midwater. | Pleuronectes platessa. | 1 | 1·83 | ... | I. | Cottus bubalis. | 1 | 5·25 |
| | ... | ... | P. flesus. | 1 | ·98 | ... | I. | Unrecognisable. | 2 | |
| | ... | ... | Clupea sprattus. | v.m. | ·98–1·07 | ... | II., III. | | | |
| | ... | ... | Callionymus lyra. | 1 | ·93 | ... | III. | | | |
| | ... | ... | Gadus sp.? | 5 | ·95–1·0 | ... | I., III. | | | |
| | ... | ... | Motella sp.? o.g. colourless. | 5 | ·77–·83 | ·13–·15 | I., III. | | | |

| Date. | Locality. | Position of Net. | EGGS. | | | | | LARVÆ. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Species. | No. | Diam. of Egg. | Diam. of Oil Globule. | Stage of Development. | Species. | No. | Length. |
| | | | | | mm. | mm. | | | | |
| Mar. 7. | ½ mile S. of Mew-stone. | Bottom. | Clupea sprattus. | m. | ·97–1·07 | ... | I., II., III. | Callionymus lyra. | 1 | 2·21 |
| | | ... | Callionymus lyra. | 4 | ·82–·88 | ... | I., II., III. | Motella sp.? | 2 | 2·6, 2·9 |
| | ... | ... | Gadus sp.? | 9 | ·97–1·17 | ... | I., III. | | | |
| ,, 10. | West Channel. | Surface. | Nil. | | | | | | | |
| | ... | Midwater. | Motella sp.? o.g. colourless. | 3 | ? | ? | I., III. | Motella sp.? | 2 | ? |
| | ... | ... | C. sprattus. | 11 | ? | ... | I., II., III. | Gadus sp.? | 1 | 2·67 |
| | ... | ... | ... | ... | ... | ... | ... | C. sprattus? | 1 | 4·16 |
| | ... | Bottom. | Motella sp.? o.g. colourless. | 4 | ? | ? | III. | Unidentified. | 1 | 2·5 (?) |
| ,, 11. | West Channel. | Surface. | Motella sp.? o.g. colourless. | 6 | ? | ? | I., III. | | | |
| | ... | ... | Motella sp.? o.g. copper. | 5 | ·77–·82 | ·13–·15 | I. | | | |
| | ... | Midwater. | Motella sp.? o.g. colourless. | sev. | ? | ? | II., III. | Gobius niger? | 1 | 3·55 |
| | ... | ... | Motella sp.? o.g. copper. | sev. | ? | ? | I. | | | |
| | ... | Bottom. | Motella sp.? o.g. colourless. | sev. | ? | ? | II., III. | C. sprattus. | 2 | |
| | ... | ... | Motella sp.? o.g. copper. | sev. | ? | ? | I. | | | |
| | ... | ... | Clupea sprattus. | m. | ? | ... | I., II. | | | |
| ,, 15. | West Channel. | Surface. | Gadus merlangus. | 7 | 1·22–1·25 | ... | II., III. | | | |
| | ... | ... | Gadus sp.? | 5 | ·98–1·06 | ... | II., III. | | | |
| | ... | ... | Motella sp.? o.g. colourless. | 6 | ·74–·76 | ? | I., II., III. | | | |
| | ... | ... | Callionymus lyra. | 1 | ·82 | ... | II. or III. | | | |
| | ... | ... | Pl. microcephalus. | 1 | 1·51 | ... | II. | | | |
| | ... | ... | P. flesus. | 1 | ·94 | ... | II. | | | |
| | ... | ... | Solea vulgaris. | 1 | 1·5 | ... | II. | | | |
| | ... | ... | Topknot. | 1 | 1·07 | ·18 | I. | | | |
| | ... | Midwater. | Clupea sprattus. | sev. | ? | ... | I., II., III. | | | |
| | ... | ... | Motella sp.? o.g. colourless. | sev. | ·72–·81 | ? | II., III. | | | |
| | ... | ... | Motella sp.? o.g. green. | 1 | ·76 | ·14 | I. | | | |
| | ... | ... | Gadus merlangus. | 18 and more | 1·22–1·28 | ... | I., II., III. | | | |
| | ... | ... | Gadus sp.? | 5 | 1·0–1·18 | ... | II., III. | | | |
| | ... | ... | *Gadus morrhua.* | 1 | 1·40 | ... | II. or III. | | | |
| | ... | ... | Callionymus lyra. | 6 | ·87–·88 | ... | I., II. | | | |

| Date. | Locality. | Position of Net. | EGGS. | | | | | LARVÆ. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Species. | No. | Diam. of Egg. | Diam. of Oil Globule. | Stage of Development. | Species. | No. | Length. |
| | | | | | mm. | mm. | | | | |
| Mar. 15. | West Channel. | Midwater. | Pl. microcephalus. | 4 | 1·43–1·48 | ... | I., II., III. | | | |
| | ... | ... | P. flesus. | 5 | ·97–·98 | ... | I. | | | |
| | ... | ... | Topknot. | 3 | ·95, 1·02, 1·05 | ·175–·185 | I., II., III. | | | |
| | ... | ... | *Topknot.* | 6 | ·90–·91 | ·14–·15 | II., III. | | | |
| | ... | Bottom. | Not examined. | | | | | | | |
| ,, 19. | 1 mile S. of Breakwater Fort. | Surface. | Clupea sprattus. | 10 (?) | ·93–·98 | ... | I. | | | |
| | | ... | Motella sp.? o.g. colourless. | v.m. | ·73–·80 | ·125–·165 | I., III. | | | |
| | ... | ... | Motella sp.? o.g. copper. | 1 | ·76 | ·14 | I. | | | |
| | ... | ... | Gadus sp.? | 3 | ·97, ·98, 1·0 | ... | I. | | | |
| | ... | ... | Pleuronectes flesus. | 1 | 1·1 | ... | III. | | | |
| | ... | ... | Topknot. | 3 | 1·02–1·05 | ·18 | I. | | | |
| | ... | Midwater. | Clupea sprattus. | v.m. | ? | ... | I., II., III. | | | |
| | ... | ... | Motella sp.? (unfertilised). | 1 | ·81 | many o.g's. | ... | | | |
| | ... | ... | Topknot. | 4 | 1·03–1·09 | ·18 | I. | | | |
| | ... | ... | Topknot. | 1 | ·97 | ·14 | II. or III. | | | |
| | ... | ... | Pl. microcephalus. | 1 | 1·41 | ... | I. | | | |
| | ... | ... | Callionymus lyra. | 2 | ·85, ·87 | ... | III. | | | |
| | ... | ... | Motella sp.? o.g. colourless. | m. | ·77 | ? | I., II., III. | | | |
| | ... | ... | Gadus sp.? | 3 | ·94–1·01 | ... | II., III. | | | |
| | ... | Bottom. | Clupea sprattus. | 3 | ? | ... | I. | | | |
| ,, 21. | East Channel. | Surface. | Topknot. | 1 | 1·025 | ·19 | I. | Cottus bubalis. | 1 | 3·7 |
| | ... | ... | Gadus sp.? | 1 | ·98 | ... | I. | Clupea sprattus. | 1 | 3·5 |
| | ... | ... | Motella sp., o.g. colourless. | m. | ·72–·83 | ·12–·16 | I., II. | Unrecognisable. | 2 | |
| | ... | ... | Motella sp., o.g. green. | 2 | ·76 | ·14 | I. | | | |
| | ... | Midwater. | Clupea sprattus. | 6 | ·95–·99 | ... | I., II., III. | | | |
| | ... | ... | Pleuronectes flesus. | 2 | 1·0, ·93 | ... | I., II. | | | |
| | ... | ... | Topknot. | 1 | 1·04 | ·21 | I. | | | |
| | ... | ... | Motella sp.? o.g. colourless. | 25 | ·75–·81 | ·13–·15 | I., II. | | | |
| | ... | ... | Motella sp.? o.g. green. | 3 | ·72–·78 | ·13–·14 | I. | | | |
| | ... | Bottom. | Motella sp., o.g. colourless. | 9 | ? | ? | I. | | | |
| | ... | ... | Motella sp. (unfertilised). | 1 | ·80 | many o.g's. | ... | | | |
| ,, 25. | West Channel. | Surface. | Clupea sprattus. | 1 | 1·0 | ... | I. | | | |

| Date. | Locality. | Position of Net. | EGGS. | | | | | LARVÆ. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Species. | No. | Diam. of Egg. | Diam. of Oil Globule. | Stage of Development. | Species. | No. | Length. |
| | | | | | mm. | mm. | | | | |
| Mar. 25. | West Channel. | Surface. | Motella sp. (unfertilised). | 1 | ·75 | many o.g's. | ... | | | |
| | ... | ... | Motella sp.? o.g. colourless. | 5 | ·72–·83 | ·14–·17 | I. | | | |
| | ... | Midwater. | Callionymus lyra. | 2 | ·88, ·91 | ... | II. | Gobius niger? | 3 | 3·3, 3·07 |
| | ... | | ... | ... | ... | ... | ... | Motella sp.? | 1 | 2·6 |
| | ... | Bottom. | Motella sp.? (unfertilised). | 1 | ·775 | many o.g's. | ... | | | |
| | ... | ... | Motella sp.? o.g. colourless. | 6 | ·71–·82 | ·13–·17 | I. | | | |
| | ... | ... | Motella sp.? o.g. green. | 2 | ·71, ·70 | ·16, ·175 | I. | | | |
| | ... | ... | Gadus sp.? | 1 | ·94 | ... | I. | | | |
| | ... | ... | Unidentified. | 1 | 1·12 | ·205 | I. | | | |
| ,, 27. | Cawsand Bay. | Bottom. | Eggs not examined. | ... | ... | ... | ... | Agonus cataphractus. | 1 | 13·5 |
| | ... | ... | ... | ... | ... | ... | ... | Callionymus lyra. | 2 | 6·2, 6·01 |
| April 2. | ½ mile S. of Mewstone. | Bottom. | Eggs not examined. | ... | ... | ... | ... | Pl. microcephalus. | 1 | 5·5 |
| | | ... | ... | ... | ... | ... | ... | Gobius niger? | 1 | 6·4 |
| | ... | ... | ... | ... | ... | ... | ... | C. sprattus. | 3 | 5·5, 5·7, 5·9 |
| | ... | ... | ... | ... | ... | ... | ... | Callionymus lyra. | 3 | 6·17, 6·0, 6·0 |
| ,, 9. | 1 mile S. of Mewstone. | Surface. | Gadus merlangus. | 1 | 1·20 | ... | II. | | | |
| | | ... | Gadus sp.? | 3 | 1·07–1·13 | ... | I. | | | |
| | ... | ... | Motella sp.? o.g. colourless. | 1 | ·78 | ? | III. | | | |
| | ... | ... | Callionymus lyra. | 4 | ·78–·89 | ... | I., II., III. | | | |
| | ... | ... | Solea vulgaris. | 1 | 1·33 | ... | I. | | | |
| | ... | ... | Topknot. | 1 | ·88 | ·125 | III. | | | |
| | ... | Midwater. | Gadus sp.? | 2 | 1·17 and 1·08 | ... | II. | Motella sp.? | 1 | 2·92 |
| | ... | ... | Motella sp.? o.g. colourless. | 1 | ·75 | ? | III. | Rhombus lævis? | 1 | 4·41 |
| | ... | ... | Callionymus lyra. | 2 | ·90, ·87 | ... | II., III. | | | |
| | ... | ... | Solea vulgaris. | 1 | 1·41 | ... | I. | | | |
| | ... | ... | Pl. microcephalus. | 1 | 1·39 | ... | II. | | | |
| | ... | ... | P. flesus. | 1 | ·93 | ... | III. | | | |
| | ... | ... | Topknot. | 1 | 1·04 | ·19 | III. | | | |
| | ... | ... | *Trachinus vipera.* | 1 | 1·43 | several pale green o.g's. | II. | | | |
| | ... | Bottom. | Solea vulgaris. | 1 | 1·35 | ... | I., II. | | | |

| Date. | Locality. | Position of Net. | EGGS. Species. | No. | Diam. of Egg. | Diam. of Oil Globule. | Stage of Development. | LARVÆ. Species. | No. | Length. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | mm. | mm. | | | | |
| April 9. | 1 mile S. of Mew- | Bottom. | Pl. microcephalus. | 1 | 1·3 | ... | I. | | | |
| | stone. | ... | Clupea sprattus. | 1 | ? | ... | III. | | | |
| | ... | ... | Callionymus lyra. | 3 | ? | ... | II., III. | | | |
| | ... | ... | Gadus sp.? | 3 | 1·03–1·135 | ... | I., II. | | | |
| | 1 mile S. of Break- | Surface. | Gadus sp.? | 2 | ·97, 1·16 | ... | II., III. | | | |
| | water Fort. | ... | Motella sp.? o.g. colourless. | 4 | ·70–·82 | ·13–·16 | I., II., III. | | | |
| | ... | ... | Motella sp.? o.g. green. | 2 | ·69 | ·17 | I. | | | |
| | ... | ... | Clupea sprattus. | 2 | 1·0, 1·03 | ... | II. | | | |
| | ... | ... | Callionymus lyra. | 2 | ·79 | ... | I. | | | |
| | ... | ... | Pleuronectes flesus. | 3 | ·94, ·95, ·97 | ... | II., III. | | | |
| | ... | ... | Topknot. | 2 | ·86, ·88 | ·12 | II., III. | | | |
| | ... | Midwater. | Clupea sprattus. | 1 | 1·08 | ... | I. | | | |
| | ... | ... | Callionymus lyra. | 2 | ·83, ·84 | ... | II. | | | |
| | ... | ... | Topknot. | 1 | ·82 | ·14 | II. | | | |
| | ... | ... | Gadus sp.? | 1 | 1·19 | ... | II. | | | |
| | ... | ... | Motella sp.? o.g. colourless. | 2 | ·76, ·79 | ·13 | I. | | | |
| | ... | ... | Motella sp.? o.g. green. | 2 | ·73, ·715 | ·17, ·16 | I., II. | | | |
| | ... | ... | Motella sp.? (unfertilised). | 1 | ·75 | many o.g's. | ... | | | |
| | ... | Bottom. | Clupea sprattus. | 2 | 1·03, 1·05 | ... | III. | Gobius niger? | 2 | 3·5, 3·6 |
| | ... | ... | Callionymus lyra. | 1 | ? | ... | III. | Callionymus lyra. | 1 | 3·2 |
| | ... | ... | Topknot. | 2 | ·82, ·87 | ·13, ·12 | II. | | | |
| | ... | ... | Topknot. | 1 | ·99 | ·175 | II. | | | |
| | ... | ... | Motella sp.? o.g. green. | 1 | ·70 | ·14 | I. | | | |
| | ... | ... | Gadus sp.? | 3 | ·93–·97 | ... | II. | | | |
| | ... | ... | Gadus merlangus. | 1 | 1·23 | ... | II. | | | |
| ,, 14. | 1–3 m. S. to W.S.W. | Surface. | Callionymus lyra. | 3 | ·84–·86 | ... | I., III. | Clupea harengus. | 2 | ? |
| | of Mewstone. | ... | Topknot. | 1 | 1·02 | ·18 | I. | Callionymus lyra. | sev. | 4·0–4·7 |
| | ... | ... | Motella sp.? o.g. colourless. | 1 | ·77 | ·14 | I. | | | |
| | ... | ... | Gadus sp.? | 2 | 1·02, 1·14 | ... | I. | | | |
| | ... | Midwater. | Gadus sp.? | 3 | ? | ... | III. | Callionymus lyra. | sev. | 3·7–4·3 |
| | ... | ... | *Pleuronectes limanda.* | 1 | ·81 | ... | III. | Clupea harengus. | 1 | ? |
| | ... | ... | Callionymus lyra. | 4 | ·83–·86 | ... | III. | C. sprattus. | 2 | ? |
| | ... | ... | ... | ... | ... | ... | ... | Motella sp.? | 1 | 2·8 |

