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North Sea Investigations.

(*Continued.*)

By

Ernest W. L. Holt,

Naturalist on Staff in Charge of Investigations.

Economic.

Scientific.

I. On the Destruction of Immature Fish in the North Sea.

In subjoining the continued results of my statistical inquiries it is necessary to occupy but little space with introductory remarks, since the question has assumed no new features. The suggestions as to size-limits embodied in the draft report of the Parliamentary Committee would, if carried into effect, leave the North Sea fishery practically *in statu quo*.

It is true that the proposed size-limits would prohibit the sale of some small quantity of fish, of several species, that now finds its way into our markets, but the quantity is so far insignificant that its exclusion would not materially affect the profits of the vessel. I have endeavoured to show that no size-limit that fails to exclude from the market so large a proportion of the immature plaice caught on the Eastern grounds as to render that area unprofitable, is likely

to have any effect in increasing the supply either of that or of any other North Sea trawl-fish. No arguments having been brought forward against these views, I am not called upon to defend them further.

Of course I am aware that the difference in the size at which maturity is attained by fish in different districts presents a great obstacle to the formulation of a limit which shall be beneficial to all districts alike. Indeed, I would go further, and say that it is impossible to legislate sensibly by size-limit unless each district is treated separately.

The Procrustean method of cutting down the sizes in all districts to suit the requirements of that wherein the fish are the smallest entirely fails to commend itself to me.

Plaice.—In the last number of this Journal (p. 124) the statistics were carried up to the end of August, 1893, but as a year has now elapsed since I commenced to take the whole number of fish landed, the figures from April, 1893, may now be conveniently recapitulated.

Month.	Total No. of boxes.	North Sea.			Iceland.	
		Total.	"Large."	"Small."	No. of boxes.	No. of "voyages."
1893.	I.	II.	III.	IV.	V.	VI.
April	10,833	10,633	7,964	2,669	200	2
May (N. Sea, less 1 day)	19,859	15,176	7,532	7,644	4,683	20
June	19,555	12,205	5,880	5,325	7,350	30
July (less 1 day)	24,680	13,304	10,585	2,719	11,376	36
August (less 4 days)	19,141	12,287	10,668	1,619	6,854	21
September (less 7 days)	9,887	9,637	9,001	636	250	1
October	16,191	16,191	15,582	609	...	...
November (less 1 day)	11,219	11,219	10,403	816	...	...
December (less 7 days)	4,570	4,570	4,483	87	...	...
1894.						
January	4,463	4,463	4,254	209	...	...
February	3,707	3,707	3,604	70	...	...
March (less 6 days)	6,673	6,673	5,484	1,184	...	...
April (less 4 days)	15,997	14,911	7,844	7,067	1,086	7

I mentioned in my last report that a certain amount of the "small" plaice which appears in the returns were landed by foreign steam-trawlers—chiefly from Hamburg, Bremerhaven, &c. These vessels, in addition to catching what they can with their own gear, occasionally buy up the catches of the small boats on the eastern grounds and bring it across to our markets. It is therefore probable enough that some of the fish so landed is derived from grounds inaccessible to large vessels, but I have not noticed any difference in the quality.

In order to arrive at the quantity landed by our own vessels it is necessary to deduct from each month, as landed by foreign steam-trawlers, the following amounts :

1893.	April	294 boxes.
	May	1642 ,,
	July	120 ,,
	November . . .	620 ,,
	December . . .	87 ,,
1894.	January . . .	200 ,,
	March	448 ,,
	April	2255 ,,

It therefore appears that the unusually large quantity of "small" landed in the winter months is almost wholly accounted for by the contributions of foreign vessels. Previous to the cholera epidemic at Hamburg in 1892 I am not aware that these large vessels devoted much attention to the small plaice; in any case they did not land them here. Since that period, however, they have frequently landed their fish at this port, and, as I am informed, at Hull also. Last summer they landed several "voyages" of large plaice from Iceland, and from time to time they bring in large quantities of haddocks; but, as a rule, "small" plaice form by far the principal item in their contributions to our market. I do not consider that the difference alluded to, viz. that some of the fish are brought from small inshore boats, is sufficient to justify the exclusion of these foreign-caught fish from the returns, which profess to deal only with fish derived from first-class vessels. A small number of boxes from the Humber and Boston deeps, caught either in small boats or in a net worked from the shore, are not included. Sixty-eight boxes of mature but very small fish from the Baltic, consigned viâ Hamburg to this market, are also excluded. They are dealt with elsewhere in the present report (p. 194).

Remembering that vessels will work the Eastern grounds only when considerable catches can be made thereon, it is possible by observing the fluctuations in columns 4 and 6 to compute roughly the number of boats diverted from the North Sea plaice fishery proper, as apart from the pursuit of exclusively small fish on the area alluded to. Considering this, and taking into account the number of days omitted in various months, it may be inferred that the supply of fair-sized fish increased considerably in May, 1893, since the totals in column 3 remain about the same in April and May, although columns 4 and 6 give evidence of a great diversion of fishing power during the latter month. The decrease of column 3 in June may be partly accounted for, I suppose, by the injurious effects of the prevailing calm on the fishing of sailing vessels, since the increase in column 6 is more or less neutralised by a corresponding reduction in column 4, and so implies but little diversion of the power supplying column 3. This column shows a marked improve-

ment in July; but though in August a still further increase is noticeable (allowing for days omitted), the augmentation of fishing power indicated by the decrease in columns 4 and 6 would seem to show that the supply available for individual boats had on the whole diminished. A further reduction of individual supply may be inferred from comparison of the different columns in September, though the total remains unaffected, or is perhaps rather higher. In October, however, the distribution of power remaining practically the same as in September, we find a very marked increase in column 3, indicating an individual supply not inferior to that of July. This confirms to some extent opinions which I have heard expressed—that the unusually warm spring and summer (of 1893) would be productive of a fine autumn supply. If any such connection exists, the only explanation that occurs to me is that the warm weather has hastened the growth of the fish, so that the annual autumnal recruiting from the small fish on the Eastern grounds has been unusually great.

In November the supply again falls, and this in spite of the landing of individual catches of from 73 to 219 boxes from the "Holman" between the 16th and 23rd of the month; but the tempestuous weather of that month will be within the recollection of every one. While several fishing vessels were lost, many were temporarily disabled, and the consequent paralysis of fishing power is a factor that must be reckoned with in addition to scarcity of fish, which itself is usually enhanced by coarse weather. The lowest ebb is reached in February, but a rapid improvement is noticeable in the succeeding months; April is the only month in which we are able to compare the statistics of two years collected in exactly the same way, and so far as the large fish are concerned, the present year (allowing for days omitted) yields rather better results than the last. The difference, however, is not very great, but there is a very marked increase in the amount of small fish destroyed, indicating that the season is earlier this year than last on the Eastern grounds. It might also be inferred, by the consequent diversion of boats to these grounds, that the individual supply of large fish showed an improvement; but the fact is that a great number of boxes reckoned as "large" contained, during the month in question, only "half-fish." These are mostly immature, but above the limit which, for reasons given in former reports, I have found convenient for separating "large" and "small." The Iceland season is also early this year, or, perhaps, I should rather say that boats have commenced to go there earlier than they did last year. The first voyage had an unfortunate termination, as the vessel ran against Filey Brigg in a fog, and became a total wreck, with a loss of several hands. Some 20 boxes of her plaice, included in the above returns, were brought

to market by a yawl, but were condemned as unfit for food. A similar fate befell a consignment of Iceland plaice which reached the market by steamer, viâ Norway, on the same date, the 11th April. They were in very bad condition, and it is doubtful whether such consignments would pay expenses in any case.

As I did not commence to collect statistics of both large and small plaice until April, 1893, it is only possible to compare the catches of 1892 and 1893 by making use of the Board of Trade returns. In the figures given for 1892 (Journal, 1893, p. 84) only the "small" are from my own observations, the boxes of other specification being derived by converting the weight given in the Board of Trade returns into boxes, and eliminating the number of boxes of "small" which appear in my own records. As it is therefore probable that some error exists in the 1892 returns, from inaccuracy of the official figures or of conversion of weight into boxes, I put forward the following results with all due reserve :

1892. Six months, May to October, total, 86,000 boxes.
1893. ,, ,, ,, ,, 125,000 ,,

The apparent increase of 39,000 boxes looks promising enough, but is considerably discounted when we find that no less than 30,000 is due to an increase of Iceland fish, leaving a North Sea increase of only 9000 boxes. Examining the columns of large and small, a rough calculation being made, as in the case of the totals, for the days omitted, we find a total of 71,000 "large" and 22,000 "small" for 1893, as against 73,000 "large" and 11,000 "small" for 1892.

The increase, therefore, is entirely confined to Iceland and "small" North Sea fish, while in "large" North Sea fish there is a deficit of 2000 boxes.

Comparing the numbers of "large" month for month in the two years, the fluctuations are much in the same proportion, the chief exception being in July and August. In 1892 nearly two thirds of the total catch of these two months was obtained in the first of them, whereas in 1893 rather more were caught in August than in July.

That plaice are actually decreasing in the North Sea is a fact so generally recognised that it hardly needs illustration, but the present scarcity may not be so apparent from figures dealing with aggregate catches as it becomes when we examine the catches of individual boats. In examining the total figures it must be borne in mind that the fishing power is enormous, our own large fleet being supplemented not only by foreigners, but by vessels hailing from other British ports, such as Scarborough, Shields, Aberdeen, Glasgow, and even Milford Haven.

The scarcity is most felt in the winter months, when, for whatever

reason, the fish are very hard to catch. Thus in the last winter a smack failed to average two boxes of plaice in ten consecutive voyages along the neighbouring coast and off Flamborough Head, an area which has the reputation of being fairly productive for the season. The matter may be further illustrated by extracts from some observations of which my friend Mr. R. Douglas permits me to make use. On the 1st February, 1893, a steam-trawler landed one plaice after ten days' fishing, on the 3rd another landed one box after eight days. On the 13th December, 1892, a steam-trawler had three boxes for fourteen days, and on the next day two similar vessels had two each for eight days. These figures are unfortunately by no means so rare as to be exceptional.

A new departure in the trawling industry has been made by the launch, during last year, of several steam-vessels designed for fleeting vessels. Their function is simply to fish, the catch being taken to market and the coal supplied by cutters. As the company to which they belong does not land its fish at this port I have no means of knowing what the results have been, but it is obvious that a steam-vessel, staying perpetually on the fishing ground, is a most powerful engine of destruction,—dangerously so, in fact, in the present state of the grounds.

Haddock.—The appended figures show the total number of boxes of "small" fish landed during the months specified :

1893.	September (less 7 days) . .	4670	boxes.
	October	8457	,,
	November (less 1 day) . .	6712	,,
	December (less 8 days) . .	5792	,,
1894.	January	5248	,,
	February	3848	,,
	March (less 6 days) . .	5363	,,
	April (less 4 days) . . .	8502	,,

On the whole the supply of "small" haddock has shown a steady increase since my inquiries were commenced, allowing for fluctuations in individual months. It has so far been impossible to extend the statistics so as to include fish of all sizes, so that I am unable to say what proportion the "small" bears to the total. During the present year, however, I have noticed large catches consisting entirely of "small," a condition not previously observed. So far as I know, the general supply shows no marked decrease.

Cod.—The figures relate to trawled codling, with the restrictions explained in previous reports :

1893.	September (less 7 days) . .	2123	boxes.
	October	2939	,,
	November (less 1 day) . .	2491	,,

1893.	December (less 8 days) . .	2730 boxes.
1894.	January	3096 ,,
	February	2607 ,,
	March (less 6 days) . .	2363 ,,
	April (less 4 days) . . .	1093 ,,

Examination of the returns given in the two previous numbers of this Journal (1893, p. 87, and 1894, p. 128) shows that whatever decrease took place in the summer as compared with the winter months of 1893 is much more striking in regard to the late than to the early months of that year. I drew attention (Journal, 1893, loc. cit.) to the large catches that were made on certain grounds in the winter of 1892–3, and expected that a similar condition would obtain during the next winter. There has been, however, no congregation of small codling on those or any other grounds at all comparable to that of the previous winter. It is true that the aggregate number landed is considerably in excess of last year's supply, but the fish have been brought in in small quantities. Considerable catches first became apparent in November, 1892, and continued to appear until March, 1893. The principal grounds, it will be remembered, were the Yorkshire Hole, and, later on, Flamborough Head. Now a considerable number of boats were working the Hole after the gale of November, 1893, as a fair supply of soles had appeared there; but there was no quantity of codling. In fact, the first record I have of any considerable catches of codling is in February. Seventy boxes is the largest "voyage" (as against 122 last year), and 16 boxes is quite exceptional. "Voyages" of from 60 to 23 boxes are recorded between the 2nd and 5th of March, and thereafter no catches of any magnitude were observed. In all cases the best catches were made during the past winter off Flamborough Head, none occurring at the Yorkshire Hole or any of the other grounds mentioned. The absence of these shoals of codling is evidently not due to scarcity, it is simply a failure to congregate as they did in the winter of 1892–3, and it seems quite possible that the gale of November may have had something to do with it. The fish did congregate, as in the former winter, later in the season off the Head, though in less numbers, and, as our experience is limited to two years, it is not possible to say whether the earlier congregation is a normal feature or the reverse. Answers to inquiries I have made have been too vague to be altogether reliable.

Complaints by deep-sea liners were very general in February of the present year as to the scarcity of cod on the off-shore grounds. The cause, they supposed, was the prevalence of westerly winds, which had apparently the effect of setting the fish into the shore, the best catches being made near the coast. The fish, however, seem to

have made their appearance off Whitby in the same month, though the success of different boats in their pursuit showed considerable variety.

II. On the Territorial Fishing Grounds of Scarborough and its Neighbourhood.

In July, 1893, at the invitation of Professor M'Intosh, I took part in some trawling operations which were being carried on by the steamship "Garland" in the neighbourhood of Scarborough, with the object of obtaining soles to stock the Scotch Fishery Board's hatchery at Dunbar, &c. I was thereby afforded an excellent opportunity of making myself acquainted with the condition of the inshore fishing grounds, which, two years previously, had been closed to trawling by an enactment of the North-Eastern Sea Fisheries Committee.

It was claimed by those who had chiefly interested themselves in procuring the bye-law that a considerable improvement had already manifested itself in the local line-fishery, but on that point, from want of any personal acquaintance with the pre-existing conditions, I can offer no independent opinion. I was invited, however, by Mr. J. Woodall, vice-chairman of the committee, to put forward any conclusions which my observation of the present condition of the grounds might suggest as to the desirability of the retention or abolition of the bye-law.

I propose in this note to give a very brief acount of the investigation, and of the conclusions derived therefrom, and I take this opportunity of thanking Mr. Woodall, not only for hospitality extended to myself during my stay at Scarborough, but for a great deal of valuable information as to the fisheries of Scarborough and the surrounding district.

The grounds examined extend along the coast for a distance of a little over ten miles, as the crow flies, from Hayburn Wyke to Filey Brigg. Scarborough lies about midway between these two points, forming the apex of a very gentle general incurvation of the Yorkshire coast-line in this district. The land descends everywhere in rather abrupt cliffs to the beach, which is rocky in general character, though here and there are patches of smooth sand at the water's edge. Beyond low water mark a considerable stretch of land rock separates the area suitable for trawling from the margin, except at Cloughton, where a very narrow strip of sand extends almost to the head of the Wyke, or small bay which bears that name. Beyond the land rock, the existence of various isolated rough patches makes the trawling ground rather intricate, but we were fortunate in obtaining the services of an efficient pilot, and suffered little or no

damage to the nets. It may here be remarked that the proper charting of the inshore waters for piscatorial purposes is a duty that might be very profitably undertaken by the fishery authority under whose jurisdiction they fall, since the Admiralty authorities take no account of such physical characters of the bottom as do not interfere with navigation, and the information available from existing charts is, in consequence, lamentably meagre from the point of view of the fisherman or of those concerned in the study of fishery problems.

Speaking generally, our hauls were made along the edge of the land rock, or following the trend of the coast a little further out; but it is also possible, by avoiding certain outlying rocks, to trawl right out to a ground beyond the three miles limit. This ground extends practically from Whitby to Flamborough Head, but we are not at present concerned in discussing its condition. All the grounds I have mentioned are collectively termed the Scarborough "in" grounds. The "off" grounds bearing the same name lie about thirty miles seawards.

The grounds close inshore may for the present purpose be classed together, since we found no great variation in their condition or products, but one of them calls for a little separate notice. This is the Cloughton Wyke Ground, consisting of the narrow strip of sand already alluded to. It has long been famous as a sole ground at the right season, and used to be worked as follows:—At the commencement of the ebb the boat would be taken as far in as the water allowed, the trawl shot and hauled out of the Wyke, thence about two miles offshore and north to another little inlet called Hayburn Wyke. On the flood the *modus operandi* would be reversed, but by far the most soles would always be taken on the ebb. According to my information the soles were chiefly taken near the head of Cloughton Wyke itself, and Mr. Woodall tells me that they were found to feed on a species of Nereis which occurs there in great numbers. I am also informed by Mr. G. L. Alward, on what he considers to be reliable authority, that soles have been dug out of the sand at low water in the same wyke, a statement which the burrowing habits of soles in captivity go far to support.

My own experience of Cloughton Wyke is confined to a single haul, made during the daytime in very clear water. We did not catch any soles, and I am assured that it is only possible to catch soles there in daylight when the water has been rendered turbid by heavy weather from the eastward. Moreover the season for soles had hardly begun. The ground was clean except for a little *Flustra foliacea* and a few hydroids. The fish caught differed in no respect from those taken on the other parts of the inshore grounds. The

ground lying to the south of Scarborough was also fairly clean, but elsewhere a considerable amount of rubbish was met with. The commonest hydroid in this, as in any other part of the North Sea known to me, is *Hydrallmania falcata*. Seaweeds are represented chiefly by *Fucus serratus* (near the rocks), and various red weeds (Delesseria, &c). Usually we caught a few edible crabs, and sometimes a lobster, but of smaller Invertebrates other than hydroids and polyzoans my notes mention the occurrence of only *Portunus holsatus*, *Corystes cassivelaunus*, and *Asterias rubens*.

My records deal, in all, with thirteen hauls, and the fish taken on the different grounds may be treated collectively, as, on the whole, one ground yielded much the same as another. Soles, which formed the object of the "Garland's" operations, were decidedly scarce, sixteen and a half pairs being the most obtained in any one night's fishing. They were, however, all fine fish, no immature specimens being taken. We were told that it was too early in the season to get many soles in the trawl, though good catches were being made by the liners. I cannot pretend to say why these fish should be more readily caught on a hook at this time of the year, since we were working practically the same ground as the liners; but such seems to be undoubtedly the case, and it is only one amongst the many features of marine biology which our ignorance at present relegates to the category of mysteries. One can understand that directly after spawning the fish are more hungry, and so take a bait more readily than at other times; but that is far from explaining why they are more successful in evading a trawl at that season. It seems probable that the reason is to be sought in some sessional change in the organisms on which they prey, or in the habits of such organisms. Be this as it may, I record the simple fact on authority that appears to me to be entirely reliable.

Neither turbot nor brill find a place in the list of fish caught, though at one time I am told that the former species was not infrequent in the bay. There is only mention of one lemon sole, a specimen of 5 inches.

In each of two hauls about twenty plaice are recorded; on all other occasions the number was considerably less, so that this fish cannot be regarded as at all numerous during the time we worked. On one occasion we took three of 17 inches; specimens of 14 and 15 inches are mentioned in two hauls; in all the rest the size was smaller, the minimum being 5 inches. Common dabs were only moderately abundant, and most were small. The only other flat-fish taken were three specimens of *Solea lutea*—about two or three miles off the Castle. In Eagle Clarke and Roebuck's "Yorkshire Vertebrata" this species is included as "reported as having been taken

at Whitby." Beyond this I find no record of its occurrence on the north-east coast of this country. I know that it occurs regularly on the Well Bank to the south, and it is mentioned by McIntosh as common at St. Andrews, while Edwards says that it occurs also on the coast of Banffshire. The present record points to the probable correctness of that from Whitby, and no doubt the species is generally distributed along the eastern coast. There is, however, no evidence of its occurrence in estuarine waters on this coast.

Turning to round-fish, cod of any size were extremely scarce. One fine fish was taken, and on several occasions we got a few small ones, 5 to 7 inches long. Haddock varied in number, but were comparatively scarce except in two hauls, when we took a great number from 5 to 9 inches long. Very few on any occasion exceeded a length of 12 inches. Whiting were much more abundant as a rule, and varied in size from 3 to 14 inches. In one haul, when the cod end was enclosed in an outer bag of fine mesh, a considerable number less than 6 inches in length were caught, but when the outer bag was removed very few of these very small fish came aboard. I noticed also a decided improvement in the quality of the fish towards the end of our operations, since, while in the earlier hauls immature specimens (*i. e.* less than 9 inches long) were in the majority, the numbers were equalised later on, and sometimes the mature fish were actually the most numerous. It was evident that a movement was taking place amongst the larger fish, having the effect of driving the small ones elsewhere, since I have found that cannibalism is highly developed in this species. In reporting on the Humber fisheries in previous numbers of this Journal I have already adverted to the great sessional irregularity of the movements of whiting in inshore waters, and can only now repeat that the conditions at a given time in one year cannot be relied on to hold good for others.

Gurnards were always fairly abundant, but the number of small always exceeded that of the large, except in the last haul but one, when the large fish were in a decided majority. These fish, therefore, appeared to be undergoing a movement similar to that noticed among the whiting. Several very small herring and a few thornback rays were taken, completing the list of food-fishes, unless we include the monk or angler in this category. Several of the latter were taken, none of very large size. Unsaleable fishes were represented by a few "hard-heads" (*C. scorpius*), "bull-routs" (*A. cataphractus*), lesser weevers, and dragonets.

To review the above results briefly, we may say that the investigation showed that the fish forming the object of a legitimate trawl-fishery were confined to a few whiting, gurnards, and dabs, a very moderate quantity of soles, and an infinitely minute number of plaice

and cod. On the other hand, a rather large quantity of undersized haddock, whiting, and gurnard were thereby destroyed; while the destruction of small plaice, though not great in actual numbers, was very considerable in regard to the local supply of this species.

It is evident, therefore, that there is a *primâ facie* case against trawling on these grounds at this time of the year, merely because the waste is in excess of the products. We may consider the matter from another point of view, viz. whether the consumer can be adequately provided by means other than trawling. This question may be so limited as to deal only with the soles, since these are the only important product which cannot obviously be obtained without encroaching on the three-mile limit; and here we find an answer in the affirmative. While our best night's fishing yielded only 16½ pairs, and our catch was usually much less, 25 and 18 pairs were respectively taken by two cobles line-fishing on these grounds during one night of our stay at Scarborough. Such success was not exceptional, and I do not think a coble ever caught so little as we did on any one night. That the catches of the "Garland" are no fair test of what may be achieved by trawling is an objection which may be urged with some show of reason so far as concerns any one night's fishing, since it is well known that a sailing vessel will trawl more soles than a steamer if both are fishing side by side over the same ground. But when we consider the dependency of a smack on the wind, and the intricacy of these particular grounds, I think it may fairly be assumed that a sailing vessel would not have materially improved upon our aggregate catch during the week. I therefore consider that the interests of the consumer can be sufficiently served by line-fishing.

Policy in fishing matters is too often degraded to the merely social aspect of the case, viz. the relative claims of local and other fishermen, or of the local liners and trawlers when the two industries co-exist in the same fishing community. With this I have nothing whatever to do, but may remark that, according to my own experience, one class is burdened with about as much providence and public spirit as the other.

I did not neglect, while at Scarborough, to make inquiries as to the effect which the territorial restriction of trawling was thought to have had on the inshore line-fishery, but as evidence on this subject was given before the Parliamentary Inquiry, in some cases by the men who were my own informants, I need only refer to the matter very briefly. It was asserted that the sole fishery had very greatly revived since trawling was forbidden in these waters, and I have no doubt that this is the case. It requires no argument to show that

trawling and lining cannot be carried on together in one limited area without injury to the latter industry.

As to the haddock fishery, I was told that the trawlers still encroach so much on the territorial haddock grounds that not much benefit has been felt by the liners. These grounds lie further out than those on which the soles are chiefly caught, so that the sole-fishery is not affected by this poaching. The matter is therefore of less general importance, but owing to the amount of undersized fish on the ground it could not but be beneficial to enforce the bye-law in its entirety.

III. The Blonde (*Raia blanda*, Holt and Calderwood, MS.), a Species hitherto confounded with *R. maculata*, Montagu.

In collaboration with Mr. Calderwood, I have been engaged, since I first entered the Association's service, in attempting to revise the British Rajidæ, and one result of our efforts has been the discovery of a species which has hitherto escaped separate description. It seems, therefore, advisable to put forward a brief diagnosis at once, reserving a full description to another occasion.

The species was first met with by one of us on the west coast of Ireland, but the large size of the only specimens obtained rendered it impossible to define it in a satisfactory manner. Recently, however, we have had the good fortune to obtain a nearly complete series from the North Sea, and there can be no doubt of its distinctness.

In the appended diagnosis especial stress is laid on those points which serve to distinguish the species from the closely allied *R. maculata*.

Size.—Reaches a width of over 30 inches; males become sexually mature at a width of 24 inches or more; the egg-purse about $5\frac{1}{2}$ inches long, exclusive of attachment processes.

Shape.—Anterior profile obtusely rounded, the extremity of the snout projecting in a short *semicircular* process, except in adult males, where it is more or less conical, *never sharply pointed.* Anterior margin with two salient curves, varying in degree according to age and sex. Tail rather broad anteriorly, and distinctly flattened in old examples.

