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1885 Phillips, Chas. D. F., M.D., 10, *Henrietta Street, Cavendish Square, W.* ..... *C.*
1887 Phipson, Mrs., *Cumballa Hill, Bombay*..... *ann.*
1885 Pochin, H. D., *Bodnant Hall, Eglwysbach, Denbighshire* ..... *C.*
1884 Potter, Michael C., M.A., *Herbarium, New Museums, Cambridge* ... *ann.*
1884 Powell, Thos. Harcourt, *Drinkstone Park, Woolpit, Bury St. Edmunds* ..... *C.*
1886 Power, Henry, F.R.C.S., 37A, *Great Cumberland Place, W.* ..... *ann.*
1888 Prance, C. R., M.D., 18, *Princess Square, Plymouth* ..... *ann.*
1885 Pritchard, Urban, 3, *George Street, Hanover Square, W.* ..... *ann.*
1884 Pye-Smith, P. H., M.D., 54, *Harley Street, W.* ..... *C.*

1884 Radford, Daniel, *Mount Tavy, Tavistock* ..... *ann.*
1884 Ralli, Mrs. Stephen, *Cleveland House, Clapham Park* £30
1885 Ransom, W. B., *Trinity College, Cambridge* ..... *C.*
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.*
*1891 Rollit, Sir Albert, M.P., *Dunster House, Mark Lane, E.C.* ..... *ann.*
1884 Rowe, J. Brooking, F.S.A., F.L.S., *Mulgrave Street, Plymouth*..... *ann.*
1891 Rundle, E., *Royal Cornwall Infirmary, Truro*..... *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., *The Laurels, Bickley, Kent* ..... *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, *The Field, Stroud* ..... *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.*
1889 Simpson, Francis C., *Maypool, Churston Ferrers, R.S.O., S. Devon* *ann.*

1891 Sinclair, William F., *Bombay Civil Service* ..... *C.*
1884 Skinners, the Worshipful Company of £42
1889 Slade, Lieut. E. J. Warre, R.N., *H.M.S. Rodney, Chatham* ..... *C.*
1884 Sladen, W. Percy, Sec. Linn. Soc., 13, *Hyde Park Gate, S.W.* ..... *ann.*
1884 Sowerby, William, *Royal Botanical Society, Regent's Park, N.W.* ... *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., 9, *Wilton Street, Grosvenor Place, S.W.* ..... *C.*
1884 Stalbridge, The Rt. Hon. Lord, 12, *Upper Brook Street, W.* ..... *ann.*
*1884 Stewart, Prof. Chas., 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.*
1888 Swain, W. Paul, M.R.C.S., *The Crescent, Plymouth* ..... *ann.*

1889 Taylor, Thomas George, 6, *St. Mary Street, Stonehouse* ..... *ann.*
1884 Thompson, Prof. D'Arcy W., *University College, Dundee* ..... *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.*
1889 Tweedy, W. Gage, 8, *Athenæum Terrace, Plymouth* ..... *ann.*
1885 Tylor, E. B., D.C.L., F.R.S., *Museum House, Oxford* ..... *ann.*

1884 Upcher, Henry R., *Sherringham, Cromer* ..... *ann.*

1891 Vachell, C. J., M.D., 38, *Charles Street, Cardiff* ..... *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.*
1888 Vosper, Samuel, *Stonehouse, Plymouth* ..... *ann.*

1884 Walker, Alfred O., *Nantyglyn, Colwyn Bay, N. Wales* ..... *ann.*
1884 Walker, P. F., 36, *Princes Gardens, S.W.* ..... *ann.*
†1884 Walsingham, Lord, F.R.S., *Merton Hall, Thetford* £20
1890 Waterhouse, Edwin, *Feldemore, Dorking* ..... *ann.*
1888 Weiss, F. Ernest, 3, *Grosvenor Terrace, Withington, Manchester* ..... *ann.*
1890 Were, Nicholas, 9, *Osborne Place, Plymouth* ..... *ann.*
1891 Wildy, A. G., 13, *Furnival's Inn, E.C.* ..... *ann.*
1890 Wilson, J. B., *Grammar School, Geelong, Victoria* ..... *ann.*
1884 Wilson, Scott B., *Heather Bank, Weybridge Heath* ..... *C.*
1884 Woodall, John W., M.A., F.G.S., *St. Nicholas House, Scarborough* ... *ann.*
1888 Woods, G. W., F.I.C., F.C.S., *Ballagawne, Riggindale Road, Streatham, S.W.* ..... *ann.*
1884 Woollcombe, W. G., M.A., F.R.A.S., F.L.S., 101, *King Edward's Road, S. Hackney, London* ..... *ann.*

1891 Young, Sydney, M.D., *University College, 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.*

Henry Nottidge Moseley, Esq., F.R.S.

We regret to record the death, on November 10th last, of H. N. Moseley, M.A., LL.D., F.R.S., &c., Linacre Professor of Human and Comparative Anatomy in the University of Oxford, one of the earliest and warmest supporters of the Association. He was one of the speakers at the Foundation Meeting in 1884, and was Chairman of the first Council.

Director's Report.

The general condition of the Laboratory since the date of my report in the last number of the Journal calls for little mention. Some slight repointing of the walls and glazing has been necessary to keep out the winter rains, and the overhaul of one of the gas engines deemed desirable for the proper continuation of pumping without loss of gas. In other respects the entire building continues to render every satisfaction.

The work done by the various members of the Staff will be most readily estimated by the perusal of the several papers written by the members, and need not be mentioned in detail by me.

In my last report I made mention of the fishery investigations to be carried on by Mr. Holt in the North Sea, stating that in this Journal I would probably be in a position to state upon what lines the observations had been begun.

Since the issue of last number, another Fishery Conference has been held at Fishmongers' Hall under the auspices of the National Sea Fisheries Protection Association. At this conference the capture and sale of undersized fish was again under discussion, and again a resolution was passed defining, to the satisfaction of most of those present, the sizes below which soles, plaice, turbot, &c., should not be captured and sold. The discussion, as well as the resolution, proved abundantly to anyone at all acquainted with the sizes at which the various food fishes first spawn, that the sizes were arrived at purely with a view to keeping *undersized* fish out of the market, and without any reference to the maturity or immaturity of these fish. It showed most clearly how much information is yet needed by those who are personally interested in the fish trade, and who draw up measures for its regulation, and how important is the work undertaken by the Marine Biological Association in that area of the North Sea most frequented by trawlers from Grimsby, Hull, Great Yarmouth, and Lowestoft, as well as from other countries.

The following is a brief sketch of the work at present being carried on by Mr. Holt, who contributes, in another part of this Journal, a preliminary report on his methods of procedure.

The objects are—

1. To prepare a history of the North Sea Trawling Grounds, comparing the present condition with the condition say twenty or thirty years ago, when comparatively few boats were at work.

2. To continue, verify, and extend observations as to the average sizes at which the various food fishes become sexually mature.

3. To collect statistics as to the sizes of all the fish captured in the vicinity of the Dogger Banks and the region lying to the eastward, so that the number of immature fish annually captured may be estimated.

4. To make experiments with beam trawl nets of various meshes, with a view to determine the relation, if any, between size of mesh and size of fish taken.

It will be seen at once that, for one person, a very great amount of work is involved, and that before reliable data can be collected on all four points considerable time must elapse. In Mr. Holt's early reports, therefore, it has been thought advisable not to treat each heading in detail, since one season of the year may be more suitable for collecting information on one point than on another, but rather simply to state the results of work accomplished. During this, the spawning season, for instance, most attention must necessarily be given to heading No. 2 ; hence, in Mr. Holt's present report, the relation of size to immaturity is principally mentioned.