| Date. | Locality. | Position of Net. | EGGS. | | | | | LARVÆ. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Species. | No. | Diam. of Egg. | Diam. of Oil Globule. | Stage of Development. | Species. | No. | Length. |
| | | | | | mm. | mm. | | | | |
| April 14. | 1–3 m. S. to W.S.W. | Bottom. | Gadus sp.? | 1 | ? | ... | III. | | | |
| | of Mewstone. | ... | Callionymus lyra. | 1 | ·84 | ... | III. | | | |
| ,, 17. | Off mouth of Yealm. | Surface. | Motella sp.? o.g. green. | m. | ·72–·73 | ·16–·17 | I, II. | | | |
| | ... | Midwater. | Pl. microcephalus. | 1 | 1·33 | ... | III. | | | |
| | ... | ... | Callionymus lyra. | 4 | ·82–·92 | ... | II., III. | | | |
| | ... | ... | Topknot. | 1 | 1·07 | ·18 | I. | | | |
| | ... | ... | Motella sp.? o.g. green. | m. | ·72–·75 | ·16–·17 | I. | | | |
| | ... | ... | Gadus sp.? | 1 | ? | ... | III. | | | |
| | ... | Bottom. | Motella sp.? o.g. green. | v.m. | ? | ? | I., II., III. | | | |
| | ½ mile S. of Mew- | Surface. | Callionymus lyra. | 2 | ·86, ·88 | ... | II., III. | | | |
| | stone. | ... | Motella sp.? o.g. green. | m. | ? | ? | II., III. | | | |
| | ... | Midwater. | Topknot. | 1 | ·90 | ·13 | II. | | | |
| | ... | ... | Pleuronectes flesus. | 1 | ·99 | ... | II. | | | |
| | ... | ... | Clupea sprattus. | 1 | 1·0 | ... | I. | | | |
| | ... | ... | Callionymus lyra. | 3 | ·82–·84 | ... | II. or III. | | | |
| | ... | ... | Motella sp., o.g. colourless. | 3 | ·76–·82 | ·13–·14 | I. | | | |
| | ... | ... | Motella sp., o.g. green. | v.m. | ·73–·75 | ·15–·20 | I. | | | |
| | ... | ... | Gadus sp.? | 1 | 1·0 | ... | I. | | | |
| | ... | ... | Gadus merlangus. | 1 | 1·2 | ... | III. | | | |
| | ... | Bottom. | Motella sp.? o.g. green. | m. | ? | ? | II., III. | | | |
| | West Tinker Buoy, | Surface. | Motella sp.? o.g. colourless. | 4 | ·73–·80 | ·13–·17 | I., II., III. | | | |
| | outside Break- | ... | Motella sp.? o.g. green. | 7 | ·70–·82 | ·14–·18 | I. | | | |
| | water. | ... | Gadus sp.? | 1 | ·98 | ... | II. | | | |
| | ... | ... | Clupea sprattus. | 1 | ·96 | ... | II. | | | |
| | ... | ... | Callionymus lyra. | 1 | ·85 | ... | II. | | | |
| | ... | ... | Topknot. | 2 | ·82, ·85 | ·15, ·14 | II. | | | |
| | ... | ... | Topknot. | 1 | 1·02 | ·175 | I. | | | |
| | ... | Midwater. | Callionymus lyra. | 2 | ·80, ·88 | ... | II., III. | | | |
| | ... | ... | Motella sp.? o.g. green. | m. | ·73–·75, etc. | ·17–·19, etc. | I., II. | | | |
| | ... | ... | Motella sp.? o.g. colourless. | 1 | ·73 | ·16 | II. | | | |
| | ... | ... | Gadus sp.? | 2 | ·95 | ... | II., III. | | | |
| | ... | Bottom. | Motella sp.? o.g. colourless. | 1 | ·87 | ·15 | II. | Gobius niger? | 1 | 4·73 |
| | ... | ... | Callionymus lyra. | 1 | ? | ... | III. | Callionymus lyra. | sev. | ? |

| Date. | Locality. | Position of Net. | EGGS. Species. | No. | Diam. of Egg. | Diam. of Oil Globule. | Stage of Development. | LARVÆ. Species. | No. | Length. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | mm. | mm. | | | | |
| April21. | West Channel, ½ m. outside Break-water Light. | Contents of surface, midwater, and bottom nets, mixed. | *Solea variegata.* | 1 | 1·44 | many. | II. | Solea vulgaris. | 1 | 5·14 |
| | ... | | Callionymus lyra. | 2 | ·88, ·91 | ... | II. | Solea sp.? | 1 | 7·4 |
| | ... | | Topknot. | 2 | 1·02, 1·04 | ·18, ·195 | I., II. | Callionymus lyra. | 1 | 3·64 |
| | ... | ... | Topknot. | 1 | ·82 | ·14 | II. | Pleuronectes limanda | 1 | 3·08 |
| | ... | ... | Motella sp.? o.g. colourless. | 7 | ·75–·86 | ·12–·19 | I., II., III. | | | |
| | ... | .. | Motella sp.? o.g. green. | m. | ·72–·78 | ·16–·18 | I., II., III. | | | |
| ,, 22. | In Channel between Drake's Island & Great Western Docks. | Surface. | Motella sp.? o.g. green. | 3 | ? | ? | I., II. | Pl. platessa ? | 1 | 12·0 |
| | | ... | Motella sp.? o.g. colourless. | 1 | ? | ? | I. | Callionymus lyra. | 1 | 1·67 |
| | | Midwater. | Motella sp.? o.g. green. | 6 | ? | ? | I., II. | | | |
| | | ... | Motella sp.? o.g. colourless. | 1 | ? | ? | I. | | | |
| | ... | ... | Callionymus lyra. | 1 | ? | ? | III. | | | |
| | ... | Bottom. | Motella sp.? o.g. green. | 5 | ? | ? | I., II. | | | |
| | ... | ... | Motella sp.? o.g. colourless. | 4 | ? | ? | I. | | | |
| ,, 24. | 4 miles S.S.W. of Breakwater Light. | Surface. | Motella sp.? o.g. colourless. | 1 | ·80 | ·15 | III. | | | |
| | | Midwater. | Motella sp.? o.g. green. | sev. | ? | ? | II., III. | Callionymus lyra. | 2 | 4·82 |
| | 3–4 miles S. of Mewstone. | Surface. | ... | ... | ... | ... | ... | Callionymus lyra. | 1 | 6.5 |
| | | Midwater. | Callionymus lyra. | 1 | ·88 | ... | I. | | | |
| | ... | Bottom. | ... | ... | ... | ... | ... | Clupea harengus. | 1 | ? |
| | ... | ... | ... | ... | ... | ... | ... | C. sprattus. | 1 | ? |
| | ... | ... | ... | ... | ... | ... | ... | C. lyra. | 2 | ? |
| ,, 25. | Off the Mewstone. | Surface. | | | | | | | | |
| | ... | Midwater. | Motella sp.? o.g. green. | sev. | ? | ? | II. or III. | Clupea sprattus. | 1 | 20·0 |
| | ... | Bottom. | | | | | | | | |
| ,, 29. | Inner Eddystone Trawling Ground. | ... | No eggs. | ... | ... | ... | ... | Solea vulgaris. | 2 | 6·5, 4·1 |
| | | ... | .. | ... | ... | ... | ... | Callionymus lyra. | sev. | [etc. |
| | ... | ... | ... | ... | ... | ... | ... | Motella sp.? | sev. | 5·3, 5·8, 4·7 |
| | ... | ... | ... | ... | ... | ... | ... | Gadus sp.? | 1 | 9·5 |
| | ... | ... | ... | ... | ... | ... | ... | Arnoglossus sp.? | 1 | 9·5 |
| | ... | ... | ... | ... | ... | ... | ... | Solea lascaris ?? | 2 | 8·3, 10·34 |
| | ... | ... | ... | ... | ... | ... | ... | | | |

*Record of Demersal Eggs.*

| Date. | Species. | Stage of Development. | Locality. | Situation. |
|---|---|---|---|---|
| Feb. 8th. | *Cottus bubalis* | Newly laid | Drake's Island | Under stone between tidemarks. One batch of eggs. |
| „ 24th. | „ „ | I., II., III. | „ „ | Under stone between tidemarks. Several batches of eggs. Some larvæ hatched during transit to Laboratory. |
| Mar. 11th. | *Agonus cataphractus* | I. | „ „ | Attached under "roots" of Laminaria. One batch of eggs. |
| „ „ | *Cottus bubalis* | I., II., III. | „ „ | Common under stones between tidemarks. |
| Apr. 11th. | *Agonus cataphractus* | I. | Rum Bay | One batch of eggs (?). |
| „ 23rd. | *Gobius niger* | I., II. | Drake's Island | Attached to a large stone. One large batch of eggs. |
| „ 24th. | *Gobius pictus* | I., II. | 3 miles S. of Mewstone | Attached inside valve of shell of *Pectunculus glycimeris.* |

The Cottus eggs could nearly always be easily hatched out, even when obtained in the earliest stages of development, but neither of the two batches of eggs of *Agonus cataphractus* showed any signs of development, though they retained their more or less transparent appearance for weeks. I have only had two larvæ of this species in the tow-nets, one on February 6th (7 mm. long) and the other on March 27th (13·5 mm. long), both taken in Cawsand Bay.

The eggs of *Gobius niger* also failed to hatch. They were attached to a large stone, which had to be broken up before it could be carried to the Laboratory. Possibly the shock to the eggs in breaking the stone caused their death.

The *Gobius pictus* eggs measured about ·80 mm. longer axis and ·63 mm. across the widest part, and the larvæ hatched from these eggs measured about 3·0 mm. in length. In shape, as well as in size, the eggs agreed exactly with those previously referred to this species by Holt and Byrne (*Journ. M. B. A.*, v., p. 336), and there can be little doubt that this identification is correct.

# Notes and Memoranda.

By

**H. M. Kyle, D.Sc.**

(With Plate III.)

## Malformation in Tub (*Trigla lucerna*, Bloch).

During the past year (1902) several cases of peculiarly shaped gurnards were reported from Brixham and Plymouth, and three specimens eventually fell into my hands. They are hunchbacked in form, and are so distinct from the common type that in the days of Couch and Parnell they would have been raised to the dignity of a separate species. No records of such malformations in the gurnards—though common enough in fresh-water forms, as perch and trout—have ever been made so far as my knowledge goes, so that a brief description seems advisable.

In essential characters they are really the tub, and only the peculiar longitudinal compression of the vertebræ, with consequent shortening of the total length, and alteration in the proportions of the various parts of the body, mark them off from this species.

The colouration of the body has for the most part disappeared, as it was some time after capture before they were seen and preserved, but the characteristic deep blue of the large pectorals is still conspicuous. The body is smooth, except for the marginal spines at the base of the dorsal fins. These marginal spines are, as usual, twenty-five in number. The fin-ray formulæ are the same as in the ordinary tub.

$$\text{D}, \frac{8}{16\text{–}17}; \text{ A}, 16\text{–}17; \text{ P}, (1+8+2)+3; \text{ V}, \frac{1}{5}; \text{ C}, 4+9+3.$$

Vert. 11/21; scales on lateral line, 75.

The specimens are thus in all essential respects the *T. lucerna;* their appearance, however, is very different. The body between the head and tail is short and stunted in proportion to the size of the head; it is likewise deeper and thicker. In two of the specimens this appearance extends uniformly from head to tail (Fig. 1), but in the third there is a sudden contraction just behind the abdominal region, which recalls the hog-backed variety of trout.

The total lengths from the snout to the caudal fork are 20·2 cm., 22·2 cm. for the first two, and 22 cm. for the third. The girths, measured across anus, are correspondingly 63 per cent., 65 per cent., and 50 per cent. of the total length. The head, measured along the side from the spines on the snout to the posterior margin of the opercular flap, is 35 per cent. in the first two specimens, in the third 29 per cent. of the total length; the ordinary values for this dimension are 25 to 27 per cent. The pectorals are 41 to 44 per cent. of the total length, except in the third specimen, where they are normal—namely, 30 per cent. The ventrals are also of great length.

These dimensions help to display the appearance of the specimens. The head seems large and elongated, almost sunk into the thick and deep anterior region of the body. In proportion to the head, the body ought to be 30 cm. long, whereas it is only 20 to 22 cm. Similarly the pectorals, which, except in the third specimen, extend to the root of the tail, are obviously out of proportion, likewise the ventrals. These alterations in the proportions are due not to any structural deformity, but to the shortness of the vertebræ; these seem compressed together and broad in proportion to their length, and the other parts of the body are compelled to follow suit. The internal organs were well developed, and more especially the air bladder, which was apparently larger than normal. Two of the specimens were males, apparently mature; the third was an immature female.

### **Halibut** (***Hippoglossus vulgaris,*** Flem.), or **Pole-Dab** (***Pleuronectes cynoglossus,*** Linn.).

Two young pleuronectid post-larvæ were taken in the bottom-net in the Moray Firth in August, 1896, and though there is some doubt as to their identity, it seems advisable to publish a short notice of them. It is so seldom that one naturalist is able to obtain a complete series of the young forms of any fish with pelagic eggs and larvæ, that it requires the co-operation of several to differentiate one form from another. Early stages of both these forms have already been described by other observers, and a description of the present specimens—of a stage undescribed as yet—may aid to their more exact determination and to a fuller knowledge of the young stages of one or other of the species.

The spawning season of the halibut, ascertained from the observation of ripe specimens, seems to be chiefly towards the end of April and beginning of May, so far as Britain is concerned. Unripe specimens, however, have been obtained in June, and at Iceland from June to August seems to be the spawning time.* The pole-dab, again, appears to have a similar spawning period. Cunningham† obtained the ripe eggs on the west coast of Scotland towards the end of June,

* *British Marine Food-Fishes*, McIntosh and Masterman.

† *Trans. Roy. Soc. Edinburgh*, vol. xxxii., part i., p. 101.

whilst Holt* obtained them in April and May on the west coast of Ireland; whilst young specimens about 42 mm., obtained on the 19th August, he considers to be four to six months old. The spawning season therefore does not aid to the identification of the present specimens, nor does the place where they were captured. Both species occur in the Moray Firth, the halibut being, if anything, the commoner.

The eggs of the halibut are very large, and vary, according to different observers, between 3·0 and 4·0 mm. From their large size we should expect the larvæ issuing from them to be also large. On the other hand, the eggs of the pole-dab are comparatively small—1·15 to 1·70 mm., and the length of the vitelligerous larva only 4·0 to 4·6 mm. The latest stage of the larval form of the latter species, described by Holt, was 5·57 mm.; the yolk was absorbed, but the notochord and the marginal fins are still in the embryonic condition (*loc. cit.*, Plate IX., Fig. 75). There is a blank between this stage and the next at 42 mm., when the adult characteristics have already been assumed. On the other hand, only one reputed specimen of a post-larval halibut has up to the present been described, and that by Dr. Petersen.† This specimen was 32 mm. long; the migration of the left eye had hardly begun, and the fin-rays were absent from the pectorals and ventrals. The fin-ray formulæ of the unpaired fins left doubts as to whether the specimen was a young halibut or pole-dab, but the large mouth and depression above the snout led Petersen to class it as the former.