Proportions.—Width of the disc about twenty-five per cent. greater than its length, and about thirty per cent. less than the total length; the tail slightly the longer in males. The length of the snout from $4\frac{3}{4}$ (in young) to nearly $5\frac{1}{2}$ times (in adults), and the distance from the tip of the snout to the coracoid from $2\frac{1}{2}$ to $2\frac{6}{11}$ times in the width of the disc. The distance between the nostrils

equal to or rather less than their distance from the tip of the snout. The length of the eye from $1\frac{1}{2}$ (young) to 2 times (adults) in the distance between the supra-orbital ridges, which is equal to, or in large examples greater than, the combined length of the eye and spiracle.

Dentition.—Teeth small; obtuse in females and immature males, sharply pointed in adult males; arranged in from less than sixty to over ninety rows in the upper jaw.

In specimens about	9	inches across the disc about	66	rows.	
„ „	16	„ „	74	„	
„ „	23	„ „	78	„	
„ „	29	„ „	93	„	

Spinulation.—*Upper surface.*—A few spines at the end of each orbital ridge and along the rostrum in young examples; the former frequently, the latter always wanting in adults. A spine on each shoulder in young examples may persist until a large size is attained. Exclusive of sexual alar spines, the other large spines typically in a median row from the head to the dorsal fins, the last spine between the dorsals, and in a lateral row on each side of the tail. These rows are formed by a young and adult series, the young series of the lateral caudal rows being frequently lost before the old series appears. The latter usually very imperfect in males, but double in its anterior region in females. The young series of the median row often imperfectly replaced, except on the tail, in either sex. Very large examples may have lost nearly all the adult median series. Of the median series in young examples, three or four, *always more than two,* spines are in front of the pectoral region.

Small asperities confined to the pre-pectoral region of the disc in young examples, *extending all over the disc* in half-grown fish of either sex and in adult females. Gill region and central area of the pectorals smooth in adult males.

Under surface.—Young examples (9 inches across disc) with a *narrow border of very closely set asperities along the anterior margin,* not extending to the angles of the pectorals. A similar border, in rather larger examples, along the edge of the tail. Under surface otherwise smooth. Some asperities about the region of the coracoid and anterior part of the abdomen in half-grown examples of either sex, and about the general surface of tail in females. The anterior border increases in width with age, and in old males, rarely in old females, extends backwards over a great part of the snout. Adult females in addition have scattered asperities over the whole under surface, except the outer parts of the paired fins.

Colour.—The upper surface a pale fawn, may incline to chestnut, rarely to cold sepia; usually darker over the abdomen and lighter on the head than elsewhere. Thickly sprinkled with small dark

brown spots, rarely exceeding ¼ inch in diameter, *which extend to the margins of the disc.* A number of small pale rounded areas, with a certain bilateral symmetry of arrangement, on the wings, each area surrounded by a ring of spots not larger than the rest, and never coalescing with each other; occasionally a central "pupil" spot. Under surface white, sometimes a little brown on the tip of the snout.

* * * * * * *

It will be seen from the above that the new species differs from *R. maculata*, Montagu, in many points. Comparing specimens of equal size, the eye is smaller, the teeth smaller and more numerous, and the distance between the snout and the coracoid greater in *R. blanda* than in *R. maculata*.

The difference in spinulation is very strongly marked, since *R. maculata* never attains anything like the same development of the asperities of the upper surface, as is present in half-grown *R. blanda*. The anterior border of asperities on the under surface is also entirely wanting in *R. maculata*; the greatest degree of ventral spinulation attained by that species throughout life taking the form of a few scattered asperities on the snout, about the pectoral region, and on the tail. Moreover the maximum width attained by *R. maculata* hardly exceeds 20 inches, and its egg-purse only measures about 2½ inches exclusive of attachment processes. Though the size of the spots on the upper surface is subject to variation, they are always larger and more numerous than in *R. blanda* of the same size, and never extend to the margins of the disc. In some examples they are altogether absent. There may or may not be a single conspicuous ocellus on each wing, but if present it is always surrounded by a ring of largish spots, which are frequently more or less coalesced; such an ocellus is always larger than any of those exhibited by *R. blanda*, and though other pale areas may exist on the wings of *R. maculata* they are never at all distinct.

There are a number of spotted rays found in the South Atlantic and Mediterranean, which all appear to possess the anterior border of ventral asperities, but are yet specifically distinct from *R. blanda*. The species which most closely approach it are *R. asterias* (Müll. and Henl.) and *R. punctata* (Risso); but of these the former, besides differing conspicuously in colour, has a very much larger mouth, while the latter, a very small species, has much larger teeth than *R. blanda*.

A species described under the name of *R. brachyura* by Lafont (Soc. Linn. Bordeaux, xxviii, 1873, p. 503, pl. xxv) may possibly be identical with *R. blanda*, but the description is very meagre and the figure primitive. It is impossible from the context to be certain whether a statement that there are no "aiguillons" on the ventral

surface precludes the presence of such asperities as are present in *R. blanda;* while the figure, so far as it resembles anything that is likely to have an actual existence, is more like *R. asterias* than *R. blanda.* It having proved impossible to procure specimens of a spotted ray from the same locality, we are compelled to pass the species over as insufficiently defined.

Turning to British authors, Montagu's descriptive remarks apply only to the smaller British species of spotted ray, the varieties he mentions being merely colour phases. He states, however, that *R. maculata* grows to a larger size than *R. clavata,* which is not the case in any district with which I am acquainted. It is therefore possible that he knew the larger species, but did not recognise it as distinct. However, as his description is obviously based on the smaller, his claim as sponsor thereto holds good.

Day's figure of *R. maculata* is undoubtedly taken from an immature male of *R. blanda,* which appears from the scale given to have been about 25 inches across the disc. The author remarks that in this specimen the spots were rather closer together than usual, but the drawing does not strike one as a very successful illustration of either species. The description given in the text refers chiefly to the smaller species.

Couch evidently selected a specimen of *R. blanda* for special description, but his general remarks apply to both species, and his figure specially to neither, though probably taken, at least as far as the spots are concerned, from *R. maculata.* Subsequent to the publication of his work on the British fishes, the late Dr. Day described as new to Britain a spotted ray which he considered to be identical with *R. punctata,* Risso. It was stated, possibly by a clerical error, that the teeth were larger than those of *R. maculata.* The identity of the specimen is now lost, but the Day collection, now in the British Museum, contains a small spotted ray, which bore no label when received at South Kensington. It is undoubtedly a young example of *R. blanda,* but it remains uncertain whether it is the specimen recorded as *R. punctata.*

But if our ichthyologists have hitherto failed to distinguish between *R. maculata* and *R. blanda,* the same reproach cannot be urged against our fishermen and fish merchants. Under the names of Homelyn and Blonde, or Blund, respectively, these two species have long been recognised as distinct at Grimsby, and presumably at the other great fishing centres of the North Sea. It is true that, owing to the scarcity of young blondes, many are unable to distinguish the latter from homelyns, but certain specific characters are well enough known to those specially engaged in the skate trade. The name "blonde" is said to have been derived from the Belgian

fishermen, with what truth I know not; and in naming the species *R. blanda* we have made use of the Latin epithet which assimilates most closely in sound to the vernacular name in general use.

In conclusion we may be permitted to express our indebtedness to Dr. Günther for advice and references, and especially for invaluable aid in the comparison of specimens at the British Museum. Indeed, I may add that it was chiefly at his instigation that those inquiries were instituted which have now resulted, as I trust, in finally establishing the distinctness of the two species.

IV. The "Recessus Orbitalis," an Accessory Visual Organ in Pleuronectid Fishes.

I have applied the above name to a structure described in a paper read before the Zoological Society, of which the present remarks are a brief abstract. It first came under my notice when examining the cephalic anatomy of a common sole, but as I could find no mention of it in Cunningham's Treatise on that species, I supposed that the specimen before me might be exceptional. It proved, however, to occur regularly, not only in the sole, but in all other Pleuronectids which I examined, viz. the halibut, long rough dab, brill, plaice, flounder, and lemon "sole." The material at my command proving unsuitable for a study of its development, I am unable to form any very valid opinion as to its homologies, and can only put forward what I know of its condition in the adult.

The *recessus* in those species in which it is most conspicuously developed consists of a diverticulum of the membranous wall of the orbital cavity. It is sac-like in form, with very delicate membranous walls, except where the latter are traversed by anastomosing muscular bands. Such bands may also cross the lumen of the sac, and may even form more or less complete septa. The *recessus* of the lower eye lies below the skin immediately behind the eye, occupying a space bounded by the anterior face of the superficial jaw muscles, the backward continuation of the interorbital septum and the membranous wall of the orbital cavity. With this cavity it communicates by one or more rather large openings with thickened rims, and frequently by other smaller openings, the whole number being rather close together, and variable within the limits of a single species. In the brill the *recessus* of this eye is in the form of a conical process of the membranous wall, of which only the apex is strengthened by internal muscular apparatus. In the halibut there is no definite sac in connection with the lower orbit, but a portion of the membranous wall is differentiated by the development of numerous interlacing muscular bands, backed by very delicate mem-

branous sacculi. The condition first described, actually met with in the plaice, is sufficiently applicable to the other species mentioned.

The *recessus* of the upper eye is in all cases a definite sac, always larger than its fellow of the lower eye, and always situate on the blind side of the skull, and to some extent overlaid by the superficial jaw muscles of that side. It communicates with the upper orbital cavity by a narrow neck, which passes through the large foramen between the pseudo-mesial process of Traquair and the parasphenoid. It is essentially similar in internal structure to the fully developed organ of the lower eye. Its shape depends merely upon its topographical relationships.

In the fresh condition the *recessus* of either eye, when sac-like in form, is colourless and quite translucent, except for a slight milky opacity where the muscular bands are most numerous. It is, as may be supposed from the description of its internal structure, highly elastic, and is filled in life by a colourless fluid also present in the orbital cavity. It is rather richly supplied with blood-vessels, distributed on the inner face of the sac when such is present, and we may assume, as in the case of peritoneal and synovial cavities, that the fluid is deposited by mechanical filtration through the blood-vessels. In any case I have been unable to detect any special secretory apparatus in the epithelium of its walls. The only source of innervation which I have discovered is from the V. cranial, whether from sensory or motor roots I am as yet unaware.

The fluid coagulates after a time into a milky white plasma, finely granular in microscopic preparations, and taking on a faint pink stain from borax carmine, but the *recessus* retains its elasticity for some considerable time after death. Thus, if the eye is pushed inwards, the fluid is forced into the *recessus*, which thus becomes enormously distended; but as soon as the pressure is relaxed the *recessus* contracts, and the eye rises to its former level.

It will be familiar to those who have observed the habits of flat-fish in aquaria that the eyes are normally protracted to a considerable degree. If the fish is frightened by placing some object near the eyes, the latter are immediately withdrawn into their sockets, while a corresponding inflation may be observed in the region of the *recessus* of the lower eye—the only one which can be seen. As soon as the object of terror is withdrawn the eyes rise again. Now there is no protracting apparatus in the muscles of the eye, and it is evident that the mere relaxation of the oblique and recti muscles would be quite insufficient to protract so heavy an organ as the eye to the degree actually attained. It is therefore evident that this result is attained by the pressure of the fluid contents of the orbital cavity, and that the *recessus* is functional in

regulating these vertical movements,—in affording an outlet to the fluid of the orbital cavity when the eye is withdrawn by the contraction of the recti and oblique muscles, and in protracting it when these muscles are relaxed by driving back the fluid into the cavity. Its action appears to be almost if not wholly involuntary; but though one might expect to find a connection with the sympathetic system, I have not succeeded in doing so.

According to my observations, limited to Pleuronectes, Solea, and Rhombus, the power of protraction is possessed in degrees corresponding to the order in which I have named these three genera, and the *recessus* is developed in the same degree. That the organ of the upper eye is always the larger is explained by the condition of the orbital cavity. That of the lower eye is in part bounded only by loose skin, which allows some play to the elasticity of the undifferentiated part of the membranous wall when the eye muscles are contracted, and is also sensible to the pressure of the external element when the muscles are relaxed. The upper orbital cavity, however, bounded as it is by the skull and firm dorsal muscles, is wholly dependent on its accessory organ as an outlet for the fluid. The eye, in fact, could not possibly be retracted if no *recessus* were present. The great inequality in the accessory organs of the halibut, which exhibits the minimum development of the lower and the maximum of the upper *recessus*, is probably due to the convexity of the head, whereby the lower eye is set in a higher plane than the upper, which is also much nearer the dorsal ridge than in the other species studied. Hence it is evident that the pressure required to raise both eyes to the same level must be very unequal, but I have no means of saying from actual observation that the eyes are protracted to the same plane in life.

A pouch-like diverticulum of the membranous wall of the orbital cavity was discovered many years ago by Dr. Günther in *Chorinochdismus dentex*, one of the Gobiesocidæ. So far as I can tell from examination of the organ in a specimen that has been a very long time in alcohol, it corresponds well enough to the *recessus* of flat-fishes. Dr. Günther conjectured that it might represent a *saccus lacrymalis;* but though I am loath to speculate on this subject without a knowledge of its development, I am bound to say that the relationships of the organ to the orbital cavity do not appear to point to this homology. The organ lies between the eye and the maxilla, but the different position of the *recessus* of the lower eye in a flat-fish is only such as would be brought about by the rotation which we know to take place in the eye of a metamorphosing Pleuronectid larva. A difference in the levels of the eye in the British Museum series of *C. dentex* suggests that the function of the organ is similar

to that which I have demonstrated in the case of the *recessus ;* and very probably this structure, which I suspect to be no more than a specialised portion of the membranous wall, not homologous with any known visual organ in higher animals, may prove to have a wider distribution than is at present known to us.

V. On an Adult Specimen of the Common Sole with Symmetrical Eyes, with a Discussion of its Bearing on Ambicoloration.

Under the above title a detailed description of the specimen in question was communicated to the Zoological Society at a recent meeting. The fish is a female 15 inches long, differing from a normal specimen in no external feature of note except that the left (normally the upper) eye is nearly opposite to the right. The eye is partially withdrawn below the skin, and its vision doubtless must have been to some extent further impeded by the sensory filaments, which extend right up to the periphery of the cornea. Still, without doubt, the fish could see reasonably well with this eye. The left side is colourless, and the effect of the eye, which had the iris of the normal colour, peering out from the dead white surrounding region, was very striking in the fresh condition. On examining the skull it was found that the union of the left ectethmoid and sphenotic into the " pseudo-mesial process " of Traquair had taken place as usual, and had taken on its usual fibrous connection with the large ligament bone which underlies the interneural spines of the anterior part of the dorsal fin. The abnormality of the skull was, in fact, limited to a slightly less development of the left ectethmoid, especially of its anterior spur, and the greater size of the very variable foramen which exists between the pseudo-mesial process and the parasphenoid. This foramen normally gives exit to a cranial nerve, and puts the left *recessus orbitalis* into communication with the left (or upper) orbital cavity ; but in the specimen before us it is traversed by the muscles and the optic nerve of the left eye. The muscles have precisely their normal attachment, and the left ectethmoid has undergone the normal rotation. The eye rests internally against the pseudo-mesial process, and the general arrangement of the parts suggests that it has been drawn by the rotation of the attachment of the oblique muscles as far inwards as the interposition as the pseudo-mesial process has permitted it to go.

The question of ambicoloration is dealt with at some length in the paper, but the exigencies of space only permit me to notice a few points. In the first place it is evident that the occurrence of a normally coloured flat-fish with practically symmetrical eyes renders it evident that there is no necessary connection between the ambi-

colorate condition and the partial arrest of the migration of the upper eye met with in so-called "Cyclopean" examples. In making full reference to the recent important memoir of Messrs. Cunningham and MacMunn on the *Coloration of the Skin of Fishes* (Phil. Trans., 1894, p. 765), such additional material as I have examined points to a general acceptance of the opinions on ambicoloration therein formulated, but several minor details require a few words. Thus the restriction, apparent from the examples studied by these authors, of pigmentation of the lower side to the region posterior to an imaginary line drawn through the pre-operculum, in partially ambicolorate but structurally normal turbot, does not hold good in the case of one which has recently come into my hands. No malformation is apparent, but the anterior border of the continuous pigmentation is formed by a line which passes from the origin of the dorsal to the angle of the pre-operculum, and thence forward again across the lower part of the gill cover to the anterior end of the isthmus. In addition, the maxilla and a great part of the mandible are also coloured. Accordingly, while admitting that Cunningham and MacMunn's limitation covers the great majority of cases, we must hold that any degree of ambicoloration, short of completeness, may occur in the turbot without apparent structural abnormality.

The authors note that reliable records of the "Cyclopean malformation" are limited to certain genera and species, which do not include the sole, but are unable to discover any "correlation between the occurrence of this malformation and any peculiarity of the species in which it occurs." So far as the sole is concerned, this species has a skeletal peculiarity in the form of a great blade-like ligament bone interposed between the base of the front part of the dorsal fin and the top of the skull, which is not present in any of the genera in which the malformation has been observed. Taking into consideration the relationship of the parts concerned in the malformation, I suggest the possibility that this feature may supply the missing correlation. It is also possible, and perhaps more likely, that the burrowing habits of the sole would be fatal to the survival of a "Cyclopean" example of this species, since the length of the "hook" necessitated by the great forward extension of the dorsal would be a serious impediment to it, while all available evidence supports the opinion of the authors that their abnormal flat-fish do not differ at all in habit from their normal brethren.

The authors note the frequent occurrence in the brill of a form of ambicoloration in which spots of pigment occur in a series along the interneural and interhæmal regions of the lower side, and Bateson (in a communication to the Zoological Society which I have not yet in print) has pointed out that these spots are symmetrically arranged

with regard to the numbers of the dorsal and anal fin-rays. I not find it stated, however, that these spots are obviously the su vivors of those which are so conspicuous in the metamorphosing lar of nearly all flat-fish, and which occur, moreover, in the larval con tion of many round-fishes. Further, the same series of spots a retained throughout life on the ocular side of some of the small Pleuronectids (*e. g. Rhombus norvegicus*), and I am strongly opinion that the frequency of this form of ambicoloration in the br points to atavism as an important factor in ambicoloration general Messrs. Cunningham and MacMunn cite a difficulty in the way of t interpretation of atavism, which I am unable to appreciate. It is th the "symmetrically vertically swimming ancestor of the flat-fish must have had "an unpigmented white or silvery ventral surface, other symmetrical fishes have," whereas in an ambicolorate flat-f the dorsal and ventral regions are equally pigmented. But vertica swimming fishes are not all pale on the under surface, such forms Platax and Dascyllus, in remotely related families, being as da below as above; and it is surely reasonable to suppose that t flat-fish of to-day were derived from high laterally compressed fish such as these, rather than from round-fish of the ordinary type. Ev flat-bellied round-fish living at great depths may be as dark, or dark on the belly than on the back, as in the case of *Macrurus æquali* and I do not see why the fact, so ably demonstrated by Cunningha that the colourless side of a flat-fish may retain the power of pigme production under favourable conditions of light, should not sugg to us that the pale ventral surface of a round-fish may be potentia darker, or even as dark as the dorsal region.

Another point which appears to me to distinctly hint at atavi as a factor in ambicoloration is the constant or very usual co-existen of what one may term "ambiciliation," *i. e.* the dermal armature much more equally developed in ambicolorate than in norma coloured flat-fish. It is difficult to see how this can depend on t light, while it is quite intelligible that any reversion of the der should react equally on the colour and the armament.

VI. The Reproduction of *Caranx trachurus*, Linn., the Scad o Horse-mackerel.

In my paper on the eggs and larval and post-larval stages Teleosteans taken during the survey of the west coast of Irela ("Sci. Trans. R. Dub. Soc.," vol. v, ser. 3, p. 9), I included so notes on the intra-ovarian egg of this species, as to the developme of which no previous information was forthcoming.

The material then at my disposal seemed to justify the conjectu

that the ripe egg would be found to be pelagic, and similar to that of the mackerel, only smaller.

I am now able to describe the ripe unfertilized egg, having obtained a number of spawning females from the North Sea on the 19th May, 1894. Ripe males were obtained on the same day, but the milt appeared in bad condition; at all events, an attempt at artificial fertilization proved unsuccessful.

The fish, which were stated to have been caught on the previous day, appeared perfectly fresh, and on pressing those which appeared to be gravid the spawn was readily discharged. Somewhat to my surprise, the ripe ova were in most cases accompanied by a great number which were still opaque, though only gentle pressure was applied. When only ripe ova were ejected the whole mass had a distinctly yellowish colour, which I subsequently found to be caused by the fact that the oil-globule is usually of a bright orange colour to the naked eye. Under the microscope, whether by reflected or transmitted light, the globule appears cupreous. In the spawn of one individual the globules were practically colourless.

The eggs, for the most part, were not spherical, but were quite translucent, and floated buoyantly in the *estuarine* water of the Cleethorpes tanks. I estimated the diameter, in the spherical condition, to vary from 1·03 to 1·09 mm. The diameter of the oil-globule, when only one was present, varied from ·26 to ·27 mm., but some ova, when first extruded, exhibited two or three smaller globules which soon fused into one. *Motella mustela* and *Trigla cuculus* show a similar, if less rapid, fusion of the globules after deposition, and the last-named species also illustrates a similar variation in the coloration of the globules.

The zona, in the species under discussion, is very thin, and is sparingly and rather irregularly dotted with minute vesicle-like markings—a character noticeable in the newly deposited ova of many Teleosteans.

The chief peculiarity occurs in the yolk, which in the ova that seem to be ripe is perfectly colourless and translucent, and divided throughout its substance into a number of segments of varying size. The segments are mostly more or less rounded in outline, and the general appearance can be more aptly compared to that of a mass of small bubbles than to anything else. Fig. 1 shows the surface of such an ovum. It will be noticed that the segments do not overlie any part of the oil-globule, which appears invariably to occupy a small area of unsegmented yolk-substance. In most ova this area is confined to the immediate neighbourhood of the globule, but in one it occupied at least one third of the whole yolk mass. The segmented area was evidently encroaching by the formation of fresh segments,

as during the time I had the ovum under observation, a vesicle which appeared at first to be united by a narrow neck to the undifferentiated

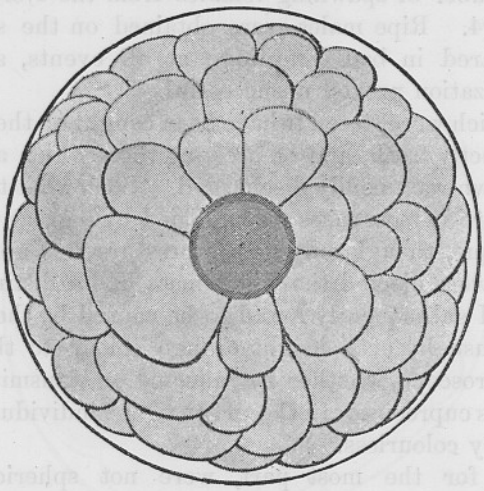

FIG. 1.—Unfertilized egg shortly after extrusion.

region became entirely separated from it. The process was probably taking place over the whole area, but it was only possible to observe the final constriction in the case of this particular segment, as none of the others were in profile. I conclude that the formation of the yolk segments takes place after the hyaline enlargement of the ovarian egg has manifested itself, and, so far as my observations go, it appears to extend gradually from pole to pole. I am inclined to suspect that it may extend more rapidly along the periphery, since in examining some ova immediately after extrusion I failed to satisfy myself that the central region was segmented. Others, however, at the same stage, and all older living ova examined, were segmented throughout.

I attempted artificial fertilization, but do not think it was successful. Forty-eight hours later all the ova were dead, except a few kept in a vessel to which no milt had been applied. These last presented the appearance shown in Fig. 2. A very slight perivitelline space had appeared, and there was a small and slightly opaque blastodermic cap : the character of the yolk was unchanged, and the eggs still floated.

The dead ova in all the vessels, whether supplied with milt or not, exhibited a similar blastoderm, which, as is well known, frequently appears without fertilization. The yolk presented a peculiar appearance, the segments being restricted to an irregular mass

underlying the blastoderm (Fig. 3). None were visible in the vegetative third of the yolk mass, nor did they extend, as a rule, to the periphery in any region. The blastoderm was opaque and granular. as was also, but to a less degree, the unsegmented part of the yolk,

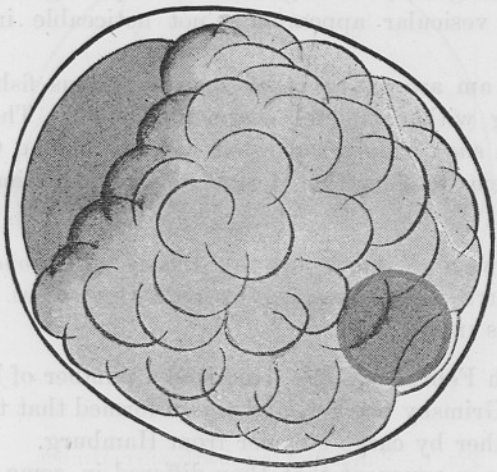

FIG. 2.—Living unfertilized egg forty-eight hours after extrusion.

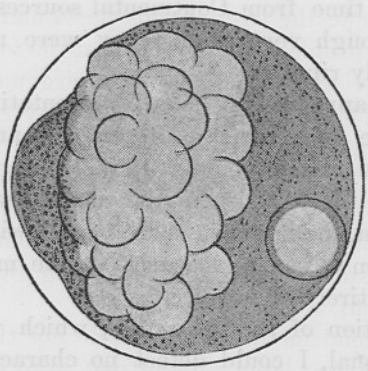

FIG. 3.—Dead unfertilized egg forty-eight hours after extrusion.

The segmented part, however, retained in great measure its former translucency, but the segments, especially those near the surface, were very irregular. I consider that this condition was arrived at by decomposition setting in from the periphery, involving the breaking down of the peripheral segments, and not by a shrinkage of the segments towards the central area.

To recapitulate: the egg of the scad is pelagic, and measures

about 1·03 to 1·09 mm. in diameter before fertilization ; it possesses a single oil-globule, ·26 to ·27 mm., either colourless or of a bright orange colour (and probably of any intermediate tint), which presumably disappears more or less with the development of the egg. The perivitelline space is probably small. The yolk is colourless, and segmented throughout, the segments in early stages having a very characteristic vesicular appearance, not noticeable in the ova of Clupeoids.