Already the information collected shows many points of interest. From the work of a similar nature, carried on by Mr. Holt himself in Ireland, from Dr. Fulton's results, published in the Scotch Fishery Board's Reports, and from observations made at Plymouth, it is obvious that a very considerable variation takes place in the sizes at which fishes become sexually mature in different localities ; and it is probably not too much to say that as surely as legislation will have to be resorted to for the preservation of fish until they have spawned, so surely will the matter have to be studied for each coast separately. In localities where there is no foreign element introduced, or where only English boats fish in territorial waters, the Sea Fishery District Committees will naturally be looked to for the proper conduct of affairs, and it will therefore be highly necessary that each committee should understand the guiding principles of natural history involved ; but where, as in the North Sea, foreign fishermen compete with those from this country, International Legislation must of necessity be brought about, otherwise the outcry, at present so loudly heard, will not cease, and the market for little fishes which have not spawned being kept open, the fishing grounds will be depleted, and the east coast industry ruined.

I have made reference to the Fishery Conference, and its resolu-

tion as to the sizes under which fish should not be allowed to be taken. I do not wish for a moment to have it supposed that I undervalue the importance of such conferences, my attendance on the 24th, 25th, and 26th February last was sufficient to dispel any such idea; what I mean to indicate is, that when a measure is proposed, which must necessarily start from a knowledge of the spawning periods and life history of fish, a large body of men who have no such knowledge—although they may have worked among fish all their lives—must necessarily deal with the question from a trade point of view only.

I do not intend to go further into the question at this juncture, but only to point out that the two points stated above have lately been seen to be widely apart.

The experiments on the production of an artificial bait have been continued. The question still presents serious difficulties, and a decided success has not yet been attained. Mr. Hughes, the chemist who undertook this inquiry, has now left the Laboratory, but contributes a final paper to this number of the Journal.

At first sight, the production of an attractive, easily-procured, and inexpensive bait does not seem a serious problem; but, as several who have made the attempt have found, the construction of some substance of suitable consistency in which to convey the attractive elements, is a problem calling for considerable ingenuity, patience, and perseverance.

The fishermen in this locality still suffer from a great scarcity of bait. Night after night boats are compelled to remain in harbour because the crew have found it impossible to procure bait; and I am told that the way in which one or two crews succeed is by rowing about during the night as the trawlers are coming in, buying up small quantities of shell-fish here and there till sufficient is collected. It is a laborious and often very expensive method, and certainly calls for some alteration. We still hope, therefore, by continuing the artificial bait experiments, to be able to produce some satisfactory results.

At the same time I cannot but think that if the rights of the foreshores can be sufficiently guarded, extensive bait cultivation might be carried out in certain suitable localities. It is successfully done in several parts of Scotland, although there the supply is far short of the demand, and I see no reason why it should not be equally well done in England.

On the 27th of January, owing to the repeated breaking down of the steam-launch, I was obliged to report to Council that it was absolutely necessary to have some more reliable craft with which to carry on our sea work. The Association not being able to afford

the heavy cost of keeping up a steamer of the size required, it was thought advisable to purchase a sailing trawler, in which trips of many days' duration could be made. There are many localities of great interest which should be visited, but which are impossible to reach unless by employing the expensive method of hiring a special vessel; and for carrying on our fishery investigations some large boat, capable of going where any other fishing-boat can go, is of inestimable importance. I have made many inquiries, and have looked at several boats, but, so far, have not found a vessel suitable both in condition and in price.

Mr. Garstang, formerly Assistant to the Director, who left Plymouth to take up a research Fellowship at the Owens College, Manchester, has again been offered an appointment on the Staff. He has accepted, and his appointment will date from May. His duties will consist chiefly in superintending the collection, preservation, and identification of specimens.

The demand for specimens for use in laboratories and museums throughout the country increases, and requires constant attention. We can supply specimens which, in very many cases, could not otherwise be obtained. The proper preservation of certain classes of soft animals is in itself an art developed during the last fifteen years, almost entirely by the persevering efforts of Sig. Lo Bianco, of Naples. Within the past year these methods have been published, and with practice it is hoped that the specimens sent out from the Plymouth Laboratory may gradually gain the character so long possessed by the Naples specimens alone.

At present all the preserving is done by the Laboratory Assistant, Mr. Joseph Walker, and we venture to think that although our results are not yet sufficiently fine to be quite satisfactory, a very decided advance has been made.

Quite recently a new price list of zoological specimens has been issued. This is the second list, and from the experience gained by the first, it has been found necessary to raise very many of the prices. If, however, the quality of material produced is better, we do not think that any of the prices will be found to be too high, and it has been our aim to keep the prices of animals most commonly used for teaching purposes, and therefore ordered in large quantities, as moderate as possible.

During the last few months I have received communications from several important centres on the east, west, and south coasts of England, asking for information relating to the construction of sea-fish hatcheries and marine laboratories.

The idea that some practical benefit is to be derived from such establishments seems to be gaining ground. In one or two locali-

ties definite steps are already being taken to form small stations of this kind; and as this Association and its Laboratory are naturally looked to as being an institution founded on a broad and sound basis, proposals have been made in one or two instances to place such small hatcheries under our supervision. Everyone knows what has been accomplished by the hatching and rearing of salmon and trout in our rivers, and now that the hatching of sea fish is making such strides, it is but natural that the attempt should be made to benefit our sea fisheries in a like manner. Norway, the United States of America, and Newfoundland have set us the example; and as the success attained becomes known in this country our fishermen may learn to believe that, as the agriculturist cannot expect to reap a harvest on ground where no seed has been sown, neither can he, considering the immense increase of fishing craft within recent years, expect the same fishing grounds continually to yield abundance. At present, when one district ceases to yield a remunerative return, the only idea present to the mind of the fisherman is to find out some new or little fished ground. But now, in the case at least of Great Britain, the limit to this method has been fairly well reached, and we must look to the preservation of spawning fish and the protection of the young, in order to keep up the balance of nature.

Amongst the Notes and Memoranda will be found a few extracts from a recently published Newfoundland Report showing what is being done in that country.

W. L. Calderwood.

On a Species of Siphonophore observed at Plymouth.

By

J. T. Cunningham, M.A.

Last autumn the occurrence of a small Siphonophore in the produce of the surface tow-nets attracted my attention. I first noticed it in the contents of a small net, worked five miles south of the Eddystone, on September 12th, and afterwards it was obtained in great abundance close to the Plymouth Breakwater, and even inside the Sound. It was brought in numbers to the Laboratory almost every day up to about the middle of October, but after the end of that month it was not seen again.

This Siphonophore was a Monophyid, and its single nectocalyx was from 3 to 6 or 7 mm. in length. Its appearance as a whole when slightly magnified is represented in Figs. 1 and 2, p. 213.

An elaborate description of the organism would be impossible without a detailed explanation of the structural features which are common to the family Monophyidæ, and which distinguish that family from other divisions of the Siphonophora. Such a detailed explanation would be quite superfluous, since a reference to Haeckel's Report on the Challenger Siphonophora, p. 125, and elsewhere, will at once afford a lucid and definite analysis of the whole class, and enable anyone to follow the discussion of the identity and position of the species here considered. I shall therefore confine myself to the question of identification, using the terms adopted by Haeckel for the various organs.

It will be seen at once, then, that the form belongs to the genus Muggiæa, the definition of which is "Monophyidæ with an angular pyramidal nectophore, and a complete infundibular hydrœcium in its ventral side. Bracts spathiform or conical, with a deep ventral groove, a bevelled basal face, and a simple ovate phyllocyst." I have not figured the bracts, nor have I been able to make a thorough

examination of them, but have seen enough of them to know that they do not invalidate the identification of the genus.