The two specimens taken in the Moray Firth were obtained in the bottom tow-net, in company with post-larval plaice, lemon-dabs, and one topknot. Their lengths (in spirit) are 12 and 14 mm.; metamorphosis has hardly begun; the notochord is bent upwards, though not into its final position. True fin-rays to the number of eighteen have appeared in the caudal fin, but in the marginal fins no true rays could be detected until the specimens had been cleared in xylol and mounted in balsam. The length and narrowness of the caudal region show a very early stage of metamorphosis. Across the abdomen the breadth is 2 mm.; across the caudal region, immediately behind the abdomen, only 1 mm., omitting the fins. The head is 18 per cent. of the extreme length and the mandible is 50 per cent., the eye 25 per cent. of the length of the head. Black pigment is present in the form of stellate chromatophores; any other colour which may have been present has disappeared in the spirit.

* *Trans. Roy. Soc. Dublin*, vol. v. (Series II.), p. 84.

† "On the Biology of our Flat-Fishes," *Danish Biol. Stat.*, iv., 1893, p. 130, Plate II., Fig. 20. The same specimen was mentioned by Collet and Lilljeborg.

There are two conspicuous black bands across the caudal region, three smaller ones on the lower half of the body only alternating with the other two, and a black patch at the root of the tail. Black chromatophores are scattered over the peritoneum posteriorly, along the ventral interspinous bones, and along the lower margin of the abdomen; a few black spots are present also on the clavicle. On the head, a line of black chromatophores marks off the posterior margin of the large optic lobes; the mandible is also pigmented, but not so deeply, and an irregular double row extends longitudinally along the inner surface of the gill cover. The eyes are of an intense black, and are notched in front (Fig. 2).

The most striking features of the post-larvæ, in addition to their length and relative thinness, are the long head, the projecting snout, with the deep depression over the eyes, the projecting abdomen, and the early stage of metamorphosis. The left eye has not yet begun its migration. Of all the pleuronectid larvæ yet described, it is undoubtedly the latest and largest at this stage. In these striking features they are very like the long-rough dab.* The distribution of pigment is about the same; the large mandible and depression behind the snout are alike in both. They differ, however, from the long-rough dab in having a more elongated body at the stage of metamorphosis mentioned, and in having a greater number of fin-rays in the medium fins. Perfect accuracy was impossible in the counting of the latter, because the embryonic condition still persisted at the anterior and posterior ends, but the numbers were approximately D, 103 to 105; A, 83 to 85. These are beyond the formulæ for the long-rough dab, but are within those for the halibut, as given by Smitt;† they are also within those for the pole-dab (*P. cynoglossus*), and herein lies the difficulty. The latest stage, described by Holt, has a similar distribution of pigment, with the exception of the absence of chromatophores along the ventral aspect; these may, of course, develop later. Holt's specimen was less than 6 mm. in length; but their absence is of some importance, because they are present even in the earliest stage of the long-rough dab, to which the halibut is more nearly allied. In Holt's specimen the notochord is not yet bent up, and the other post-larval characteristics have not appeared. As regards form, internal structure, and structure of the head, these species are too closely allied to show distinctive characteristics at such early stages. The size of the mouth might be thought of as a guide, because the long-rough dab and halibut have a large mouth and the pole-dab a small one, and in this respect the present specimens are

* *Ann. Rep. Scottish Fishery Board*, xvi., for 1897, pp. 235, 236, Figs. 17–26.

† *Scandinavian Fishes*, part i., p. 409.

more like the former; but in the early stages the pole-dab appears also to have a relatively large mouth, so that altogether personal opinion has too much to do with the question.

It must remain unsettled for the present whether the pole-dab between 6 mm. and 12 to 14 mm. develops so slowly as to be but little further advanced on its early condition, and is able also to take on characteristics which are very like those of the young long-rough dab. It is not impossible, because the further out to sea the pleuronectids pass their lives, from larva to adult, the more prolonged is their metamorphosis, and the pole-dab* has been obtained at greater depths than the halibut.†

***Zeugopterus punctatus,*** Bl. (Müller's Topknot).

During February, 1901, a young topknot was obtained in a rock-pool at St. Andrews, and as it showed an interesting stage in the development of the scales, Professor McIntosh kindly asked me to write a short note on it. The total length of the specimen is 36 mm., and greatest breadth without fins 15·5 mm. It is thus not quite so broad, relatively to the length, as in the adult. The head, measured along the side, is more than 30 per cent. of the total length, therefore greater in proportion than it is later. These results are in accord with the now well-known observations that as a fish grows its breadth increases and head diminishes relatively to the length.

The fin-formulæ are—

D, 95; A, 70; V, 6/6; P, 8/10.

It is therefore a little abnormal in the pectoral of the eyed side, having only 8 rays where usually there are 11 to 12. The ventrals are well-developed, and are now joined to the anal. According to Smitt (*Scandinavian Fishes,* p. 456), they are separated from the anal at an earlier stage. The colour and markings on the eyed side are as in adult specimens, the blind side being quite colourless. The lateral line is complete on the former side, but on the latter the arch over the pectoral region is not yet formed. There is no trace of "otocystic spines" on the eyed side, nor on the blind side.

The greatest peculiarity, however, is that the scales are still in an early stage of development. On the blind side, which in the adult has only cycloid scales, none can be detected, and on the eyed side the surface of the body and head seems covered over by numerous small soft papillæ. When a scale is examined under a high power, it is seen that these papillæ are due to a pigmented epidermal fold which covers

* Goode and Bean, *Oceanic Ichthyology*, 1896, p. 434.

† I am indebted to Mr. E. W. L. Holt for the doubt with regard to these specimens. At first I was disposed to regard them definitely as young halibut, but from a drawing sent to him Mr. Holt is inclined to think them the pole-dab.

over the projecting part of the scale. The laminated portion is exceedingly thin and slender, and of the future denticles only the chief ones are present, and those in a rudimentary condition (Fig. 3). The central large spine (frequently double) springs directly from the nucleus, and is longer than the scale itself. At the tip it is bent upwards or outwards, a condition which later gives rise to the roughness of the eyed side of the adult topknot. The spines are, as yet, soft and flexible, and when stained with methylen blue display a central stained core surrounded by a clear unstained marginal portion. The smaller spines are bent downwards or inwards at their tips, as if to keep the scale in position. The posterior portion of the scale has a number of black stellate chromatophores scattered over its external surface.

### *Phycis blennoïdes,* Brunner.

In the *Annales du Musée d'Histoire Naturelle de Marseille*, tome v., p. 126, Holt has doubtfully ascribed certain pelagic eggs, with single oil-globule, to this species. In a previous number of the same journal, tome iv., Marion figured a larva in all respects similar to that of *G. minutus*, save that it was smaller, and ascribed it doubtfully to *Phycis*. More recent research has shown that the eggs described by Holt belong to another species of gadoid, and from observations made at Banyuls during the spring of 1898 I found that Marion's conjecture was in all probability correct. The ripe eggs of *Phycis*, obtained in May, varied from ·80 to ·88 mm. in size, being slightly smaller therefore than those of the poor cod.* There was no oil-globule. During the same month the eggs of this species and of *G. minutus* were taken together in the tow-nets. At first these were all relegated to the latter form, but the constant occurrence of a large number at ·80 mm., as well as the observation of the freshly extruded eggs of *Phycis*, left little doubt that both species were really present.

During the first two or three days of development of the tow-net eggs, there was no trace of pigment on embryo or zona; later, a few black spots appeared along the sides of the body and on the head. On hatching, the larva is from 2 to 2·2 mm., and possesses the usual gadoid characteristics. The figure given by Marion (*loc. cit.*, Plate II., Fig. 16) represents it accurately.

It is curious that *Phycis* should so closely resemble the poor cod rather than the more nearly related species—the hake, rockling, and ling; but the herring and its allies have already afforded examples of widely different types of eggs in neighbouring species.

* ·906 mm., McIntosh and Masterman, *British Marine Food-Fishes.* 1·0 mm., Raffaele, *Mitt. Zool. Stat. zu Neapel*, 1888.

### *Echinorhinus spinosus*, Blain.

The distribution of the spinous shark seems to be extensive, from the North Cape to the Cape of Good Hope, but it is not a common visitor to the shores of Britain, nor indeed anywhere. Day mentions over twenty records of its appearance, spread over some sixty years, and most of the specimens were obtained on the south coast. Stead (*Jour. M. B. A.*, vol. iv. p. 264) gives a description of a further sample captured in 1895. A female specimen, 7 feet long, and about 5 cwt. in weight, was caught in the beam-trawl off the Eddystone, on the 28th November, 1902.

### Hybridism in Marine Fishes.

The possibility of hybrids occurring amongst sea fishes has been displayed by various naturalists, of whom Mr. Thomas Scott may be more particularly mentioned. Whilst working on the *Garland* on the east coast of Scotland some twelve years ago, Scott succeeded in fertilising the eggs of several species by the milt of others. The conditions on board were not favourable to the success of the experiments; the embryos died before hatching. One lot of eggs, however, of brill crossed with the turbot, was sent to the St. Andrews Marine Laboratory,* and the young larvæ hatched out there, and seemed as strong and healthy as normal larvæ reared in aquaria.

The probability that hybrids actually occur in the adult condition is a much more difficult matter to determine. At different times supposed hybrids have been examined, only to be rejected, and but few examples have stood the test of scrutiny. According to Günther, a fish obtained at Bristol, the skin of which is in the national collection, may have been a cross between a shad and a pilchard, and another example in the same collection a cross between the two shads.† A nearer approach to certainty, with respect to the shads, has been attained by Hoek,‡ who has made a statistical investigation of the characters of supposed crosses between the two shads of the Rhine. The characters are intermediate between the two species, and reasoning from this fact, as well as from the possibility of cross-fertilisation whilst the fish are spawning on the same or neighbouring grounds, Hoek is inclined to believe that the forms he describes are in reality hybrids.

In this case the species are nearly allied, and for the most part live in fresh water, where hybridisation had already been shown to occur.

* W. C. McIntosh, *Ann. Rep. Scottish Fishery Board*, ix., p. 317, Plate XIII.

† Day, *British Fishes*, vol. ii., p. 238.

‡ "Neuere Lachs- und Maifisch-Studien," *Tijd. Nederl. Dierkundige Vereenig.* (2), vol. vi., p. 3, 1899.

Better examples of marine forms are found in the so-called turbot-brill and brill-turbot which Smitt* describes. Such specimens are far from uncommon, and have been mentioned by various naturalists. Holt,† into whose hands several specimens came, carefully reviews their characteristics, and points out, in addition to their intermediate character, that his specimens, though large, were still sexually immature. He was inclined to consider them as hybrids between a male turbot and female brill.

During the past year a few observations have been made on this matter, which seem to call for brief notice here.

On the 25th January, 1902, several thousand eggs of plaice were fertilised by the milt of a flounder, both running, and as only a few died during the first few days, the fertilisation must have been successful. Development proceeded very slowly until the 6th February, when the eggs were transferred to the tanks at the Laboratory. At this time the embryo was half-way round the yolk. Development then became rapid, due to the higher temperature, and many embryos were endeavouring to hatch on the 8th. The great majority died during this process, and the few that managed to escape died within a few hours.

Experiments which were going on in the Laboratory at the same time with another batch of eggs from the same plaice, but fertilised by the milt of a plaice, had no better success, and it may be that there was something wrong either with the eggs originally or in the surrounding conditions. Nevertheless, the phenomena displayed during the development of the hybrids are worthy of record.

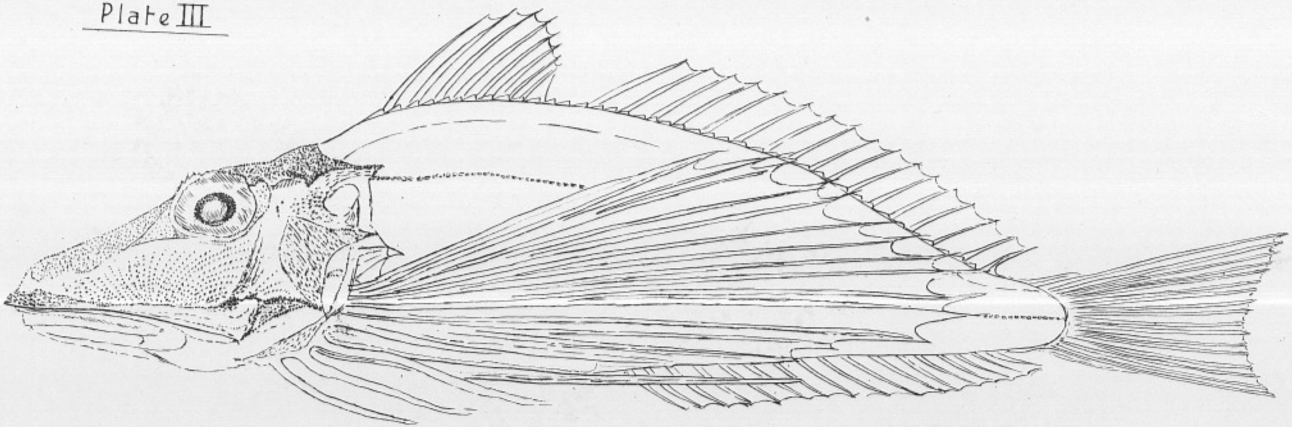
The colouring of the embryos generally was that of the plaice; the length of the few larvæ which hatched was from 3·5 to 4 mm., being little more than half that of the ordinary plaice larvæ; the yolk-sac was 2 mm. long, so that, as may be imagined, the tail of the larva was extremely short. This had probably a great deal to do with their inability to break through the egg-capsule. Further, instead of the tail being straight, it was curved round the yolk-sac; in fact, if we imagine a small flounder larva with plaice markings, foisted off on a large plaice yolk-sac, we have the exact appearance of these larvæ. The male element seemed to affect the length of the larva, which in other characteristics followed the female; the blastopore, also, was never completely closed, a round, circular opening on the posterior aspect of the yolk-sac being plainly visible. Consequently, on hatching, the yolk-sac was soon ruptured by the entrance of sea-water.

Only two embryos were exceptions to the above. These did not hatch until three days later—namely, on the 9th February. The

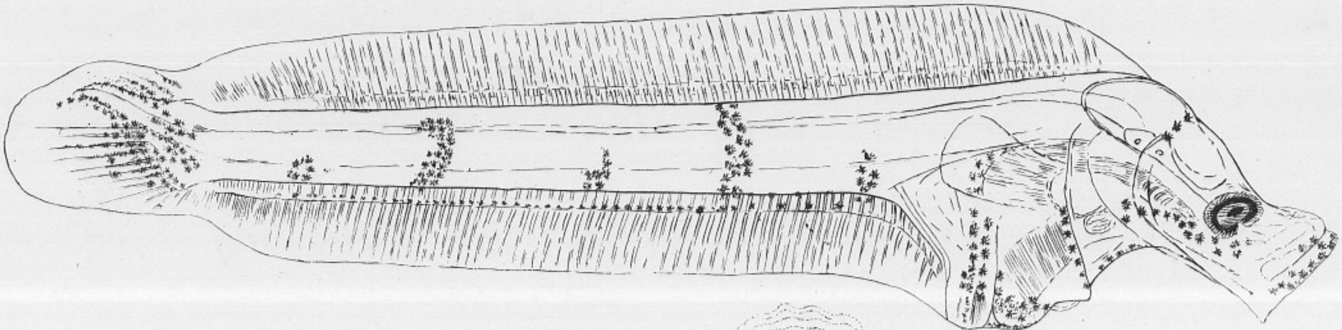
* *Scandinavian Fishes*, vol. i., p. 444.

† *Journ. M. B. A.*, vol. iii., 1895, p. 292.

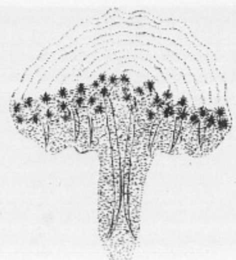
Plate III



1. x 7/8



2. x 12



3. x ca.150

H.M.K, ad nat delt.

pigment in their case was that of the flounder; the blastopore closed in the usual way, but the short larva was coiled round the yolk-sac in an unnatural manner. The organs of the body were, however, well developed, and the eyes later assumed their black pigment. These larvæ were able to move about in the water but sluggishly, and died within a few hours.