So far as I am aware, no other acanthopterous fish is known to possess an egg with completely segmented yolk. The existence of this feature in such widely separated families as the Clupeidæ and Carangidæ seems to show that it is of no taxonomic importance.

VII. On a Dwarf Variety of the Plaice (*Pleuronectes platessa*, Linn.), with some Remarks on the Occasional Ciliation of the Scales in that Species.

On the 28th February, 1894, I noticed a number of boxes of small plaice in the Grimsby market, and was informed that they had been consigned thither by cargo steamer from Hamburg.

It was at once apparent that they differed in some respects from the small plaice landed by our own fishing-boats, as also from any that I had hitherto examined among consignments which reach this port from time to time from Continental sources. It was evident, in fact, that, although very small, they were nearly all sexually mature, and actually ripe.

I selected what appeared to be a representative series for closer examination at the Cleethorpes Laboratory, and found that the smallest ripe female measured only 9½ inches in total length, whilst the largest fish of the lot, also a ripe female, was only 13½ inches long. My selection, having been made mainly with a view to inquiry as to size in relation to sexual maturity in the more important sex, consisted almost entirely of females.

With the exception of the coloration, which was in some individuals rather unusual, I could detect no character in which these fish differed to an appreciable extent from the North Sea examples with which I am familiar, but from the presence in the same consignment of a number of unusually spinous flounders (*P. flesus*, Gottsche) I formed the idea that they must have been caught in some locality to which our own vessels never penetrate.

I need hardly say that, in view of the opinion I have expressed in this Journal and elsewhere as to the large size at which North Sea plaice first begin to spawn, the occurrence of such small mature examples (possibly from a North Sea ground) came as rather a shock to me.

Therefore when, through the courtesy of Mr. G. H. Mudd, I had been put into communication with the consigners, I was greatly relieved to find that the fish were actually caught in the Baltic, and not in the North Sea at all.

Since it appeared to be within the bounds of possibility that the very unusual weather of last summer might have had some effect in accelerating the maturation of the sexual organs in young fish, I had in the meantime examined a number of small plaice which were being brought into the market from the usual sources (including a large number landed by a German steam-trawler from the Horn Reef), but found the conditions to be precisely similar to those which I had noted and recorded in previous years.

The Hamburg merchant from whom I derived my information as to the origin of the small spawning fish also tells me that they never grow to a large size and are sometimes called "Golden butts." Now "Goldbutt" is the vernacular name which Gottsche found to be applied to what he considered the most typical examples of *Pl. platessa*, Linn. He describes two varieties, *Pl. borealis* and *Pl. pseudoflesus*.*

The points in which the latter variety differs from the type (of Gottsche) are indicated as the presence of ciliated scales on the ocular side (on the sides of the head and of the abdomen, along the lateral line, and along the bases of the dorsal and anal fins), and the small number of the dorsal and anal rays. This variety, in which, as is implied by the description given by Smitt,† the blind side may also be to some extent ciliated, is stated by that writer to be identical with Nilsson's var. *baltica*, and to be commonest in the Sound and the Baltic. I do not find that Gottsche expressly mentions that it has been taken in the North Sea, since its occurrence in Hamburg market is no proof of this. Kroyer, however, has recorded it from Hästholm.‡ Gottsche noted that "gold butt" first appeared in the Hamburg market in winter, and only rarely. At Copenhagen they were in the market the whole of summer. Most were taken in Oresund. *Pl. pseudoflesus* are simply stated to have been taken in company with "gold butt."

I had considered it very probable that *Pl. pseudoflesus* occurred amongst the small plaice which are constantly landed at Grimsby during the spring and summer from the opposite coast of the North Sea, but had never succeeded in finding any, nor, among the first lot which I obtained from the Baltic, could I find any trace of ciliation. As I have already remarked, those which I examined were

* Wiegm. Arch., 1835, p. 143.

† Hist. Skand. Fish., ed. 2, 1893, i, p. 393.

‡ *Teste* Smitt, loc. cit.

nearly all females, a point worthy of note in this connection. The number of fin-rays, however, presented some approach to the formula given by Gottsche, but the variation was in excess of that therein indicated, since some of the specimens had as many rays as a typical North Sea plaice.

Two other consignments of small Baltic plaice were received at Grimsby a little later, and I again examined a number of specimens. In one consignment I found a single fish with very well-marked ciliation, but the rest of those which I handled appeared in the somewhat dim light of the fish market to be quite smooth. In the third consignment a box proved to contain nearly equal numbers of ciliate and smooth examples. The ciliation was present in different degrees, so that there was an absolute continuity in the series from the perfectly smooth to the fully ciliate condition.

In those examples in which the ciliation is most strongly marked, the scales on the head and interspinous regions of the ocular side have the free margin produced into from two to four distinct spines, which are outwardly directed, so as to project vertically to the surface of the body. The scales of the median region of the body are only feebly or not at all ciliate, the spines when present being more numerous than those in the regions previously referred to, but much smaller and not outwardly directed. The scales on the ocular sides of the fin-rays are also feebly ciliate.

On the blind side the ciliation is much less marked, and is altogether absent from the scales on the prominent parts. The scales on both sides exhibit a certain degree of imbrication, but not more than may be observed in young examples of ordinary North Sea plaice, the non-imbrication of the scales in this species being a character only entirely applicable, at best, to large examples.

The proportions of the small Baltic fish, whether ciliate or smooth, are of no service in distinguishing them from ordinary plaice, but some of the ciliate examples are rather strikingly coloured.

The following notes were taken from the fresh condition :—Ocular side reddish brown, with a number of orange spots. Of these the larger are irregular in shape, and surrounded by a narrow pale "halo," while each scale in the orange part is outlined with dark brown. The largest spot, in an individual 10 inches long, measured $\frac{7}{16}$ by $\frac{3}{8}$ inch. These spots occur chiefly on the dorsal half of the body, viz. along the interneural ridge, and dorsal to the lateral line. The smaller orange spots are also most numerous on the dorsal half. A number of dark brown or blackish spots, some interspersed with a little orange, occur chiefly on the ventral half. Rows of large blackish patches, some with an orange centre, occur along the dorsal and anal fins, and some small dark markings are present on the

caudal fin. The blind side has the semi-translucent whiteness characteristic of normally coloured plaice.

Most of the smooth examples which I examined had only small pale orange spots, rather few in number and remote from each other. Such was also the case in only slightly ciliate examples, but both series showed intermediate degrees of coloration, rendering it impossible to draw any absolute distinction based on colour alone.

While dealing with the coloration it is worthy of remark that amongst a number of flounders (*Pl. flesus*) present in the consignments of small plaice, some were pigmented in very much the same way as the most ciliate of the plaice, but had no dark pigment, while the blind side was dead white. Other flounders in the same consignment were uniform brown or blackish brown (on the ocular side).

The flounders were very much more spinous than any which I have seen from our own coasts, practically the whole of the ocular surface being in some cases covered with rough tubercles, which were also present to a considerable degree on the blind side. According to Smitt (op. cit., p. 397) Scandinavian flounders appear to be also more spinous than our own, in which the tubercles, according to my experience, are confined to the lateral line and the bases of the dorsal and anal fins. On examining examples from the Atlantic coast of Denmark I find some in which the spinulation is rather in excess of that exhibited by British specimens, a condition which might be expected from the intermediate position of the locality.

To return to the Baltic plaice, I handed over a series of ciliate and non-ciliate examples to Dr. Günther, who suggested that the ciliate ones were the males. I know of no observations which support such an opinion, but, on examining those which I had reserved for my own use, I find that it appears to be correct.

I append a list of the fish examined for this purpose.

	Inches long.			
A.	$12\frac{1}{4}$	Smooth; female; mature	D. 75	A. 55
B.	$11\frac{3}{8}$	„ „ „	„ 72	„ 51
C.	$10\frac{5}{8}$	„ „ „	„ 67	„ 54
D.	10	„ male; immature	„ 75	„ 55
E.	12	Head feebly ciliate; female; mature	„ 68	„ 53
F.	9	Head and interspinous regions ciliate; male; mature	„ 67	„ 51
G.	$9\frac{3}{4}$	„ „ „ „ „	„ 69	„ 52
H.	$8\frac{3}{8}$	Ciliation extending a little on to trunk „ „	„ 72	„ 52
J.	$9\frac{3}{8}$	Intermediate between H and L „ „	„ 64	„ 48
K.	$9\frac{3}{8}$	„ „ „ „	„ 70	„ 54
L.	$11\frac{1}{2}$	Everywhere ciliate except in immediate neighbourhood of pectoral; male; mature	„ 72	„ 54

The details of ciliation given above refer to the ocular side.

In ten other non-ciliate examples, all or nearly all females, the fin-

ray formula was D. 63—74, A. 47—55. The formula of all which I have examined is therefore D. 63—75, A. 47—55, and it is evident from the condition in those separately enumerated that the formula shows no grounds for suggesting a distinction, other than sexual, between the ciliate and smooth examples. I have omitted to transcribe the proportions, as they differ in no degree inexplicable as individual variation.

The inferences which appear to be permissible from the details enumerated above are as follows :—(1) The female, in these dwarf Baltic plaice, is either smooth, or ciliated only on the head. (2) The male is almost always more or less ciliate ; perhaps always ciliate when mature, the ciliation increasing with the growth of the fish.

I may add that none of my examples show the ciliation especially conspicuous along the lateral line, though this has been given as a character of *Pl. pseudoflesus*.

It would appear, then, that the variety last named is merely the male of what Gottsche considered to be the typical form of *Pl. platessa*, *i.e.* the "gold butt." The "scholle," the variety *Pl. borealis* of the same author, appears to be the ordinary North Sea plaice.

Apart from these Baltic fish, I have met with instances of ciliation in two other examples of the plaice. The first was a mature male, $19\frac{3}{8}$ inches in length, taken in April of the present year on the Great Fisher Bank. In colour and general appearance it resembles a number of normal examples taken at the same time, but the scales on the ocular side have about 8 to 10 very short pectinations in the central region of the posterior edge. On the blind side the scales are either smooth or only very feebly ciliate.

The other example is a male from Iceland, $24\frac{1}{2}$ inches long. The ciliation of the ocular side is much the same as in the Fisher Bank specimen, but the scales of the blind side are smooth. In both examples the scales of the caudal region imbricate to some extent, but not more than in smooth fish from the same locality, and the ciliation is by no means confined to this region of the body.

There is good reason to believe that there is a regular migration of plaice between the Fisher Bank and the north-west coast of Denmark (and probably also the Sound), and that, in fact, the Fisher Bank plaice are reared on the Danish coast. It is not, therefore, surprising that ciliate examples should be met with both on the Fisher Bank and at Hästholm.

It seems probable enough that the characters of ciliation and size would be found to vary in a degree corresponding to the locality if a series could be obtained from the different parts of Denmark, from the Baltic to the southern region of the North Sea coast. No such material, however, is available, and all that can be said, in view of

observations recorded above, is that the diagnosis of *Pl. platessa* must be so amended as to allow for the occurrence of ciliated scales, especially in males.

Judging by the analogy of fresh-water fish (*e. g. Salmo*, &c.), it seems quite possible that fish which reach a large size in the North Sea might remain permanently stunted if confined to the Baltic. On such an hypothesis one might regard the small mature Baltic plaice as distinct in nothing, save environment, from their larger brethren in the North Sea. The very general ciliation of the males in the former, and the rarity of this character in the latter seems, however, to show that a more important distinction exists, and that the small fish are a true variety, indistinct enough, no doubt, if specimens from intermediate localities could be procured. Living ova, which I took from some of the specimens described above, measured from 1·706 to 1·796 mm. in the unfertilized condition, dimensions which overlap the extremes recorded for the ova of Atlantic plaice, but which nevertheless yield a considerably less mean diameter. That the Baltic herring are considerably smaller than the North Sea and Atlantic representatives of the same species is well known, and it would appear that the difference in size is apparent from the earliest stages, since the former, when newly hatched, are only 5·2 to 5·3 mm. long (Kupffer), and therefore about 2 mm. shorter than such newly hatched North Sea larvæ as have come under my own notice (Ann. Mag. Nat. Hist., 1889, p. 369).

On the other hand, the flounders which I found amongst the consignment of Baltic plaice were fully as large as those met with on our own coasts, and it is a significant fact that the flounder is a fish which flourishes best in brackish or even in nearly fresh water. The low specific gravity of the Baltic water is familiar to everybody, as is also the fact that its existing fauna differs, in the absence of certain marine organisms, from that of the open sea. Hence it is very interesting to note that these small plaice appear to reach a limit of size (about 13½ inches) which practically corresponds to the size which is attained by a young North Sea plaice before it leaves such an estuary as the Humber for the offshore grounds. It is, no doubt, the quest of food suitable to its increasing needs that causes the emigration of the young North Sea fish, and even without special knowledge of the food-supply in the Baltic, it is perhaps permissible to assume that it is the inadequacy of the food that limits the growth of the goldbutt. It is restricted, in fact, to a permanently estuarine condition.

The question of dermal armature in relation to environment is much more difficult, and I am not at present prepared to attack it; I may say, however, that materials which I have been accumulating

point to some conclusion in which the theory of protection has no very obvious place.

VIII. On some Specimens of *Molva abyssorum*, Nilss., from Iceland and Faroe.

The present note is a brief abstract of a paper read before the Zoological Society in May of the present year. The species was previously known only from the coast of Scandinavia, where it occurs chiefly at depths exceeding 100 fathoms, and appears to be known as the Birkelonge, or "Trade Ling." I was able to show that it occurs regularly, if in rather small numbers, on the lining grounds off Faroe, and has also been taken, both by line and trawl, on the south coast of Iceland.

The species may be described as differing from the common ling (*M. vulgaris*, Flem.) chiefly in characters which, in Gadoid fishes, have been found to be indifferently associated with either an abysmal or a boreal habitat. Thus the maximum size reached is smaller, the eye larger, the fin-rays more numerous, the body more slender and elongate, and the caudal peduncle very much more slender than in the common ling. The visceral anatomy shows very well marked characters; the liver is very large, and the walls of the alimentary canal extremely delicate—so much so, in fact, that it is difficult to lift the intestine, even in fresh specimens, without rupturing it. Besides being more delicate, the intestine is also much shorter than that of the common ling, while the stomach is much larger. The comparative shortness of the intestine has been noted by Günther in the case of a deep-sea member of the Percidæ, and a reduction in the thickness of the walls of this structure appears to be strictly comparable to the reduction noticeable in the bones and muscles of deep-sea fish generally.

The air-bladders of the two species of ling do not differ materially, but the kidney of the deep-sea fish is less swollen in its posterior region than that of *M. vulgaris*. Moreover the so-called head-kidney in *M. abyssorum* is more definite in outline than the corresponding structure in the common ling, and was found to be typically reniform in structure and obviously functional. The head-kidney of the common ling, however, contains a certain amount of reniform matter, and cannot be regarded as wholly functionless.

At the time my remarks were written, the only figure of *M. abyssorum* which I was able to discover was a small outline drawing given by Ström (Sond. Beskriv.), and I had therefore appended a larger and more detailed figure, adding another of the common species for purposes of comparison. However, before my

paper was communicated to the Society, the appearance of Smith's edition of the History of Scandinavian Fishes (Lond., 1893) supplied coloured illustrations of both species. The figure of *M. abyssorum* differs from my own specimens, and from the descriptions given by other authors, in that the upper jaw is shown as longer than the lower. In all my own specimens, seven in number, the lower jaw projects distinctly, but Smith states that the contrary was the case in those which had come under his notice. They appear to have been of rather smaller size, and there is an indication in my own series that the relative length of the lower jaw increases with the growth of the fish. This is well known to occur in *Gadus virens*, in which the relative lengths of the jaws in the young are completely reversed in the adults, but I do not think it can occur to anything like the same extent in the species under discussion.

My paper, besides dealing at length with the points referred to above, gives detailed measurements of all the specimens, and discusses the relative antiquity of the two species. My conclusion that *M. abyssorum* is a specialised offshoot from a form not greatly differing from the common ling of the present day is exactly opposite to that arrived at by Prof. Smith, who holds *M. abyssorum* to be "essentially the predecessor" of the other. To me it appears impossible to accept this view without also regarding the typically abysmal Gadoids as more primitive than the littoral forms, and such an inference seems wholly unsupported by the interpretation which the present state of our ignorance permits of the evidence of the subject.

Young Stages of Zeugopterus punctatus.

By

J. T. Cunningham, M.A.,
Naturalist to the Association.

On May 4th of the current year a number of small Pleuronectids were captured by the hand in a pool left by the ebb tide at Plymouth Breakwater, and brought to me alive. Two of them were very transparent, and, from their habit of lying on the right side when at rest, evidently sinistral forms. One of them was almost perfectly symmetrical; while in the other the torsion of the facial region and eyes had commenced. The pigmentation had the form of interrupted transverse bands, which were most conspicuous on the dorsal and ventral fins; on the dorsal fin seven bands were indicated. The terminal portion of the original trunk, containing the notochord, was seen at the upper edge of the caudal fin. The neurochord was covered with pigment, forming a very distinct band, situated, however, not in the skin, but in the connective tissue surrounding the neurochord or spinal cord. The mouth was large, and the snout upturned. The pectoral fin was large, the pelvic small. But the most important characteristic was the presence of two straight spines projecting laterally from the auditory region. These have been called otocystic spines by Prof. McIntosh, but I think they would be more appropriately described as periotic spines, as they are evidently projections of the periotic cartilage or bone; to which particular bones of the periotic region they belong has not been determined. Mr. Holt cut sections of the spines *in situ*, and found that they consisted of a knob of periotic cartilage passing into a mass of undifferentiated cells, the whole forming the core of a dermal spine consisting of hyaline ossified tissue. In my specimens I observed a third spine, much smaller, situated in the region of the frontal bone, behind and above the eye; it was visible in both the stages.

The numbers of the fin-rays were D. 90, A. 69, in one specimen, which was kept alive for a few days and preserved when the right

eye had reached the dorsal edge of the head. The younger specimen was 11 mm. in length; the other, after being preserved and mounted, is 10 mm., a diminution which may be due to the process of preservation, or partly perhaps to the advance in metamorphosis, a reduction of size during the transformation having been observed by me in the flounder.

A sinistral Pleuronectid having these periotic spines was described and figured by McIntosh and Prince (Trans. Roy. Soc. Edinb., vol. xxxv, pl. iii, 1890, p. 846) as a stage in the history of the turbot. The specimen was 9·8 mm. long, and another specimen a few mm. longer, having similar spines, is mentioned. The mention of the spines alone seems to indicate that these specimens were either of the same species as the specimens obtained by me, or a closely allied form. The figure given, probably drawn from a spirit specimen, is not perfectly characteristic.

A discussion of the identification of the larva with otocystic spines is given by Prof. McIntosh in the Tenth Report of the Fishery Board for Scotland, p. 279. He refers to Mr. Holt's opinion, that it belongs to the brill, and mentions another specimen, taken on Smith Bank off Caithness, in which the dorsal had 87 and the anal 62 rays.

In the Eleventh Report, published in 1893, Prof. McIntosh makes a further contribution to the question of larval sinistral Pleuronectids. He mentions no new specimens of the form here under consideration, but gives his reasons for concluding that the young specimens shown in pl. xiv, figs. 7, 10, and 11 of the Tenth Report, belong to *Zeugopterus punctatus*: these were 4·5 to 9 mm. in length. He also thinks it possible that the form with periotic spines may be a later stage of the same species, the diminution in the size of the eye being due to changes accompanying growth, or to abnormality. With this opinion I cannot agree. The form without the spines has larger eyes, and has the eye on the edge of the head when only 9·5 mm. long; it is, I think, a distinct species.

It is somewhat difficult to follow the successive discussions in which Prof. McIntosh has described and compared his specimens of young sinistral forms, more particularly as his figures are, as a rule, inadequately characteristic, often having been delineated from dead and imperfectly preserved specimens. Mr. Holt has been able to give a more comprehensive and more completely illustrated description of specimens of similar characters procured in the survey of the west coast of Ireland in 1890 and 1891. His results were published last year in the Scientific Transactions of the Royal Dublin Society, vol. v, ser. 3. The form with periotic spines (if it is a single species and not more than one) is represented in Mr. Holt's collection

(Species XIV in the memoir) by a number of specimens 5·87 to 10·62 mm. in length. The characteristic spines were present even in the smallest specimens, a fact sufficient to disprove Prof. McIntosh's supposition that the spines are developed only at the later stages. Mr. Holt figures two stages, one perfectly symmetrical, 7 mm. in length, having no fin-rays except the first indications of the caudal, but having the characteristic transverse imperfect bands of pigment. The other figure shows a stage 10·62 mm. long, in which the fin-rays of the dorsal and ventral fins are developed. This stage, however, is younger than those I have described, the termination of the original body or opisthure not being so much reduced as in my specimens, and not distinctly marked off from the dorsal and ventral fins. The number of fin-rays in Mr. Holt's specimen was D. 80 ca, A. 66 ca ; it was not possible to count the exact number.

Mr. Holt considers, and I agree with him, that this form cannot belong to *Arnoglossus megastoma*, nor to *A. laterna*, of which he has identified young specimens 19 mm. and 25 mm. in length respectively. The eyes are relatively much larger in *A. megastoma*, and the young *A. laterna* seems to have less pigment. He concludes that the parent form is either *Rhombus lævis*, the brill, or *Zeugopterus norvegicus*, the Norway topknot. Now, in my own opinion the suggestion of the brill is out of the question for several reasons, one of which is that in my specimen the fin-rays are D. 90, A. 69, while the maxima in the brill according to Day are D. 85, A. 63. The symmetrical stage of the brill figured by Raffaele, and nearly 8 mm. long, is of a different shape, and much more opaque and pigmented.

With regard to *Z. norvegicus*, Günther (Proc. Roy. Soc. Edin., No. 127, p. 217) gives the fin-rays as D. 80, A. 66, and I have counted D. 84 in one of my specimens, so that there is no evidence that the number reaches as high as in my young form.

The remaining sinistral forms to be considered are the turbot, *R. maximus*, whose young are known, and not identical with the present form ; and the other two topknots, *Z. punctatus* and *unimaculatus*. The fin-rays of the latter, according to Day, are D. 70 to 80, A. 61 to 68. *Z. punctatus*, on the other hand, according to the same authority, has D. 87 to 101, A. 69 to 80, so that there is strong probability that this is the parent form we are seeking. This conclusion is supported by the shape of the outline of the fins in the larval specimens, the posterior part of the fish approaching a rectangular shape, as in the adult *Z. punctatus*, and by the comparison of the shape of the snout in the latter and the young form. The snout in the adult is very much shortened as compared with the young, but it exhibits, apart from the anterior part of the dorsal fin which is attached to it, a deep depression at the edge between

the cranium and the extremity of the upper jaw; and further, the end of the upper jaw is broad and truncated in a manner which resembles the character of the young form as seen in my specimens. My conclusion as to the identification of the form with periotic spines agrees with that of Prof. McIntosh, but I differ from him in not including the series of smaller forms without the spines.

Experiments on the Rearing of Fish Larvæ in the Season of 1894.

By

J. T. Cunningham, M.A.,

Naturalist to the Association.

It may be useful to put on record the following notes of renewed attempts to solve the difficult problem of rearing fish larvæ.

On January 23rd a large number of eggs were observed in one of the aquarium tanks which contained several whiting. The eggs were collected and placed in a hatching jar, and began to hatch on January 29th. I prepared a small tank in the Laboratory for rearing the larva. The outflow pipe was protected by placing over it an inverted hatching-jar, open at both ends and resting on a layer of sand and gravel. The water was supplied to the tank by a solid carbon block filter attached to one of the jets. The inflow of water was very slow indeed. The temperature in the tank on February 3rd was 12° C., and on this date the larvæ in the tank were healthy, having the jaws developed, but the yolk not yet all absorbed. One lot of larvæ were put into the tank on January 30th, a second lot on February 1st. On February 4th I put in some fine particles of worm food, that is to say, ovarian eggs of Nereis obtained by mincing the worms and then separating the eggs by decantation. On the 5th, as the larvæ did not seem to take the worm-food readily, I put in some tow-net collections strained through fine bolting cloth so as to exclude the larger animals. Then I saw the larvæ pecking at this food, and in one I took out I found (in the stomach) a Gasteropod larva with spiral shell. On the 6th I put in a little of both kinds of food, and observed that the larvæ preferred the pelagic material, but they did not feed vigorously on either kind. On the 7th I examined a few, and found the stomachs of most of them empty and dilated, but in one was a small Copepod. On the 8th the number of the larvæ was diminished; on the 9th very few were to be seen, and on the 10th none were found. In the course of this experiment I found that when the supply of water was very much reduced on account of the choking of the char-

coal filter a scum of bacteria in the zooglœa form soon appeared on the surface. I therefore replaced the charcoal filter by sand filters made in a box or bottle, during the whole experiment supplying water only through some kind of effective filter.

On March 10th flounder and plaice eggs were first seen at the surface of the large tank, containing flat-fishes, in the aquarium. On the 12th I collected a considerable number and put them in a hatching jar, and shortly afterwards placed others in a second hatching jar. It was not practicable to separate the larger plaice eggs from the smaller ones of the flounder. On the 19th the flounder eggs were found to be hatched; the plaice larvæ began to emerge on the 22nd, and on the 24th I turned all the larvæ out into one of the Laboratory tanks, the inflow of water passing through a filter of sand and gravel contained in a glass jar. I fed them as usual, partly with eggs of Nereis, partly with strained material from the tow-nets. On the same day I put some of the larvæ into a bell-jar filled with water brought in from the open sea. In the tank, in addition to the inflow of water I arranged a delivery of air in small bubbles at the bottom of the tank, thinking that this would serve two purposes, to aërate the water and to keep the food-particles suspended.