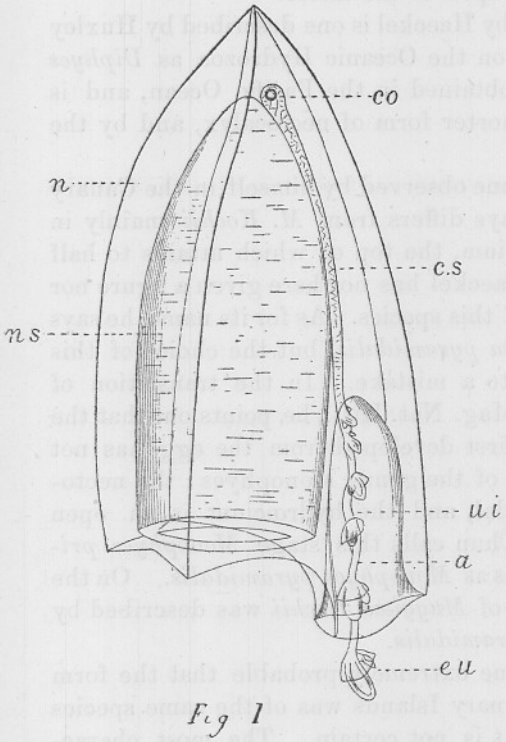


FIG. 1.—Muggiæa atlantica, seen from the right side.

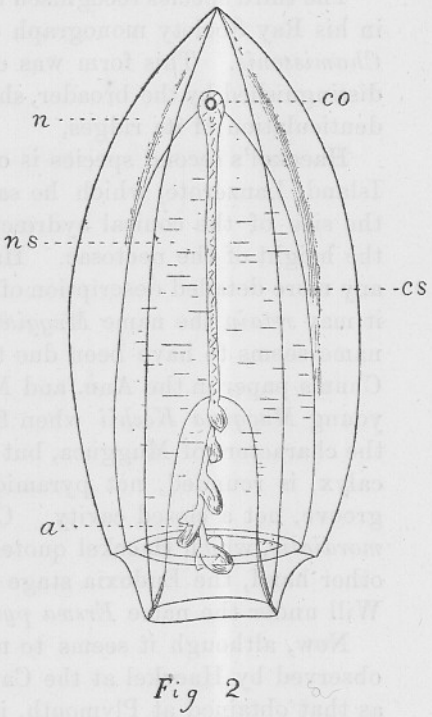


FIG. 2.—The same from the ventral side.

a, siphosome or common tubular stem, bearing *eu*, cormidia or groups of zooids at intervals; *co*, oleocyst; *cs*, somatocyst; *n*, nectocalyx; *ns*, nectosac or cavity of the nectocalyx; *ui*, hydrœcium, cavity from the apex of which the siphosome depends.

Only one species of Muggiæa has been adequately investigated; two others are mentioned by Haeckel, but they have not been sufficiently described. The first species is described by Dr. Carl Chun in a paper in the Sitzungsberichte der k. preuss. Akad. der Wissenschaften, translated in Ann. and Mag. Nat. Hist., 5th series, vol. xi, p. 153. It was originally described as *Diphyes Kochii*, and afterwards as Muggiæa. Chun adopts the name *Muggiæa Kochii*. This species was obtained at Trieste in the Adriatic, and by Chun at Malaga on the coast of Spain. It is obviously different from the Plymouth species, for although its shape is similar, its size about the same, and the ridges of the nectocalyx are smooth, the hydrœcium is much shorter, and the somatocyst only extends to half the height

of the nectosac; whereas in the Plymouth species the hydrœcium extends to one third the height of the nectosac, and the upper end of the somatocyst is above the apex of the latter.

The third species recognised by Haeckel is one described by Huxley in his Ray Society monograph on the Oceanic Hydrozoa as *Diphyes Chamissonis*. This form was obtained in the Pacific Ocean, and is distinguished by the broader, shorter form of nectocalyx, and by the denticulation of its ridges.

Haeckel's second species is one observed by himself in the Canary Island, Lanzerote, which he says differs from *M. Kochii* mainly in the size of the conical hydrœcium, the top of which attains to half the height of the nectosac. Haeckel has nowhere given a figure nor any more detailed description of this species. As for its name, he says it may *retain* the name *Muggiæa pyramidalis*, but the choice of this name seems to have been due to a mistake. In the translation of Chun's paper in the Ann. and Mag. Nat. Hist., he points out that the young *Muggiæa Kochii* when first developed from the egg has not the characters of Muggiæa, but of the genus Monophyes; the nectocalyx is rounded, not pyramidal, and the hydrœcium is an open groove, not a closed cavity. Chun calls this stage *Monophyes primordialis*, which Haeckel quotes as *Monophyes pyramidalis*. On the other hand, the Eudoxia stage of *Muggiæa Kochii* was described by Will under the name *Ersæa pyramidalis*.

Now, although it seems to me extremely probable that the form observed by Haeckel at the Canary Islands was of the same species as that obtained at Plymouth, it is not certain. The most characteristic feature about the Plymouth form seems to me to be the great length of the somatocyst and the position of the oleocyst above the apex of the nectosac. I wrote to Professor Haeckel on the subject, and he replied that he was unable after so many years to ascertain whether his species and mine were the same, as he had neither specimens nor drawings which sufficiently exhibited the test structures. At the same time I think it is inconvenient to use for another species either of the names *pyramidalis* or *primordialis*, which have been applied to stages of *Muggiæa Kochii*. I have therefore to find a new name for the species occurring at Plymouth, which may or may not have a range extending to the Canary Islands, and will call it *M. atlantica*. There is one point to be noted which makes it very probable that the Canary Island form and the English form are the same, namely, that in the former according to Haeckel the hydrœcium extends to half the height of the nectosac, and in the latter its relative height is nearly as great, so that in the Canary Island form the somatocyst may extend as in the English to the apex of the nectosac.

The form I have described was also noticed at Plymouth by Mr. G. C. Bourne, who states in his report of his cruise in H.M.S. "Research," this Journal, vol. i, No. 3, that he also obtained it off the south-west coast of Ireland, and that it seems to be the *Muggiæa Kochii* of Chun and Haeckel. I have indicated above the points by which it is definitely distinguished from *Muggiæa Kochii*.

In the paper already cited, Chun gives a detailed account of the interesting and complicated changes which he discovered to take place in the life-history of *Muggiæa Kochii*. The egg first develops into a stage resembling Monophyes, in which the nectocalyx is smooth and without ridges. The characteristic pyramidal nectocalyx then develops and separates, carrying the siphosome with it. The cormidia or eudoxomes, when fully developed on the tubular stem or siphosome, become free, and continue to live as independent organisms or colonies, which were originally described under the name *Eudoxia Eschscholtzii*. The Eudoxia bears a genital calyx resembling a nectocalyx in shape, and this produces ova or spermatozoa. Each Eudoxia is unisexual, but produces several genital calyces in succession, all of the same sex. From the egg of the Eudoxia develops the Monophyes-like larva and the series of stages recommences. Probably the *Muggiæa atlantica* has a similar life-history, but I was unable to make a more complete study of it, partly because I had other work to attend to, partly because I could only obtain pelagic material when the total results of the day's collecting were brought in somewhat late in the afternoon. The specimens as brought to me were always in the condition shown in my figures, only a short basal portion of the siphosome remaining attached to the nectocalyx. Detached eudoxomes were present in the bottles, but in a somewhat damaged condition.

North Sea Investigations.

By

Ernest W. L. Holt,
Naturalist on Staff in charge of Investigations.

The reasons which induced the Association to undertake this work, and the nature of the investigations proposed to be carried out, will be familiar to readers of this Journal (see vol. ii, No. 2, p. 88), and need not be here recapitulated. I shall, therefore, confine myself to a brief account of such progress as has already been made.

Grimsby was selected as head-quarters, as being the port from which the largest number of boats work, and, in fact, the head-quarters of the North Sea Trawling Industry. A local body, the Marine Fisheries Society, has for the last few years been carrying on work in Grimsby, principally in connection with the culture of sea fish, and for that purpose has erected an aquarium or hatchery at Cleethorpes, a small watering-place and fishing village on the outskirts of the town. It was felt that it would be of great advantage if the Association could secure the co-operation and assistance of this Society, and communications accordingly passed between the Director and Mr. O. T. Olsen, Secretary of the Society and also a member of the Association, and to whose energy and enthusiasm the foundation and subsequent success of the Society are in great measure due. As a result the Society at once promised every assistance in their power, and furthermore placed their premises at Cleethorpes at my disposal for such work as could be most conveniently carried on there. The hatchery contains glass and slate tanks of various sizes, with apparatus for circulating the water, and its reservoir is connected with the sea pump of the adjacent public baths, so that direct communication with the Humber can be established at any time. There is an ample supply of hatching boxes of various patterns, and machinery for setting them in motion after Captain Dannevig's method. A museum and office are attached, and the Society has further been at the trouble and expense of erecting a small laboratory for my accommodation.