On the 15th February the converse experiment was tried; the ripe eggs of the flounder were fertilised by the milt of the plaice. During the first few days the mortality was very great, but a week later several thousands were still alive and in a healthy condition. The blastopore was completely closed, and the caudal region was beginning to separate off from the yolk; the eyes were formed, and the pigment over the embryo was that of the flounder. A good many died in the later stages within the egg, but a considerable number hatched out and lived for several days, although the water had not been changed for a fortnight. The larvæ which hatched out were a little larger than the ordinary flounder larvæ at that stage, but were in other respects like the flounder. They were strong and active, and did not seem in any way less capable of development than ordinary larvæ reared under similar conditions.

On the 5th March a flat-fish was brought to my notice by some fishermen at Brixham. In their opinion it was a flounder, but they were somewhat puzzled by its smooth appearance and slightly different shape. On examination, it was found that so far as external characters went it was more nearly a plaice. The fin-ray formulæ were too high for the flounder, and the characteristic plaice tubercles were present on the head, whilst the rough spines of the flounder were absent. The only resemblance to the flounder was in its small, closely-set scales and coarse-looking skin, which was much darker than is usual in the plaice, even from deep water. The specimen was 17 inches long and was full of roe. The ripe ova were obtained from it readily, and even to the naked eye appeared much smaller than the normal plaice ova. On examining them under the microscope, they appeared clear and transparent like normal ova. Under a high power the characteristic corrugations of the capsule of plaice eggs were seen. Their size, however, was abnormally small. Of fifty whose dimensions were taken, none exceeded 1·3 mm., and the majority were nearer 1·2 mm. These were representative of the rest in the ovary. The ordinary size of plaice eggs lies between 1·6 and 1·8 mm., so that from this character alone one might infer some mixture of plaice and flounder.

## DESCRIPTION OF PLATE III.

Fig. 1.—Abnormal Tub (*T. lucerna.*)

Fig. 2.—Post-larval Pleuronectid (*P. cynoglossus* or *H. vulgaris*).

Fig. 3.—Scale from eyed side of young Topknot (*Z. punctatus*).

# Notes and Memoranda.

By

W. Garstang, F. Balfour Browne, and R. Gurney.

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**Motella fusca. A new British Record.** On April 9th Mr. Lowe, Curator of the Municipal Museum, found on the shore under a stone a ripe female Motella, which he brought up to the Laboratory. The fish measured 19 cms. It had three barbels, and on investigation failed to agree with the descriptions of any of the five recognised British species: *M. mustela*, *tricirrata*, *macrophthalma*, *maculata*, or *cimbria*.

The fin-ray formula is :—D, 51 (or 52); P, 17 (or 18); V, 6 (or 7); A, 42; C, 26. The head is broad, with the upper surface flattened, and its length is contained about $5\frac{1}{2}$ times in the total length, being therefore equal to about 18 % of the total length. The mouth is relatively small, extending backwards to underneath the eye, the upper jaw being less than half the length of the head and slightly longer than the lower jaw.

The length of the base of the first dorsal fin is slightly longer than the length of the postorbital space, the latter being 92 % of the former. The width of the vomers together is greater than the longitudinal diameter of the eye.

The teeth in the upper jaw are, in an outer row, large and somewhat irregular, the others being smaller and more regular. In the lower jaw the outer teeth are small, and there is an irregular row of larger teeth inside.

The colour of the fish is a uniform olive-brown, paler under the body and on the cheeks, the under side of the head being yellowish-white and only slightly pigmented. The fins, now that the fish is preserved, are more or less uniform with the body in colour, but have a slightly bluish tinge.

Our specimen does not agree with the descriptions given by the various authors of any of the three British species which it approaches in its characters: *M. mustela*, *tricirrata*, or *maculata*.

In its fin-ray formula it corresponds most nearly, except perhaps in its pectoral fins, with *M. mustela*, and also in the smallness of the mouth and general colour it agrees best with this species. The posterior nostrils, which are placed slightly nearer to the anterior ones than to the front edge of the eye, have not however the semicircular flap which protects them in that species, but have an evenly raised margin, as in *M. tricirrata.*

The width of the vomers also, as compared with the longitudinal diameter of the eye, agrees with the description of *M. tricirrata*, and differs from that of *M. mustela* (Smitt, *Scandinavian Fishes*, pt. i. pp. 552, 555). Also bearing in mind the number of barbels present, we may perhaps dismiss *M. mustela* from our speculations.

Our specimen differs from *M. tricirrata*, then, in its fin-ray formula, and it also differs in the length of the base of the first dorsal fin as compared with the length of the postorbital space and in the relative length of the mouth to the head. It differs also from *M. maculata* in its fin-ray formula and in its uniform colour, and also in the entire absence of the black-spotting characteristic of that species, and it agrees very closely with the description of *M. fusca* given by Moreau (*Poissons de la France*, iii. p. 272).

He states that this species is smaller than the others. Our specimen is mature at 19 cms. In *M. fusca* the proportion of length of head to body length, the backward extension of the mouth as compared with the length of the head, the length of the base of the first dorsal fin as compared with the postorbital space, the fin-ray formula and also the colour of the female, correspond exactly with our specimen, which we therefore record as an example of this species.

A description of the ripe unfertilised ova will be found on another page.

W. Garstang and F. Balfour Browne.

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**Monstrilla Helgolandica, *Claus*, at Plymouth.**—Two specimens of the species occurred during last year (1902) in the tow-nets at Plymouth. The first was taken in July and the second on September 15th, both being females, the second specimen bearing a number of green eggs nearly ready to hatch. The species has not hitherto been recorded from British seas, the specimens referred to it by Bourne (*Q. J. M. S.*, 1890) being identical with *M. longiremis*, Giesb. The original, very inadequate, description given by Claus (*Freilebenden Copepoden*, 1863) has since been amplified by Timm (*Zool. Anz.*, 1893, and *Wiss. Meeresuntersuchungen*, i. p. 376) from specimens taken near Heligoland. The Plymouth specimens agree in all respects with his description, though it is as well to add that both were abundantly provided with a rich chocolate-coloured pigment. Timm, having only preserved material, speaks doubtfully of the colour.—R. Gurney.

# Report of the Council, 1901-1902.

## The Council and Officers.

The four ordinary quarterly meetings of the Council have been held, at which the average attendance has been eight. On each occasion the meeting has taken place at the rooms of the Royal Society, and the Council desires to thank the Royal Society for the accommodation given.

The Council has to record with deep regret the death of Mr. Robert Bayly, one of the Governors of the Association, whose generous support and valued advice and assistance contributed very largely to the successful establishment of the Laboratory at Plymouth.

## The Plymouth Laboratory.

The Laboratory continues to be maintained in a state of efficiency, and is well provided with the necessary appliances for marine investigation and biological research. The building, fittings, and machinery are in good order, and the Aquarium is well stocked with fishes and invertebrates.

## The Boats.

The steamer *Oithona*, purchased last year, has been constantly and successfully working along the Devonshire coast, and has proved herself a seaworthy and satisfactory ship. She has been fitted with a powerful steam trawling winch, which has greatly increased her usefulness for practical fishery research.

The floating laboratory *Dawn* was this year again placed at the disposal of the Association by Mr. J. W. Woodall, and was stationed during the summer at Exmouth. The addition of the workroom on deck has greatly increased her usefulness.

We have continued to make use of the sailing boat *Anton Dohrn* for work in Plymouth Sound.

## The Staff.

Mr. Frank Balfour Browne has been working during the year as an Honorary Assistant to Mr. Garstang for fishery investigations. In other respects there has been no change in the staff, which is now constituted as follows:—Director (Dr. E. J. Allen), Naturalist in charge of Fishery Investigations (Mr. Walter Garstang, assisted as above by Mr. Browne), Fishery Naturalist (Dr. H. M. Kyle, who is appointed in conjunction with the Devon County Council), and Director's Assistant (Mr. R. A. Todd).

Mr. Stuart Thomson, Lecturer on Biology at the Plymouth Technical School, has been engaged in carrying out researches under Mr. Garstang's direction.

## Occupation of Tables.

In addition to the names mentioned above, the following naturalists have been engaged in research work at the Plymouth Laboratory during the year:—

W. M. ADERS, PH.D., Marburg (Hydrozoa).
L. DANTAN, St. Vaust (Fisheries).
F. W. GAMBLE, D.Sc., Manchester (Crustacea).
R. GURNEY, B.A., Oxford (Crustacea).
Miss HEATH, Torquay (General Zoology).
K. LUCAS, Cambridge (Tunicata).
G. E. NICHOLS, Royal College of Science, London (Mollusca).
W. B. RANDLES, Royal College of Science, London (Mollusca).
H. M. WOODCOCK, University College, London (Protozoa).

Four students attended a class in Marine Biology held by Dr. Gamble during the Easter vacation, and Mr. M. D. Hill sent his assistant to the Laboratory to collect material for research work.

## The Library.

The thanks of the Association are due for the following books and current numbers of periodicals presented to the Library during the year:—

Transactions and Proceedings of the Royal Society of London.
Royal Society. Reports of the Malaria Committee.
Royal Society. Reports of the Evolution Committee.
Transactions and Proceedings of the Zoological Society of London.
Report of the British Association for the Advancement of Science. (Glasgow, 1901.)
Journal of the Royal Microscopical Society.
Quarterly Journal of Microscopical Science. (Presented by Prof. E. Ray Lankester, F.R.S.)
Report of H.M. Inspectors of Fisheries. (England and Wales.)
Report of the Sea and Inland Fisheries of Ireland for 1900.
Return, Sea Fisheries. (Restrictive Legislation in Foreign Countries.)

Report of the Inter-Departmental Committee appointed to inquire into the System of Collecting Fishery Statistics.
Eleventh Annual Meeting of Representatives of Authorities under the Sea Fisheries Regulation Act, 1888.
Report of the Limnological Commission.
Tests and Certificates of the National Physical Laboratory. (Observatory Dept.)
Catalogue of the Radcliffe Library, Oxford.
Cambridge Natural History. (Amphibia and Reptiles.)
Proceedings and Transactions of the Royal Irish Academy.
Annual Report of the Fishery Board for Scotland.
Proceedings of the Scottish Microscopical Society.
Marine Biological Association of the West of Scotland. Annual Report.
Handbook of the Marine Station, Millport.
Lancashire Sea Fisheries. Memoir.
Lancashire Sea Fisheries Committee. Superintendent's Report.
Lancashire Sea Fisheries Laboratory. Report.
Transactions and Annual Report, Manchester Microscopical Society.
Proceedings and Transactions of the Liverpool Biological Society.
Northumberland Sea Fisheries Committee. Report on Scientific Investigations.
Proceedings of the Bristol Naturalists' Society.
Transactions of the Royal Geological Society of Cornwall.
Rousdon Observatory. Meteorological Observations.
The Fishing Gazette.
Science Gossip.
Annual Reports of the Department of Marine and Fisheries, Canada.
University of Toronto. Studies.
Annals of the South African Museum.
Illustrations of the Zoology of the Royal Indian Marine Survey Ship *Investigator*.
Report on the Administration of the Government Museum and Connemara Public Library.
Memoirs of the Bernice Panahi Bishop Museum.
Proceedings of the Linnæan Society of New South Wales.
Records of the Australian Museum.
Fisheries of New South Wales. Report of the Commissioners of Fisheries for [1900.
Transactions and Proceedings of the New Zealand Institute.
Proceedings of the Royal Society at Victoria.
Fauna Hawaiiensis.
Key to the Birds of the Hawaiian Group.
Bulletin du Museum d'Histoire Naturelle, Paris.
Bulletin Scientifique de la France et de la Belgique.
Mémoires de la Société Zoologique de France. Bulletin de la Société Zoologique de France.
Bulletin de la Marine Marchande.
Congrès International de Pêches Maritimes et Fluviatiles. (Bayonne—Biarritz, 1899.)
Bulletin de la Société Centrale d'Aquiculture et de Pêche.
Mission Océanographique dans le Golfe de Gascogne en Galice et en Portugal.
La Feuille des Jeunes Naturalistes.
Le Mois Scientifique.
Verhandlungen der Naturforschenden Gesellschaft in Basel.
Wissenschaftliche Meeresuntersuchungen. Aus der Biologischen Anstalt auf Helgoland.

Mittheilungen des Deutschen Seefischerei-Vereins.
Allgemeine Fischerei-Zeitung.
Mittheilungen aus dem Naturhistorischen Museum in Hamburg
Laboratoire Ichthyologique de Nikolsk. St. Pétersbourg.
Aus der Fischzuchstanstalt Nikolsk.
Die Cypriniden des Kaukasas.
Bulletin du Laboratoire Biologique de St. Pétersbourg.
Russian Fishery Journal.
Revue Internationale de Pêche et de Pisciculture.
The International Exhibition of Fisheries. St. Petersburg.
Acta Societatis pro Fauna et Flora Fennica.
Bergens Museums Aarbog.
An Account of the Crustacea of Norway. By G. O. Sars. (Bergens Museum.)
Norsk Fiskeritidende.
Norges Fiskerier.
Det Kongelige Norske Videnskabers Selskabs Skrifter.
Aarsberetning vedkommende Norges Fiskerier.
Die Erste Nordmeerfahrt des Norwegischen Fischereidampfers *Michael Sars.*
Meddelande fran Göteborgs Fiskeriforening.
Archiv for Mathematik og Naturvidenskab.
Nyt Magazin for Naturvidenskaberne.
Svensk Fiskeri Tidskrift.
Oversigt over det Kongelige Danske Videnskabernes Selskabs Forhandlinger.
Mémoire de l'Académie Royale des Sciences et des Lettres de Danemark.
Bihang till Kongl. Svenska Vetenskaps Akademiens Handlingar.
Selskabet for de Norske Fisheriers Fremme.
Mittheilungen aus der Zoologischen Station zu Neapel.
La Nuova Notarisia.
Verslag van den Staat der Nederlandsche Zee Visscherijen.
Mededeelingen over Visscherij.
Tijdschrift der Nederlandsche Dierkundige Vereeniging.
Het Zoölogisch Station der Nederlandsche Dierkundige Vereeniging. Dr. P. P. C. Hoek.
La Cellule.
Bulletin de la Société Belge de Géologie.
Annales du Musée du Congo.
Revista de Pesca Maritima.
Annaes des Sciencias Naturaes.
Bolletino della Societá di Naturalisti in Napoli.
Bulletin and Report of the United States Commission of Fish and Fisheries.
Manual of Fish Culture. Revised Edition. U.S.F.C.
Bulletin and Memoirs of the Museum of Comparative Zoology at Harvard College.
Bulletin of the United States National Museum.
Annual Report of the Smithsonian Institution.
Bulletin and Annual Report of the American Museum of Natural History.
Annals of the New York Academy of Sciences.
Bulletin of the Illinois State Laboratory.
Publications of the Field Columbian Museum.
Contributions to Biology from the Hopkins Seaside Laboratory of the Leland Stanford Junior University.
Johns Hopkins University Circulars.
Proceedings of the Boston Society of Natural History.