The plaice larvæ lost the yolk and began to feed on March 27th. They took the worm food more readily than the living material from the tow-nets. On April 2nd they were nine days old, and at this time the very fine primordial rays had appeared in the posterior part of the larval median fin membrane. On April 9th there were not many surviving, and in these no great advance in development was visible, but the commencement of the formation of the permanent caudal fin was indicated. The number steadily diminished, and the last specimen was seen on April 23rd, when it was thirty days old. In these older specimens the formation of the permanent fin-rays had not commenced, still less had the rotation of the eyes begun to take place.

The larvæ in the bell-jar in water from the open sea lived a much shorter time; the last was seen on April 1st.

Another lot of plaice larvæ were hatched on April 9th, and I turned them out into one of the Laboratory tanks supplied with water directly from a jet without filtration, and I provided no air supply. I fed these very carefully on the usual worm food, which they took readily. I carefully washed the food, so as to keep out as much as possible the blood and soluble matters derived from the worms. These larvæ began to die off as usual after some days, but two were seen alive on May 16th, when they were thirty-seven days old, or five weeks and two days, which is a much longer period than I have succeeded in keeping them before.

Nerve Elements of the Embryonic Lobster.

By

Edgar J. Allen, B.Sc.Lond.

After repeated trials with dilute solutions of methylene blue upon larvæ and embryos of a number of the smaller decapod crustacea, a favourable object for the study of the nervous system was at last found in the embryo of the common lobster. The embryos of this animal are specially advantageous on account of their large size, which enables them to be readily manipulated without much damage being done to their tissues, and also on account of the large size of the individual nerve elements.

In order to expose the ganglionic cord in the thorax, it is only necessary to break the yolk with needles and carefully remove it. If the embryo thus prepared be placed with the dorsal surface of the cord uppermost in a dilute solution of methylene blue in sea water (1 : 50,000 or 1 : 100,000), staining of one or more nerve elements takes place.

By practising this method upon a large number of embryos at various stages of development, staining of the following elements has been obtained :

1. Elements starting from cells in the brain or anterior thoracic ganglia, and giving off fibres which can be traced throughout the length of the ganglionic cord to the sixth abdominal ganglion. The fibres of some of these elements pass down the cord upon the same side as that on which the cell is situated, whilst others decussate and pass down upon the opposite side. Many of the fibres give off collateral branches to the neuropile of each ganglion through which they pass. One pair of fibres belonging to this group are the so-called giant fibres. They possess a diameter many times greater than any other fibre in the cord, and start from a cell which lies on the ventral surface of the brain. In the sixth abdominal ganglion these fibres break up into a number of smaller branches.

2. Elements originating in a cell in one of the ganglia of the cord, from which a fibre is given off, which after decussation with its

fellow of the opposite side runs forwards along the cord, and can be traced to the anterior part of the brain, where it ends by breaking up into fine branches.

3. Elements starting from a cell in one ganglion and giving off a fibre which, after sending a number of arborescent branches to the neuropile of that ganglion, ends in a small tuft of fine branches in the ganglion next behind.

4. Elements starting from a cell in one ganglion giving off a fibre which sends out lateral branches to the neuropile of the ganglion, passes forwards to the next ganglion, where it gives off a lateral tuft of branches, and ends also in a tuft of branches in the next ganglion, but one in front of that in which the cell lay. The terminal tuft lies close to the lateral tuft of the element of the next ganglion, and directly opposite the terminal tuft of an element of group 3.

5. Elements starting from a cell in a ganglion, giving off a fibre, which passes through one of the lateral nerves of the cord, and finally breaks up upon a muscle. A considerable number of elements of this type can be distinguished, and these are repeated in successive ganglia. They must be regarded as motor elements.

6. Elements originating in a cell which lies in the dorsal ectoderm of the abdomen—therefore entirely outside the ganglionic cord,—and gives off a fibre which eventually enters one of the abdominal ganglia, where it bifurcates, sending one branch forwards towards the brain, whilst the other passes backwards through the posterior ganglia. These elements are probably sensory in nature.

A full account of these observations, with figures, has appeared in the Quarterly Journal of Microscopical Science.

Faunistic Notes at Plymouth during 1893-4.

With Observations on the Breeding Seasons of Marine Animals, and on the Periodic Changes of the Floating Fauna.

By

Walter Garstang, M.A.,

Fellow and Lecturer of Lincoln College, Oxford; late Naturalist to the Marine Biological Association.

The year 1893 was one of exceptional interest to the marine zoologist. During the first two months Plymouth experienced a continuous succession of heavy gales, but towards the middle of March the winds became lighter, and the sea, which had been running remarkably high outside the breakwater, subsided. From that time onwards till the middle of September we enjoyed six months of the most delightful weather,—a period, with scarcely a break, of calm seas and almost cloudless skies. Under the influence of the great heat the temperature of the Channel waters rose continuously, until in August it had attained a point unprecedented for quarter of a century; and it was of the highest interest to observe the effect of this high temperature, and of the prolonged calmness of the sea, upon the floating population of the neighbouring portion of the Channel. Numbers of semi-oceanic forms which rarely reach our shores arrived in remarkable profusion. In June the tow-nets were crowded with Salps, while towards the latter end of August they were almost choked by masses of living Radiolaria.

Even the bottom fauna was influenced, as was shown by the extraordinary abundance in the Sound thoughout the spring and

summer of the Tectibranch *Philine aperta*. *Oscanius membranaceus* also, though to a less extent, was unusually plentiful, penetrating even some distance up the Hamoaze.

Another phenomenon which is probable referable to the same cause, although in a somewhat different manner, is the relatively greater abundance this year (1894) of many of the regular constituents of the bottom fauna. For example, the Hydroids *Tubularia indivisa* and a smaller form which appears to be *Tubularia humilis*, together with *Coryne pusilla* and *Eudendrium ramosum*, have been taken in the Sound this year in unusual quantity. The same remark applies to many Nudibranchs, and especially to the Æolid *Facelina coronata*,* which has been remarkably common this year at Plymouth. I do not doubt that the unusual abundance of these and other forms may be directly attributed to the very favorable physical conditions under which the reproduction of their species took place in the preceding year. The destruction of larval life by physical agencies must then have been considerably less than the normal rate. Indeed, in the case of the oyster, as was attested by Prof. Herdman in a letter to Nature (July, 1893, p. 269), there was undoubtedly an unusually heavy fall of spat on the west coast of France last year, which implies that an unusually large percentage of larvæ were enabled to attach themselves and to pass safely through the critical stages of their metamorphosis; and also, perhaps, that the reproductive activities themselves were rather above the normal.

So much for the general aspects of the fauna during the past eighteen months. Additional facts bearing out the above remarks may be gathered from the body of this paper.

In the three succeeding sections are given—firstly, a list of the principal captures and additions to the fauna made since my last† communication to this journal up to May 30th, 1894, when I left Plymouth; secondly, some observations on the breeding seasons of marine animals at Plymouth; and thirdly, some remarks on the periodic changes in the constitution of the floating fauna.

In several respects, however, I have to regret the incompleteness of my notes. They are compiled directly from my diaries, and are written on foreign soil, where I am without access to some of the appropriate works of reference and to several of my manuscripts. On this account the last two sections especially of this paper are offered simply as preliminary communications upon the interesting

* I showed some years ago that the smaller Nudibranchs are annuals, and require only a year to attain their full growth. The same thing is true of Hydroids and many other Invertebrates (this Journal, 1890, p. 450).

† *Notes on the Marine Invertebrate Fauna of Plymouth* for 1892, vol. ii, 1892, pp. 333 to 339.

subjects of which they treat; I shall endeavour to expand them both in scope and detail when further observations have been made and the time is ripe.

Roscoff; *June 30th*, 1894.

I. Faunistic Records.

Hydrozoa.—Several additional colonies of *Tubiclava cornucopiæ* have been obtained in 15 to 25 fathoms of water south of the Mewstone. In all cases they were growing, like our first specimen, on shells of *Aporrhaïs* or *Turritella*, tenanted by the Gephyrean *Phoscolion strombi*. Some of the colonies were young, and possessed a reticulate stolon, like Norman's original specimens from the Shetlands—thus confirming my anticipation that the solid carpet-like base of large colonies is not a specific difference, but a senile character (Trans. Devon. Assoc., 1892, pp. 378–9).

Clava cornea (of Hincks) is abundant on the fronds of Fucus growing in that branch of the Hamoaze known as the Lynher, or St. German's River.

In tide-pools under the Hoe two species of *Clava* are common, one being *C. multicornis*, and the other a larger and stouter form, which seems to be the *Clava leptostyla* of Hincks's monograph. To prevent confusion, however—since one of the characteristics of our form, at any rate, the purple colour of the gonophores, is nowhere mentioned,—I give its leading features here.—Colonies clustered, attached to stems of algæ and to the floor of limestone pools; polyps very large and stout, tall when extended, of a rich salmon-flesh colour; digestive cavity having a distinctly spiral marking, or even coiled appearance, which is seen when the polyps are fully extended as well as when contracted; gonophores in two, three, four, or rarely five large compact round bunches immediately beneath the tentacles, and of a conspicuous purple colour when mature.

Tubularia indivisa has been dredged occasionally in Millbay Channel. Good colonies were obtained there on April 13th, 1894, but the gonophores were provided with very short stalks, and did not form pendulous racemes. With them were large colonies also of *Tubularia larynx*, crowded with gonophores. On March 9th a small colony of a *Tubularia* was dredged in Barn Pool, growing on some Ceramium or Polysiphonia attached to a root of Laminaria. The stems were without annuli, the tentacles were white, and there was a collar-like expansion below the hydranths, and I inferred the species to be the *T. humilis* of Hincks's monograph. On the 19th, however, I collected some other colonies from tide-pools below the Hoe, and they resembled the preceding in almost all points except

in the absence of a collar. The polypites were white, the stems entirely destitute of annulations or corrugations, and white. The colonies were crowded with gonophores, which each exhibited a red patch. I scarcely doubt that these two forms belong to the same species.

Coryne pusilla has been common in tide-pools below the Hoe, side by side with *Clava multicornis* and *Tubularia humilis;* also on the breakwater, and at Cremyll below the garden battery. Intermediate varieties between the *Coryne pusilla* and *C. fruticosa* of Hincks are common. On July 17th, 1893, I found an extensive colony of another *Coryne* attached to a root of Laminaria trawled in the Sound. The stems were slender, branched, and irregularly annulated; the polyps red, much elongated, and provided with fifteen to eighteen tentacles, scattered or irregularly whorled. The colony attained a maximum height of $1\frac{1}{2}$ inches, but was for the most part less than this, and of lax growth. It is undoubtedly allied to Hincks's *C. vermicularis*, and I record it as such; but it should be noted that the colony was certainly not dense, and the tentacles were apparently less numerous than in Hincks's type. As our colony was without gonophores, however, it is possible that these differences may have been due to immaturity.

Eudendrium ramosum has been frequently dredged on the New Grounds and in Millbay Channel.

Garveia nutans was dredged in Millbay Channel several times during April and May, 1894. It is interesting to notice that while this species is common between tide-marks at Hilbre Island at the mouth of the Dee, at Plymouth it is rare, and lives in deep water only (15 to 20 fathoms).

Another Gymnoblast which I found plentiful on certain stones at Cremyll presents several remarkable features which will justify a separate description: it is now under examination.

During the latter half of February and March, 1893, the tow-nets contained numerous specimens of the Anthomedusa *Rathkea octopunctata*, which is the *Lizzia octopunctata* of Forbes' "Naked-eyed Medusæ," and the *Cytæis octopunctata* of M. Sars. Haeckel has made a mistake in treating these as different forms, and in assigning them to different genera, viz. to *Margellium* and *Rathkea* respectively. In Haeckel's system (System der Medusen, pp. 95 and 97) each of these types possesses eight bundles of tentacles, but in *Rathkea* the bundles are perfectly similar to one another, while in *Margellium* the four perradial bundles contain a greater number of tentacles than the four interradial. The mature *Rathkea* (= *Cytæis*) *octopunctata* of Sars and Haeckel is characterised by having three tentacles to each bundle; but since Sars has shown that the inter-

radials develop later than the perradials, and that the lateral tentacles of each bundle develop later than the median tentacle, a stage is consequently passed through in which the perradial bundles consist of three tentacles and the interradials of only one. On the other hand, *Margellium octopunctatum* is defined by Haeckel as possessing perradial bundles of three tentacles and interradials of two tentacles—apparently on the sole basis of Forbes' figure (loc. cit., pl. xii, fig. 3). In this definition Haeckel has disregarded Forbes' statement that the number of tentacles in the interradial bundles is "either two or three, . . . the number varying in different specimens" (loc. cit., p. 65), and I am able to confirm Forbes fully in this respect. The development of the lateral tentacles in the interradial bundles takes place very irregularly. In some instances I have seen them arising together, one on each side of the median tentacle, and growing at a uniform rate; but in the majority of cases there is an irregularity in the time of their origin, and one of the lateral tentacles may have become considerably developed before the rudiment of the other has appeared. It thus very often happens that individuals may be seen to possess interradial bundles of two tentacles only, and it is this condition which Forbes has figured. It is, however, as I have just shown, simply an instance of temporary asymmetry due to inequality of growth. The species *Margellium octopunctatum* of Haeckel has consequently no existence. The oral tentacles (*Mundgriffel*) of our own specimens show a single bifurcation only (cf. Giard, Bull. Sci. France et Belgique, xix, 1888, pp. 317, 318, pl. xxi), whereas Haeckel gives "Mundgriffel 3—4 mal dichotomisch getheilt" as one of the characteristics of his species,—upon what grounds I do not know. The buds, so characteristic of this medusa, form a longitudinal row on each of the four sides of the manubrium, each row containing from two to four buds, which increase regularly in size from the oral to the umbrellar region of the manubrium. I have not detected the spiral arrangement attested by Giard, although his remarks on the order of their development apply equally well to the specimens I have examined. The medusa was taken in the tow-nets in February and March of this year also, but not in the same abundance as last year. It was succeeded towards the end of April by other Margelid medusæ, *Bougainvillea* (*Margelis*), both *principis* and *ramosa* of Haeckel, which seem, indeed, to form only one species.

Other Anthomedusæ that have been taken are *Corymorpha nutans*, which was abundant in May this year; *Sarsia prolifera* and *tubulosa* (rarely), *Podocoryne* (*Dysmorphosa*) *carnea*, *Tiara octona*, *Amphinema Titania* (= *Saphenia dinema* of Forbes), and *Amphicodon amphipleurus* of Haeckel. The last-mentioned very remarkable medusa

had numerous buds arising from the tentacle bundle; it was taken on a few occasions only during April of this year.

Among Calyptoblastic Hydroids, I may record that *Diphasia rosacea* is common on stones in Millbay Channel.

The Campanularian medusæ offer great difficulties in the way of satisfactory identification, owing to our ignorance of the limits of growth and modification of which so many of the medusæ are capable after liberation; I will therefore content myself with descriptions in several cases. Several specimens of a large, delicate, and perfectly transparent medusa were dipped up from the boat's side on October 6th, 1892, which I found, upon examination, to be the *Irene pellucida* of Will, redescribed by Claus in the Arbeiten des Zoologisches Inst. zu Wien, iv. This medusa is the *Geryonopsis pellucida* of Forbes' monograph (p. 40), but is altogether distinct from the species described by Haeckel under the name *Irene pellucida*. The umbrella was depressed and broad, 2·4 cm. in diameter. The gonads extended 8 mm. from the edge of the umbrella, *i. e.* only two thirds of the radius. There was a distinct peduncle (*Magenstiel*), conical in form, 5 mm. long. The oral lips, four in number, were produced and fimbriated. The tentacles, sixty-four in number, were very regularly disposed (4 + 4 + 8 + 16 + 32). The primary and secondary tentacles were as long as or longer than the oral lips, and the tentacles of the remaining orders diminished regularly in size and length according to their respective orders. Each tentacle consisted of a basal bulb and a terminal filament, often coiled. There was no trace, however, of true "spiral cirri." In addition there was also a variable number of tentacle rudiments, devoid of filaments, in positions which indicated the commencing formation of a sixth order of tentacles, sixty-four in number. Otolithic vesicles were present, usually one between every two adjacent tentacles, never more. Every tentacle was provided with an excretory pore, opening into the umbrellar cavity at the tip of a tubercle placed just above the velum. The species differs from the *Irene pellucida* and *Irene viridula* of Haeckel's monograph in the absence of spiral cirri. From the former it also differs in the fimbriation of the oral lips, in the absence of a conspicuous constriction between peduncle and stomach, in the regularity of the tentacles, and in the distal position of the gonads on the radial canals. From the *Geryonopsis delicatula* of Forbes it differs in the regularity of the tentacles, in the absence of a conspicuous contraction of the peduncle, and in the smaller size of the oral lips and of the velum.

In addition to *Laodice cruciata* (= *Thaumantias pilosella* of Forbes and the "Irene viridula" of Mr. Bles's *Notes on the Plankton of Plymouth*, this Journal, II, 1892, p. 342), which is common at Plymouth every summer, numbers of an *Irene*-like Phialid were taken

in the tow-nets during August, 1893. The tentacles were regular, and sixteen in number. One or generally two otocysts were situated between every two adjacent tentacles. There were no cirri. The mouth had four very short lips, absolutely smooth; and there was no peduncle. The gonads formed four oval swellings almost at the distal extremities of the four radial canals.

Early in February this year I again saw a number of Leptomedusæ resembling those just described in many respects, but approaching more nearly Haeckel's *Phialidium variabile*. The size was in some cases as much as that of a threepenny piece. The tentacles, sixteen in number, were long, and arose from stout pigmented bulbs. There was one otocyst between every two adjacent tentacles, and in one instance I saw two in that position. No peduncle. Radial canals four; gonads oval, elongated, in the distal halves. The species at first suggested to me the *Epenthesis cymbaloidea* of Haeckel, but the occasional occurrence of two otocysts in an intertentacular arc, the absence of a distinct ocellus, and the sharp boundary between the basis and filament of the tentacles, eventually inclined me towards *Phialidium variabile*.

Another Leptomedusa which it may be useful to record is the *Thaumantias octona* of Forbes, which I observed on two occasions in February and March, 1894. Haeckel places this medusa in the genus *Eucope*, owing to his belief that the "two vesicles" which Forbes describes and figures in juxtaposition on the edge of the umbrella are the optical expression of an otolithic capsule. These bodies, however, are quite separate from one another, as described by Forbes; and although I am not able to throw any light on their function or fate, I may say that Haeckel's suggestion is devoid of foundation.

The interesting Lucernarian *Depastrum cyathiforme* was twice obtained last year, in March at Drake's Island, and in May at Rame Head. One of the specimens obtained at the latter place exhibited a distinct lateral bud, a phenomenon not hitherto recorded, I believe, among Lucernarians.

Ctenophora.—A number of specimens of the lobate Ctenophore *Bolina hydatina* were obtained on several occasions in the Sound during the latter half of May this year. Many of the specimens were of the full size mentioned by Chun in his monograph, viz. up to 4 cm. in length, and were obtained in capital condition in spite of their extreme delicacy. The species was first identified at Plymouth by Mr. Riches, who noticed specimens in the tow-nets towards the end of May, 1892. Its recurrence at exactly the same period this year renders all the more remarkable its apparent absence from Plymouth during the intermediate year, especially when the calmness and warmth of that summer are taken into consideration.

ANTHOZOA.—During May, both in 1893 and 1894, the Leptomedusæ which then abounded in the Sound, and which seemed to be in part the young stages of *Irene pellucida*, and in part *Phialidium variabile*, were infested to a large extent with parasitic Actinian larvæ, which I had little doubt (after external examination only, however) were the young stages of *Halcampa chrysanthellum*.

In my notes on the fauna for 1892 (Journal, 1892, p. 334) I recorded *Bunodes coronata* as occurring at Plymouth. This is perfectly true, but the species which I intended at the time to record was *Bunodes verrucosa* (= *gemmacea* of Gosse). *Chitonactis coronata* (the *Bunodes coronata* of Gosse) has been taken on many occasions in the deeper water outside the Breakwater, as well as once or twice in the deep water of Millbay Channel. I have no doubt that those who are familiar with the recent changes and present state of Actinian nomenclature will forgive my momentary confusion of names, which I now correct.

In my former list I omitted to mention that *Epizoanthus incrustatus* * is common at Plymouth on a patch of ground a short distance south of the Mewstone, where it covers the shells tenanted by *Anapagurus lævis*. Another species of Zoanthid, *Epizoanthus couchii*, which is common in the Sound around the Duke Rock, and to a less extent in Millbay Channel, in which localities it may be found forming linear or retiform colonies over stones and shells.

TURBELLARIA.—Mr. Gamble identified as *Fecampia erythrocephala* (Giard) a remarkable Rhabdocœle which he found infesting a large percentage of young shore-crabs (*Carcinus mænas*) in the summer of 1893. I had seen a few specimens previously in basins in which some coralline from tide-pools had been placed; they must have just emerged from the crabs in the coralline. The curious cocoons formed by *Fecampia* are also very plentiful on stones at Plymouth, both on the shore and down to a depth of 5 or 6 fathoms.

CHÆTOPODA.—I am unable to refer to Miss Buchanan's preliminary report on the Polychæta of Plymouth (Brit. Assoc., 1892), but at the risk of repetition will record here a few species which I believe are not mentioned in her list. A single mutilated specimen of *Maldane cristagalli* of Claparède was dredged on a patch of ground, consisting of hard rock and intervals of sand, a short distance south of the Breakwater Fort on December 14th, 1892. It was associated with specimens of *Glycera capitata* and *Eunice Harassii*. The former, however, lives at Plymouth wherever there is abundance of clean coarse shell sand, and *Eunice Harassii* is not uncommon in Millbay Channel and around the Duke Rock, where it lives in holes of stones.

* The nomenclature of Haddon's *Revision of British Actiniæ* (Trans. Roy. Dublin Soc., vol. iv, 1891) is here followed.

It is also sometimes taken on the shore. The much larger Eunicid, *Marphysa sanguinea*, is common both in Rum Bay and at Drake's Island. It inhabits deep crevices of the rocks, and can only be obtained by breaking the latter to pieces by means of a crowbar.

On January 26th, 1893, I noticed among a number of *Phyllodoce maculata*, which emerged from material dredged off the west shore of Drake's Island, two specimens of a charming white *Phyllodoce* with reddish eyes, which I was not able to identify. *Each segment except the most anterior ones was provided with a girdle of cilia.* The parapodial lamellæ were fan-shaped, and each was marked with a brown, or rather a fawn-coloured spot. The inferior edge of each lamella was also provided with large vibratile cilia. The back of the worm was faintly pigmented with fawn-colour. The small but handsomely marked Syllid, *Proceræa picta* of Ehlers, is fairly common among the stones dredged in Millbay Channel. A species of *Myrianida** is constantly recurring at Plymouth, one or two specimens at a time. I believe it is identical with the *Myrianida maculata* of Claparède, though I cannot at present say whether it is different from the *Myrianida pinnigera* of Montagu, whose original description I have not seen. It is easily recognised by its colour, which is white, with deep orange-red blotches on the back of every third or fourth segment. It is fairly frequent among the roots of *Laminaria*. On one occasion (May 29th, 1893) I found a specimen under a stone at the Breakwater, which was provided with a chain of buds, some of which had detached themselves before my return to the laboratory. *Amblyosyllis* (*Gattiola*) *spectabilis*, I find, is a spongicolous form, and can often be obtained in quantity by tearing open the larger sponges, of *Desmacidon*-like texture, dredged in Millbay Channel. A large eyeless *Polydora* (? *flava*, Claparède) is common in Rum Bay, and at Rat Island in St. German's River, where it constructs mud burrows between the layers of shaly rock. In February I have found many of these burrows also containing a long segmented gelatinous egg-string, almost as long as the worm itself (*i. e.* about two inches), lying flat and straight in the burrows. The worm itself possesses a bifid præoral lobe, and the branchiæ commence on the eighth segment (*i. e.* the third after the apodous segment). The dorsal blood-vessel is conspicuous, the blood being crimson. At Rat Island I have also taken specimens of *Scoloplos armiger*, living, like the *Polydora*, in the mud between layers of shale, and also in the dirty sand around. In November, 1892, a single specimen of the

* Good figures of this species are given by Malaquin (*Mem. Soc. des Science et des Arts*, Lille, 1893, p. 287, pl. i), who identifies the *Myrianida maculata* of Claparède with the *M. fasciata* of Milne-Edwards.

remarkable *Ammotrypane aulogastra* of Rathke (*non* Johnston) was dredged off the Duke Rock.

Two specimens of the pelagic post-larval stage of *Arenicola* (described in this Journal, III, 1893, p. 48, by Dr. Benham) were again obtained this year in February, but about a fortnight earlier than in 1893.

Gephyrea.—*Phoronis hippocrepia* has been frequently dredged, especially in Millbay Channel, and I have also taken it on the shore at Cremyll.

Mollusca.—Several specimens of *Lima Loscombii* have been taken alive in about 20 fathoms off Stoke Point and south of the Mewstone. Large specimens of *Arca tetragona* can be obtained in Rum Bay by breaking the rocks there to pieces with a crowbar. They live in deep holes and crevices of the rocks, to which they are permanently attached by their stout operculum-like byssus. In the majority of cases the shells are remarkably abraded and polished by the efforts of the molluscs to enlarge the crevices in which they are fixed, so as to make room for their own increasing size. Not only is their layer of bristles entirely worn away in many cases by this friction of the valves against the surrounding rock, but the rock itself is rubbed away and polished by the incessant friction. In many cases I found the rock to be an almost perfect mould around the mollusc, while the aperture to the crevice by which the larval or young *Arca* had originally entered was not large enough to admit a specimen of even half the bulk to which the mollusc had attained!