An arrangement has also been arrived at whereby I secure the services of the Society's care-taker for such purposes as they may be required, the Association bearing half the expense of his salary.

I arrived at Grimsby on the 1st of January, and a certain amount

of time was necessarily taken up in arranging preliminaries and settling the method of procedure.

At present it seems advisable to confine my remarks to describing the system on which work is carried out, deferring any report on the results until such time as they shall be complete.

I visit the market every morning in order to obtain fish for investigating the condition of the reproductive organs at different sizes. The quantity that can be got is, of course, regulated by the price, which during the first two months of the year has been remarkably high. It has, therefore, been impossible to devote much attention to soles, but it may be expected that during the next few months the price will become more reasonable, while the incidence of the spawning period will be of advantage. In the case of turbot and brill, which are brought to market ready gutted, it is possible to make the necessary examination without injuring the saleable quality of the fish, and for this purpose Mr. Bulpit, a salesman in the market, has kindly allowed me access to any fish that come to his stall. The removal of a small piece of the testis or ovary, for microscopical examination in doubtful cases, causes no injury. The fish purchased are conveyed by the attendant to the hatchery, where, with the necessary apparatus at hand, careful observations are subsequently made. Details as to the number of fish examined will be found annexed.

Incidentally to this investigation a good deal of information is obtained as to the spawning period of the prime fish on the different grounds, and much can also be learnt by observing the operations at the gutting tables, where the coarser kinds of fish are cleaned for transmission or curing.

Considerable difficulty has been encountered in obtaining accurate statistics as to the distribution and annual destruction of immature fish on the different grounds. The weight of fish captured is accessible, since Mr. W. Hood, statistician to the Board of Trade at this port, kindly allows me to inspect his books, and by this means, from general observations of the fish in the market at different seasons, a computation can be made; but its value is at best doubtful. Obviously statistics, to be reliable, must be collected at sea, and for this purpose I have endeavoured to enlist the assistance of as many skippers of trawling vessels as possible, and have been helped by the influence of Mr. Olsen, Mr. G. L. Alward, and others at Grimsby, and have been promised assistance from other parts of the coast. At first I tried entrusting such skippers as would take them with note-books, lists of sizes, and measures, but soon found that, although in a few cases the results were satisfactory, this method of keeping records was too great a tax upon the time of

busy men. I have therefore had forms printed, which require little beyond the filling in of figures, with the best results. It takes time to extend the operations to a sufficiently large scale, as it is only the most intelligent amongst the community who readily interest themselves in matters of this kind. I am able to collect a certain amount of information myself at sea, as Mr. G. L. Alward has been most kind in procuring me a berth whenever I want it on any of the vessels belonging to the various companies with which he is connected. So far I have only made two trips, as fishing has hitherto been confined to grounds where small fish are not plentiful. The season for the grounds on the eastern side of the North Sea is only just opening.

By inducing skippers to bring me in all the "rubbish" from the last haul of a trip, with careful data as to position and soundings, it has been possible to collect considerable information as to the fauna of the different grounds. Objects of special interest are also usually brought to me.

For investigating the relation of size of mesh to size of fish caught, I have caused a number of cod ends of different sized mesh, braided in different ways, to be prepared. These can be easily laced on to any trawl, and as the cod end is the part of the net in which the opportunity of escape, if any, presents itself to the fish, the object desired can be gained in this way at a great saving of expense. Mr. G. L. Alward has most generously presented the Association with a trawl, 24 feet beam, which can be used in connection with these cod ends. So far no opportunity of testing them has occurred, for want of a boat, but I have now made arrangements for making the first series of experiments at an early date.*

The following are found convenient limits for dividing large and small fish:

Turbot	17 inches.	Cod	20 inches.
Brill	15 „	Haddock	10 „
Sole	12 „	Whiting	8 „
Lemon Sole	10 „	Grass Whiting = Pollack	18 „
Plaice	17 „	Coal-fish	20 „
Halibut	23 „	Hake	24 „
Witch	12 „	Ling	24 „
Megrim	12 „	Tusk	16 „
Sand dab	6 „	Cat-fish	20 „
Long Rough Dab	6 „	Gurnard	9 „
Flounder	7 „	John Dory	14 „

The fish enumerated in the returns are selected on account of their proximity to the size limits.

* Since this went to press I have made one trial of the nets, with results of some interest.

Return of Fish examined during Month of January, 1892.

Locality from which fish derived.	Name of fish.	No. caught.	No. received from other boats.	No. examined.	No. males.	No. females.	No. large.	No. small.	No. immature.	No. approaching ripeness.	No. ripe.	No. spent.
North Sea	Turbot	—	3	3	1	2	0	3	2♀	1	0	0
„	Brill	—	7	7	1	6	0	7	5♀	1♂ 1♀	0	0
„	Plaice	—	65	65	22	43	13	52	11♂ 31♀	5♂ 4♀	4♂ 6♀	1♂ 2♀
„	Poledab or Witch	—	4	4	0	4	4	0	0	4♀	0	0
„	Cod	—	2	2	1	1	1	1	1♀	1♂	0	0
„	Haddock	—	7	7	1	6	7	0	0	1♂ 6♀	0	0

Return of Fish examined during Month of February, 1892.

North Sea	Turbot	—	39	39	19	20	26	13	3♂ 5♀	16♂ 15♀	0	0
„	Brill	—	17	17	6	11	10	7	1♀	6♂ 10♀	0	0
„	Sole	—	44	44	22	22	9	35	1♂ 11♀	21♂ 11♀	0	0
„	Lemon Sole	—	9	9	3	6	8	1	1♀	3♂ 5♀	0	0
„	Plaice	—	51	51	15	36	32	19	3♂ 17♀	5♀	9♂ 5♀	3♂ 7♀
„	Halibut	—	7	7	3	4	1	6	2♂ 4♀	1♂	0	0
„	Common Dab	—	16	16	8	8	9	7	2♀	4♂ 6♀	4♂	0
„	Long Rough Dab	—	2	2	0	2	2	0	0	0	2♀	0
„	Cod	—	11	11	5	6	9	2	3♂ 4♂	1♂ 1♀	1♂	0

Return of Fish examined during Month of March, 1892.

North Sea	Turbot	—	12	12	8	4	6	6	1♂ 4♀	7♂	0	0
„	Plaice	—	4	4	0	4	0	4	2♀	0	0	2♀
„	Common Sole	—	9	9	7	2	4	5	0	6♂ 2♀	1♂	0
„	Lemon Sole	—	32	32	18	14	28	4	6♀	8♂ 6♀	5♂	5♂ 2♀
„	Common Dab	—	36	36	24	12	36	0	0	12♂ 4♀	12♂ 4♀	0
„	Long Rough Dab	—	1	1	0	1	1	0	0	0	1♀	0
„	Whiting	—	17	17	10	7	16	1	1♀	9♂ 4♀	1♂ 2♀	0
„	Tusk	—	3	3	0	3	3	0	2♀	1♀	0	0
„	Grey Gurnard	—	51	51	24	27	50	1	1	21♂ 24♀	2♂ 2♀	0

Further Experiments on the Production of Artificial Baits.

By

Frank Hughes.

Since the publication of the last paper a number of experiments have been made in connection with the Bait question. The object aimed at was to obtain some material which would serve as a medium for the application of some or other of the extracts prepared by the methods given in the previous report. A number of common substances were tried without success. The majority were either not sufficiently porous, or, if possessing that qualification, they lacked that strength and toughness which is absolutely necessary in a bait which must lie in the water for some hours.