Proceedings of the American Philosophical Society.
Transactions of the American Microscopical Society.
Studies from the Zoological Laboratory, University of Nebraska.
The American Journal of Anatomy.
Journal of Applied Microscopy and Laboratory Methods.
Proceedings of the American Society of Microscopists.
Results of the Branner-Agassiz Expedition :
    Molluscs from the Vicinity of Pernambuco. W. H. Dahl.
    New Birds of the Families Tanagridæ and Icteridæ. R. Ridgeway.
Papers from the Harriman Alaska Expedition :
    Hydroids. C. C. Nutting.
    Nemertines. W. R. Coe.
    The Ascidians. W. E. Ritter.
Bulletin of the Buffalo Society of Natural Sciences.
Science Bulletin. The Museum of the Brooklyn Institute of Arts and Sciences.
Bulletin from the Laboratory of Natural History of the State University of Iowa.
Publications of the University of Pennsylvania.
Brown University. Contributions from Anatomical Laboratory.
Bryn Mawr College. Monographs. Reprint Series.
The Wilson Bulletin. Oberlin, Ohio.
Oberlin College, Ohio. Laboratory Directions for the Study of Amphioxus.
Publicaciones de la Universidad de la Plata.
Communicaciones del Museo Nacional de Buenos Aires.
Annales del Museo Nacional de Montevideo.
Revista Chilena de Historia Natural.
Journal of the College of Science, University of Tokyo.
Journal of the Fisheries Society of Japan.
Journal of the Fisheries Bureau. Tokyo, Japan.
Annotationes Zoologicae Japonenses.

To the authors of the Memoirs mentioned below the thanks of the Association are due for separate copies of their works presented to the Library :—

Salmo salar. The Digestive Tract of Kelts. J. K. Barton.
What is an Echinoderm ? F. A. Bather.
On *Ilyopsyllus coriaceus* and other Crustacea taken at Alnmouth, Northumberland. G. S. Brady.
On Copepoda and other Crustacea taken in Ireland and on the N.E. Coast of England. G. S. Brady.
On Entomostraca collected in the Solway District and at Seaton Sluice, Northumberland, during the Summer 1894. G. S. Brady.
On the British Species of Entomostraca belonging to Daphnia and other allied Genera. G. S. Brady.
Description of a new Species of Cyclops. G. S. Brady.
On the Nature and Origin of Fresh Water Faunas. G. S. Brady.
Address to the Members of the Tyneside Naturalists' Field Club. G. S. Brady.
On Ostracoda taken amongst the Scilly Isles, and on the Anatomy of *Darwinella Stevensoni*. G. S. Brady and D. Robertson.
On the Distribution of British Ostracoda. G. S. Brady and D. Robertson.
Variation in *Aurelia aurita*. E. T. Browne.

The Movements of the Intestines studied by means of the Röntgen Rays. W. B. Cannon.
The Plankton of the North Sea and Skagerak in 1900. P. T. Cleve.
The Seasonal Distribution of Atlantic Plankton Organisms. P. T. Cleve.
Additional Notes on the Seasonal Distribution of Atlantic Plankton Organisms. P. T. Cleve.
The Physiological Zero and the Index of Development for the Egg of the Common Fowl, *Gallus domesticus*. C. L. Edwards.
Unilateral Coloration with a Bilateral Effect. C. H. Eigenmann and C. Kennedy.
Description of a new Cave Salamander. C. H. Eigenmann.
Annelides Polychètes de la Casamance. P. Fauvel.
Notes bibliographiques sur les Insectes nuisibles aux livres et aux reliures. A. Giard.
Sur un Coléoptère nuisible aux carottes Portegraines. A. Giard.
Sur un Acarien vivant sur les Chenilles d' *Agrotis segetum* Schiff. A. Giard.
Pour l'Histoire de la Mérogonie. A. Giard.
Sur l'Homologie des Thyroïdes Laterales avec l'Epicarde des Tuniciers. A. Giard.
A New Sounding and Ground-Collecting Apparatus. G. Gilson.
Annelides Polychètes de la Mer Rouge. H. C. Gravier.
On some Markings on the Skin of a Dolphin. Dr. S. F. Harmer.
President's Address. Norfolk and Norwich Naturalists' Society. Dr. S. F. Harmer.
*Dendrocometes paradoxus:* Conjugation. Prof. Hickson and J. H. Wadsworth.
Report on Norwegian Fishery and Marine Investigations. J. Hjort.
Structure of the left Auriculo-Ventricular Valve in Birds. A. Hodgkinson.
Notes on D'Orbigny's Figure of *Onychoteuthis dussumieri*. W. E. Hoyle.
On a New Species of Sepia and other Shells collected by Dr. R. Koettlitz in Somaliland. W. E. Hoyle.
On the Generic Names Octopus, Eledone, and Histiopsis. W. E. Hoyle.
L'Esthòtique dans les Sciences de la Nature. C. Janet.
Notes sur les Fourmis et les Guêpes. C. Janet.
Essai sur la Constitution Morphologique de la Tête de l'Insecta. C. Janet.
Sur les Nerfs Cephaliques, les Corpora Allata et le Tentorium de la Fourme (*Myrmica rubra*). C. Janet.
The Methods and Results of the German Plankton Expedition. J. T. Jenkins.
The Fish Fauna of Japan, with Observations on the Geographical Distribution of Fishes. D. S. Jordan.
Start Bay and One of its Problems. H. M. Kyle.
A Treatise on Zoology. Prof. E. Ray Lankester.
Marine Fish Destroyers. W. C. McIntosh.
Descriptive Guide to the Collection of Corals on view at the South London Art Gallery, Camberwell. J. Morgan.
The Ascidians of the Bermuda Islands. W. G. Van Nam.
On Oceanography of the North Polar Basin. F. Nansen. (Presented by Mr. W. Garstang.)
Studies in Relation to Malaria. The Structure and Biology of *Anopheles maculipennis*. G. H. Nuttall and A. E. Shipley. The Pupa. G. H. Nuttall and A. E. Shipley.
Further Observations upon the Biological Test for Blood. G. H. F. Nuttall.
Papers from the Harriman Alaska Expedition. C. C. Nutting.
The Laboratory Equipment of the Bahama Expedition from the University of Iowa. C. C. Nutting.
The Sea-bottom, its Physical Conditions and its Fauna. C. C. Nutting.
Le Cantonnement de Pêche. A. Odin.

A Collection of the Polychæta from the Falkland Islands Some Notes on the Bipolar Theory of the Distribution of Marine Organisms. Miss E. M. Pratt.
Étude Monographique sur le groupe des Infusoires Tentaculifères. René Sand.
Exosporidium marinum. René Sand.
Nematopoda cylindrica. Nov. gen., Nov. spec. René Sand.
Esquisse de l'Evolution de la Division Nucleaire chez les Etres vivants. René Sand.
On some Parasites found in *Echinus esculentus*. A. E. Shipley.
On a New Species of Bothriocephalus. A. E. Shipley.
The Abysmal Fauna of the Antarctic Region. A. E. Shipley.
O Aquario Vasco da Gama. A. da Sitva.
A Catalogue of Crustacea. Prof. D'Arcy Thompson, C.B.
History of the Fisheries of New South Wales, etc. L. G. Thompson.
Marine Fish Hatcheries of Port Hacking, with five Photographs. Hon. J. H. Want, K.C., M.L.C.
A First Study in Natural Selection in *Clausilia laminata*. W. F. R. Weldon.
Les Caféiers. E. de Wildeman.
Die Ursachen des Aussterbens von *Planaria alpina* in Hundsruckgeborge und von *Polycelis cornuta* in Taunus. W. Voigt.

## General Report.

Considerable progress has been made with the preparation and arrangement in permanent form of a detailed record of the distribution of the fauna in the immediate neighbourhood of Plymouth. This record, which embodies the results of work done by various naturalists since the time of the foundation of the Laboratory, has specially occupied the attention of Dr. Allen and his assistant, Mr. Todd, for several years past, and when completed should be a substantial contribution to the problems of local distribution, apart from the assistance afforded to future investigations at the Laboratory.

A Report has been published in the Journal of the Association by Dr. Allen and Mr. Todd on the fauna of the Exe estuary. This report embodies the results of work done during the summer of 1901 on board the floating laboratory *Dawn*, which was stationed at Exmouth, and used as a centre for collecting in the estuary. The comparison of the fauna and physical conditions in the Exe estuary with those found during the previous summer in the Salcombe estuary has proved interesting. The thanks of the Association are due to Mr. J. W. Woodall, who not only placed the *Dawn* at the service of the Association, but also met all expenses connected with her maintenance at Exmouth.

Mr. Garstang has been able to devote some attention to working out the results of the periodic cruises which he made in 1899 and 1900 at the mouth of the English Channel for the purpose of investigating the plankton and physical conditions prevailing at different seasons of the year; but owing in part to illness and in part to the time which he has given, at the request of H.M. Government, to matters relating to the British participation in the scheme of International Investigations recommended by the Christiania Conference, these results are not yet completed.

Trawling experiments in the bays on the South Devon coast, similar to those carried on some years ago by Mr. Stead and Mr. Holt, have been resumed during the present year, our steamer *Oithona* being used for the purpose. The investigations have been carried out by Dr. H. M. Kyle, who has made monthly trawlings at fixed stations in the bays, measuring and recording the most important food-fishes, and examining their food and their condition as to spawning. Work of a similar character has also been extended to the offshore grounds, and an attempt has been made to obtain definite information as to the movements of certain kinds of fish. Over five hundred plaice have been marked in the bays and returned to the sea, and a sufficient number of these have been again captured by the fishermen to demonstrate an outward migration from the bays, when the spawning season is coming on.

Mr. Balfour Browne has been engaged during the year in the study of the eggs and larvæ of food-fishes and in experiments on the rearing of larval fishes.

Mr. Stuart Thomson has continued his work on the scales of fishes as an index of age, and has already published a preliminary note upon the subject in the Journal of the Association. Mr. Thomson finds that in certain fishes the lines of growth are comparatively widely separated from one another, in that portion of the scale formed during the warmer season of the year when the rate of growth is rapid, but much less widely separated in that part built up during the colder season.

Mr. Robert Gurney has continuously occupied his Founder's table at the Laboratory, and has completed a number of valuable observations on the different stages in the larval development of various decapod crustacea.

## Published Memoirs.

The following papers, either wholly or in part the outcome of work done at the Laboratory, have been published elsewhere than in the Journal of the Association :—

BROWNE, E. T.—*Variation in* AURELIA AURITA. Biometrika, vol. i., No. 1, p. 90.

MACBRIDE, E. W.—*The Development of* ECHINUS ESCULENTUS. Proc. Roy. Soc., vol. lxix., p. 268.

PUNNETT, R. C.—*On Two New British Nemerteans.* Quart. Journ. Micr. Sci., vol. xliv., 1901, p. 547.

PUNNETT, R. C.—*On the Composition and Variations of the Pelvic Plexus in* ACANTHIAS VULGARIS. Proc. Roy. Soc., vol. lxviii., p. 140; vol. lxix., p. 2.

RANDLES, W. B.—*On the Anatomy of Trochus.* Report Brit. Assoc., Glasgow, 1901, p. 377.

## Donations and Receipts.

The receipts for the year include the grants from His Majesty's Treasury (£1,000) and the Worshipful Company of Fishmongers (£400), Special Donations from Mr. G. P. Bidder (£200), Mr. T. H. Riches (£100), Mr. J. W. Woodall (£39 3*s.* 10*d.*, the expenses of the *Dawn*), and Mr. W. F. Thomas (£5), Founder's Subscription (Mr. R. Gurney, £100), Composition Fees (£15 15*s.*), Annual Subscriptions (£130), Rent of Tables in the Laboratory (£19), Sale of Specimens and Fish (£296), Admission to the Tank Room (£135).

## Vice-Presidents, Officers, and Council.

The following is the list of gentlemen proposed by the Council for election for the year 1902–1903 :—

*President.*

Prof. E. Ray Lankester, LL.D., F.R.S.

*Vice-Presidents.*

The Duke of Abercorn, K.G., C.B.
The Earl of St. Germans.
The Earl of Morley.
The Earl of Ducie, F.R.S.
Lord Avebury, F.R.S.
Lord Tweedmouth, P.C.
Lord Walsingham, F.R.S.
The Right Hon. A. J. Balfour, M.P., F.R.S.
The Right Hon. Joseph Chamberlain, M.P.
Sir Edward Birkbeck, Bart.
Sir Michael Foster, K.C.B., M.P., F.R.S.
A. C. L. Günther, Esq., F.R.S.
Sir John Murray, F.R.S.
Prof. Alfred Newton, F.R.S.
Rev. Canon Norman, D.C.L., F.R.S.
Sir Henry Thompson, Bart.
Rear-Admiral Sir W. J. L. Wharton, K.C.B., F.R.S.

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### Members of Council.

G. P. Bidder, Esq.
G. C. Bourne, Esq., F.L.S.
Francis Darwin, Esq., F.R.S.
Prof. J. B. Farmer.
G. Herbert Fowler, Esq.
S. F. Harmer, Esq., F.R.S.
Prof. W. A. Herdman, F.R.S.
Prof. G. B. Howes, F.R.S.
J. J. Lister, Esq., F.R.S.
Prof. E. A. Minchin.
Prof. Charles Stewart, F.R.S.
Prof. D'Arcy W. Thompson, C.B.
R. N. Wolfenden, Esq., M.D.

*Hon. Treasurer.*

J. A. Travers, Esq.

*Hon. Secretary.*

E. J. Allen, Esq., The Laboratory, Citadel Hill, Plymouth.

The following Governors are also members of the Council :—

J. P. Thomasson, Esq.
The Prime Warden of the Fishmongers' Company.
E. L. Beckwith, Esq. (Fishmongers' Company).
Prof. Sir J. Burdon Sanderson, Bart., F.R.S. (Oxford University).
A. E. Shipley, Esq. (Cambridge University).
Prof. W. F. R. Weldon, F.R.S. (Brit. Assoc. for Advmt. of Science).

*Dr.* *Statement of Receipts and Expenditure for the Year ending 31st May, 1902.* *Cr.*

| | | £ s. d. | £ s. d. |
|---|---|---|---|
| To Balance from last year, being Cash at Bank and in hand, viz.:— | | | |
| Plant Repairs and Renewals Fund ...... | | 200 0 0 | |
| *Less* Amount overpaid on General Account | | 132 0 9 | 67 19 3 |
| ,, Current Income:— | | | |
| H.M. Treasury ............................ | | 1,000 0 0 | |
| Fishmongers' Company (including half-year's payment of £200 on account of year to 31st May, 1903) ................. | | 400 0 0 | |
| Annual Subscriptions ........................ | | 130 3 0 | |
| Rent of Tables ................................ | | 19 5 0 | |
| Interest on Investment .................... | | 18 17 7 | 1,568 5 7 |
| ,, Extraordinary Receipts:— | | | |
| Founder's Subscription— | | | |
| R. Gurney .................................. | | 100 0 0 | |
| Life Member's Composition Fee— | | | |
| Col. G. M. Giles .......................... | | 15 15 0 | |
| Special Donations— | | | |
| G. P. Bidder .............. | £200 0 0 | | |
| T. H. Riches .............. | 100 0 0 | | |
| J. W. Woodall ........... | 33 18 10 | | |
| Sir T. Freake .............. | 5 5 0 | | |
| W. F. Thomas ........... | 5 0 0 | 344 3 10 | 459 18 10 |
| | | | £2,096 3 8 |

Investment held 31st May, 1902, £500 Forth Bridge Railway 4% Guaranteed Stock.

*Examined and found correct,*

(Signed) Edwin Waterhouse.
Stephen E. Spring-Rice.
G. B. Howes.
George P. Bidder.