A remarkably elongated specimen of *Loligo media* was trawled on April 14th, 1893, eight miles south of the breakwater. I took the following notes of its dimensions:

Maximum length of mantle . . .	136	mm.
„ breadth of fin	27	„
Anterior extremity of fin to apex of body .	98	„
Posterior „ „ „ „ .	43	„

The extraordinary abundance of the Tectibranch *Philine aperta* during 1893 has been already mentioned. Hundreds of specimens could easily be obtained at any time in the eastern portion of the Sound, and the species with its gelatinous egg-masses was so abundant in July as to choke the meshes of the shrimp-trawl when worked in Jennycliff Bay. *Oscanius membranaceus* also, though not so abundant as *Philine*, was unusually plentiful, especially in Millbay Channel and the Hamoaze.

In February of this year I found a single specimen of an apparently undescribed * type of Tectibranchiate mollusc which unites in

* This is the *Colpodaspis pusilla* of Michael Sars, a very rare and interesting form, of which only two specimens have previously been obtained.

a remarkable manner the most salient characters of the Notaspidea and Cephalaspidea. I have prepared figures of this little animal, a description of which will be published immediately.

Several rare Nudibranchs have been taken, chief of which are the Æolid *Berghia cœrulescens* and *Hero formosa*. Both forms inhabit the deeper waters outside the Breakwater, and the latter is by no means uncommon. Additional captures have also been often taken of *Æolidiella glauca* and *Platydoris planata*, and, less frequently, of *Amphorina cœrulea*, *Antiopa hyalina*, *Embletonia pulchra*, *Hermæa bifida*, and *Thecacera pennigera*. The specific habits of most of these forms are still unknown, but in the case of two Dorids, *Rostanga coccinea* and *Lamellidoris oblonga*, the following observations upon their habits may be useful. Just as *Jorunna Johnstoni** lives among small *Halichondriæ*, upon which it feeds, and which it strikingly mimics in general and even detailed appearance, so I have found that *Rostanga coccinea*, which is of a bright scarlet colour, lives—in both senses—upon red encrusting sponges. This species, which formerly seemed to be rare at Plymouth, I have been able to obtain easily by dredging or collecting in those places where its food-sponges are abundant. On the other hand, *Lamellidoris oblonga* lives not upon sponges, but upon Polyzoa of the genus *Cellaria*, especially the stouter species, the twigs of which it clasps firmly with its foot. This Dorid is not well described by Alder and Hancock, no doubt from their lack of a sufficient number of specimens from which to educe the characteristic features. The back normally shows a variable number of irregular, ring-like, dark spots (of which there are usually eight or nine more conspicuous than the rest), and round the entire periphery of the back there is a pigmented border, which has no sharply defined edges, but is a marked feature when a number of specimens are examined and compared. The edges of the rhinophoral fossæ are raised into a slight rim or sheath provided with three tubercles. The chief differences between individuals for the most part concern simply the relative intensity of the brown pigmentation: the annular spots and border were indistinguishable in only three out of forty specimens. I first noticed this species on December 19th, 1892, when scores of specimens were taken from *Cellaria* trawled seven miles south of the Breakwater. With them were associated a few specimens of *Lamellidoris pusilla* and *Lamellidoris proxima*.

Another small Dorid, whose back is strikingly marked by conspicuous purple tubercles upon a field of yellow, seems to be new to science, and will be described elsewhere.

* Garstang, *Notes on the Structure and Habits of* Jorunna Johnstoni, Conchologist, vol. ii, 1892.

In November, 1892, among coralline from tide-pools, I repeatedly found specimens of a minute white Dorid, whose back exhibited a regularly arranged series of very spiny tubercles. I was completely at a loss as to its identification, until towards the end of the month several slightly larger specimens were taken, which showed traces of pigmentation,—brownish patches here and there, and a brown ring on each rhinophore. During the next month or two I followed out the growth of these little Nudibranchs by obtaining fresh specimens from the tide-pools from time to time, until I had a complete series between the minute and absolutely white form and the fully developed and highly pigmented *Ægirus punctilucens*. From these observations I am strongly inclined to regard the *Ægirus hispidus* of Hesse as merely one of the younger stages of *Ægirus punctilucens*. They also enable me to identify, as a still earlier stage of the same species, a remarkable post-larval form which had occurred in the autumn tow-nettings, as observed both by Mr. Bles at Plymouth and Mr. Vallentin at Falmouth. It was simply one of these minute white *Ægirus* with the addition of a pair of large velar lobes, by means of which it swam freely in the water.

Two other Gastropod larvæ that I have noticed in the tow-nettings are worthy of record. One is the *Echinospira diaphana*, figured in Bronn's Thier-Reichs, and the other the *Cirropteron semilunare* of Michael Sars (Besk. og Jagttag., &c., Bergen, 1835). In each of these forms the velum is produced into ciliated lobes, three on each side in *Echinospira*, and two in *Cirropteron*. The former occurs in the summer tow-nettings every year; the latter I have only seen once, towards the latter end of August, 1893.

Crustacea.—To my former record of *Apseudes talpa* I may add here the occurrence of *Apseudes Latreillii* at Plymouth. I found numerous specimens in the mud around the roots of corallines from Drake's Island in July, 1893, and on other occasions.

In addition to the Schizopoda mentioned in my previous Notes, I have taken the following also at Plymouth:—*Siriella frontalis* (M. Edw.), Drake's Island, among weeds, June 2nd, 1893, one specimen. *Siriella jaltensis*, which occurred in the tow-nets at night in September, 1892, abundant on the shore at Drake's Island among weeds, June 2nd, 1893. *Heteromysis formosa* (S. I. Smith), a few at a time only, Millbay Channel, New Grounds, Cawsand Bay, Yealm, and off Stoke Point. *Leptomysis mediterranea*, common in Cawsand Bay, June 5th, 1893. *Leptomysis gracilis*, October, 1893. *Erythrops elegans*, October, 1892 and 1893. *Mysidopsis gibbosa*, Cawsand Bay, several occasions. *Hemimysis Lamornæ*, Cawsand Bay, July 5th, 1893. *Macromysis inermis* and *M. neglecta*, among weeds everywhere. *Schistomysis arenosa*, Cawsand Bay, Whitsand Bay.

The form "allied to *S. arenosa*," referred to in my previous Notes, is this species, as Canon Norman, who kindly examined some specimens, has assured me.

Nika edulis has been trawled in the Sound occasionally, but is rare.

Pirimela denticulata is not uncommon in the patches of clean coarse shelly gravel to the south of Drake's Island. Its highly speckled appearance renders it very inconspicuous on this ground, into which, however, it promptly burrows so as to be completely hidden from view.

Stenorhynchus egyptius (M. Edw.) is not uncommon on weedy ground, and is at once distinguishable from the other spider-crabs by its stripes of reddish-brown pigment. The habit of decking the body and limbs with bits of seaweed is as marked in this species as in any of the others, and as it generally lives among reddish weeds its own coloration contributes greatly to its disguise.

Echinoderma.—During August, 1893, the tow-nets frequently contained one or two specimens of the interesting type of *Bipinnaria* larva described by me in the Quart. Journ. Micr. Sci., January, 1894.

Tunicata.—During August and September, 1893, a considerable number of specimens of a small *Doliolum* were found in the tow-nettings. They agree with Herdman's *Doliolum tritonis* in all respects except that the stigmata begin dorsally close behind the second muscle band,—a point of no great importance. When alive these little creatures are perfectly transparent, and dart about with great activity in the water.

Earlier in the year—from the middle of June to the end of the first week in July—the Sound was visited by large shoals of the Salp *Thalia democratica-mucronata*. Many of the specimens first taken were of the sterile or nurse generation, and were provided with young chains; the later specimens, on the other hand, were chiefly sexual forms derived from the breaking up of the chains, and a large number of these contained embryos—one only to each adult—in different stages of development.

II. Notes on the Breeding Seasons of Marine Animals at Plymouth.

These notes are founded almost entirely on my own observations, and are necessarily incomplete, though, I believe, not inaccurate. My original intention was to continue such observations for at least another year before publication, in order to be able to present a fairly complete record; but my departure from Plymouth has interfered with this plan, and, at the request of several friends, I publish

my notes as they are. They will serve, I hope, as at least an indication of the breeding periods of many forms at Plymouth. A more extensive list, including the records given in various monographs and original memoirs, for the whole of the British Isles, is at present under preparation, and will be presented for publication at no distant date.

PROTOZOA.

Noctiluca miliaris.—(Swarm-spores) March (S. F. Harmer).

PORIFERA.

Principally July, August, September.

HYDROZOA.

In those Hydroidea which possess sessile gonophores or sporosacs the breeding season may be regarded as practically coincident with the period of gonophore-formation, although actually a little later; but in the case of those Hydroids which attain maturity in the form of free medusæ, the time that may elapse between the separation of the medusæ and the deposition of ova is in the majority of cases still unknown, and is certainly not a constant quantity. The periods given here will therefore be the periods of gonophore- or sporosac-formation. The breeding seasons of free medusæ may be regarded as the periods when they attain their full growth and greatest abundance—information upon which points may be gathered from the third section, dealing with the floating fauna.

Tubularia indivisa.—February, March, April.
Tubularia larynx.—April.
Tubularia bellis.—April.
Tubularia humilis.—March.
Myriothela phrygia.—May to August (Bourne).
Clava multicornis.—March, April.
Clava leptostyla.—March.
Clava cornea.—February (Bourne), May.
Tubiclava cornucopiæ.—May, June.
Hydractinia echinata.—August.
Perigonimus repens.—August.
Podocoryne carnea.—August (and earlier).
Coryne pusilla.—May; July (Bourne).
Coryne vaginata.—May to August (Bourne).
Syncoryne eximia.—May (Bourne).
Eudendrium ramosum.—February, March.
Eudendrium capillare.—May, September.
Garveia nutans.—April.
Obelia geniculata.—March, September.

Gonothyræa Loveni.—April, October, November (sparsely).
Sertularia argentea.—February.
Sertularia pumila.—March, April, May, June, July.
Diphasia pinnata.—April.
Diphasia rosacea.—April.
Sertularella Gayi.—February, August, September, October.
Hydrallmania falcata.—January.
Halecium Beanii or *halecinum.*—January to July.
Plumularia setacea.—February to June.
Plumularia pinnata.—April.
Antennularia antennina.—May, June, July.
Antennularia ramosa.—May.
Aglaophenia pluma.—August.
Aglaophenia myriophyllum.—August.
Aglaophenia tubulifera.—October.

Siphonophora.

Muggiæa atlantica.—August, September (J. T. Cunningham; E. J. Bles).

Scyphozoa.

Aurelia aurita.—(Strobilising) February, (breeding) June, July.

Anthozoa.

Alcyonium digitatum.—November, December, January.
Actinia equina.—January onwards (to August ?).
Bunodes verrucosa (*gemmacea*).—April, September.
Urticina felina (*Tealia crassicornis*).—May.
Chitonactis coronata.—January to April.
Cereus pedunculatus (*Sagartia bellis*).—December, January, February.

Turbellaria.

Fecampia erythrocephala.—August, September.
Leptoplana tremellaris.—August (F. W. Gamble).
Eurylepta cornuta.—August (Gamble).
Stylostomum variabile.—August (Gamble).
Cycloporus papillosus.—August (Gamble).

Nemertina (cf. Riches, Journ. M. B. A., III, 1893, p. 5).

Cephalothrix bioculata.—April, June.
Cephalothrix linearis.—March.
Amphiporus lactifloreus.—March.
Amphiporus pulcher.—September.
Amphiporus dissimulans.—March, September, October.
Tetrastemma dorsale.—September, October, November.

Tetrastemma candidum.—September, October, November.
Tetrastemma vermiculatum.—September, October, November.
Nemertes Neesii.—March to October.
Lineus obscurus (= *gesserensis*).—January, February.

ARCHIANNELIDA.

Dinophilus tæniatus.—April (Harmer).
Histriobdella Homari.—September (E. J. Allen).

CHÆTOPODA.

Ophryotrocha puerilis.—August.
Nereis fucata.—May.
Phyllodoce maculata.—January, February.
Hesione (= *Psamathe*), sp.—August.
Scoloplos armiger (*?*).—February.
Polydora (*flava ?*).—February.
Sabellaria spinulosa.—May.
Serpulidæ.—June.
Terebellidæ.—May.
Polycirrus aurantiacus.—July.
Cirratulus cirratus.—February (and earlier).

HIRUDINEA.

Pontobdella, sp.—August (advanced embryos only).

POLYZOA.

Crisia ramosa.—July.
Flustrella hispida.—March.
Smittia, sp.—March (Harmer).

MOLLUSCA.

Amphineura.

Chiton, sp.—March.

Gastropoda.

Littorina littorea.—February.
Littorina littoralis.—February.
Littorina rudis.—June.
Capulus hungaricus.—January, February, March.
Buccinum undatum.—January, February, March, April.
Purpura lapillus.—January, February, March, April, November.
Murex erinaceus.—May (and earlier).
Nassa reticulata.—February, March, April, July, September.
Nassa incrassata.—April, June, August, September.
Lamellaria perspicua.—January to May.

Aplysia punctata.—June to October.
Philine aperta.—May, June, July.
Elysia viridis.—October (and earlier ?).
Hermæa dendritica.—June.
Æolis papillosa.—March, April, May, June.
Æolidiella Alderi.—August.
Favorinus albus.—November.
Facelina coronata.—April, May.
Galvina Farrani.—May, October.
Galvina exigua.—March.
Galvina cingulata.—July.
Tergipes despectus.—March.
Doto fragilis.—January.
Doto coronata.—April.
Candiella (*Tritonia*) *plebeia.*—November.
Hero formosa.—April.
Doris tuberculata.—January to June.
Acanthodoris pilosa.—January, February.
Lamellidoris bilamellata.—November (?).
Lamellidoris oblonga.—April.
Lamellidoris pusilla.—February.
Goniodoris nodosa.—December, January to May, September.
Goniodoris castanea.—February, May, July, September.
Polycera quadrilineata.—July, August.

Lamellibranchia.

Arca tetragona.—July.
Teredo navalis.—May.

Cephalopoda.

Eledone cirrosa.—April, May.
Sepiola atlantica.—July, August.
Loligo media.—April, May, June, October (late embryos).
Loligo Forbesii.—April to September.

CRUSTACEA.

Cladocera.

Podon (*intermedius*, Lilljeborg ?).—March, April, June (?).
Evadne Nordmanni.—March (scarce), July, August, September. Winter ova in September and October (E. J. Bles).

Copepoda.

Some forms or other may be found breeding at almost any time of the year.

Cirrhipedia.

Chthamalus stellatus.—January, February, March, August, September.
Sacculina carcini.—May, June, July, August, September.

Leptostraca.

Nebalia bipes.—April, May, June, July (late embryos).

Edriophthalmata.

The great majority breed between April and August.

Cumacea.

Pseudocuma cercaria.—May, June.

Schizopoda.

Siriella jaltensis.—June.
Gastrosaccus sanctus.—August.
Gastrosaccus Normani.—September.
Heteromysis formosa.—October, November.
Erythrops elegans.—October (late embryos only).
Mysidopsis gibbosa.—July.
Leptomysis mediterraneæ.—June.
Macromysis flexuosa.—April, May, June, July.
Macromysis inermis.—June.
Schistomysis arenosa.—June.
Schistomysis spiritus.—June, July, August (late stages only).

Decapoda.

Homarus vulgaris.—August, September. Larvæ hatched in May and June.
Palinurus vulgaris.—Larvæ hatched in July (Cunningham).
Palæmon serratus.—November, December, January to June.
Palæmon squilla.—July (and earlier).
Palæmonetes vulgaris.—May, June, July, August (late stages only).
Pandalus annulicornis.—November, December, January, February.
Pandalus brevirostris.—April.
Hippolyte Cranchii.—April, May.
Virbius varians.—May, June, July.
Nika edulis.—May.
Crangon vulgaris.—December, January to August.
Crangon fasciatus.—May.

Crangon sculptus.—June.
Crangon trispinosus.—July.
Diogenes varians.—July.
Eupagurus Bernhardus.—April.
Eupagurus Prideauxii.—March, April, May, June, July.
Anapagurus lævis.—April, May.
Galathea squamifera.—April.
Galathea dispersa.—March.
Galathea intermedia.—March.
Porcellana longicornis.—March, April, May, June, July.
Porcellana platycheles.—April, May, June, July.
Eurynome aspera.—January, February, March, April.
Stenorhynchus phalangium.—May.
Stenorhynchus tenuirostris.—May.
Hyas coarctatus.—August.
Carcinus mænas.—December, January to August.
Portunus depurator.—March to August.
Portunus holsatus.—March.
Portunus arcuatus.—March, April, May.
Portunus pusillus.—April.
Portunus marmoreus.—May.
Pilumnus hirtellus.—April, May, June.
Xantho floridus.—May, June.
Xantho rivulosus.—May, June.
Cancer pagurus.—February to ?.

PANTOPODA.

Nymphon gracilis.—May.
Ammothea, sp.—August.

ECHINODERMA.

Asterias rubens.—May.
Asterina gibbosa.—May, June.
Ophiothrix (*? pentaphyllum*).—February.
Amphiura squamata.—May, June, July.
Echinus miliaris.—May.
Echinus acutus.—July.
Antedon rosacea.—Pentacrinoid larvæ in September and October.

TUNICATA.

Oikopleura dioica.—March, April.
Thalia democratica-mucronata.—July.
Botrylloides rubrum.—August, September, October.
Botryllus violaceus.—June, July, August.
Styelopsis grossularia.—May, June, July, August, September.

Ciona intestinalis.—September (and earlier ?).
Clavelina lepadiformis.—June.
Archidistoma aggregatum.—June.
Morchellium argus.—September (and earlier ?).
Amaræcium Nordmanni.—June.

PISCES.

Elasmobranchii.

Scyllium catulus.—November, December, January.
Scyllium canicula.—December, January, February.
Acanthias vulgaris.—January, February, March.

Teleostei.

Chiefly between January and June.

III. MATERIALS FOR A CALENDAR OF THE FLOATING FAUNA.

The floating fauna of the sea in the immediate neighbourhood of land is so largely composed of larval or other forms derived from the bottom fauna, and possessing in the majority of cases only a transitory pelagic existence, that, from the very nature of the case, the floating fauna assumes a highly periodical character, whose phases are directly dependent on the seasons of breeding, hatching, and metamorphosis of the animals living on the adjacent or underlying tracts of submarine land. This fact alone invests the recording of such simple phenomena as the breeding seasons of marine animals, or their rates of growth and metamorphosis, with a high degree of interest and value; and in the days to come, when this fact has been sufficiently and practically appreciated, we shall make much more rapid progress in our knowledge of the bionomics of the sea. The dependence of the floating and the bottom faunas of our coasts upon each other is so intimate that it is impossible to separate the efficient study of the one from that of the other. A bottom-haunting species no sooner attains its breeding or its hatching period than the floating fauna immediately receives a new addition to its numbers. For a longer or shorter period the larvæ in question lead a pelagic life, and then, sooner or later, sink once more to the bottom to undergo their final transformations. Seeing that every species has its own particular breeding season, which does not necessarily coincide with that of any other species, and that the duration of the pelagic stage is equally variable in different cases, it follows that there must be a perpetual change going on in the constitution of the floating fauna in any one locality, an incessant rising to the surface of new forms just commencing their pelagic phase,

and an incessant sinking to the bottom of surface larvæ whose floating period has come to an end. Were our work completed, our calendar of the floating fauna would largely coincide with, or bear a definite relation to, our calendar of the breeding seasons of bottom-living animals; but the insufficiency of present records, combined with their obvious want of mutual correspondence, shows what a large amount of observation and work remains to be done before the desired pitch of correspondence is attained.

The periodic character of the floating fauna is also manifested in other ways, and especially in certain seasonal changes which the gradual rise or fall of temperature during the year superinduces. These changes are due to actual immigrations of forms whose homes for the most part are in other regions, but which arrive at particular points upon our coasts when the temperature and other physical conditions admit of, and conduce to, their migration. The periodical changes which were first dealt with here were those of larval or metamorphic forms (*e. g.* most medusæ), whose derivation from the bottom fauna, and, in most cases, whose eventual return to it give rise to an incessant *vertical* interchange of material; but the forms which are especially concerned in these seasonal changes are for the most part creatures whose entire existence is pelagic (*e. g.* Siphonophores, *Trachomedusæ*, Copepods, *Sagitta*, *Salpa*), and which exhibit a merely *horizontal* translation from place to place according to the stress of physical conditions.

The situation of Plymouth at the head of a landlocked bay and at the western end of the English Channel renders the study of its floating fauna both difficult and interesting. This fauna is in fact not one fauna, but three faunas,—that of the harbour itself, which may be called the indigenous element; that of the adjacent coasts and of mid-Channel, which may be termed the tidal or Channel element; and that of the Atlantic, or the oceanic element. It is only by taking special precautions that one can isolate the first of these constituents from the other two, viz. by tow-netting within the Breakwater at low tide, when the wind has been light or northerly. At high water the Sound is naturally invaded by foreign forms carried inwards by the flood tide, and this may include eddies from the Channel tide properly so called; while protracted southerly or westerly winds inevitably produce an incursion of pelagic forms from the Channel or the ocean. A special study of the floating fauna would therefore take all these points into practical consideration, and I mention them here in order to warn those who may use these brief notes of the different factors of which the fauna at Plymouth consists, and of the impossibility, after the irregular experience of a few years only, of producing a calendar which shall in all points

discriminate properly between the essential and the accidental phenomena observed.

Notwithstanding this consideration, however, and in spite of the incompleteness of my records, of which no one is more conscious than myself, I believe that I am in a position to offer a least the groundwork for the construction of such a calendar,* the completion of which would be an incalculable boon to the working naturalist, and lead to results of which one can dimly foresee the nature and importance.

January.—The tow-nettings in January are a trifle richer than those taken in December, but beyond that possess few positively distinctive features.

The alga *Halosphæra viridis* is usually present.

There is a marked scarcity of Cœlenterate life. The jars often seem to contain nothing but Copepods† and a few *Sagitta*, which, however, are usually large at this time of the year.

The Invertebrate larval forms present are Cirrhipede *Nauplii*, Polychæte trochospheres and later larvæ, with a few veligers and *Zoææ*.

Teleostean ova and larvæ make their appearance and increase in numbers towards the end of the month. Herring larvæ (*Clupea harengus*) are now taken.

The fauna distinctly ameliorates towards the end of the month.

February.—The improvement, both quantitative and qualitative, of the floating fauna, which was noticeable towards the end of January, becomes marked this month.

Teleostean ova and larvæ are plentiful.

The sea swarms with Copepod and Cirrhipede *Nauplii*, with Polychæte larvæ (Polynoidæ, Phyllodocidæ), with Prosobranch, and especially Opisthobranch veligers, and with Decapod larvæ, both *Mysis* and *Zoæa* stages.

* Since my paper was written I have found that my idea of a calendar of the floating fauna is not new, and that a very full and valuable summary of the periodic changes in the pelagic fauna of St. Andrews was published by Prof. McIntosh in 1889 (Seventh Report, Scottish Fishery Board), part iii, pp. 259–301). The resemblances and differences between our records are of considerable interest.

† It is easily observable that various species of Copepods are also periodic in their occurrence, but I do not refer to them in these notes, as I have not yet familiarised myself with the different forms and names. Reference should be made on this point to Mr. G. C. Bourne's *Report on the Copepoda of Plymouth*, this Journal, vol. I, 1889, pp. 144–152. It would appear from Mr. Bourne's report that *Clausia elongata* is characteristic of the three last and three first months of the year; *Oithona spinifrons*, *Euterpe gracilis*, and *Corycæus anglicus* of the spring (though the two latter species have been recorded for September by Mr. Bles); *Paracelsus parvus* of the summer; *Temora longicornis* of the early summer and autumn; *Anomalocera Patersonii* of the autumn. *Cetochilus septentrionalis* (= *Calanus finmarchicus*) and *Dias longiremis* were obtained throughout the year; but the former most abundantly in the autumn, the latter in the spring.

Cœlenterates make their appearance. The ephyræ of *Aurelia* lead the way, and become increasingly abundant. *Rathkea octopunctata* represents the Anthomedusæ; and a medusa that appears to be the *Phialidium variabile* of Haeckel ushers in the Leptomedusæ. Minute *Obelia* medusæ become noticeable as the month progresses. Occasionally the Channel tide introduces the ova and larvæ of Ctenophores and errant specimens of the Siphonophore *Muggiæa atlantica*.

The Polyzoan larvæ *Cyphonautes* and the larvæ of Lamellibranchs are common; and the pelagic post-larval stage of *Arenicola*, in its gelatinous tube, may from time to time recur.

Echinoderm larvæ, especially *Auricularia*, are usually abundant during a portion of the month.

The Appendicularian *Oikopleura dioica* is often plentiful.

March.—*Halosphæra* is plentiful this month, and *Rhizoselenia* and *Chætoceros* often become extremely abundant.

At the end of the month the gelatinous alga *Tetraspora* of Pouchet makes its appearance, first in the Channel and soon afterwards in the harbour.

Shoals of ephyræ of *Aurelia* may be taken in the first fortnight, showing a distinct increase in size since their first appearance; but towards the end of the month, during their metamorphosis into the medusa form, they begin to disappear and are difficult to discover.

Rathkea octopunctata is plentiful. The Anthomedusæ *Sarsia prolifera* (and *tubulosa?*) and *Podocoryne* (*Dysmorphosa*) *carnea* make their appearance; and the earlier phases of the Leptomedusæ *Clytia Johnstoni* and *Irene pellucida* (Claus, *non* Haeckel) are to be obtained, together with numbers of small *Obelia* and a few *Thaumantias*.

The Cereanthid larva *Arachnactis* appears, and is plentiful towards the end of the month.

Minute Planarians are sometimes noticeable.

The later stages of *Phyllodoce* larvæ are plentiful; the larvæ of *Polydora* also occur.

Crustacean larvæ of all kinds abound, and the *Zoææ* of *Porcellana* begin to appear.

The Cladocera *Podon* and, more scantily, *Evadne* arrive. Echinoderm larvæ (*Auricularia, Bipinnaria, Pluteus*) occur at times.

A striking feature of March tow-nettings is the profusion of the Appendicularian *Oikopleura dioica*, which is now breeding; its gelatinous houses (a mysterious scum to the unwary) are often a great nuisance, but a greater is to follow.