It is this length of time which renders such materials as sponge, however fine, quite useless, since no extract, even if very much thickened, will remain in a piece of sponge more than a few minutes. Mr. Bateson in his report on this subject suggested the use of China clay; I tried a number of experiments with this, both dried and soft. In the latter case disintegration occurred at once, and the dried clay did not absorb sufficient extract to render it attractive; besides this, fish always reject any hard substance, even if it be made attractive with the smell of a favourite food. A somewhat promising material was obtained by boiling down skate skins until they were quite soft, and pressing them into blocks. The large amount of gelatine in these skins caused the fibres to adhere, forming a compact mass. This was somewhat porous and elastic, and took up a considerable amount of extract, but, like a number of other gelatine preparations, would not withstand the prolonged action of the water. A number of experiments were tried with this material, but no mixture could be obtained which would remain unacted on by water for a sufficient time. Other substances, such as gums, were tried, but without success.

Throughout my experiments I have never found any substance at all attractive to the conger other than the extracts, &c., prepared from pilchard, squid, or whelks; these were always attractive, particu-

larly the squid and pilchard preparations. It seems unlikely that anything other than these should be attractive, although there are cases where substances, which animals in the ordinary course of events would not meet with, are extremely attractive. In these cases it would seem likely that there is a strong resemblance between the smell of these substances and that of some favourite food of the animals, although in most cases it is not easy to find.

It will be seen from the above account that the difficulty of finding a "medium" still remains unsolved, and, on that account, the work is still incomplete. If this were discovered, further experiments could be made in the preparation of extracts, and a satisfactory bait would soon result.

At the same time, if nothing is found attractive but preparations of the bait now in use, no very great advantage will be obtained, since the same result could be arrived at by keeping the ordinary bait in a frozen condition. This can be done for a considerable time—six to eight weeks; and the expense, when done on a large scale, would not be very great.

The question appears to me to be one of those which are not so likely to be solved by continuous investigation as by some accidental observation, since it is probable that some substance may be found suitable for the purpose which at first it would appear absurd to use. In the same way some material, other than squid, &c., might be found to be attractive to the fish.

On the Rate of Growth of some Sea Fishes, and the Age and Size at which they begin to Breed.

By

J. T. Cunningham, M.A.

THE following paper is to be regarded as the sequel of that published in the preceding number of this Journal, on the rate of growth and distribution of young marine fishes. I am still continuing inquiries of this character, and have now to record the additional results obtained up to the end of March, 1892. I have also described and criticised some of the results of other workers in the same field.

Gadus morrhua, the Cod.

Continuous observations on the growth of marine fishes in captivity have very seldom been made up to the present time. Isolated observations are scattered here and there in Day's British Fishes, and Marion, in the Annales du Musée de Marseille of 1891, has described how he reared the alevins of a species of mullet and of Sargus till they were nearly a year old, but none of these experiments were carried on with the object or with the result of ascertaining definitely the most important facts in the life-history of the species. So far as I have discovered, continuous observations on the growth of fish from the earliest stage almost to the adult condition have only once been attempted before I carried out my own upon flounders, namely, those of Dannevig upon cod. Dannevig's results are described in his Reports upon the Fish Hatchery of Flödevig, published by the *Selskab for de Norske Fiskeriers Fremme*,* and an account of them by Professor Cossar Ewart is to be found in the Fifth Report of the Fishery Board for Scotland for the year 1886. In one respect Dannevig's experiment was superior

* See Aarsberetning, 1886, of Selskabet for de Norske Fiskeriers Fremme, Bergen; Beretning om Flödevigens Udklækningsanstalts Virksomhed i Femaaret, 1883—1888, Arendal, 1889.

to mine, namely, that he hatched his specimens as well as reared them, while mine were obtained at an early stage of life from the sea. I believe that this is the only case in which larvæ artificially hatched from marine pelagic fish eggs have been successfully reared in captivity. This success can only be attributed to the fact that the young fry were turned into a large reservoir of clean sea water. The reservoir was made by building two dams across a narrow rocky gully, opening on to the shores of the inlet on which Flödevig stands. Flödevig is about 6 miles from the town of Arendal on the south coast of Norway. The reservoir was about 43 yards long, 20 yards broad, and 5 yards in greatest depth, and sea water could be constantly pumped into it by means of a steam-engine. The reservoir was like an enclosed portion of the sea-shore, and seaweeds grew in it as on the shore.

Into this large reservoir Dannevig put, on the 3rd May, 1886, about 500,000 cod larvæ hatched on the 27th April. The larvæ when put in were 5 mm. or $\frac{1}{5}$ of an inch in length. Up to the 6th of June their growth was slow, they measured then only 15 mm., and up to this time they refused the artificial food, namely, finely chopped mussels and fish, which was offered to them. After this they began to eat the food thrown into the pond, and their rate of growth rapidly increased. On July 12th, when two and a half months old, they measured 5·5 cm. or nearly 2·2 inches. The subsequent growth will be seen from the following table:

Date.		*Age.*	*Length.*
1886	May 3	6 days	5 mm.
	June 6	1 month 9 days	1·5 cm.
	July 12	2 months 15 days	5·5 cm.
	Aug. 12	3 months 15 days	7·0 cm.
	Sept. 12	4 months 15 days	8·5 cm.
	Oct. 12	5 months 15 days	11·5 to 15·7 cm.
1888	Feb.	1 year 10 months	35·6 to 40·7 cm., 14 to 16 inches.
	Autumn	2½ years	9 to 18 inches.

The last entry in the above list is taken from a separate report by Dannevig on the work done at Flödevig between 1883 and 1888. This report is dated February, 1889, but the paragraph concerning the cod was apparently written in the autumn of 1888. It is there stated that the total number of fish surviving was from 200 to 400, and that they seemed likely to spawn in the following spring. I have not been able to find anything further about these fish in later reports.

Fulton finds the smallest ripe cod to be 20 inches long, and Holt thinks that the smallest ripe female is considerably larger. Dannevig's specimens had not reached 20 inches in two and a half

years, and there is no evidence in his experiment that any specimens spawned at two years of age. In fact, his experiment was made merely with the object of proving that artificially hatched larvæ could grow into adult fish, and he seems to have paid little attention to questions as to the size or age at which sexual maturity is attained. It seems to me probable that, either by reason of the confinement or of insufficient food, the size reached by Dannevig's specimens in two a half years was considerably below the normal size of free individuals of that age.

Dannevig mentions in his Report for 1886 that on the 13th May he placed 5000 newly hatched flounders in the pond or reservoir above mentioned with the young cod; in the translation given by Prof. Ewart, loc. cit., the species is erroneously given as *Pleuronectes limanda*, but Dannevig himself states that *skrubbe*, the word he uses, means *Pl. flesus*. In May, 1888, these flounders had attained a length of 7 or 8 inches, so that some of my captive flounders, described in the following section, though reared in comparatively small tanks, were larger than those kept by Dannevig in a large open-air reservoir. Dannevig says nothing about the spawning of these captive flounders.

Ewart states that Dannevig reared herring in the same reservoir, but I can find no reference to herring in the reports of the latter.

Pleuronectes flesus, the Flounder.

The specimens of this species reared in the aquarium, whose length in the spring of last year was given in my previous paper, were measured again this year when they were about two years old. Their lengths and conditions were as follows:

February 23rd, 1892. Specimens in a table tank 5 feet by 2½ feet in area, by 1 foot 5 inches deep, measured and examined. Total number of specimens 24.