*June 24th*, 1902.

| | | £ s. d. | £ s. d. |
|---|---|---|---|
| By Current Expenditure:— | | | |
| Salaries and Wages— | | | |
| Director ........................................ | | 200 0 0 | |
| Naturalist ...................................... | | 250 0 0 | |
| Naturalist's Assistant ...................... | | 100 0 0 | |
| Director's Assistant ........................ | | 108 6 8 | |
| Wages ........................................ | | 572 10 10 | 1,230 17 6 |
| Travelling Expenses ........................ | | | 31 13 4 |
| Library ............................................ | | | 69 13 1 |
| Journal, Printing and Illustrating ......... | | 63 3 3 | |
| *Less* Sales of Journal ....................... | | 8 2 10 | 55 0 5 |
| Buildings and Public Tank Room— | | | |
| Gas, Water, Coal, etc. .................... | | 98 0 3 | |
| Stocking Tanks, Feeding, etc. ........... | | 29 2 11 | |
| Maintenance and Renewals .............. | | 103 19 8 | |
| Rent of Land, Rates, Taxes, and Insurance | | 15 5 0 | |
| | | 246 7 10 | |
| *Less* Admissions to Tank Room ......... | | 135 17 3 | 110 10 7 |
| Laboratory, Boats, and Sundry Expenses— | | | |
| Stationery, Office Printing, Postages, etc. | | 103 19 6 | |
| Glass, Chemicals, and Apparatus .................. | £96 1 0 | | |
| *Less* Sales ....................... | 6 7 11 | 89 13 1 | |
| Purchase of Specimens .................... | | 29 19 4 | |
| Maintenance and Renewals of Boats, Nets, Gear, etc. | £581 8 6 | | |
| *Less* Sales .................... | 287 10 2 | 293 18 4 | |
| Coal and Water for Steamer ............. | | 139 18 8 | |
| Insurance of Steamer (two years) and Boiler ........................................ | | 32 15 10 | |
| Boat Hire ........................................ | | 10 1 0 | |
| | | 700 5 9 | |
| *Less* Sale of Specimens ...... | £216 13 0 | | |
| Sale of Fish ........... | 80 5 11 | 296 18 11 | 403 6 10 |
| | | | 1,901 1 9 |
| By Extraordinary Expenditure— | | | |
| Cost of Purchase of and Fixing Steam Winch and Feed Tank on s.s. *Oithona* | | | 158 9 4 |
| By Balance of Cash at Bank and in hand, Plant, Repairs, and Renewals Fund, including £25 added during year ... | | 225 0 0 | |
| Deduct Cost of Steam Winch, etc., as above | | 158 9 4 | |
| | | 66 10 8 | |
| *Less* Amount overpaid on General Account | | 29 18 1 | 36 12 7 |
| | | | £2,096 3 8 |

# Report of the Council, 1902–1903.

## The Council and Officers.

The work of the Council has this year been considerably augmented in consequence of the fact that a commission has been accepted from H.M. Government to carry out in the southern British area the programme of scientific fishery investigations adopted by the International Conference, which met at Christiania in 1901. In addition to the four ordinary meetings of the Council, three special meetings have been held, these being entirely devoted to the organisation of the international work. The average attendance at the meetings has been nine. The Council have again to thank the Royal Society for allowing all the meetings to be held in their rooms at Burlington House.

## The Laboratories.

No changes of importance have been made at the Plymouth Laboratory, where the ordinary routine work has been carried on with but little interruption. The buildings are in a good state of repair, and the Laboratory is maintained in an efficient condition.

In order to carry out the work which is required by the international scheme in the southern part of the North Sea, premises have been rented by the Association close to the fishing harbour at Lowestoft, and have been furnished in a manner suitable for conducting laboratory investigations.

## The Boats.

For the North Sea fishery investigations the Council have hired for a period of three years the steam trawler *Huxley*, a vessel 115 feet long and 191 tons gross tonnage. Some difficulty was experienced in obtaining a vessel suitable for the work with the funds provided by Government, but the Council were fortunate in securing the assistance of one of their members, Mr. G. P. Bidder, who himself purchased the

*Huxley* from her former owners, and let her upon favourable terms to the Association. Accommodation for the naturalists has been fitted up in the old fish-hold of the trawler, and a small laboratory has been built on deck. The *Huxley* commenced work in November last.

The Association's steamer *Oithona*, which works in connection with the Plymouth Laboratory, continued the general collecting and the fishery investigations in the South Devon bays during the summer of 1902. She was, however, laid up for the winter months, as the funds at the disposal of the Association did not allow of her being kept in commission throughout the year.

The old sailing boat *Anton Dohrn*, which has done good service for many years, has been replaced by a new and slightly larger boat, which has been given the same name.

## The Staff.

The Staff at present employed by the Council is as follows:—

STATIONED AT PLYMOUTH.

*Director.* E. J. Allen, D.SC.
*Hydrographer* (International Investigations). D. Matthews.
*Assistant Naturalist for Invertebrates.* S. Pace.
*Assistant* „ „ *Plankton* (International Investigations). L. H. Gough, PH.D.

STATIONED AT LOWESTOFT.

*Naturalist in charge of Fishery Investigations.* W. Garstang, M.A.
*Assistant Naturalist for Fishes* (International Investigations). W. Wallace, B.SC.
*1st Assistant Naturalist for Invertebrates* (International Investigations). C. Forster Cooper, B.A.
*2nd* „ „ „ „ R. A. Todd, B.SC.

Dr. H. M. Kyle, who was a member of the Association's Fishery Staff during the greater part of the year, has left in order to take up an appointment as Biological Assistant at the Central Bureau of the International Investigations in Copenhagen.

## Occupation of Tables.

In addition to those mentioned above, the following have been engaged in research work at the Laboratory during the year:—

G. C. CHUBB, B.Sc., University College, London (Development of the ovary of Antedon).
Miss R. M. CLARK, Plymouth High School (Polyzoa).
Prof. C. B. DAVENPORT, Chicago (Variation of Mollusca).
L. DONCASTER, B.A., Cambridge (Fertilisation in Echinoderms).
E. G. GARDINER, Boston, Mass. (Rhabdocoels).

G. H. GROSVENOR, Oxford (Mollusca).
R. GURNEY, B.A., Oxford (Development of Crustacea).
Prof. S. J. HICKSON, F.R.S., Owens College (Protozoa).
M. D. HILL, M.A., Eton College (Alcyonium).
G. W. SMITH, Oxford (Tunicata).
Miss I. SOLLAS, Cambridge (Porifera).
J. S. THOMSON, Plymouth Technical School (Scales of Fishes).
W. WALLACE, B.Sc., St. Andrews (Fishes).
H. M. WOODCOCK, B.Sc., University College, London (Sporozoa).

Eleven students attended the Easter Vacation Course in Marine Biology, which was conducted by Mr. L. Doncaster, of King's College, Cambridge.

## The Library.

The Library has been entirely re-catalogued by Mr. Pace, the titles of the works being typewritten on cards of standard size (5 × 3 in.).

The thanks of the Association are due for the following books and current numbers of periodicals presented to the Library during the year:—

Transactions and Proceedings of the Royal Society of London.
Royal Society. Reports of the Malaria Committee.
Transactions and Proceedings of the Zoological Society of London.
Zoological Record.
Report of the British Association for the Advancement of Science.
Journal of the Royal Microscopical Society.
Quarterly Journal of Microscopical Science. (Presented by Prof E. Ray Lankester, F.R.S.)
Report of H.M. Inspectors of Fisheries (England and Wales) and Statistical Tables.
Report of the Sea and Inland Fisheries of Ireland for 1900.
Department of Agriculture, Ireland. Proceedings of the Inland Fisheries Conference.
Twelfth Annual Meeting of Representatives of Authorities under the Sea Fisheries Regulation Act, 1888.
Report of the Collections of Natural History made in the Antarctic Regions during the Voyage of the *Southern Cross*. (Presented by the Trustees of the British Museum.)
Royal College of Surgeons Museum. Catalogue of Physiological Series. Vol. II.
The Museums Journal.
Journal of Conchology.
Catalogue of the Radcliffe Library, Oxford.
Proceedings and Transactions of the Royal Irish Academy.
Annual Report of the Fishery Board for Scotland.
Proceedings of the Scottish Microscopical Society.
Marine Biological Association of the West of Scotland. Annual Report.
Lancashire Sea Fisheries Committee. Superintendent's Report.
Lancashire Sea Fisheries Laboratory. Report.
Proceedings and Transactions of the Liverpool Biological Society.
Northumberland Sea Fisheries Committee. Report on Scientific Investigations.

Proceedings of the Bristol Naturalists' Society.
Report of the Bristol Museum and Reference Library.
Hastings and St. Leonards Natural History Society's Report.
Rousdon Observatory. Meteorological Observations.
The Fishing Gazette.
Annual Reports of the Department of Marine and Fisheries, Canada.
University of Toronto. Studies.
Annals of the South African Museum.
Cape of Good Hope. Report of the Marine Biologist. Marine Investigations in South Africa.
Report on the Administration of the Madras Government Museum and Connemara Public Library.
Memoirs of the Bernice Pauahi Bishop Museum.
Proceedings of the Linnæan Society of New South Wales.
Records of the Australian Museum.
Fisheries of New South Wales. Report of the Commissioners of Fisheries for 1901.
Transactions and Proceedings of the New Zealand Institute.
Proceedings of the Royal Society of Victoria.
Government of Egypt Zoological Gardens Report.
Conseil Permanent International pour l'Exploration de la Mer. Bulletin des Résultats acquis pendant les Courses Périodiques.
Nouvelles Archives du Muséum d'Histoire Naturelle. Paris. (Presented by the Director of the Royal Gardens, Kew.)
Bulletin du Museum d'Histoire Naturelle, Paris.
Bulletin Scientifique de la France et de la Belgique.
Bulletin de la Société Zoologique de France.
Bulletin de la Marine Marchande.
Bulletin de la Société Centrale d'Aquiculture et de Pêche.
Travaux de l'Institut de Zoologie de l'Université de Montpellier et de la Station Zoologique de Cette.
La Feuille des Jeunes Naturalistes.
Le Mois Scientifique.
Verhandlungen der Naturforschenden Gesellschaft in Basel.
Bulletin Suisse de Pêche et Pisciculture.
Wissenschaftliche Meeresuntersuchungen. Aus der Biologischen Anstalt auf Helgoland.
Mittheilungen and Abhandlungen des Deutschen Seefischerei-Vereins.
Allgemeine Fischerei-Zeitung.
Mittheilungen aus dem Naturhistorischen Museum in Hamburg.
Laboratoire Ichthyologique de Nikolsk. St. Pétersbourg.
Aus der Fischzuchstanstalt Nikolsk.
Bulletin du Laboratoire Biologique de St. Pétersbourg.
Russian Fishery Journal.
Revue Internationale de Pêche et de Pisciculture.
Acta Societatis pro Fauna et Flora Fennica.
Bergens Museums Aarbog.
An Account of the Crustacea of Norway. By G. O. Sars. (Bergens Museum.)
Norsk Fiskeritidende.
Selskabet for de Norske Fiskeriers Fremme Aarsberetning.
Det Kongelige Norske Videnskabers Selskabs Skrifter.
Aarsberetning vedkommende Norges Fiskerier.
Meddelande fran Göteborgs Fiskeriforening.

Archiv for Mathematik og Naturvidenskab.
Nyt Magazin for Naturvidenskaberne.
Svensk Fiskeri Tidskrift.
Bihang till Kongl. Svenska Vetenskaps Akademiens Handlingar.
Svenska Hydrografisk Biologiska Kommissionens Skrifter.
Nova Acta Regiæ Societatis Scientiarum Upsaliensis.
Oversigt over det Kongelige Danske Videnskabernes Selskabs Fordhandlinger.
Mémoires de l'Académie Royale des Sciences et des Lettres de Danemark.
Report of the Danish Biological Station.
The Danish Ingolf Expedition.
Foreløbig Meddelelse fra det Danske Hydrografiske Laboratorium.
Mittheilungen aus der Zoologischen Station zu Neapel.
La Nuova Notarisia.
Verslag van den Staat der Nederlandsche Zee-Visscherijen.
Mededeelingen over Visscherij.
Tijdschrift der Nederlandsche Dierkundige Vereeniging.
La Cellule.
Bulletin de la Société Belge de Géologie.
Annales du Musée du Congo.
Annaes des Sciencias Naturaes.
Bolletino della Societá di Naturalisti in Napoli.
Bulletin and Report of the United States Commission of Fish and Fisheries.
Bulletin and Memoirs of the Museum of Comparative Zoology at Harvard College.
Bulletin of the United States National Museum.
Annual Report of the Smithsonian Institution.
Bulletin and Annual Report of the American Museum of Natural History.
Annals of the New York Academy of Sciences.
University of Pennsylvania. Contributions from the Zoological Laboratory. Contributions from the Botanical Laboratory.
Biological Bulletin of the Marine Biological Laboratory, Woods Holl, Mass.
Bulletin of the Illinois State Laboratory.
Publications of the Field Columbian Museum.
Contributions to Biology from the Hopkins Seaside Laboratory of the Leland Stanford Junior University.
Johns Hopkins University Circulars.
Proceedings of the American Philosophical Society.
Transactions of the American Microscopical Society.
Science Bulletin of the Museum of the Brooklyn Institute of Arts and Sciences.
Bulletin from the Laboratories of Natural History of the State University of Iowa.
Bryn Mawr College Monographs. Reprint Series.
The Wilson Bulletin. Oberlin, Ohio.
Oberlin College Laboratory Bulletin.
Tufts College Studies (Scientific Series).
Proceedings of the Miramichi Natural History Association.
Bulletin of the Lloyd Library.
University of California Publications.
Communicaciones del Museo Nacional de Buenos Aires.
Annales del Museo Nacional de Montevideo.
Revista Chilena de Historia Natural.
Journal of the College of Science, University of Tokyo.
Journal of the Fisheries Society of Japan.
Annotationes Zoologicae Japonenses.

To the authors of the Memoirs mentioned below the thanks of the Association are due for separate copies of their works presented to the Library:—

The Anatomy of *Scalibregma inflatum*, Rathke. J. H. Ashworth.

The Anatomy of *Arenicola assimilis*, Ehlers, and of a New Variety of the Species. J. H. Ashworth.

Ueber einige Educte des Pferdegehirns. A. Bethe.

Die Heimkehrfähigkeit der Ameisen und Bienen. A. Bethe.

The Early Development of Lepas. M. A. Bigelow.

Le Caryophysème des Eugléniens. P. A. Dangeard.

Fiskeri og Videnskab. G. M. Dannevig.

Second Report on the Result of Crossing Japanese Waltzing Mice with European Albino Races. A. D. Darbishire.

The Advance of Biology in 1897. C. B. Davenport.

A History of the Development of the Quantitative Study of Variation. C. B. Davenport.

On the Variation of the Shell of *Pecten irradians*, Lamarck, from Long Island. C. B. Davenport.

The Statistical Study of Evolution. C. B. Davenport.

On the Variation of the Statoblasts of *Pectinatella magnifica* from Lake Michigan, at Chicago. C. B. Davenport.

The Hydrography of the Faeroe-Shetland Channel. H. N. Dickson.

On rearing the later stages of Echinoid Larvae. L. Doncaster.

Kritisches und Polemisches. Hans Driesch.

Über ein neues harmonisch-äquipotentielles System, etc. Hans Driesch.

Zwei Beweise für die Autonomie von Lebensvorgängen. Hans Driesch.

Neue Ergänzungen zur Entwickelungsphysiologie der Echinidenkeimes. Hans Driesch.

Studien über das Regulationsvermögen der Organismen. Hans Driesch.

Neue Antworten und neue Fragen der Entwickelungsphysiologie. Hans Driesch.

Morphology of the Madreporaria. J. E. Duerden.

Bunodeopsis globulifera, Verr. J. E. Duerden.

Neuere Untersuchungen über den Hummer. E. Ehrenbaum.

South African Corals of the Genus Flabellum. J. S. Gardiner.

On the Anomalous Snakes in the Collections of the Zoological Institute, Strassburg. L. H. Gough.

Tierleben in einem Taubenschlag in Basel. L. H. Gough.