April.—*Tetraspora* abounds, discolouring the sea and choking the meshes of the nets in two or three minutes. Towards the end of the

month these floating and troublesome algæ begin to be converted into so many gelatinous balls of motile spores.

The Diatoms *Rhizoselenia* and *Coscinodiscus* also abound, but *Halosphæra* disappears until the autumn.

Among Anthomedusæ, *Rathkea* disappears and *Bougainvillea* takes its place. *Amphicodon amphipleurus* may also occur. Among Leptomedusæ, small medusæ of *Obelia* and *Clytia* are numerous.

The later stages of *Arachnactis* are represented.

Larvæ of the Nemertine *Cephalothrix* may be found.

It is impossible to speak with much confidence, but there appears to be a rapid reduction during this month of the numbers of *Nauplii* and Polychæte larvæ.

Megalops larvæ become increasingly numerous. Large Portunid *Zoææ* make their appearance towards the end of the month.

Plutei are almost the only Echinoderm larvæ, and they do not seem to be plentiful.

May.—The formation of spores in *Tetraspora* proceeds apace, and leads to a rapid reduction in the numbers of the alga already noticeable early in May. Towards the end of the month the gelatinous alga has entirely disappeared.

The sea swarms with Craspedote medusæ, especially with those of the Campanularians, *e. g. Obelia lucifera* of fair size, *Phialidium variabile* (*?*), *Thaumantias*, and half-grown *Irene pellucida*. The most abundant Anthomedusa is *Corymorpha nutans*, but *Amphinema Titania* and *Tiara octona* also may occur.

Full-grown Ctenophores usually become numerous in the latter half of this month; *Hormiphora plumosa* always, and the magnificent lobate form *Bolina hydatina* in particular years.

Towards the end of the month *Aurelia aurita* begins to reappear in the form of young medusæ.

The parasitic larvæ of the Actinian *Halcampa* are plentiful on Campanularian medusæ.

The Polychæte larvæ and *Nauplii*, so abundant in February and March, are now scarce.

The *Zoææ* of *Porcellana* and of Portunidæ are particularly numerous.

Every year at this time the harbour is invaded by shoals of young brill (*Rhombus lævis*) in their pelagic stage.

June.—This is the month, *par excellence*, for *Aurelia aurita* and Ctenophores. Leptomedusæ also abound; large *Obeliæ* are now plentiful, and a new form, *Laodice cruciata* (*Thaumantias pilosella* of Forbes), makes its appearance.

The first specimens of pelagic Terebellid larvæ in gelatinous tubes may perhaps be taken.

The Gastropod larva *Echinospira diaphana* always occurs.

The Cladoceran *Podon* is generally abundant, but *Evadne* is generally still in mid-Channel. *Sacculina Nauplii* are plentiful.

Minute *Oikopleuræ* of the same year's brood are frequently abundant. After an exceptionally warm, calm spring the harbour may be invaded by hordes of Salps (*Thalia democratica-mucronata*).

July.—A transition is gradually effected during July between the distinctively summer and autumn faunas.

Rhizoselenia and Dinoflagellates (*Ceratium, Peridinium*) are common.

The Anthomedusæ are represented by numbers of *Podocoryne carnea* with some *Sarsia eximia;* the Leptomedusæ by numbers of *Laodice cruciata, Obelia,* and (in the Channel) of *Saphenia mirabilis.*

The Siphonophore *Muggiæa atlantica,* which occurs during the earlier part of the year only in scanty numbers, becomes plentiful towards the end of this month.

The first specimens of *Chætopterus* larvæ may be taken.

Balanid *Nauplii* become again numerous, and *Evadne* arrives in large numbers.

Echinoid *Plutei* are to be obtained.

August.—In variety and intrinsic interest of the forms to be captured, this and the next month are perhaps the richest in the year,—a feature which accords well with the fact that during this month the sea temperature attains its maximum for the year.

The more oceanic element includes numbers of Radiolaria, *Muggiæa,* young *Geryonia appendiculata, Evadne* (and perhaps *Podon*), and *Doliolum Tritonis,*—all of which, after a warm summer, may occur in plenty and even profusion.

Numbers of interesting larval forms are also taken, of which the chief perhaps are Müller's larva (in shoals towards the end of the month), *Pilidium* (abundantly), Annelid larvæ (*Polygordius* occasionally, *Polydora, Pectinaria, Nerine, Magelona, Chætopterus*), Gastropod larvæ (*Rissoa, Ægirus, Cirropteron semilunare*), *Actinotrocha,* Cirrhipede larvæ (*Sacculina*), Echinoderm larvæ (*Plutei,* large *Bipinnariæ*), *Tornaria,* and the larva of *Amphioxus.*

Conspicuous among Anthomedusæ are *Amphinema Titania* and *Podocoryne* (*Dysmorphosa*); and among Leptomedusæ, *Saphenia mirabilis, Laodice cruciata,* and small *Obeliæ.*

Dinoflagellates and diatoms (*Rhizoselenia*) are plentiful.

September.—The floating fauna during September differs very slightly from that of the preceding month.

The disappearance of the medusæ *Laodice cruciata* and *Saphenia mirabilis* is effected, and *Willia stellata* appears.

Almost all the other forms plentiful in August retain their abund-

ance for the greater part of September, the possible exceptions being *Radiolaria, Bipinnaria,* and *Tornaria.*

On the other hand Terebellid larvæ are increasingly numerous; the larvæ of *Muggiæa,* of the Nemertine *Cephalothrix,* and of the Gephyrean *Thalassema* may be found; and Müller's larvæ, *Pilidium,* the larvæ of *Magelona, Chætopterus, Rissoa,* and *Ægirus* are generally in the earlier part of the month especially plentiful.

Apparently characteristic of this period are the clouds of pelagic Rotifers which may occasionally be taken.

The diatom *Chætoceros* is especially abundant.

October.—With the end of September an impoverishment of the fauna sets in, owing chiefly to the disappearance of the more oceanic element.

Chætoceros is the most plentiful diatom. The alga *Halosphæra* reappears. Dinoflagellates are abundant, and a few Radiolaria may still occur. The following medusæ may be present:—*Cytæandra areolata, Eutima insignis,* and large *Irene pellucida.*

Nemertine larvæ, including those of *Cephalothrix,* are numerous. Polychæte larvæ of the genera *Polynoë, Chætopterus, Polydora,* and *Terebella* are still present.

Larval Lamellibranchs and *Cyphonautes* are numerous, as indeed they seem to be during the greater part of the year.

Decapod larvæ are scarce, especially those of the Brachyura. *Sagitta* is generally present, and a few *Plutei* may be taken.

November.—The impoverishment continues. There is a great scarcity of medusæ, veligers, and Zoææ. The larvæ least rare are those of Polychætes, Cirrhipedes, *Macrura,* and *Cyphonautes. Cephalothrix* larvæ and Ophiurid *Plutei* may occur.

The diatom *Coscinodiscus* is present in profusion.

December.—Medusæ are still rare or even entirely absent. Annelid trochospheres and Opisthobranch veligers show signs of increasing numbers. *Cyphonautes* is present.

Fishery Publications of the United States.

By

J. T. Cunningham, M.A.,
Naturalist to the Association.

In recent years the Bulletin of the United States Fish Commission has outgrown its older brother, the Report of the Commissioner, and in some respects supplanted it. The last volume of the Report, part xvii, bears the date of publication 1893, but it was only received by us in the present month of June, 1894, and it refers to operations carried out in the two years 1889–91,—in other words, from three to five years ago. The volume consists of three general reports and six appendices. The former are the Report of the Commissioner, that of Mr. Richard Rathbun on the Inquiry respecting Food-fishes and the Fishing-grounds, and that of Mr. Hugh M. Smith on the Inquiry regarding the Methods and Statistics of the Fisheries. The Appendices comprise three special reports, a Review of Sparoid Fishes, by David Starr Jordan and Bert Fesler, an article on Fish Entozoa, and a translation of Haeckel's well-known pamphlet, Plankton-Studien.

The first thing of interest which we note in the Report of the Commissioner is a statement of the amount of the appropriation of public revenue to the work of the Commission. In the year 1889–90 the total amount was $278,900, in the following year $298,900, in English money about £55,780 and £59,780 respectively. In the second of the two years mentioned the division of this money among the various departments of the work was as follows:

Commissioner's "Compensation" . .	£1,000
Propagation of food-fishes . .	30,000
Distribution of food-fishes . .	10,000
Maintenance of vessels . . .	10,780
Inquiry respecting food-fishes . .	4000
Statistical inquiry . . .	4000
	£59,780

During the two years the Commission steamer "Albatross" was engaged in surveying the fishing-grounds off the Pacific coast of the United States, her work extending along the coasts of Washington, Oregon, and California, and over the shallow water area in the eastern part of the Behring Sea. In the early part of 1891 the "Albatross" was lent to Professor Alexander Agassiz for the purpose of a biological and physical exploration of the ocean and continental slope between the Galapages Islands on the south and the Gulf of California to the north, a region which had previously been but little examined. This expedition was very successful, important and extensive information having been obtained by its means. The results of the ordinary work of the "Albatross" on the Pacific coast are described in Lieut.-Commander Tanner's special report among the appendices in this volume.

On the Atlantic coast the chief operations were conducted in the interest of the oyster industry. A complete survey was made of the coast waters of South Carolina, where the oysters were found to be all of the raccoon type, forming narrow ledges along the borders of the bays and the winding tidal channels between high and low water. It is suggested that the absence of oysters from the bottom below low water mark is due to the high specific gravity of the water, which prevents the spat from sinking below the surface. The raccoon oysters are useful as seed, improving in shape and flavour when transplanted. The investigation to which the Commissioner here refers has been fully described in two elaborate papers by John D. Battle and Bashford Dean, published in the Bulletin, vol. x, in 1892. Mr. Battle's paper contains the results of the hydrographic survey, and is illustrated by a number of charts showing the details of the observations made; while Mr. Dean describes the physical and biological conditions affecting the life of the oyster. The Commissioner next mentions an investigation in the "Fishhawk" of the oyster beds of Maryland and Virginia in Chesapeake Bay, and of the beds in Long Island Sound. He refers to the journey of Mr. Bashford Dean to Europe, undertaken for the purpose of studying the oyster industry in European countries. Many in this country who are interested in oyster-culture are well acquainted with the lucid and valuable papers in which Mr. Dean has published his observations, namely, *The Present Methods of Oyster Culture in France*, published in the Bulletin, vol. x, 1892, illustrated with ten plates of figures more or less satisfactorily reproduced from photographs of actual scenes; and *Report on the European Methods of Oyster-culture* in vol. xi, 1893, of the Bulletin, still more completely illustrated. These two papers form the best account extant of the methods now practised and the present condition of oyster-culture in Europe. Mr. Dean was sent

at the expense of the United States Fish Commission for the benefit of American oyster growers, but European and especially English people interested in the oyster industry are likely to obtain still more advantage and benefit from his careful work than Mr. Dean's own countrymen, and we owe a debt of gratitude to the Commission for thus providing us with reliable and important information without any cost or trouble to ourselves.

In reference to the Wood's Holl station the Commissioner reports that Dr. H. V. Wilson was appointed resident naturalist on behalf of the Commission in 1889, and served in that capacity in the two following years. His researches related chiefly to the development of the sea-bass, cod, and Atlantic salmon. An elaborate paper on the *Embryology of the Sea-bass* by Dr. Wilson is contained in the Bulletin, vol. ix, 1891. The study of the lobster was taken up at Wood's Holl by Prof. F. H. Herrick, and experiments in artificial propagation were conducted by Mr. V. N. Edwards. We are told that the investigations of the latter have furnished conclusive proof that the hatching work of the Fish Commission has been exceptionally successful in increasing the supply of cod on the southern New England coast, and shows that the larger fish resulting from these plantings will to some extent enter more shallow waters than are generally frequented by the cod, shoals of this species now often making their appearance in places where they were never seen before. The evidence for this would be interesting, and we shall see whether it is forthcoming among the documents published by the Commission.

The Report next mentions the investigations of the interior waters of several of the States, which were extensively and systematically carried out, and reports on which have appeared. A brief notice is then given of the inquiry into the methods and statistics of the fisheries, on which a special report is included in the volume. The rest of the Commissioner's Report is on the Department of Fish Culture which is under the chief's immediate direction. Twenty-two stations were in operation in 1890 and 1891. Sea fish were only manipulated at two stations, namely, Gloucester, Mass., and Wood's Holl, Mass., but in addition a few eggs of Spanish mackerel were hatched on the "Fishhawk" in 1891. The eggs of the cod were hatched in the largest numbers, namely, in round numbers 19 millions at Gloucester, 36 millions at Wood's Holl in 1891; at the same station in that year were hatched 3 million flat-fish fry and 3 million lobsters. The shad was still the fish most extensively treated in the operations of the Commission, nearly 70 million fry having been furnished for distribution in 1891. Altogether the number of different kinds of fish artificially propagated was thirty-eight, of which ten were marine, the rest fresh-water or anadromous.

On the interesting question of the benefits produced by the practice the Commissioner says that the results obtained have been difficult of exact determination; that good has followed is shown by the continued increase in the value of the fisheries demonstrated by carefully collected statistics. He urges that in cases where species have been introduced into waters from which they were naturally absent it is clearly shown what is possible of accomplishment, referring to the results of the importation of shad and striped bass to the Pacific coast, and of trout and white fish into streams and lakes of the Yellowstone National Park, formerly barren of food-fish.

We may turn at this point from the Report of the Commissioner to the Report on Statistics by Hugh M. Smith, M.D., in order to ascertain if we can obtain a more quantitative estimate of the results of the piscicultural operations. Concerning the shad we find it stated that this fish has become distributed along the entire Pacific coast north of Monterey Bay, California, and occurs in special abundance in the Sacramento River. Notwithstanding the fact that the fishermen have provided themselves with no apparatus especially adapted to the capture of shad, 101,071 pounds were taken in 1888, and 170,500 pounds in 1889. We are told that the quantity caught affords no idea of the abundance of the fish, and it is thought that the use of suitable apparatus will demonstrate the existence of large bodies of these fish in all the coast waters between Southern California and Puget Sound. But nevertheless it naturally occurs to the reader to wonder what proportion the amount captured on the Pacific coast bears to that taken on the Atlantic. This curiosity cannot be satisfied out of this Report. After some search we discover the statement that $482,403 was the value of the shad taken on the South Atlantic division of the coast of the United States in 1890, but this is not enough to enable one to make a comparison. There is, however, a lengthy and detailed paper on the Fisheries of the Pacific Coast in the Commissioner's Report for 1888, published 1892, and in this we find that the value of the shad captured on that coast in 1888 was $7063, which shows that although the shad has certainly been successfully introduced, the value of the yield on the Pacific side was only $\frac{1}{69}$ of that of the South Atlantic States. Planting of shad on the Pacific slope was apparently commenced in the Sacramento River in 1880. The striped bass (*Roccus lineatus*), though introduced some years before the shad, is stated to be less abundant and less widely distributed than the latter. It was chiefly found in San Francisco Bay, where specimens as much as 40 lbs. in weight have been taken, although the average weight is only 8 or 10 lbs. In 1888 only about 1000 lbs. reached the San Francisco market, but in 1889 they were more plentiful. This is all the statistical

information supplied. It is evident enough that these two species have been introduced to the Pacific coast by transporting the fry in railroad cars from the Atlantic side, and the fact is impressive as an illustration of the magnitude of the operations carried on by the Commission. Whatever its imperfections, it has made itself a piscicultural organisation which connects together the two greatest oceans of the globe. The transport of useful animals or plants from one continent to another across the ocean is a practice of considerable antiquity; the transportation of valuable fish from one ocean to another across a whole continent had never been accomplished before.

But the question still remains, is there any good evidence by which to estimate the practical results of the piscicultural operations in connection with long-established fisheries? We naturally here examine first the case of the shad fishery on the Atlantic side, since we know that artificial propagation of the shad (*Clupea sapidissima*) has been more extensively and more successfully carried out by the Commission than that of any other fish. We look to see what the Commission has to say of the condition of the fishery. We know that the United States administration does not attempt to supply annual statistics of the fisheries as our own Fisheries Department does. The Commissioner remarks that the limited appropriation and consequent smallness of the force available for statistical inquiry preclude the possibility of an annual investigation; and that even if this were attempted it is open to question whether the variations in the fisheries from year to year are generally sufficiently marked, or whether at this time the results would be of sufficient importance to warrant the largely increased expenditure that would be required to conduct the work. He thinks that comparative statistics are more valuable when they relate to definite intervals of time than when they cover successive years. He asserts that the researches of the Commission furnish data for the comparison of conditions at intervals of three or four years, and for the determination of the influences of the methods and means employed upon the prosperity of the fisheries.

In the Statistical Report the total produce of the shad fisheries in different periods is not definitely presented, but there is a very interesting account of the fishery in the Potomac River, of which the following are the most important points. In 1890, 731,453 fish were taken, weighing 2,571,002 lbs., and realising to the fishermen $75,935, or about £15,200. In 1889, 868,900 fish were taken, valued at $85,378. These figures are compared with those corresponding for the end of the previous decade, namely, less than 200,000 fish in 1878, increasing till 1880, when 600,000 was the number of

the season's catch. It will be seen that the increase since 1880, though important, is not enormous, though presumably the Commission claims that the maintenance of the fishery in a prosperous condition is due to artificial propagation. The total value of the shad caught on the South Atlantic coast is given as $482,403 in 1890, but no means of comparing this with any other time are afforded. However, we are informed in the volume that the work of this department was directed by Captain J. W. Collins, while the preparation of the report devolved upon Dr. Hugh M. Smith, in consequence of the fact that Captain Collins was called upon to do special work at the Chicago Exhibition. In the preceding volume of the series, the Commissioner's Report for 1888, there is a much more complete and detailed statistical review, prepared under the direction of Captain Collins, and covering the years 1887 and 1888. This paper contains a large number of very instructive and ably arranged tables, giving the kind of information we have been seeking.

One of these tables give a comparative statement of the catch of shad in all the United States in the years 1880 and 1888. The total catch in pounds in 1880 was 18,074,534, valued at $995,790; while in 1888 it was 35,736,385 pounds, valued at $1,672,192. Thus the amount of the catch had nearly doubled, while the value had not increased in proportion,—that is to say, the price had fallen. The total value in English money is £334,438, which is a little more than the total value of the mackerel landed on the English and Welsh coasts in 1893 (£302,516), but not half the total value of the plaice landed on the same coasts in the same year. The comparison, however, is scarcely just, because the shad is not a true sea fish, but anadromous. It is a curious thing that in another table, showing the comparison by sections, it is shown that the shad fishery in the New England States has decreased from 2,117,392 lbs. in 1880 to 1,412,945 lbs. in 1888. I can find no discussion of this decrease, but it is pointed out in the text of the paper that the total catch of alewives (*Clupea vernalis*) has not increased nearly so much as that of the shad, and that the alewife is not artificially propagated.

It has frequently been supposed that complete statistics of the fisheries of the United States have not been prepared or published. It is true, as we have already seen, that complete annual returns are not supplied; but statistics were compiled for the year 1880, and we have a complete estimate in this paper for 1888. The total value of the coast fisheries is computed to be $35,222,929, or in English money £7,338,110. This is somewhat more than the total value of the products of the fisheries of the United Kingdom in the year 1888 as computed at the Board of Trade, the sum given being £6,418,000. But it must be noted that the American total includes

over a million dollars for the whale and porpoise fisheries, and nearly two millions for the seal, walrus, and sea-otter fisheries, as well as $167,000 for reptilian fisheries, while the English returns include no air-breathing animals. Thus it is evident that if we compare the yield of fish, molluscs, and crustacea only in the two countries the fisheries of the United Kingdom are nearly equal in value to those of the United States. Comparing the number of the population employed in the fisheries in the two countries, we find the total in the United Kingdom in 1888 to be 122,526, and that in the United States 137,446; but the latter includes 28,867 shoresmen and factory hands, which ought to be deducted, leaving 108,579. A comparison of the vessels and boats employed in the industry in the two countries seems not to be possible without further explanation of the methods in which the computations are made. According to the United States return, there were in that country in 1888, 6099 fishing vessels, of a net tonnage of 170,126, and in addition 47,195 boats. The number of boats alone, apart from the vessels, is therefore greatly in excess of the total number of fishing vessels and boats of all classes registered under the Act of 1868 in the United Kingdom, namely, 27,812.

We may next pursue our inquiries concerning the results of the operations of the Commission, and ascertain whether evidence as complete as in the case of the shad is supplied with regard to other species, and whether it supports conclusions of the same favorable nature concerning the influence of artificial propagation. At the end of Dr. Smith's report on statistics in the volume for 1889 to 1891 it is stated that the fishermen of the southern New England coast have been much surprised, as well as pecuniarily benefited, by the appearance of young cod in great abundance on grounds where the fish have been scarce or absent for years. The fishery began in 1889, when a few small vessels made good fares, one schooner landing 300,000 lbs. of the fish. Inquiries conducted by the Commission showed that in 1890 by the last of July about 4,000,000 lbs. of small and medium-sized cod were taken in the inshore waters of southern New England, which even the most sceptical fishermen were willing to acknowledge were fish that had been artificially propagated at the Government hatcheries at Wood's Holl and Gloucester. As a result of this single fishery over $100,000 was added to the income of the fishermen, and there was reason to believe that a permanent summer fishery had been inaugurated that promised good returns.

It would, of course, be desirable to have the complete statistics of the New England cod fishery in order to critically examine this statement about the increased abundance of cod. Acknowledgments

by the most sceptical fishermen are not in themselves conclusive. We find that the cod is the most important single species in the New England fisheries, the total catch in 1889 amounting to 97 million pounds, valued at 2½ million dollars. But it appears that this fishery is carried on chiefly on the banks east of 65° W. long. It might be suggested that the inshore cod in question migrated in from the banks, but on the whole the probability seems to be on the side of the Commission, which regards these cod as its own production. It is interesting to ascertain the extent of the propagation of cod in the years preceding 1890. The number of fry produced were—

			Totals.
1889.	Gloucester .	11,000,000	
	Wood's Holl .	8,000,000	
			19,000,000.
1888.	Gloucester .	627,040	
	Wood's Holl .	8,843,600	
			9,470,640.
1887. } 1886. }	Wood's Holl .	20,000,000	20,000,000.

The number of cod eggs hatched increased in 1890 and 1891; in the former year it was 21 millions, in the latter 55 millions. The pelagic eggs of marine fishes are still hatched by the officers of the Commission in the Chester tidal boxes and the improved McDonald tidal boxes. No mention is made of any attempt to test the efficiency of apparatus which has been found so much more satisfactory in Europe,—for instance, the Dannevig hatching box, or the hatching jars arranged on the plan used in our Laboratory at Plymouth. At Wood's Holl lobster eggs were stripped from the berried females, and also treated in the Chester and McDonald apparatus and in the universal hatching jar, the total number taken being 8,317,600, and the production of fry 54 per cent. The fry were released when two to four days old, except a few which were kept in the jars for six weeks. A fuller account of this experiment is contained in Mr. Rathbun's report on Food-fishes and Fishing Grounds, from which it appears that the Americans have found the problem of rearing lobster larvæ as difficult as we at Plymouth. It is stated that in none of the trials did more than a small percentage survive for any considerable length of time. Specimens about one month old were taken at the surface in Wood's Holl Harbour, how many or how frequently is not stated; in England the capture of pelagic lobsters is very rare. The stomachs of these specimens contained fragments of Copepods and of the larval stages of crabs, so that their natural food appeared to be other pelagic crustacea. As at Plymouth, it was

found that they would eat almost any animal food, from hard-boiled eggs to their own fellows, and rapidly gorged themselves, after which the majority soon died.

Among special observations and experiments described in Mr. Rathburn's report we have it stated that Mr. V. N. Edwards has studied the spawning and hatching of *Pseudo pleuronectes americanus*, the flat-fish or winter flounder, and has discovered that the eggs of this species are adhesive and sink in sea water. The best method of handling them was found to be to spread them thinly on panes of glass and place them in a current of water in the hatching boxes! It seems scarcely credible that any species of the Pleuronectidæ should not have buoyant pelagic ova. But the statements seem to leave no room for doubt, as Mr. Edwards is represented as squeezing the eggs from the fish and hatching them with facility; it is even stated that occasionally adhesion occurs among the eggs in the ovary, which when pressure is applied come out in a solid mass. It was an unexpected fact that the eggs of the sprat and pilchard are pelagic, while those of the herring are adhesive; and now we have a surprise in the opposite direction in the discovery of adhesive eggs in a flat-fish. The mere statement, however, requires to be supplemented, as doubtless it will be in time, by a description with figures by the original observer. Alex. Agassiz and Whitman in 1885 attributed a certain pelagic egg to this species, but apparently they were mistaken. The eggs of *Pleuronectes maculatus* and *Paralichthys oblongus* were obtained at Wood's Holl by Mr. Edwards, and were buoyant.

It had generally been believed that the American oyster, *Ostrea virginica*, did not reproduce itself in San Francisco Bay, where large numbers of seed or yearling oysters brought over from the Atlantic coast are reared for the market. Mr. Townsend, naturalist of the steamer "Albatross," has, however, found in several parts of the bay, Atlantic oysters naturally spatted and derived from parents on the planted beds in such conditions—*e. g.* attached to rocks and piles—as left no doubt that they had developed from free spat *in situ*. Mr. Rathbun's report gives a fuller account of the oyster investigations referred to by the Commissioner himself. It is to be hoped that the efforts of the Commission will succeed in improving the condition of the oyster industry on the Atlantic coast, for the statistical review in the Report for 1888, already frequently referred to, shows that a serious deterioration had taken place between 1880 and 1888. The total decrease in bushels was from 22,195,915 to 21,765,640, made up as follows. The production in the New England States had increased enormously—more than doubled, in fact; in the Gulf States it was nearly four times as great in 1888 as in 1880, and there was also an increase in the Pacific States and in the South Atlantic

States. But a large proportion of the total production was derived from the Middle Atlantic States, which may be regarded as the chief original source of American oysters, and this quantity had decreased from 20 million to 17 million bushels.