Of these three were ripe males, and one was a female, which though not actually ripe had a well-developed ovary, which would without doubt yield ripe ova this season. The lengths of these were—

Males.		*Female.*
23·3 cm., 9·2 in.	...	21·3 cm., 8·4 in.
22·2 „ 8·8 „		
21·0 „ 8·3 „		

The remaining specimens were all unripe; their sexes were not determined. Their lengths were—

(1) 24·8 cm., 9·7 in.	(8) 17·3 cm.	(15) 14·0 cm.
(2) 20·8 „	(9) 17·2 „	(16) 13·7 „
(3) 20·0 „	(10) 16·7 „	(17) 13·4 „
(4) 19·7 „	(11) 16·4 „	(18) 12·5 „
(5) 19·2 „	(12) 15·7 „	(19) 12·2 „
(6) 18·0 „	(13) 14·5 „	(20) 10·5 „ 4·1 in.
(7) 18·0 „	(14) 14·2 „	

I separated the three ripe males and the ripening female, placing them in another tank, and returned the rest alive to the tank they were taken from.

On March 21st I examined the unripe specimens again, to see if any had become ripe in the interval, but could find no signs of sexual maturity in any of them. Two of them had died in consequence of the handling they underwent on the first occasion. I now took one specimen, the third on the above list, killed it and dissected it. I found it was a female ; the ovary was quite small, and showed no signs of reproductive activity. The organ extended only about 1·5 cm. beyond the posterior boundary of the abdominal cavity, and the ova were not separately visible to the eye. It seemed evident that this specimen would not have spawned during the present season.

The other specimens of the same age had been living in a large tank 18 feet by 3½ feet in area, and 2 feet in depth. I emptied this tank on February 24th, and found in it sixty-five flounders. Of these nine were males in a perfectly ripe condition, whose lengths were—

(1) 23·4 cm., 9·2 in.	(4) 21·0 cm., 8·3 in.	(7) 19·8 cm., 7·8 in.
(2) 23·1 „ 9·1 „	(5) 20·8 „ 8·2 „	(8) 17·4 „ 6·9 „
(3) 22·1 „ 8·7 „	(6) 20·0 „ 7·9 „	(9) 16·2 „ 6·4 „

Three were females with large swollen ovaries, not perfectly ripe, but evidently preparing to spawn this season ; their lengths were—

(1) 26·7 cm., 10·5 in.	(2) 24·8 cm., 9·8 in.	(3) 23·0 cm., 9·0 in.

The rest were unripe ; they varied in length from 23·2 cm. or 9·15 inches down to 7·2 cm. or 2·8 inches.

I placed the ripe males and ripening females in a separate tank, and returned the unripe specimens to the tank they came from.

On March 24th I emptied the tank and examined the unripe specimens again. I found one more ripe male, but this was apparently one that had escaped capture on the previous occasion, as it was injured by the net. It was 21·3 cm. long.

Among the specimens in the small tank, two were left-sided or reversed, that is, having the eyes on the left side instead of on the right. Of the sixty-six specimens in the large tank four were

reversed; one of these sixty-six had a few small patches of pigment on the lower side of the skin, but in no other specimen did any pigment occur on the lower side.

Thus the largest of these specimens known to be two years of age was 26·7 cm. long or 10·5 inches, while the smallest was 7·2 cm. or 2·8 inches. I feel convinced myself that this great difference in size is chiefly due to differences in nutrition, produced by the competition for a limited supply of food among a large number of individuals in a confined space. It proves at least that under certain conditions a flounder may be only 3 inches long when two years old, and it is quite possible that these conditions are sometimes realised in nature. On the other hand, the size of the larger specimens agrees perfectly with the size of those taken at sea which I had estimated to be of about this age.

With respect to sexual or reproductive maturity, the spawning season is not yet passed, and some of the specimens now unripe may be found to be ripe in April or even in May. But I am inclined to think that the majority, if not all, of the specimens found to be unripe in February and March will not spawn this year. I was surprised to find the proportion of ripe specimens so small. It was 16 per cent. in the small tank, 20 per cent. in the large, or 19 per cent. taking the two together. In my last paper I recorded the fact that none of these captive flounders were ripe at one year of age, and inferred that they would breed for the first time when two years old. It now appears that only a small proportion breed at that age, the majority not attaining to sexual maturity in the second spawning season after that in which they were hatched. It seems probable, therefore, that the greater number of young flounders breed for the first time when three years old, while a small proportion begin to breed at two years. If this were the case normally in flounders and other flat-fishes, not only under artificial but under natural conditions, then in this respect the life-history of the flat-fish would resemble that of the salmon, which has been so long and so attentively studied. For, according to the account given by Day in his British Fishes, it has been conclusively proved that out of the salmon fry hatched in a given spring, which become parrs in the following summer, a certain small proportion become smolts in the following spring when one year old, and descend to the sea, while the larger number remain in the rivers as parrs until they are two years old, and then migrate as smolts. Now a smolt which descends in spring returns as a grilse the following autumn and spawns. Therefore a proportion of salmon breed for the first time two years after the autumn in which they themselves were spawned, while the majority do not become sexually mature until the third autumn.

Of course it may be objected that it is unsafe to draw inferences from what takes place under artificial conditions; that fish kept in captivity in tanks may grow at a different rate and breed at different ages from those in their natural state. But the degree to which such differences occur may be ascertained with sufficient certainty by comparing observations made on specimens taken at sea with those made on captive specimens. In my last paper I showed that specimens living under natural conditions are taken at the spawning season, which must be one year old, and yet which are considerably smaller than the smallest ripe specimen recorded. Thus there is here some evidence that the development of the reproductive organs is not greatly modified by confinement.

Dr. Fulton's investigation of the question of immature fish was of a statistical character, and his criterion of immaturity for each species was a criterion of length. He ascertained the length of the smallest ripe fish among a very large number examined and measured, and he regarded all specimens smaller than this as sexually immature, all larger specimens as mature. Mr. Holt in the course of his observations on the west coast of Ireland introduced a new and important consideration, namely, the distinction of the sexes. Dr. Fulton spoke merely of a ripe specimen without reference to the question whether it was male or female, but it had long been known, *e. g.* in the case of the salmon, that a male fish may be sexually ripe when very small indeed, while the smallest ripe female is a great deal larger. Mr. Holt, therefore, records the sex as well as the size of ripe specimens, and finds the smallest ripe female to be considerably larger than the smallest ripe male. The importance of this distinction had been also present to my own mind long before Mr. Holt's results were published. In fact, in my previous paper, which appeared in November, 1891, I have in all cases given the sex of the smallest ripe specimen observed, and in the case of the dab have given the length of the smallest ripe specimen of each sex. My knowledge of Mr. Holt's observations is derived from a proof copy of his reports in the Report of the Council of the Royal Dublin Society for 1891.

In the statistical inquiries of both Holt and Fulton, it is tacitly assumed that the sexual maturity of a fish of a given species depends only on its size. The smallest ripe specimen is found, and it is assumed that all specimens above this size are to be considered as mature. The method of these inquiries naturally involved such an assumption, for while the minimum size of ripe or ripening specimens was ascertained, no attempt was made in them to ascertain the maximum size of immature specimens. In fact, when a specimen caught at sea is not ripe or ripening, we have at present no

criterion by which to find out whether it has spawned before or not; it may be sexually immature, or it may have spawned previously, its sexual organs being merely in an inactive state at that particular time of the year.

Now it was, *à priori*, improbable that the sexual maturity of a fish should depend simply on its size. This could only be the case if every specimen grew to exactly the same size in the same time, if there were no individual variation in the rate of growth. That such a variation exists is obvious from the examination of fishes taken at sea, and my observations on flounders, &c., in captivity, have shown how great the variation may be. Thus, when Fulton finds the smallest ripe flounder to be 7 inches long, it by no means follows that all specimens larger than this have begun to breed. I have given above the lengths of the twelve of my captive specimens which were found to be ripe males in February and March this year. The smallest of them is 6·4 inches long, the largest 9·2 inches. Therefore even a male flounder may be more than 9 inches long before it begins to breed—before it spawns for the first time. Eight out of the twelve ripe males are over 8 inches long. If these had been taken at sea last November, they would have been over 7 inches long, and would, according to Fulton's method, have been classed as mature, while, as a matter of fact, they had not begun to breed, had never yet produced milt. Similarly, with the females there are only four ripe among my captive specimens, and their lengths are from 8·4 inches to 10·5 inches, so that a female flounder may be more than 10 inches long before it breeds for the first time.