Henri de Lacaze-Duthiers, 1821–1901. S. F. Harmer.

On the Morphology of the Cheilostomata. S. F. Harmer.

The Future of British Fishery Investigation. W. A. Herdman.

Fertilization. S. J. Hickson.

Obituary Notice of Henri de Lacaze-Duthiers. S. J. Hickson.

Fiskeri og Hval Fangst i det Nordlinge Norge. J. Hjort.

Notes on the Type Specimen of *Loligo eblanae*, Ball. W. E. Hoyle.

The Luminous Organs of *Pterygioteuthis margaritifera*, a Mediterranean Cephalopod. W. E. Hoyle.

*Clunio bicolor*, Kieff; a marine Chironomid new to the Fauna of Great Britain. A. D. Imms.

On the Origin of Pearls. H. Lyster Jameson.

Various Memoirs by C. Janet.

Colour Physiology of the Higher Crustacea. F. Keeble and F. W. Gamble.

Royal College of Surgeons Catalogue. I. (Presented by the Director of the Royal Gardens, Kew.)

Notes on some Marine Turbellaria from Torres Straits. F. F. Laidlaw.
The Marine Turbellaria of the Maldive and Laccadive Archipelagoes. F. F. Laidlaw.
Typhlorhynchus nanus. F. F. Laidlaw.
L'Éclairage et l'emploi du condensateur dans la micrographie histologique. A. Bolles Lee.
Nouvelles recherches sur le Nebenkern et la régression du fuseau caryocinétique. A. Bolles Lee.
The Development of *Echinus esculentus*, together with some Points in the Development of *E. miliaris* and *E. acutus*. E. W. MacBride.
The Electric Conductivities and Relative Densities of certain Samples of Sea-Water. J. J. Manley.
British Amphipoda. A. M. Norman.
Studies in Relation to Malaria. G. H. F. Nuttall and A. E. Shipley.
Notes on the Dispersal of *Sagartia luciae*, Verrill. G. H. Parker.
Resultaten af den Internationella Undersökningen af Norra Europas Djupa Sjöar och Innanhaf År 1900. O. Pettersson.
Gephyrea of the *Southern Cross* expedition. A. E. Shipley.
On a Collection of Parasites from the Soudan. A. E. Shipley.
On the Nematodes Parasitic in the Earthworm. A. E. Shipley.
A Pot of Basil. A. E. Shipley.
Echinoidea of the Maldive and Laccadive Archipelagoes. A. E. Shipley.
Sipunculoidea of the Maldive and Laccadive Archipelagoes. A. E. Shipley.
South African Crustacea. Part II. T. R. R. Stebbing.
Lynceus and the Lynceidae. T. R. R. Stebbing.
De l'Hermaphrodisme chez les Vertébrés. P. Stephan.
Notes on the Habits of Onuphidae. A. T. Watson.
Contributions to the Natural History of the Pearly Nautilus. A. Willey.
A Study of Variation in the Fiddler Crab. R. M. Yerkes.

## General Work at the Plymouth Laboratory.

Work on the detailed record of the distribution of the local fauna has been continued as heretofore. Mr. S. Pace is now associated with Dr. Allen in this investigation, in place of Mr. Todd, who has been transferred to the Lowestoft Laboratory. Special attention is being given to the Polychæta. Several interesting species of this group, new to the British fauna, have been obtained, of which detailed descriptions will shortly be published.

The trawling experiments in the bays on the South Devon coast were continued by Dr. Kyle till October of last year, and a report upon this work has since been prepared.

Mr. Stuart Thomson has made progress with his investigation upon the scales of fishes as an index of age, and has prepared a detailed account of his researches which will shortly be published in the Journal of the Association.

Mr. E. G. Gardiner, of Woods Holl, has spent the winter at the Laboratory engaged on a study of the British Rhabdocoels.

## The International Fisheries Investigations.

### SECTION I.—NORTH SEA WORK.

### A. THE TOTAL PROGRAMME OF INVESTIGATIONS.

THE share of the international programme undertaken by the Association consists of the following parts:—

1. A scientific survey, by means of the s.s. *Huxley*, of the trawling grounds lying between the east coast of England and about 3° 30′ E. longitude.

The survey of the continental grounds, from which the largest supplies of undersized flat-fish are derived, falls to the share of Denmark, Germany, and Holland; but investigations on these grounds by the English boat have already been carried out, and will be continued in future from time to time, so that the fullest possible information may be provided concerning the distribution and sizes of fish in this important region.

On all the North Sea voyages of the s.s. *Huxley* arrangements have been made so that the following points may receive particular attention at each station:—

(i.) The nature of the bottom.
(ii.) The nature and abundance of animal life living on the bottom and serving as food for fish or otherwise.
(iii.) The size and weight of the fishes caught.
(iv.) The food of the more important fishes.
(v.) The condition of the fishes as regards sex, maturity, or spawning.
(vi.) The temperature of the sea at surface and bottom.

All fishes of marketable species which are caught are counted and measured. The weight of the catch is separately determined for each species. The records thus obtained are used for comparing the relative abundance and mass of particular species on different grounds, and the differences in the range of size exhibited by the fish of different areas at different seasons of the year.

2. A simultaneous survey of the regular fisheries on the trawling grounds with the assistance of reliable masters of commercial fishing vessels.

The promises of assistance received by the Association from influential boat owners and fishermen are sufficiently numerous to enable a careful selection to be made of the most reliable and competent men for this work. About fifty sailing trawlers from the southern ports and fifty steam trawlers from the northern ports will be employed during the first year. Whether the number of co-operating fishing boats be increased or not will depend on the results of the present year's experience. The Association, however, cannot too publicly acknowledge the spirit of friendliness and confidence with which their proposals for co-operation have been received both by boat owners and fishermen.

Special books of forms are distributed to the fishermen, who record, after every haul of the trawl, in addition to other details, the geographical position, and the total quantity of each kind of fish caught, the more important species being divided into "large," "medium," and "small."

The fishermen's records do not of course enter into the details which characterise the work of the scientific steamer; but they supplement these more exact observations by providing throughout the year a series of synoptic data as to the general course of the fishing in different parts of the area.

The accuracy of the fishermen's records will be systematically controlled by comparison with the catches of the s.s. *Huxley*, which has been fitted with an otter trawl for work on the grounds visited by the steam trawlers, and with a beam trawl for use on the grounds worked by the Lowestoft and Ramsgate smacks, each trawl being of the same kind and size as those used by the regular fishing boats.

The services of specially chosen shrimp fishermen are also being utilised in various districts in connection with the inshore fisheries.

3. Experiments on migration by the marking and liberation of fishes in large numbers over wide areas.

These experiments are designed to throw light on the following points:—

(*a*) The extent and direction of the seasonal and other migrations of food-fishes at different stages of their growth, and over the entire area, particular attention being paid to the migrations of undersized flat-fish.

(*b*) The percentage of fish on the trawling grounds actually caught by the trawling fleets from one year to another.

The results of these experiments will be compared with the fluctuations of fish on the various grounds shown by the trawling records, in order to determine the extent to which the seasonal and other migrations of fish account for the variation in the supply of fish on different grounds.

The experiments will also show the extent to which the so-called "nurseries" of flat-fish serve as a source of supply for the whole of the North Sea area, or for special parts of it.

The general results will be compared with those to be obtained by a biological study of the local varieties of plaice and soles.

4. Special investigations on the rate of growth, age, fecundity, and racial varieties of the more important fishes, especially flat-fish.

These investigations, or some of them, will be carried out in the Lowestoft Laboratory by the scientific staff from material collected on the trawling voyages of the s.s. *Huxley*. One of the aims of the Laboratory investigations will be to provide the necessary materials for a scientific forecast as to the probable effect on the fisheries of the various measures which have been proposed for protecting undersized fish.

5. Special quantitative investigations at sea (in co-operation with the Dutch and German vessels) concerning the abundance of the floating eggs of the sole, as a means of estimating the numbers of the breeding stock of this species.

6. Special investigations in the markets of the chief fishing ports as to variations in the size and weight of fish landed throughout the year.

These investigations are to provide additional data for converting the official statistics on the weight of fish landed into their equivalents in numbers of fish.

## B. WORK AND RESULTS TO DATE.

1. The *Huxley* began her fishing work on the 1st November. Her equipment was not then quite complete, but it was considered desirable to begin operations with the least possible delay in order to make preliminary observations and experiments before the winter.

Up to the middle of June the *Huxley* had completed twelve scientific trawling voyages in the North Sea. Investigations have been made along the western, southern, and eastern slopes of the Dogger Bank; in the deep-water area between the Dogger Bank and Shields; on the Hartlepool, Whitby, and California Grounds; in Bridlington Bay; on the Dowsing, Leman, Botney, and New Zealand Grounds; on the deep-water trawling grounds between the English and Dutch coasts; on the Terschelling and Ameland Grounds; in Heligoland Bay; on the shallow grounds north and south of the Horn Reef; and on the deeper grounds between the Horn Reef and the Dogger Bank.

Over 34,000 fishes have been measured, the majority being flat-fish. The animal life of the bottom has been systematically studied from the point of view of distribution, and the food-contents of about 3,000 fishes have been examined and determined.

In the investigation of the plaice nurseries near the Horn Reef in May, Mr. Garstang was joined on board the *Huxley* by the distinguished superintendent of the Danish investigations, Dr. C. G. Joh. Petersen. Opportunity was thus afforded of repeating investigations on some of the same stations which had been explored by the Danish vessel *Thor* six weeks earlier. The comparison of results revealed certain changes in the distribution of fish in the interval, which were further investigated with definite and interesting results.

2. The system of fishermen's records has been put into execution first of all at the port of Lowestoft, where a limited number of sailing trawlers and of steam trawlers belonging to Messrs. Hewett's fleet have been rendering returns since April last. The fishermen employed have shown great interest in the work, and carried it out very satisfactorily. The numbers of boats engaged will be gradually extended to the numbers mentioned in the programme.

3. Plaice have been marked and liberated in various parts of the area south of the latitude of Bridlington. In November and December last the first experiments were made on the grounds where small flat-fish congregate west of the Borkum Reef, and the results obtained are already of great interest and importance. They indicate that during December and January there was a marked migration southwards and westwards of the small plaice previously congregated on the inshore grounds of the northern and western coasts of Holland, the distances travelled being in many cases quite unprecedented, viz. from one hundred to one hundred and sixty miles in six weeks or two months. Over ten per cent. of the fish liberated have already been recovered. Although it is not proposed to draw conclusions at the present stage of the inquiry, these results already suggest that the supply of flat-fish in the southern part of the North Sea, as far south as the Thames estuary, is maintained to some extent by immigrations of small fish from the "nurseries" off the north coast of Holland.

4. The appointment of the Senior Fishery Assistant at the Lowestoft Laboratory to be Biological Assistant at the Central Bureau in Copenhagen has somewhat retarded the progress of the special investigations, since the time of the Chief Naturalist has been mainly spent in organising the work at sea which has been sketched out above. No time, however, will be lost in developing this branch of the work.

5. The investigation of fish eggs will not be commenced until the next breeding season. During a recent visit of the *Huxley* to Heligoland for this purpose, Drs. Heincke and Ehrenbaum joined Mr. Garstang for a day's fishing, and demonstrated their appliances for this part of the work. Uniform apparatus is now being prepared for next season's investigations.

6. Special assistants are being trained for the work in the markets, but have not yet begun operations away from Lowestoft.

## Section II.—HYDROGRAPHIC AND PLANKTON WORK IN THE ENGLISH CHANNEL.

The English portion of the international scheme of hydrographic and plankton observations, the execution of which has been assigned to the Marine Biological Association, is to be carried out in the western half of the English Channel.

These investigations have for their object the study of the seasonal changes which take place in the physical and biological conditions prevailing over the entire region covered by the international programme, though more particularly directed to a study of the waters entering the North Sea from different directions. They are designed to determine (1) the origin, history, and physical and biological characters of the water found in each locality at different seasons of the year and at corresponding seasons in different years, changes in which must necessarily have a profound influence upon the distribution and abundance of the fish-life in the sea, and (2) the variations which take place in the floating and swimming organisms (plankton) which constitute the fundamental food-supply of the sea.

### A. METHOD OF INVESTIGATION.

The investigation is being carried out (1) by means of a series of quarterly cruises made simultaneously over the whole area by the vessels of the participating countries, as a result of which a thorough knowledge, based upon the most accurate available methods, is obtained of the conditions prevailing at all depths at certain fixed stations, together with a less detailed knowledge at intermediate points; and (2) by observations, more especially of the surface conditions, at as many points as possible during the time intervening between the seasonal cruises.

The particular portion of the work which falls to the lot of the Marine Biological Association may now be described in more detail.

#### I. Seasonal Cruises.

The seasonal cruises are carried out as nearly as circumstances will allow during the first fortnights of February, May, August, and November, with the view of studying in detail the mid-winter, mid-spring, midsummer, and mid-autumn conditions.

The following twenty stations in the western half of the English Channel are to be worked on each cruise:—

List of Stations.

I. 10 miles S.W. ¼ S. southerly of the Eddystone.
II. 47 „ „ „ „ „ „ (mid-channel).

| | | | |
|---|---|---|---|
| III. | 8 miles | | N. by W. of Ushant. |
| IV. | 55 | „ | W. by N. of Station III. (Parson's Bank). |
| V. | 40 | „ | N.N.E. of Station IV. (mid-channel). |
| VI. | 30 | „ | N. of Wolf Rock (Bristol Channel). |
| VII. | 8 | „ | S.E. of Wolf Rock (Mount's Bay). |
| VIII. | 95 | „ | „ „ (mid-channel). |
| IX. | 30 | „ | N.E. by E. of Station VIII. |
| X. | 9 | „ | N.E. by N. of Casquets (Hurd's Deep). |
| XI. | 28 | „ | E.N.E. ½ E. of Station X. (off Cape La Hague). |
| XII. | 14 | „ | N.E. by N. of Cape Barfleur. |
| XIII. | 25 | „ | N. ¾ E. of Station XII. (mid-channel). |
| XIV. | 2 | „ | S. ¾ W. of St. Catherine's Point. |
| XV. | 10 | „ | S. by E. of Anvil Point. |
| XVI. | 8 | „ | S.S.W. of Portland Low Light. |
| XVII. | 30 | „ | E.S.E. of Start Point (mid-channel). |
| XVIII. | 15 | „ | N.N.W. of Station XVII. (Great West Bay). |
| XIX. | 20 | „ | S. by E. of Start Point (mid-channel). |
| XX. | 5 | „ | S.S.W. of Bolt Head. |

(The bearings given are magnetic.)

At each station the following programme of work is carried out:—

1. *Hydrographic and Meteorological.*—The temperature of the water at the surface is taken, and also, by means of the Pettersson-Nansen water-bottle with thermometers graduated to $\frac{1}{10}°$ centigrade, the temperatures at 5, 10, 15, 20, 30, 40, 50, 75, 100, 125 metres, and at the bottom.

Samples of water are procured at each of the above depths, and from these samples the salinity is subsequently determined in the laboratory by Volhard's titration method.

Observations of the temperature of the surface water are taken every two hours when running between the stations, and meteorological observations, including readings of the barometer and of the wet and dry bulb thermometer, are made at similar intervals.

2. *Plankton.*—Samples are taken with the following nets at each station:—

(*a*) A vertical haul with a small Hensen net, the silk of which has 150 meshes to the inch.

(*b*) Hauls with the Garstang closing net, fitted with silk having 100 meshes to the inch, at 10 metres, mid-water, and bottom.

(*c*) Surface gatherings with four ordinary tow-nets having silk 26, 50, 100, and 150 meshes per inch respectively.

The eight samples from each station are subsequently examined in the laboratory, all the species of animals and plants they contain being recorded, and the abundance of each indicated according to the system adopted by the International Council.