In conclusion we may refer to the account in the Commissioner's particular report of an investigation, by the United States Senate, of certain charges brought against the administration of the Commission,—charges of want of discipline, inefficiency, and corruption. A committee of the Senate thoroughly inquired into the charges, and found none of them to be established, but decided from the evidence that the Commission was properly administered, and was performing valuable work worthy of its cost to the State. On this result all who know anything of the Commission will heartily congratulate it and its energetic chief, Colonel McDonald.

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Marine Biological Association of the United Kingdom.

Report of the Council, 1893-94.

The Council.

The Council has met on nine occasions during the past year for the transaction of the business of the Association. Of these the meeting on May 12th was held at the Plymouth Laboratory. The average attendance at these meetings has been six. No vacancy has occurred in the course of the year.

The Council has again to acknowledge the courtesy of the Royal Society in granting the use of its rooms for the various meetings of the Association.

By the death of Mr. John Bayly, of Plymouth, the Association has lost one of its first and most generous supporters, who had been a Governor almost from the commencement; and, by the death of Prof. A. Milnes Marshall, a member of the first Council of the Association in 1884.

The Plymouth Laboratory.

The Council is able to report satisfactorily of the condition of the building, fittings, and machinery at the Plymouth Laboratory, with the exception of some leakage in the large reservoirs, which will be repaired shortly. The Ejector, by which sea water is thrown up to the Laboratory reservoirs, and the rotary pumps by which the circulation is maintained, have lately been overhauled and placed in thorough repair.

The Boats.

It is greatly to be regretted that there is no immediate prospect of a satisfactory boat being obtained by the Association: the question

is purely a financial one, and its solution is only to be found in the generosity of public companies or private individuals. It is impossible that a sea-going boat can be purchased out of income, so long as the revenue of the Association is so small. During the past year the work of collection has been largely carried out by means of hired vessels, a method both expensive and unsatisfactory. The little sailing boat "Anton Dohrn" is utilised whenever the weather permits, and is in good repair.

The Library.

The Library becomes annually more useful. Among the Fishery publications are included not only the official publications of the United Kingdom, of the United States, Canada, and Newfoundland; of Norway, Sweden, Denmark, Germany, the Netherlands, France, and Russia; but also the publications of local authorities and fishery societies at home and abroad. Among the results of various expeditions which are still in course of publication, may be mentioned the publications of the German "Plankton" Expedition, of H.H. the Prince of Monaco, of the Norwegian North Atlantic Expedition, and of the expedition of the Danish gunboat Hauch. Gifts and exchanges have been made during the past year of the publications of the Royal Societies of London and Edinburgh, the Zoological Society, the Royal Microscopical Society, the Academies of Copenhagen and Stockholm, the Harvard Museum, the Australian Museum, the Bergen Museum, the College of Science at Tokio, the Royal Society of Victoria, the Natural History Societies of Finland, Norway, the Netherlands, Boston (U.S.), and many others. To these Societies, and to the numerous donors of books and papers, the Council render the thanks of the Association.

In addition to such gifts and exchanges, the Library purchases all the most important periodicals which bear upon marine zoology.

The Museum and Exhibition Series.

The type-collection of the Plymouth fauna has been materially added to during the past year.

The series of specimens mounted for exhibition, to which reference was made in the last report of the Council, has been considerably increased, and has won great attention on the occasions on which it has been shown, viz. the meeting of the Museums Association in London, 1893, the soirée of the Royal Microscopical Society, 1894; the two soirées of the Royal Society, 1894; and the Cornwall Fisheries Exhibition, 1893.

At this last Exhibition, which was held with a view to the foundation of a Fisheries Technical School in Cornwall, the Association took a prominent part. Besides the exhibition of mounted specimens illustrating the rate of growth in food-fishes and the richness of the Plymouth fauna for scientific work, &c. &c., a complete set of a naturalist's equipment of dredges, trawls, and tow-nets was shown, and lectures were delivered by Mr. Cunningham on "The Natural History of Marketable Sea-Fishes," by Mr. Garstang on "Animal Life in our Seas and the Methods for its Investigation," and by the Hon. Secretary on the "Conditions for Successful Oyster Culture." A medal was awarded to the Association for its services to the Exhibition.

The Staff.

Through the generosity of the Worshipful Companies of Fishmongers and of Drapers, each of which has made a special donation of £105 for the purpose, the Council has been enabled to retain the services of Mr. Holt at Grimsby for a third year.

The Council regret that Mr. Garstang, desiring to prosecute original researches elsewhere, has not offered himself for re-election. As the post has been an annual one, the Council do not consider that the finances of the Association justify them in filling it up at present.

Scientific Investigations.

Both Mr. Cunningham and Mr. Holt have continued during the past year their inquiries into the various questions relating to the maturity of food-fish which were so prominent last year before the House of Commons Select Committee on Sea Fisheries, and upon which much information is still required. The value of the evidence adduced on these points by the officers of the Association has been acknowledged in the Report of this Committee.*

Mr. Cunningham has finally settled by direct experiment the much-debated question of the identity of the egg of the pilchard. He has been able to rear the larvæ of plaice, hatched and fertilized in the aquarium at Plymouth, to the age of thirty-seven days; no flat-

* "Your Committee have however, had an advantage over any previous fishery inquiry in the fact that they have had laid before them the statistics which have of recent years betn collected by the Board of Trade, and the statistics compiled by the officers of the Scottish Fishery Board; and they have also had the evidence founded on the observations of the scientific experts employed by the Marine Biological Association, and by the Scottish Fishery Board. Indeed it may almost be said that this is the first fishery inquiry in which the more important complaints have been founded, not merely on the statements and the ideas of rival classes of fishermen, but upon facts and statistics."

fish larvæ have hitherto been reared in confinement from the ovum to this age, and this result is of great economic value.

Mr. Holt's valuable statistical observations on the fish landed at Grimsby have been continued. From his watching of the results of the newly opened Iceland fishery, on which he contributes a paper to the last number of the Journal, may be expected interesting light as to the effect of fishing on a virgin ground, with a direct bearing on the problems presented by the North Sea. The arrangement by which the Association contributes towards the expenses of the Cleethorpes Aquarium of the Marine Fisheries Society (Grimsby) in return for Mr. Holt's use of their Laboratory and tanks, is being continued for a second year.

Mr. Garstang reports that the following were the more interesting additions to the list of the Plymouth fauna during the past year:

Amphicodon amphipleurus, Haeckel.
Coryne vermicularis, Hincks.
Garveia nutans, Str. Wright.
Depastrum cyathiforme, M. Sars.
Fecampia erythrocephala, Giard.
Eupolia curta, Hubrecht.
Heteromysis formosa, Smith.
Erythrops elegans, G. O. Sars.
Mysidopsis gibbosa, G. O. Sars.
Leptomysis mediterranea, G. O. Sars.
Apseudes Latreilli, M. Edw.
Coryphella smaragdina, A. and H.
Doliolum tritonis, Herdm.
Thalia democratica-mucronata, Forskål.

A *Doris* and a remarkable *Tectibranch*, both of which are new to science, have not yet been described.

A number of interesting analyses of sea water have been made by Mr. Frank Hughes for the Association, and experiments on the changes produced in sea water in aquaria are being carried out by the Director.

Occupation of Tables.

The following naturalists have occupied tables in the Laboratory during the past twelve months:

E. J. Allen, B.Sc., University College, London (Development of Decapod Nervous System).
G. P. Bidder, B.A., Naples (Porifera).
E. T. Browne, B.A., University College, London (Medusæ).
Miss F. Buchanan, B.Sc., University College, London (Chætopoda).
F. W. Gamble, B.Sc., The Owens College, Manchester (Turbellaria).
S. J. Hickson, M.A., D.Sc., Cambridge (Development of Alcyonium).
W. T. Hughes, Birmingham (General Zoology).
E. W. MacBride, M.A., Cambridge (Development of Asterina).
T. H. Riches, M.A., Plymouth (Development of Nemertina).
T. C. Sumner, Royal College of Science, London (Nudibranchiata).
Prof. W. F. R. Weldon, F.R.S., University College, London (Variation of *Carcinus mœnas*).
Surgeon P. W. Bassett-Smith, R.N., Plymouth, and Mr. H. R. Battye, B.Sc., University College, London, have also made use of the Laboratory without formal occupation of a table.

The following papers, either wholly or in part the outcome of work done at the Plymouth Laboratory, or by members of the staff

stationed elsewhere, have appeared in the publications of learned Societies and in scientific periodicals during the past year; in addition to those which have been published in the Journal:

ALLEN, E. J.—*On the Central Nervous System of Crustacea*, Quart. Journ. Micr. Sci.

CUNNINGHAM, J. T., and C. A. MACMUNN.—*On the Coloration of the Skins of Fishes, especially Pleuronectidæ*, Phil. Trans. Roy. Soc., clxxxiv, B., 765.

GARSTANG, W.—*On the Relations of Hesse's Doto uncinata to the genus Hancockia*, Conchologist, ii, 110.

GARSTANG, W.—*Note on Salensky's account of the development of the Stigmata in Pyrosoma*, Tr. Liverpool Biol. Soc., vii. 245.

GARSTANG, W.—*On someBipinnariæ from the English Channel*, Quart. Journ. Micr. Sci., xxxv, 451.

GARSTANG, W.—*Preliminary note on a new theory of the Phylogeny of the Chordata*, Zool. Anz. 1894.

HOLT, E. W. L.—*Studies in Teleostean Morphology, from the Marine Laboratory, Cleethorpes*, Proc. Zool. Soc., 1894.

MACBRIDE, E. W.—*The Organogeny of Asterina gibbosa*, Proc. Roy. Soc., liv, 431.

WELDON, W. F. R. W.—*Certain Correlated Variations in Carcinus mœnas*, Proc. Roy. Soc., liv, 318.

Donations and Receipts.

The Receipts for the past year include the annual grants from H.M. Treasury (£1000) and the Worshipful Company of Fishmongers (£400); a special donation of £105 each from the Worshipful Companies of Fishmongers and of Drapers; annual subscriptions have produced £178, composition fees £15 15s., the rent of tables in the Laboratory £36, the sale of specimens £197, the admission to the aquarium £77; the total amounting, with lesser sums, to £2172. The statement of Receipts and Expenditure will be found below.

The Vice-Presidents, Officers, and Council proposed by the Council for 1894–95 are—

President.

Prof. E. RAY LANKESTER, LL.D., F.R.S.

Vice-Presidents.

The Duke of ARGYLL, K.G., K.T., F.R.S.
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 WALSINGHAM, F.R.S.
Lord REVELSTOKE.
The Right Hon. A. J. BALFOUR, M.P., F.R.S.
The Right Hon. JOSEPH CHAMBERLAIN, M.P.
Prof. G. J. ALLMAN, F.R.S.
Sir EDWARD BIRKBECK, Bart., M.P.
Sir WM. FLOWER, K.C.B., F.R.S.
The Right Hon. Sir JOHN LUBBOCK, Bart., M.P., F.R.S.
Prof. ALFRED NEWTON, F.R.S.
Sir HENRY THOMPSON.
Rev. Canon NORMAN, D.C.L., F.R.S.
Captain WHARTON, R.N., F.R.S.

COUNCIL.

Elected Members.

F. E. Beddard, Esq., F.R.S.
Prof. F. Jeffrey Bell, Sec.R.M.S.
Prof. W. A. Herdman, F.R.S.
Sir John Evans, K.C.B., D.C.L., F.R.S.
A. C. L. G. Günther, Esq., F.R.S.
Prof. A. C. Haddon.
Prof. S. J. Hickson, D.Sc.
Prof. W. C. McIntosh, F.R.S.
Lord Tweedmouth.
D. H. Scott, Esq., F.R.S.
P. L. Sclater, Esq., F.R.S. (Sec. Zool. Soc.).
Adam Sedgwick, Esq., F.R.S.
Prof. Charles Stewart, P.L.S.
Prof. W. F. R. Weldon, F.R.S.

Hon. Treasurer.—E. L. Beckwith, Esq.

Hon. Secretary.—G. Herbert Fowler, Esq., Ph.D.

DR. *Statement of Receipts and Expenditure for the Year ending 31st May, 1894.* CR.

RECEIPTS.	£	s.	d.	£	s.	d.
o H. M. Treasury				1000	0	0
, Fishmongers' Company				400	0	0
, Special Donations:						
Drapers' Company	105	0	0			
Fishmongers' Company	105	0	0			
				210	0	0
, Annual Subscriptions				178	10	0
, Composition Fees and Donations				15	15	0
, Rent of Tables £36 16 3						
, Sale of Specimens 197 9 1						
, Sale of Journal 14 1 4						
	248	6	8			
, Sale of Monograph	6	10	0			
, Admission to Tank Room	77	16	6			
, Interest on Investment	34	19	10			
				367	13	0
, Investment Sold: £230 Forth Bridge Railway 4% guaranteed Stock				303	7	3
				£2475	5	3

Examined and found correct.

F. JEFFREY BELL,
SYDNEY J. HICKSON,
EDWIN WATERHOUSE,
STEPHEN E SPRING RICE, } *Auditors*

EXPENDITURE.	£	s.	d.	£	s.	d.
By Balance from last year, being amount overdrawn at Bankers, less Cash in hand (General Fund and Bait Instigation Fund)				196	13	
„ Salaries and Wages:						
Director	200	0	0			
„ Allowance for Assistant	80	0	0			
Mr. J. T. Cunningham	250	0	0			
Mr. E. W. L. Holt, North Sea Investigation	200	0	0			
Mr. W. Garstang (Assistant Naturalist)	175	0	0			
Wages	358	7	0			
				1263	7	
„ Stationery, Office Printing, Postage, &c.				168	3	
„ Printing and illustrating Journal, &c.				85	14	
„ Sundry Expenses:						
Gas, Water, Coal, Oil, &c. £107 10 5						
Coal and Water for Steam Launch 22 5 3						
	129	15	8			
Stocking Tanks, Feeding, &c.	90	17	4			
Glass, Chemicals, Apparatus, &c. 131 13 5						
Less Sales to table renters 8 4 3						
	123	9	2			
Maintenance and Renewal of Building, Boats, and Nets	131	13	0			
„ Rates and Taxes	34	12	3			
„ Boat Hire	41	8	10			
„ Travelling	42	5	5			
„ Expenses of Exhibition of Specimens	59	7	10			
„ Library	21	3	4			
„ North Sea Investigation at Cleethorpes, Grimsby	76	12	1			
				751	4	
„ Balance forward, being Cash in Bank and in hand (General Fund and Bait Investigation Fund)				10	1	
				£2475	5	

Investment held 31st May, 1894:
£670 Forth Bridge Railway 4% Guaranteed Stock at 125...£837 10

Director's Report.—No. III.

Since the publication of the last number of this Journal six months have elapsed, and in so short a time no great development in an institution of the nature of this Laboratory can be expected. But the Laboratory has not yet reached its teens, and at the present early age a perceptible amount of growth and improvement should show itself from year to year.

The number of gentlemen who have carried on researches here has shown no diminution, but has not sensibly increased. In one respect the list given below may be regarded as showing an improvement;—it is not exclusively formed of zoologists. Mr. Darnell-Smith, a chemist and naturalist, has been good enough to take up an investigation I suggested in my last Report, and his results concerning the action of Algæ on the sea-water in which they live are most interesting. They will be published in the next number of this Journal. It is to be hoped that the study of animal physiology will soon be undertaken here once more. The number of marine animals is very great, which, by reason of various degrees of transparency, allow their internal anatomy and the behaviour of internal organs in activity or in repose, under normal and abnormal conditions, to be seen during life. Many of such animals are highly convenient for microscopic examination, and there is no doubt that such objects are of great assistance in studying the functions of living digestive, secretory, excretory, and, in fact, all the cells of the different systems of organs. Work of this kind has already been done on fresh-water and marine animals, but the immense variety of the transparent animals in the sea seems to afford special advantages. Material of this nature is constantly being brought into the Laboratory.

For some time past no scientific men from abroad have visited the Laboratory for any length of time. With all due respect to the "big brother" at Naples, I would like to remind those whose eye this may meet that there is a time of the year when Naples is hardly a desirable place of residence, and that Plymouth is just at this time one of the most attractive spots in England. The

beautiful counties of Devon and Cornwall are on either hand, Dartmoor is behind our back, and we look out upon the English Channel with its mingled northern and southern forms of life. There are, I am sure, enthusiastic naturalists abroad who would like to spend their summer holidays at the work which can so comfortably be done at this Laboratory. They would find, if they will but try the experiment, that an English summer has charms equal to those of an Italian winter and spring, and what is not unimportant to most scientific men, that the advantages of cheap lodging and living are not confined to the Continent.

Mr. Garstang, who has for some years occupied different posts at the Laboratory, has kindly consented to give a summary of his notes on the seasonal variations of the local fauna, and the data in this number of the Journal will to a certain extent be an indication of what may be expected to occur during the summer.

Mr. Garstang left the service of the Association on May 30th. He has since paid a visit to the Laboratory, and collected fresh material, and it is to be hoped that he will often be tempted to revisit the spots he has studied so closely and knows so well.

The specimen trade has since his departure been in my hands. I am glad to report that it is increasing rapidly ; to such an extent, in fact, that it is interfering with a higher phase of my duties, the investigations which have been slowly growing under my hands. The study of the influence of external physical conditions on the character and distribution of pelagic life (Plankton) is full of charms on account of its constant variety, and it is this also which makes it a particularly time-devouring study. I have found the complicated conditions of the currents in Plymouth Sound make the solution of the causes of the movements of Plankton practically hopeless as regards this locality. But comparative observations on the character and quantity of Plankton at different distances from the land, until we reach the Channel current, have given some striking results. There is at certain times a great difference in the relative quantity, and correlated with this a proportional difference in the quantity, of mackerel in the Sound and outside it. This subject will, I feel sure, yield most interesting results before long.

The boats at our disposal are by no means capable of doing all that could be done to support the functional activity of the Laboratory. The small steam-tug "Lorna," which we hire, can only leave the Sound on calm days. Our small sailing boat, the "Auton Dohon," has done excellent service, but is not capable of covering long distances within a reasonable time. I have been able to increase her efficiency materially by the addition of a centre-board to haul up in shallow water or when running before the wind, and

to lower when sailing close to the wind. She can now very often do her day's work with a considerable gain in time, bringing up material quicker, and hence fresher and earlier in the day.

The export of living animals is proving more and more successful as experience is gained, and it is increasing in importance. Members of the Association living inland can generally obtain a supply of sea-water by rail once or twice a year, and with a few simple precautions it can be used to keep alive marine animals and plants sent from Plymouth, some of which,—sea-anemones, for instance,—will live for years; others could be replaced at intervals as they die. Larvæ of Crustacea could be watched as they pass through their metamorphoses, for Aminifera could be kept alive and their growth observed, and no doubt many new and interesting facts would be collected by means of a little application and study of such animals in small aquaria.

I have been able to remedy a serious defect in the arrangements for supplying sea-water to the Laboratory. During the month of August it was noticed that the water pumped up was not fit to use, and it was not allowed to pass into the circulation. It had been proved a short time previously that the water obtained in the same way was quite as good as water from the Channel for rearing Foraminifera. The abnormal condition persisted for a time and then disappeared and reappeared, until at last a dead fish was pumped, and then a large piece of fucus, and so on.

Appearances pointed to a defect in the supply pipe which runs out from the base of the rocks below the Laboratory for a distance of fifty yards and lies on the sea-bottom. A diver went down to inspect and soon reported that the iron pipe was broken across near the outer end, and that the near end was buried in mud. I decided to repair the pipe at once, and as the weather permitted, it was put right in three days, the broken length of pipe removed, the lengths of the detached portion taken off one by one and connected with the shore end, and on the upturned end of the last length the large rose was replaced. Still for three weeks the water pumped up had something unusual about its smell and appearance, and at last the dead body of an eel, four feet long, which must have been shut in the pipe by the diver, came up. Since this time (20th September) the water has come up clear and fresh, and a state of affairs which may have lasted a couple of years or more, has come to an end. The probability is that the anchor of some ship caught the pipe and fractured it; the difficulty is to explain the presence of a vessel large enough to do the damage so close to the shore (thirty yards). Maybe the great storm of March, 1891, is to to blame for this; the wind blew off-shore for some time, and a vessel so close to the rocks would not have been in immediate danger.

This number of the Journal consists almost entirely of papers on the results of work done at this Laboratory or at the Cleethorpes Laboratory by Mr. Holt. I need say nothing of what my colleagues have done, but I should like to add that the short abstract given by Mr. Allen gives the main points only of a series of papers published elsewhere, detailing the outcome of more than a year of laborious research which Mr. Allen spent at the Laboratory. The original papers are illustrated with plates containing a number of complicated figures, showing the course of a large number of the nerves in the lobster and other histological details.

This Journal has for some time been devoted almost entirely to the publication of work done by the naturalists of the Association, and private workers in the Laboratory. It is now proposed to resume the insertion of articles on the subjects with which we are concerned, abstracted from foreign publications, or contributed by colonial, American, or continental workers in the same fields. Many of H.B.M. Consuls may have useful and interesting information on the many sides of the subject of sea fishes and sea fisheries, oyster-culture, fish-hatching, and breeding. I beg to invite the gentlemen abroad, who are employed on similar work to ours, to send either early copies of their publications, or to communicate the main results of their work for the benefit of our members and other readers.

EDWARD J. BLES, *Director*.

October, 1894.

E. J. Allen	Governors' and Founders' tables	1st June, 1893—9th August, 1894.
E. A. Minchin	Oxford University	13th March, 1894—2nd April, 1894.
J. C. Sumner	Rented a table	9th April, 1894—30th April, 1894.
	Mercers' Company	1st May, 1894—1st June, 1894.
J. J. Lister	Cambridge University	1st June, 1894—30th June, 1894.
	Rented a table	1st July, 1894—1st August, 1894.
M. D. Hill	British Association	6th July, 1894—28th July, 1894.
E. T. Browne	Rented a table	13th July, 1894—21st July, 1894.
G. P. Darnell-Smith	„ „	31st July, 1894—27th August, 1894.
G. P. Bidder	„ „	15th Sept., 1894—29th Sept., 1894.
W. Garstang		27th Sept., 1894—4th Oct., 1894.

LIST

OF

Governors, Founders, and Members.

OCTOBER, 1894.

I.—Governors.

The British Association for the Advancement of Science, 22, *Albemarle Street, W.* £500
The University of Cambridge £500
The Worshipful Company of Clothworkers, 41, *Mincing Lane, E.C.* £500
The Worshipful Company of Fishmongers, *London Bridge* £2000
The University of Oxford £500
Bayly, Robert, *Torr Grove, Plymouth* £1000
Bayly, John (late), *Seven Trees, Plymouth* £600

II. Founders.

* Member of Council. † Vice-President. ‡ President.

1884 The Corporation of the City of London £210
1888 The Worshipful Company of Drapers, *Drapers' Hall, E.C.* £210
1884 The Worshipful Company of Mercers, *Mercers' Hall, Cheapside* ... £315
1884 The Worshipful Company of Goldsmiths, *Goldsmiths' Hall, E.C.*... £100
1889 The Worshipful Company of Grocers, *Poultry, E.C.* £100
1884 The Royal Microscopical Society, 20, *Hanover Square, W.*..... £100
1884 The Royal Society, *Burlington House, Piccadilly, W.* £250
1884 The Zoological Society, 3, *Hanover Square, W.*..... £100
1884 Bulteel, Thos., *Radford, Plymouth* £100
1884 Burdett-Coutts, W. L. A. Bartlett, 1, *Stratton Street, Piccadilly, W.* £100
1888 Bury, Henry, B.A., *Trinity College, Cambridge* £100
1884 Crisp, Frank, LL.B., B.A., V.P. and Treas. Linn. Soc., 17, *Throgmorton Avenue, E.C.*..... £100
1884 Daubeny, Captain Giles A., 30, *Cornwallis Crescent, Clifton, Bristol* £100
1884 Eddy, J. Ray, *The Grange, Carleton, Shipton, Yorkshire*..... ..... £100
1884 Gassiott, John P., *The Culvers, Carshalton, Surrey* £100
‡*1884 Lankester, Prof. E. Ray, F.R.S., 2, *Bradmore Road, Oxford*..... £100
1885 Derby, The Rt. Hon. the late Earl of, K.G., 33, St. James's Square, S.W. £100

1884 Lister, S. Cunliffe, *Swinton Park, Masham, Yorkshire* £100
†1884 Lubbock, The Rt. Hon. Sir John, Bart., M.P., F.R.S., *High Elms, Bromley, Kent* £100
*1884 Poulton, Prof. Edward B., M.A., F.R.S., *Wykeham House, Oxford* £100
†1889 Revelstoke, Lord, *Membland, Yealmpton, S. Devon* £100
1890 Riches, T. H., B.A., *Inglenook, Yelverton, S. Devon* £100
1884 Romanes, G. J., LL.D., F.R.S. (late), *St. Aldate's, Oxford* £100
†1884 Thomasson, John P., M.P., *Woodside, near Bolton* £350
†1889 Thompson, Sir Henry, 35, *Wimpole Street, W.* £100
*1887 Weldon, Prof. W. F. R., F.R.S., 30A, *Wimpole Street, W.* £100
1884 Worthington, James (late), *Sale Hall, Sale, Manchester* £100

III.—Members.

ann. signifies that the Member is liable to an Annual Subscription of One Guinea.
C. signifies that he has paid a Composition Fee of Fifteen Guineas in lieu of Annual Subscription.