The results thus obtained for the flounder probably apply more or less exactly to other kinds of flat-fishes. Hence we may conclude that, when the smallest size of the mature female in a given species has been ascertained, many females do not reach maturity until they are somewhat larger than this. Therefore, in order to exclude all immature individuals, a limit of size must be taken which is above the minimum size of mature females.

Pleuronectes limanda, the Dab.

In the autumn of last year I collected from Cawsand Bay, and other parts of Plymouth Sound, a number of small dabs which I judged to be derived from the spawning of the spring of the same year.

The dates of collection and lengths of these were as follows :

1891	Sept. 29	...	4 specimens	...	4·2—5·3 cm.
	Oct. 1	...	3 „	...	4·0—4·5 „
	„ 1	...	5 „	...	4·3—6·0 „
	„ 2	...	2 „	...	4·2—4·5 „
	„ 6	...	4 „	...	4·0—6·0 „
	„ 10	...	17 „	...	4·0—6·5 „
	„ 12	...	13 „	...	4·0—5·0 „
		Total	48 „		

These were all placed in one table-tank measuring 5 feet by 2½ feet in area, and 1 foot 6 inches in depth. On March 21st, 1882, I measured these fish, or as many of them as I could catch, and found their lengths to vary from 5·0 to 12·2 cm. There were 37 of them : some of course had died. They had been fed with chopped marine worms.

The separate measurements were—

5·0 cm.	...	7·1 cm.	...	9·1 cm.	
5·6 „	...	7·5 „	...	9·1 „	
5·7 „	...	7·8 „	...	9·2 „	
6·0 „	...	7·8 „	...	9·2 „	
6·1 „	...	7·8 „	...	9·4 „	
6·6 „	...	8·7 „	...	9·8 „	
6·6 „	...	8·7 „	...	9·9 „	
6·9 „	...	8·8 „	...	10·1 „	
7·0 „	...	8·8 „	...	10·2 „	
7·0 „	...	8·8 „	...	11·4 „	
7·0 „	...	8·9 „	...	11·6 „	
7·0 „	...	8·9 „	...	12·2 „	
7·0 „	...		...		

In my paper in the preceding number of this Journal, I recorded the fact, that some specimens of the dabs, 4·7 and 5·0 cm. long, were taken in April and May, and stated that these must be a year old, because they could not reach that length if hatched in the same year. I also estimated the maximum length of specimens one year old at 13·5 cm. These conclusions were founded entirely on specimens taken at sea ; the growth of the above-recorded specimens in captivity fully comfirms my previous conclusions. None of the captive specimens showed any signs of sexual maturity, an indication that the dab does not any more than other flat-fishes begin to breed before it is two years old.

Solea vulgaris, the Sole.

I have not yet obtained young soles less than 1 year old at Plymouth, either in shallow or in deep water. Last summer I specially sought for them in deep water, but obtained none. There is some

evidence now that during the summer after they are hatched they remain in shallow water.

Dr. Fulton states that eleven young soles, $2\frac{3}{4}$ to 6 inches long, were taken in June in the Solway Firth, and that six soles, 5 to 7 inches in length, were taken in one morning's fishing on the Lancashire coast; but these are only soles about one year old, such as I stated in my previous paper to be taken in Plymouth Sound. But Mr. H. C. Sorby of Broomfield, Sheffield, has informed me that, in August 1890, he took several soles only about 2 inches long, in Bawdsey Haven in Suffolk. He sent me one specimen of these, and I found there was no doubt about its being of the species *S. vulgaris*. This specimen was 5 cm., or 2 inches long, and having been captured in August must have been about 4 months old.

Zeugopterus punctatus, Müller's Topknot.

On July 9th, 1891, I took four specimens of this species in an otter trawl at a depth of 25 fathoms between the Eddystone and the Rame Head. These specimens measured 6·2, 6·5, 8·2, 9·5 cm. (2·4, 2·6, 3·2, 3·7 inches) respectively. On March 21st, 1892, our fisherman took a specimen 8·4 cm. long 6 miles from the breakwater. To my surprise this small specimen was a perfectly ripe female yielding ripe transparent ova on the slightest pressure. The ova were ·9 mm in diameter and contained a single oil-globule ·15 mm. in diameter. The ova were evidently pelagic. Mr. George Brook has described the eggs of the other species *Z. unimaculatus* (*Ichthyological Notes*, Fourth Report of the Fishery Board for Scotland), and states that they were ·96 mm. diameter in the preserved condition and had a single oil-globule. Brook obtained the eggs from a single ripe female 5 inches in length.

Z. punctatus reaches a maximum length of 7 or 8 inches, about 18 to 20 cm. Those taken in July, 1891, may have been only one year and three or four months old, the ripe specimen being two years, but small for its age.

Scomber scobrus, the Mackerel.

Date.	Locality.	No.	Length.		Weight.		Age.
			Centimetres.	Inches.	Grammes.	Ounces.	
1891 Sept. 30	East side of Plymouth Sound on a whiffing line	1	13·8	5·4	—	—	1 year and 2 months.
Oct. 5	Outside Sound, whiffing lines	4	18, 22·6, 21·9, 25·6	7·1, 8·9, 8·6, 10·1	—	—	1 year and 3 or 4 months.

Date.	Locality.	No.	Length.		Weight.		Age.
			Centimetres.	Inches.	Grammes.	Ounces.	
1891							
Nov. 3	Anchovy nets, 1 mile outside Mewstone	5	15·9 to 19·5	6·3 to 7·7	24·0 to 48·9	·8 to 1·7	1 year and 4 months.
Nov. 4	Anchovy nets, off Rame Head	6	16·7 to 20·7	6·6 to 8·2	—	—	„
Nov. 5	Anchovy nets, off Bigbury Bay	33	15·1 to 21·0	5·9 to 8·3	—	—	„
Nov. 16	Anchovy nets, south of the Eddystone	1	19·8	7·8	—	—	„
Nov. 23	Anchovy nets, off Rame Head	4	17·1 to 18·5	6·7 to 7·3	—	—	„
June 10	8 miles outside Eddystone, whiffing	7	22·2 to 23·5, one 26·3	8·7 to 9·3, 10·3	85 to 106·3, 134·5	3 to 3¾, 4¾	1 year. 2 years.
June 23	Mackerel nets, 20 to 30 miles south of Eddystone	5	29·5 to 32·8,	11·6 to 12·9,	163 to 255·1,	7¼ to 9,	2 years.
		1	42·5	16·7	524·4	18½	3 years.
May 27	Off Looe Island	2	30·5, 31·3	12, 12½	205·5 to 230·3	7¼, 8⅛	2 years.
May 27	80 miles south-west of Penzance	2	43·2, 44·5	17, 17½	673·3 to 683·9	23¾, 24⅛	3 or 4 years.

The spawning period of the mackerel in the vicinity of Plymouth lasts from the middle of May to the end of July, these being its extreme limits. As there is no difficulty in obtaining any number of mackerel during the spawning time, the fish being taken for the market in large numbers in the ripe condition, the evidence available for the determination of the period is abundant. It would be expected that the age of young mackerel could easily be reckoned from such a short and definite spawning season. But I have not found it very easy up to the present time. More abundant data will require to be collected before the question can be satisfactorily answered. In the meantime the few observations in the above table are sufficiently interesting to be recorded, and from them a probable rate of growth can be deduced which may be tested by future observations.