### II. Intermediate Observations.

Arrangements are being made for obtaining frequent observations of surface temperature and samples of surface water and plankton from lightships round the coast, as well as from steamers running along certain routes. These observations will be extended as far to the westward and north-westward as possible.

The regular station work will be carried out as frequently as possible, in the intervals between the seasonal cruises, at one or two stations at the western end of the English Channel.

## B. WORK ALREADY ACCOMPLISHED.

All the stations set forth above were worked during the first fortnight of February (1903) with the steamer *Huxley*, and a complete set of observations and samples obtained from each. The salinity of all the water samples has since been determined, and a record of these and of the other observations made has been forwarded to the Central Bureau at Copenhagen for publication in the International Bulletin.

The samples of plankton collected have been qualitatively examined, and the species, more especially of Diatoms, Peridinidae, and Copepoda, determined in all cases. These results will also be forwarded to the Central Bureau for publication.

A similar series of observations was carried out during the first fortnight of May.

## Published Memoirs.

The following papers, either wholly or in part the outcome of work done at the Laboratory, have been published elsewhere than in the Journal of the Association:—

MacBride, E. W.—*The Development of* Echinus esculentus, *together with some points in the Development of* E. miliaris *and* E. acutus. Phil. Trans. Roy. Soc., London. Series B. vol. cxcv., 1903, pp. 285–327.

Gurney, R.—*The Metamorphosis of* Corystes cassivelaunus (Pennant). Quart. Journ. Micr. Sci., vol. xlvi. pp. 461–478.

Thomson, J. S. *The Scales of Fishes as an Index of Age.* Brit. Assoc. Report, Belfast, 1902.

Woodcock, H. M. *Life-history of* Sporozoa. Brit. Assoc. Report, Belfast, 1902.

## Donations and Receipts.

The receipts for the year for the ordinary work of the Association include the grants from His Majesty's Treasury (£1,000) and the Worshipful Company of Fishmongers (£400), Composition Fees (£15 15*s.*), Annual Subscriptions (£122), Rent of Tables in the Laboratory (£17), Sale of Specimens and Fish (£315), Admission to the Tank Room (£137).

## Vice-Presidents, Officers, and Council.

The following is the list of gentlemen proposed by the Council for election for the year 1903–1904:—

*President.*

Prof. E. Ray Lankester, LL.D., F.R.S.

*Vice-Presidents.*

The Duke of Abercorn, K.G., C.B.
The Earl of St. Germans.
The Earl of Morley.
The Earl of Ducie, F.R.S.
Lord Avebury, F.R.S.
Lord Tweedmouth, P.C.
Lord Walsingham, F.R.S.
The Right Hon. A. J. Balfour, M.P., F.R.S.
The Right Hon. Joseph Chamberlain, M.P.
Sir Edward Birkbeck, Bart.
Sir Michael Foster, K.C.B., M.P., F.R.S.
A. C. L. Günther, Esq., F.R.S.
Sir John Murray, F.R.S.
Prof. Alfred Newton, F.R.S.
Rev. Canon Norman, D.C.L., F.R.S.
Sir Henry Thompson, Bart.
Rear-Admiral Sir W. J. L. Wharton, K.C.B., F.R.S.
Admiral Sir Erasmus Ommanney, K.C.B., F.R.S.

### Members of Council.

G. L. Alward, Esq.
G. P. Bidder, Esq.
G. C. Bourne, Esq.
Prof. J. B. Farmer, F.R.S.
G. Herbert Fowler, Esq.
S. F. Harmer, Esq., F.R.S.
Prof. W. A. Herdman, F.R.S.
Prof. G. B. Howes, F.R.S.
J. J. Lister, Esq., F.R.S.
H. R. Mill, Esq.
Prof. E. A. Minchin.
Prof. Charles Stewart, F.R.S.
Prof. D'Arcy W. Thompson, C.B.
R. N. Wolfenden, Esq., M.D.

*Hon. Treasurer.*

J. A. Travers, Esq.

*Hon. Secretary.*

E. J. Allen, Esq., The Laboratory, Citadel Hill, Plymouth.

The following Governors are also members of the Council:—

J. P. Thomasson, Esq.
The Prime Warden of the Fishmongers' Company.
E. L. Beckwith, Esq. (Fishmongers' Company).
Prof. Sir J. Burdon Sanderson, Bart., F.R.S. (Oxford University).
A. E. Shipley, Esq. (Cambridge University).
Prof. W. F. R. Weldon, F.R.S. (British Association).

*Dr.* *Statement of Receipts and Expenditure for the Year ending 31st May, 1903.* *Cr.*

| | £ | s. | d. | £ | s. | d. |
|---|---|---|---|---|---|---|
| To Balance from last year, being Cash at Bank and in hand, viz.:— | | | | | | |
| Balance of Plant Repairs and Renewals Fund | 66 | 10 | 8 | | | |
| *Less* Amount overpaid on General Account | 29 | 18 | 1 | 36 | 12 | 7 |
| „ Current Income:— | | | | | | |
| H.M. Treasury | 1,000 | 0 | 0 | | | |
| Fishmongers' Company (including half-year's payment of £200 on account of year to 31st May, 1904) | 400 | 0 | 0 | | | |
| Annual Subscriptions | 122 | 16 | 0 | | | |
| Rent of Tables | 17 | 15 | 0 | | | |
| Interest on Investment | 18 | 15 | 5 | | | |
| Sales of Journal £6 13 5 | | | | | | |
| *Less* Cost of Printing, etc. 4 2 6 | 2 | 10 | 11 | 1,561 | 17 | 4 |
| „ Extraordinary Receipts:— | | | | | | |
| Life Member's Composition Fee—H. G. T. Major | | | | 15 | 15 | 0 |
| „ Balance, being amount due to Bankers | 156 | 3 | 11 | | | |
| *Less* Cash in hand, including £30 in hands of Naturalist on account of expenses | 39 | 2 | 11 | 117 | 1 | 0 |
| | | | | £1,731 | 5 | 11 |

[Note.—This liability is exclusive of the amount held to be necessary as a Plant Repairs and Renewals Fund, which, with £25 added during the year, should stand at £91 10*s.* 8*d.*]

Investment held 31st May, 1903, £500 Forth Bridge Railway 4% Guaranteed Stock.

| | £ | s. | d. | £ | s. | d. |
|---|---|---|---|---|---|---|
| By Current Expenditure:— | | | | | | |
| Salaries and Wages— | | | | | | |
| Director | 200 | 0 | 0 | | | |
| Naturalist | 250 | 0 | 0 | | | |
| Naturalist's Assistant | 108 | 6 | 8 | | | |
| Director's Assistant | 148 | 0 | 0 | | | |
| Wages | 510 | 3 | 0 | 1,216 | 9 | 8 |
| Travelling Expenses | | | | 16 | 2 | 0 |
| Library | | | | 89 | 6 | 6 |
| Buildings and Public Tank Room— | | | | | | |
| Gas, Water, Coal, etc. | 91 | 19 | 2 | | | |
| Stocking Tanks, Feeding, etc. | 29 | 5 | 0 | | | |
| Maintenance and Renewals | 95 | 13 | 5 | | | |
| Rent of Land, Rates, Taxes, and Insurance | 15 | 9 | 0 | | | |
| | 232 | 6 | 7 | | | |
| *Less* Admissions to Tank Room | 137 | 9 | 4 | 94 | 17 | 3 |
| Laboratory, Boats, and Sundry Expenses— | | | | | | |
| Stationery, Office Printing, Postage, etc. | 123 | 6 | 9 | | | |
| Glass, Chemicals, and Apparatus £95 0 2 | | | | | | |
| *Less* Sales 11 8 11 | 83 | 11 | 3 | | | |
| Purchase of Specimens | 51 | 1 | 5 | | | |
| Maintenance and Renewals of Boats, Nets, Gear, etc. £293 15 1 | | | | | | |
| *Less* Sales 61 18 8 | 231 | 16 | 5 | | | |
| Coal and Water for Steamer | 113 | 5 | 4 | | | |
| Insurance of Steamer and Boiler | 26 | 5 | 4 | | | |
| Boat Hire | 0 | 16 | 0 | | | |
| | 630 | 2 | 6 | | | |
| *Less* Sales of Specimens £292 19 6 | | | | | | |
| Sales of Fish 22 12 6 | 315 | 12 | 0 | 314 | 10 | 6 |
| | | | | £1,731 | 5 | 11 |

*Examined and found correct,*
(Signed) Edwin Waterhouse, F.C.A.
R. Norris Wolfenden.
T. H. Riches.

*June 22nd*, 1903.

## Director's Report.

The Report of the Council, which has already been in the hands of the members of the Association for some months, and is reprinted in the present number of the Journal, gives a summary of the history of the Association and of the work which has been in progress since the issue of the last Journal.

It will be readily understood that the work of organising and commencing to carry out a programme of investigations of the size of the International scheme has placed a serious strain upon the members of the old staff of the Association, and whilst expressing the regret of myself and my colleagues at our apparent neglect in not having for some time provided the Council with the material necessary for the issue of a number of the Journal, I hope that during the next few months we shall demonstrate, by the publication of work which is on the verge of completion, that although silent we have not been idle, and that steady and substantial progress has been made with the various researches which we have in hand.

The ordinary work of the Plymouth Laboratory has continued with little if any interruption. The following naturalists have occupied tables during the summer, that is to say, since the publication of the list given in the Report of the Council on p. 640 :—

The Rev. Canon Norman, F.R.S. (*Crustacea*).
Prof. W. F. R. Weldon, F.R.S., Oxford (*Variation of Mollusca*).
Dr. E. G. Gardiner, Wood's Hole (*Turbellaria*).
Dr. C. Shearer, Cambridge (*Development of Polychæta*).
G. F. Farran, B.A., Dublin (*Nudibranchiata*).
G. P. Bidder, M.A., Cambridge (*Method of measuring bottom currents in the sea*).
J. S. Thomson, Plymouth (*Fishes*).
W. R. G. Bond, B.A., Oxford (*General Zoology*).
F. W. W. Griffin, B.A., Cambridge (*Fishes*).
F. Cavers, B.Sc., Plymouth.
Rev. A Cole, Berkhamstead (*General Zoology*).
Miss J. Sollas, Cambridge (*Echinoderma*).
Miss A. Kelly, Ph.D., Strassburg (*Chemical Physiology*).
Miss R. M. Clark, Cambridge (*Polyzoa*).
Miss E. Peacey, Oxford (*General Zoology*).

Prof. Otto Pettersson of Stockholm, Vice-President of the Central Bureau of the International Investigations, and Dr. P. P. C. Hoek of Copenhagen, General Secretary of the Central Bureau, have visited the Laboratories at Plymouth and Lowestoft in order to make themselves acquainted with the details of the work being carried on in connection with the investigations. They expressed their satisfaction with the arrangements that had been made at both stations, and with the progress of the researches.

The business of supplying specimens for scientific research, for teaching purposes, and for museums continues to grow. Unfortunately the expense involved in procuring constant supplies of fresh material will in all probability never allow of this branch of our work becoming entirely self-supporting, but the service rendered would seem to be of such value that it would be a distinct misfortune if it were allowed to cease.

As regards the fishery work of the Association, the policy adopted by the Council has been to throw all its energies, for the time being, into the prosecution of the International investigations, so that as far as the responsibility rests with them they may ensure the success of that important undertaking, and English fishery science may take its proper place as compared with that of the other countries of Europe.

The new members of the staff now employed by the Council in connection with these investigations have entered upon their duties with energy and enthusiasm, and share with the old a determination that the work produced shall be of such a character that even those who in the past have felt it their duty to offer criticism of the scheme shall be compelled to recognise its value and the possibilities it offers of producing results which will be both scientific and practical.

The reports on these International investigations will appear partly in the Bulletin of the Central Bureau, and partly in a separate publication.

E. J. Allen,
*Director.*

Plymouth,
*December* 1*st*, 1903.

# OBJECTS

OF THE

# Marine Biological Association of the United Kingdom.

THE ASSOCIATION was founded at a Meeting called for the purpose in March, 1884, and held in the Rooms of the Royal Society of London.

The late Professor HUXLEY, at that time President of the Royal Society, took the chair, and amongst the speakers in support of the project were the late Duke of ARGYLL, the late Sir LYON PLAYFAIR, Lord AVEBURY, Sir JOHN HOOKER, the late Dr. CARPENTER, Dr. GÜNTHER, the late Lord DALHOUSIE, the late Professor MOSELEY, the late Mr. ROMANES, and Professor LANKESTER.

The Association owes its existence and its present satisfactory condition to a combination of scientific naturalists, and of gentlemen who, from philanthropic or practical reasons, are specially interested in the great sea fisheries of the United Kingdom. It is universally admitted that our knowledge of the habits and conditions of life of sea fishes is very small, and insufficient to enable either the practical fisherman or the Legislature to take measures calculated to ensure to the country the greatest return from the "harvest of the sea." Naturalists are, on the other hand, anxious to push further our knowledge of marine life and its conditions. Hence the Association has erected at Plymouth a thoroughly efficient Laboratory, where naturalists may study the history of marine animals and plants in general, and where, in particular, researches on food-fishes and molluscs may be carried out with the best appliances.

The Laboratory and its fittings were completed in June, 1888, at a cost of some £12,000. Since that time investigations, practical and scientific, have been constantly pursued at Plymouth. Practical investigations upon matters connected with sea-fishing are carried on under the direction of the Council; in addition, naturalists from England and from abroad have come to the Laboratory, to carry on their own independent researches, and have made valuable additions to zoological and botanical science, at the expense of a small rent for the use of a working table in the Laboratory and other appliances. The number of naturalists who can be employed by the Association in special investigations on fishery questions, and definitely retained for the purpose of carrying on those researches throughout the year, must depend on the funds subscribed by private individuals and public bodies for the purpose. The first charges on the revenue of the Association are the working of the sea-water circulation in the tanks, stocking the tanks with fish and feeding the latter, the payment of servants and fishermen, the hire and maintenance of fishing-boats, and the salary of the Resident Director and Staff. At the commencement of this number will be found the names of the gentlemen on the staff.

In the summer of 1902 the Association was commissioned by His Majesty's Government to carry out in the southern British area the scheme of International Fishery Investigations adopted by the Conference of European Powers which met at Christiania in 1901. In connection with this work a laboratory has been opened at Lowestoft.

The purpose of the Association is to aid at the same time both science and industry. It is national in character and constitution, and its affairs are conducted by a representative Council, by an Honorary Secretary and an Honorary Treasurer, without any charge upon its funds, so that the whole of the subscriptions and donations received are devoted absolutely to the support of the Laboratory and the prosecution of researches by aid of its appliances. The reader is referred to page 4 of the Cover for information as to membership of the Association.

## CONTENTS OF NEW SERIES, Vol. VI., No. 4.



## NOTICE.

The Council of the Marine Biological Association wish it to be understood that they do not accept responsibility for statements published in this Journal, excepting when those statements are contained in an official report of the Council.

### TERMS OF MEMBERSHIP.

| | | £ | *s.* | *d.* |
|---|---|---|---|---|
| Annual Members . . . | . per annum. | 1 | 1 | 0 |
| Life Members . . . | Composition Fee. | 15 | 15 | 0 |
| Founders . . . | . . . | 100 | 0 | 0 |
| Governors . . . | . . . | 500 | 0 | 0 |

Members of the Association have the following rights and privileges: they elect annually the Officers and Council; they receive the Journal of the Association free by post; they are admitted to view the Laboratory at Plymouth, and may introduce friends with them; they have the first claim to rent a place in the Laboratory for research, with use of tanks, boats, &c.; and have access to the books in the Library at Plymouth.

All correspondence should be addressed to the Director, The Laboratory, Plymouth.