1886 Adlard, R. E., 22½, *Bartholomew Close, London, E.C.* ..... *ann*
1884 Alger, W. H., *Manor House, Stoke, Devonport* ..... *C.*
†1884 Allman, Prof. G. J., F.R.S., *Ardmore, Parkstone, Dorset* £20
1889 Anderson, Dr. John, 71, *Harrington Gardens, S.W.* ..... *C.*
†1884 Argyll, The Duke of, K.G., *Argyll Lodge, Kensington, W.* ..... *C.*
1885 Armstrong, Lord, C.B., F.R.S., *Crag Side, Rothbury* ..... *C.*
1893 Ascroft, R. L., 11, *Park Street, Lytham, Lancs.* ..... *ann.*
1884 Ashworth, J. W., M.R.C.S., 40, *Benyon Road, Kingsland, N.* ..... *ann.*
1892 Assheton, R., *Birnam, Cambridge* ..... *ann.*

1890 Badger, A. B., B.A., *Glenleigh, Oakfield Road, Balsall Heath, Birmingham* ..... *ann.*
1884 Bailey, Charles, F.L.S., *Ashfield, College Road, Whalley Range, Manchester* ..... *ann.*
1893 Bailey, W. E., *Porth Enys Museum, Penzance* ..... *C.*
1884 Balfour, Prof. Bayley, F.R.S., *Royal Botanic Gardens, Edinburgh* ... *C.*
1888 Balkwill, F. H., 3, *Princess Square, Plymouth* ..... *ann.*
1893 Bassett-Smith, P. W., Surgeon, R.N., *Royal Marine Barracks, Stonehouse, Plymouth* ..... *ann.*
1884 Bateson, Wm., *St. John's College, Cambridge* ..... *ann.*
1884 Bayliss, W. Maddock, B.Sc., *St. Cuthbert's, Hampstead Heath, N.W.* *ann.*
1884 Bayly, Miss, *Seven Trees, Plymouth* £50
1884 Bayly, Miss Anna, *Seven Trees, Plymouth* £50
1884 Beaumont, W. J., 9, *New Square, Cambridge* ..... *ann.*
1885 Beck, Conrad, 68, *Cornhill, E.C.* ..... *C.*
*1889 Beckwith, E. L., *The Knoll, Eastbourne* ..... *ann.*
1887 Beddard, F. E., *Zoological Society's Gardens, Regent's Park, N.W.* ... *ann.*
1884 Beddington, Alfred H., 8, *Cornwall Terrace, Regent's Park, N.W.* ... *C.*
*1884 Bell, Prof. F. Jeffrey, 5, *Radnor Place, Gloucester Square, W.* ..... *ann.*
1887 Berrington, A. D., *Board of Trade, Whitehall, S.W.* ..... *ann.*
1890 Bidder, George, B.A., *Parker's Hotel, Napoli, Italy* ..... *C.*

1885 Bignell, Geo. Carter, M.E.S., 7, *Clarence Place, Stonehouse, Plymouth* ann.
†1885 Birkbeck, Sir Edward, Bart., M.P., 10, *Charles Street, Berkeley Square, W.* ann.
1893 Bles, A. J. S., *Palm House, Higher Broughton, Manchester* ann.
1893 Bles, D. S., J.P., *Westbourne, Kersal, Manchester* ann.
1894 Bles, M. S., J.P., *The Beeches, Broughton Park, Manchester* ann.
1889 Bolitho, T. B., M.P., *Trewidden, Penzance* ann.
1884 Bompas, G. C., 4, *Gt. Winchester Street, E.C.* ann.
1884 Bossey, Francis, M.D., *Mayfield, Redhill, Surrey* ann.
1884 Bostock, E., *Stone, Staffordshire* ann.
1890 Bourne, Prof. A. G., *The Presidency College, Madras* ann.
1884 Bourne, Gilbert C., *New College, Oxford* ann.
1884 Bradford, J. Rose, B.Sc., *Physiological Laboratory, University College, W.C.* ann.
1886 Brent, Francis, F.S.A., 6, *Tothill Avenue, Plymouth* ann.
1890 Brindley, H. H., B.A., *St. John's College, Cambridge* ann.
1886 Brooksbank, Mrs. M., *Leigh Place, Godstone, Surrey* C.
1884 Brown, Arthur W. W., 6, *Sussex Square, W.* C.
1893 Browne, Edward T., 141, *Uxbridge Road, N.W.* ann.
1893 Buchanan, Miss Florence, *University College, London, W.C.* ann.
1884 Buckton, G. B., *Weycombe, Haslemere* ann.
1886 Bullar, Miss Anna K., *Bassett Wood, Southampton* ann.
1887 Burd, J. S., *Cresswell, Higher Compton, Plymouth* ann.
1889 Burnard, Robert, 3, *Hillsborough, Plymouth* ann.

1884 Caine, H. T. C.
1884 Caine, W. S., M.P., 132 and 133, *Palace Chambers, Bridge Street, S.W.* £21
1887 Caldwell, W. H., 12, *Harvey Road, Cambridge* C.
1887 Carter, James, F.G.S., 30, *Petty Cury, Cambridge* ann.
†1884 Chamberlain, Rt. Hon. J., M.P., 40, *Princes Gardens, S.W.* ann.
1884 Chapman, Edward, *Magdalen College, Oxford* ann.
1884 Christy, Thomas Howard, *Malvern House, Sydenham* ann.
1887 Clarke, Rt. Hon. Sir E., Q.C., M.P., 5, *Essex Court, Temple, E.C.* £25
1884 Clay, Dr. R. H., *Windsor Villas, Plymouth* ann.
1885 Clerk, Major-Gen. H., F.R.S., 40, *St. Ermin's Mansions, Caxton Street, S.W.* £21
1886 Coates and Co., *Southside Street, Plymouth* C.
1885 Collier Bros., *Old Town Street, Plymouth* C.
1890 Cook, C. H., M.A., *Elmlea, South Stoke, Reading* ann.
1891 Cornish, T. H., 4, *Clarence Place, Penzance* ann.
1889 Crossman, Major-General Sir William, K.C.M.G., M.P., *Cheswick, Northumberland* ann.

1885 Darwin, Francis, F.R.S., *Wychfield, Cambridge* C.
1885 Darwin, W. E., *Ridgemount, Bassett, Southampton* £20
1889 Davies, H. R., *Treborth, Bangor* ann.
1888 Daw, R. Harvey, *Marsh Mills, Plympton, S. Devon* ann.
1889 Deacon, J. Barrington, 11, *Osborne Place, Plymouth* ann.
1885 Deby, Julien, C.E., 31, *Belsize Avenue, N.W.* ann.
1885 Dendy, Arthur, D.Sc., *Canterbury College, Christ Church, New Zealand* ann.

1884 Dewick, Rev. E. S., M.A., F.G.S., 26, *Oxford Square, Hyde Park, W.* *C.*
1885 Dixey, F. A., M.A.Oxon., *Wadham College, Oxford* ..... £26 5*s.* *and ann.*
1890 Driesch, Hans, Ph.D., *Zürich, Switzerland* ..... *C.*
†1889 Ducie, the Earl of, F.R.S., *Tortworth Court, Falfield, R.S.O.*..... £40 15*s.*
1884 Dunning, J. W., 4, *Talbot Square, W.*.....£26 5*s.*
1885 Durham, A. E., *Christ's College, Cambridge* ..... *C.*
*1884 Dyer, W. T. Thiselton, M.A., C.M.G., F.R.S., *Director of the Royal Gardens, Kew* ..... *C.*

1887 Ebrington, Viscount, *Castle Hill, North Devon* ..... *ann.*
1893 Edward, Stanley, F.Z.S., *Kidbrook Lodge, Blackheath, S.E.*..... ... *ann.*
1891 Ellis, Hon. Evelyn, *Rosenais, Datchet, Windsor* ....*C.*
1893 Enys, John Davies, *Enys, Penryn, Cornwall* ..... *ann.*
*1884 Evans, Sir John, D.C.L., Treas. R. Soc., *Nash Mills, Hemel Hempstead*..... £20
*1885 Ewart, Prof. J. Cossar, M.D., *University, Edinburgh*..... £25

1884 Fayrer, Sir Joseph, M.D., K.C.S.I., F.R.S., 53, *Wimpole Street, W.* *ann.*
1894 Ferrier, David, M.A., M.D., F.R.S., 34, *Cavendish Square, W.*..... *ann.*
1884 Fison, Frederick W., *Greenholme, Burley in Wharfedale, Leeds* ..... *C.*
*†1884 Flower, Sir W. H., C.B., F.R.S., Director of the British Museum of Natural History, *Cromwell Road, S.W.* ..... *C.*
*1885 Fowler, G. Herbert, B.A., Ph.D., 12, *South Square, Gray's Inn, W.C.* *ann.*
1884 Fox, George H., *Dolvean, Falmouth* ..... *ann.*
1889 Fraser, James, *Tregarthyn, Eton Avenue, N.W.* ..... *ann.*
1889 Freake, Sir Thomas S., *Warfleet, Dartmouth* ..... *ann.*
1886 Freeman, F. F., *Abbotsfield, Tavistock, S. Devon* ..... *C.*
1884 Fry, George, F.L.S., *Focklesbrook, Chobham, Surrey*..... £21
1884 Fryer, Charles E., *Board of Trade, S.W.* ..... *ann.*

1892 Galton, F., F.R.S., 42, *Rutland Gate, S.W.* ..... *ann.*
1884 Galton, J. C., M.A., F.L.S., *New University Club, St. James's Street, W.*..... *ann.*
1885 Gaskell, W. H., F.R.S., *The Uplands, Shelford, Cambridge* ..... *C.*
1885 Gaskell, E. H., *North Hill, Highgate, N.* ..... *C.*
1893 Gatty, Charles Henry, LL.D., F.L.S., *Felbridge Place, East Grinstead* *C.*
1884 Gibson, Ernest, F.Z.S., *Buenos Ayres* ..... *ann.*
1885 Glennie, W. R., *Berkeley Lodge, Wimbledon*..... *ann.*
1884 Gonne, William ..... £26 5*s.*
1885 Gordon, Rev. J. M., *St. John's Vicarage, Redhill, Surrey* ..... *ann.*
1885 Gotch, Prof. F., F.R.S., 11, *Prince's Park Terrace, Liverpool* ..... *ann.*
1888 Goulding, F. H., *George Street, Plymouth*..... *C.*
1884 Grove, E., *Norlington, Preston, Brighton* ..... *ann.*
1884 Groves, J. W., *Ermitage, Tunbridge Wells* ..... *ann.*
*1884 Günther, Dr. Albert, F.R.S., *Natural History Museum, Cromwell Road, S.W.*..... ..... *ann.*

*1884 Haddon, Prof. Alfred C., M.A., *Innisfail Hill Road, Cambridge*..... *ann.*
1884 Halliburton, Prof. W. D., M.D., B.Sc., *King's College, Strand, W.C.*..... *ann.*
1884 Hannah, Robert, 82, *Addison Road, Kensington, W.* ..... *C.*

1885 Harker, Allen, F.L.S., *Royal Agricultural College, Cirencester*..... *ann.*
1885 Harmer, S. F., *King's College, Cambridge* ..... *C.*
1889 Harvey, T. H., *Cattedown, Plymouth*..... *ann.*
1888 Haselwood, J. E., 3, *Lennox Place, Brighton* ..... *C.*
1884 Haslam, Miss E. Rosa, *Ravenswood, Bolton*..... £20
1884 Hayne, C. Seale, M.P., 6, *Upper Belgrave Street, S.W.*..... *ann.*
1884 Head, J. Merrick, F.R.G.S. J.P., *Ardverness, Reigate* ..... *ann.*
1884 Heape, Walter, *St. Mary's, Trumpington, Cambridge* ..... *C.*
1887 Heath, Miss A., 24, *George Street, Plymouth* ..... *ann.*
1884 Herdman, Prof. W. A., F.R.S., *University College, Liverpool* ..... *ann.*
1884 Herschel, J., Col. R.E., F.R.S., *Observatory House, Slough, Berks*... *C.*
1884 Heywood, James, F.R.S., 26, *Palace Gardens, W.* ..... *C.*
1889 Heywood, Mrs. E. S., *Light Oaks, Manchester*..... *C.*
*1884 Hickson, Prof. Sydney J., M.A., D.Sc., *Downing College, Cambrige*... *ann.*
1884 Holdsworth, E. W. H., F.L.S., F.Z.S., *South Town, Dartmouth* ..... *ann.*
1893 Holt, Mrs. Vesey W., 104, *Elm Park Gardens, S.W.*..... *ann.*
1894 Holt, Vesey G. M., F.Z.S., 17, *Whitehall Place, S.W.* ..... *ann.*
1889 Howell, Mrs. F. Bullar, *Ethy, Lostwithiel* ..... *ann.*
1887 Howes, Prof. G. Bond, F.L.S., *Science and Art Department, South Kensington* ..... *ann.*
1884 Hudleston, W. H., M.A., F.R.S., 8, *Stanhope Gardens, South Kensington, S.W.* ..... *ann.*
1885 Hurst, C. Herbert, Ph.D., *Owens College, Manchester* ..... *C.*
1884 Huxley, Rt. Hon. Prof. T. H., LL.D., F.R.S., *Hodeslea, Eastbourne* £31

1891 Indian Museum, Calcutta, 65, *Cornhill* ..... *ann.*
1888 Inskip, Capt. G. H., R.N., 22, *Torrington Place, Plymouth* ..... *ann.*

1885 Jackson, W. Hatchett, M.A., F.L.S.. *Keble College, Oxford*..... *ann.*
1893 Jago, Edward, *Menheniot, Cornwall* ..... *ann.*
1887 Jago-Trelawny, Major-Gen., F.R.G.S., *Coldrenick, Liskeard*..... *C.*
1885 James, C. H., *Ingleside, Mutley, Plymouth* ..... *ann.*
1890 Jenkins, William, *Ocean Collieries, Treorgy, Glamorganshire*..... *ann.*
1890 Johnson, Prof. T., B.Sc., F.L.S., *Royal College of Science, Dublin*... *ann.*
1890 Jones, W. V., 49, *George Street, Plymouth* ..... *ann.*
1892 Joshua, Mrs., 57, *Cadogan Square, S.W.* ..... *ann.*
1894 Justen, F. W., F.Z.S. (c/o Dulau and Co., 37, *Soho Square, W.*) ... *ann.*

1884 Kellock, W. B., F.L.S., F.R.C.S., 94, *Stamford Hill, N*..... ... *ann.*
1884 Kent, A. F. S., *Physiological Laboratory, St. Thomas's Hospital, S.W.* *ann.*

1885 Langley, J. N., F.R.S., *Trinity College, Cambridge*..... *C.*
1888 Latter, O. H., *Charterhouse, Godalming, Surrey* ..... *ann.*
1885 Lea, A. S., M.A., *Caius College, Cambridge* ..... *ann.*
1884 Lewis, George, 88, *Portland Place, W.* ..... *ann.*
1888 Lloyd, Fred. H., 5, *Gertrude Terrace, Exmouth* ..... *ann.*
1884 London, The Lord Bishop of, *The Palace, Fulham, S.W.*..... *ann.*
1888 Lopes, The Rt. Hon. Sir Massey, Bart., *Maristowe, Roborough, South Devon* ..... *ann.*

1885 Macalister, Prof. A., F.R.S., *St. John's College, Cambridge* ..... *ann.*
1884 Mackrell, John, *High Trees, Clapham Common, S.W.* ..... *C.*

1886 MacMunn, Charles A., *Oak Leigh, Wolverhampton* ..... *ann.*
1889 Makovski, Stanislaus, *Fairlawn, Red Hill* ..... *ann.*
1885 Marr, J. E., M.A., *St. John's College, Cambridge*..... *C.*
1884 Mason, Philip Brookes, *Burton-on-Trent*..... *ann.*
1884 McAndrew, James J., *Lukesland, Ivy Bridge, South Devon*..... *ann.*
1884 McIntosh, Prof. W. C., F.R.S., 2, *Abbotsford Crescent, St. Andrews, N.B.* ..... *C.*
1884 Michael, Albert D., *Cadogan Mansions, Sloane Square, S.W.*..... *C.*
1885 Mitchell, P. Chalmers, B.A., *Charing Cross Hospital, London* .. ... *ann.*
1885 Mocatta, F. H., 9, *Connaught Place, W.*..... *C.*
1886 Mond, Ludwig, 20, *Avenue Road, Regent's Park, N.W.*..... *C.*
1884 Morgan, Prof. C. Lloyd, *University College, Bristol*..... *ann.*
1891 Morgans, Thomas, *The Guildhall, Bristol* ..... *ann.*
†1889 Morley, Earl of, 31, *Prince's Gardens, S.W.*..... *ann.*
1885 Morris, John, 13, *Park Street, Grosvenor Square, W.*..... £21
1885 Morrison, Alfred, 16, *Carlton House Terrace* .... £52 10*s.*

†1884 Newton, Prof. Alfred, M.A., F.R.S., *Magdalene College, Cambridge*... £20
†1884 Norman, Rev. Canon, M.A., D.C.L., F.R.S., *Burnmoor Rectory, Fence Houses, Durham* ..... *ann.*

1885 Oliver, Prof. F. W., *Royal Gardens, Kew*..... *ann.*
1884 Ommanney, Admiral Sir Erasmus, K.C.B., F.R.S., 29, *Connaught Square, W.*..... *ann.*

1885 Paget, Sir James, Bart., F.R.S., 5, *Park Place, W.* ..... *C.*
1884 Parsons, Chas. T., *Norfolk Road, Edgbaston, Birmingham* ..... *ann.*
1891 Pass, A. C., 15, *Upper Belgrave Road, Durdham Down, Bristol* ..... *ann.*
1888 Peek, Sir Henry W., Bart., F.Z.S., *Wimbledon House, Wimbledon*... *C.*
1888 Pennsylvania, University of, *Philadelphia, U.S.A.*..... *ann.*
1885 Phillips, Chas. D. F., M.D., 10, *Henrietta Street, Cavendish Square, W.* ..... *C.*
1887 Phipson, Mrs., *Cumballa Hill, Bombay*..... *ann.*
1892 Pearce, Sir W. G., Bart., M.P., 113, *Cannon Street, E.C.*..... *ann.*
1885 Pochin, H. D., *Bodnant Hall, Eglwysbach, Denbighshire* ..... *C.*
1886 Power, Henry, F.R.C.S., 37A, *Great Cumberland Place, W.*..... *ann.*
1885 Pritchard, Prof. Urban, 26, *Wimpole Street, W.*..... *ann*
1884 Pye-Smith, P. H., M.D., 48, *Brook Street, W.*..... *C.*

1893 Quintin, St. W. H., *Scampstone Hall, Rillington, Yorks* ..... *ann.*

1884 Radford, Daniel, *Mount Tavy, Tavistock* ..... *ann.*
1884 Ralli, Mrs. Stephen, *Cleveland House, Clapham Park* £30
1885 Ransom, W. B., *Trinity College, Cambridge* ..... *C.*
1893 Rashleigh, E. W., *Kilmarth, Par Station, Cornwall*..... *ann.*
1888 Rawlings, Edward, *Richmond House, Wimbledon Common*..... *ann.*
1887 Riley, W., *Newcastle House, Bridgend, Glamorganshire*..... *ann.*
1892 Robinson, Miss M., *University College, London, W.C.* ..... *ann.*
1894 Rodd, F. R., *Trebartha Hall, Launceston, Cornwall* ..... *ann.*
1884 Rowe, J. Brooking, F.S.A., F.L.S., *Mulgrave Street, Plymouth*..... *ann.*

1892 Rüffer, M. A., M.D., 19, *Iddesleigh Mansions, S.W.* ..... *ann.*
1885 Ruscoe, John, *Albion Works, Henry Street, Hyde, near Manchester*... *ann.*

1889 Sanford, W. A., *Nynehead Court, Wellington, Somerset*..... *ann.*
1884 Schäfer, Prof. E. A., F.R.S., *University College, Gower Street, W.C*... *ann.*
1888 Scharff, Robert F., Ph.D., *Science and Art Museum, Dublin*..... *ann.*
*1884 Sclater, P. L., F.R.S., Sec. Zool. Soc., 3, *Hanover Square, W*..... *ann.*
1884 Sclater, W. L., *Eton College, Windsor* ..... *ann.*
1885 Scott, D. H., M.A., Ph.D., F.R.S., *Old Palace, Richmond, Surrey*... *C.*
*1884 Sedgwick, A., M.A., F.R.S., *Trinity College, Cambridge* ..... *C.*
1888 Serpell, E. W., 19, *Hill Park Crescent, Plymouth* £50
1885 Sheldon, Miss Lilian, *Oldhall, Newnham College, Cambridge* ..... *ann.*
1884 Shipley, Arthur E., M.A., *Christ's College, Cambridge* ..... *C.*
1886 Shore, T. W., M.D., *The Warden's House, St. Bartholomew's Hospital, E.C.* ..... *ann.*
1894 Simons, Carl W., 6, *Konigstrasse, Dusseldorf, Germany* ..... *ann.*
1885 Sinclair, F. G., *New Museums, Cambridge* ..... *C.*
1891 Sinclair, William F., *Bombay Civil Service, Bombay*..... *C.*
1884 Skinners, the Worshipful Company of, *Skinners' Hall, E.C.* £42
1889 Slade, Lieut. E. J. Warre, *St. Margaret's, Reigate* ..... *C.*
1884 Sladen, W. Percy, Sec. Linn. Soc., 13, *Hyde Park Gate, S.W*..... *ann.*
1893 Sorby, H. C., LL.D., F.R.S., *Broomfield, Sheffield* ..... *ann.*
1884 Spencer, J., 121, *Lewisham Road, Lewisham, S.E.* ..... *ann.*
1888 Spencer, Prof. W. Baldwin, M.A., *University of Victoria, Melbourne* *ann.*
1884 Spring-Rice, S. E., *H. M. Treasury, Whitehall*..... *C.*
*1884 Stewart, Prof. Chas., V.P.L.S., *Royal College of Surgeons, Lincoln's Inn Fields, W.C.* ..... *ann.*
†1884 Sutherland, The Duke of, K.G., *Stafford House, St. James', S.W.* ... *C.*
1894 Sykes, E. R., 13, *Doughty Street, London, W.C*..... *ann.*

1894 Thomas, W. F., *Bishopshalt, Hillingdon, Middlesex* ..... *ann.*
1890 Thompson, Herbert, B.A., 35, *Wimpole Street, W*..... *ann.*
1884 Thornycroft, John I., *Eyot Villa, Chiswick Mall*..... *ann.*
1888 Thurston, Edgar, *Government Central Museum, Egmore, Madras* ... *ann.*
1888 Tripe, Major-General, 3, *Osborne Villas, Stoke, Devonport* ..... *ann.*

1888 Vallentin, Rupert, 18, *Kimberley Road, Falmouth* ..... *ann.*
1891 Vaughan, Henry, 28, *Cumberland Terrace, N.W.* ..... *ann.*
1884 Venning, Mrs., 3, *Wingfield Villas, Stoke, Devon* £50
1884 Vines, Professor Sydney H., M.A., D.Sc., F.R.S., *Botanical Gardens, Oxford*..... *ann.*

1884 Walker, Alfred O., *Nantyglyn, Colwyn Bay, N. Wales* ..... *ann.*
1884 Walker, P. F., 36, *Princes Gardens, S.W.* ..... *ann.*
1893 Walker, W. H., 3, *Prince's Place, Plymouth* ..... *ann.*
†1884 Walsingham, Lord, F.R.S., *Merton Hall, Thetford*..... £20
1890 Waterhouse, Edwin, *Feldemore, Dorking* ..... *ann.*
1888 Weiss, Prof. F. Ernest, 4, *Clifton Avenue, Fallowfield, Manchester*... *ann.*
1890 Were, Nicholas, 9, *Osborne Place, Plymouth*..... *ann.*
1891 Wildy, A. G., 13, *Furnival's Inn, E.C.* ..... *ann.*
1884 Wilson, Scott B., *Heather Bank, Weybridge Heath* ..... *C.*

1884 Woodall, John W., M.A., F.G.S., *St. Nicholas House, Scarborough*... *ann.*

1891 Young, Sydney, M.D., 13, *Aberdeen Terrace, White Ladies Road, Bristol*..... *ann.*

IV.—Associate Members.

1889 Alward, George, 11, *Hainton Street, Great Grimsby.*
1889 Caux, J. W. de, *Great Yarmouth.*
1889 Dannevig, Capt. G. M., *Arendal, Norway.*
1889 Dunn, Matthias, *Mevagissey.*
1889 Olsen, O. T , F.L.S., F.R.G.S., *Fish Dock Road, Great Grimsby.*
1889 Ridge, B. J., 3, *Gainsboro' Place, Mutley, Plymouth.*
1890 Roach, W., *Sussex Street, Plymouth.*
1889 Shrubsole, W. H., 62, *High Street, Sheerness-on-Sea.*
1889 Sinel, Joseph, 2, *Peel Villas, Cleveland Road, Jersey.*
1890 Spencer, R. L., *L. and N.W. Depôt, Guernsey.*
1890 Wells, W., *The Aquarium, Brighton.*
1889 Wilcocks, J. C., *May Cottage, Shoreham, Sussex.*
1890 Wiseman, Fred., *Buckland House, Paglesham, Rochford, Essex.*

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.

Professor HUXLEY, the President of the Royal Society, took the chair, and amongst the speakers in support of the project were the Duke of ARGYLL, Sir LYON PLAYFAIR, Sir JOHN LUBBOCK, Sir JOSEPH 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 no case does any one salary exceed £250.

The Association has at present received some £20,000, of which £5000 was granted by the Treasury. The annual revenue which can be at present counted on is about £1820, of which £1000 a year is granted by the Treasury, the remainder being principally made up in Subscriptions.

The admirable Marine Biological Laboratory at Naples, founded and directed by Dr. Dohrn, has cost about £20,000, including steam launches, &c., whilst it has an annual budget of £7000.

The ASSOCIATION IS AT PRESENT UNABLE TO AFFORD THE PURCHASE AND MAINTENANCE OF A SEA-GOING STEAM VESSEL, by means of which fishery investigations can be extended to other parts of the coast than the immediate neighbourhood of Plymouth. Funds are urgently needed in order that this section of the work may be carried out with efficiency. 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. III, No. 3.

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 ann.	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.