The specimens of the entry for June 23rd in the table were selected by myself on board a mackerel boat. The boat sailed from Plymouth on June 20th, but the nets were not shot that night because there was not wind enough to enable us to get as far as was necessary. During the whole of the next day we were sailing under a light breeze catching mackerel by hook on whiffing lines. We took 150 in this manner, the bait being a slice from the silvery belly or tail of a mackerel already caught. Some of these mackerel were rather small, but the majority were large, and the great

majority were ripe males ; there was not a single ripe female among them, but a few unripe. It may be concluded from this that the males continue feeding when ripe, but the females do not. In the evening we shot the drift-nets, and, on hauling them next morning, got about 150 mackerel, among which were many ripe and many spent. The males were more numerous than the females in this lot also. Of the seven I took for examination six were selected as the smallest of the catch, and the other as a specimen of the larger sort. The condition and dimensions of these specimens were—

Small female, ovaries undeveloped	27·4 cm.	...	5¾ oz.
Small ripe female	29·5 „	...	7¼ „
Small ripe male	30·3 „	...	7¾ „
Nearly ripe female	31·0 „	...	8½ „
Small ripe male	31·3 „	...	8¼ „
„ „	32·8 „	...	9 „
Large ripe male	42·5 „	...	1 lb. 2½ oz.

Thus the smallest ripe female taken on this occasion was 29·5 cm. long (11·6 inches) and 7¼ oz. in weight. The female of 5¾ oz. was not shotten and apparently would not have spawned that season, the ovaries being quite undeveloped. The first question to be considered is, assuming about 11 inches to be the length of the smallest mature female, whether this size is usually reached in one year. We have no reason at present to suppose that the mackerel reaches maturity more rapidly than the herring, and I have, therefore, estimated the age of these mackerel, 29·5 cm. to 32·8 cm. in length, at two years. On June 10th, during the spawning period, six specimens were taken of 22·2 to 23·5 cm. in length, and whose weight did not exceed 3¾ oz. These must have been one year old at least ; they showed no signs of sexual maturity, and I have provisionally estimated their age at one year only. Then we have the specimens taken in the anchovy nets in November. I was at first inclined to conclude that these came from the spawning of the previous June or July. But this would make the growth extraordinarily rapid. Mr. Dunn, of Mevagissey, has seen young mackerel of this size in November, and it is his opinion that they are only five months old. The account of the growth given by Day, on Dunn's authority, is that the young are plentiful in the bays in August and September, when they are about 3 inches long, reaching 6 or 7 inches in November ; then they leave for the deep sea and reappear the following June, when they are 8 or 9 inches long. According to this reasoning they would increase 3 or 4 inches in length in the two months October and November, and only 2 inches in the seven months between November and June. This is manifestly improbable, and there are various considerations to support the con-

clusion that these young mackerel of November are really more than a year old, and are derived from the spawning not of the immediately preceding summer but of the previous year. I have shown that the scad (*Caranx trachurus*), which I believe spawns about the same time as the mackerel, is only 2·5 to 3·5 cm. long in September (see my previous paper). The herring is only 8 to 9 cm. long in November when spawned in April or May: the adult mackerel is about six inches longer than the adult herring, and therefore there is no reason to believe that it grows to twice the length in less time.

But the question arises, if these mackerel 16 to 21 cm. are sixteen months old, how can others taken in June and 22 to 23 cm. long be only a year old? The answer to which is, I think, that there is considerable individual variation in size. It it clear that the single specimen, taken at the end of September and measuring 13·8 cm., could not have reached that length in two or three months, and it must have been an unusually small specimen at fourteen months old.

I hope to test and confirm these conclusions this summer by following the growth of the mackerel fry from the hatching time onwards. Hitherto, mackerel fry from a few weeks upwards have not been taken, but by the use of a large and suitable net we may succeed in capturing them.

In the early summer the smaller mackerel, those I conclude to be two years old, are found near the coast, while the larger fish are caught out in the open sea. Thus in May last year Plymouth boats were catching mackerel of 12 or 13 inches in length, and about ½ lb. in weight, off Looe Island on the Cornish coast, while the large Lowestoft boats were bringing in huge mackerel up to more than 1½ lbs. in weight from off Ushant and eighty miles south-west of Penzance.

Clupea harengus, the Herring.

I have not had many opportunities of studying the growth of the herring, but have thought it would be useful to give an inclusive summary of the evidence which has been recorded by others on the subject. The question has been carefully and successfully investigated by H. A. Meyer, in the Baltic. There is a paper by this observer in the *Jahresbericht* of the *Commission zur Untersuchung der deutschen Meere*, for 1874–75–76, published in 1878. The paper is entitled *Observations on the Growth of the Herring in the Western Part of the Baltic.* Before Meyer's work various contradictory opinions had been expressed concerning the growth of the herring. For instance, the English Royal Commission of 1862, whose report was published in 1863 (*Commission on the Operation of the*

Acts relating to Trawling for Herring on the Coasts of Scotland), say that there is reason in Messrs. Yarrell and Mitchell's supposition that herring attain to full size and maturity in eighteen months, but there is no good evidence against the supposition that it reaches its spawning condition in one year. The Commissioners argue that the egg of the herring is hatched in two or three weeks, and that the young attain 3 inches in length in six or seven weeks after hatching, and that in nine months more they would reach 10 or 11 inches in length. In any case eighteen months is to be regarded as the maximum time required by the herring to reach maturity.

Axel Boeck, on the other hand, the Norwegian naturalist, concluded that mature herring were not less than three or more than four years old.

Meyer states that the spawning of spring herring in the Schlei begins in March, but takes place principally in April and May. At the end of May, 1874, he found in the Great Belt near Schleswig many larvæ 2·5 to 2·9 cm. long, on the 10th June 3·3 cm., and on 23rd June 4·3 cm. long. Likewise on 10th June, 1876, he captured larvæ up to 3·8 cm. long, but the majority were only 2·5 to 2·8 cm. If the longest of these came from eggs shed in March they could not be more than three months old, which would give an increase of 1·3 cm. per month. But the majority 2·5 to 2·3 cm. long observed on the 10th June could not be more than six weeks old, which gives an increase of 1·7 to 1·8 cm. for the month.

After about two months of age the herring changes from a transparent elongated larva without scales, and very different in appearance to the adult herring, to the permanent form of the adult. The metamorphosed young are much deeper and thicker in proportion to their length than the younger larvæ. The change of form and acquisition of the silvery livery takes place in the Schlei in July, and by the end of that month the greater number of the spring brood have passed the intermediate stage; they are then 4·5 to 5·5 cm. long. This process of change and the growth during it were watched in specimens kept in captivity in a floating box, the specimens grew from 2·5 to 2·8 cm. on the 11th June to 4·5 to 4·6 cm. on 1st August. At this length they were fully scaled.

In July and August larger young herrings of 7 to 9 cm. long (2·5 to 3·7 inches) are found mixed with the smaller, and evidently come from an earlier spawning. It is certain that the young from the spring spawning, mostly 6·0 to 7·0 cm. in length, leave the Schlei for the Baltic at the end of August and beginning of September. From this time on these young fish show themselves in numbers in all the bays of the Western Baltic, but mixed with another generation of somewhat larger fish, from which they are

separated by no evident limit. Meyer, therefore, measured the growth by taking the lengths of the smallest fish in each catch. Thus the growth of the smallest fish is shown by the following figures:

14th November, 1876	8·4 cm.	3·3 in.
End of November, 1876	9·0 „	3·5 „
End of December, 1876	10·0 „	3·9 „
End of January, 1877	11·0 „	4·3 „
End of February, 1877	11·4 „	4·5 „
End of March, 1877	13·5 „	4·9 „
End of April, 1877	13·8 „	5·4 „

This gives an increase of 1·0 cm. per month, but of course, since the variation in size of fishes of the same age is considerable, the mean growth of the young from the spring spawning was somewhat greater. Two rearing experiments made by Meyer for comparison gave a mean result of 1·07 and 1·1 cm. per month respectively; the experiments lasted four and a half and three months respectively.

Concerning the autumn herring, which spawns in the open sea in September and October, Meyer has no very conclusive observations, but the evidence he has indicates that the growth of these is equal to or rather greater in one year than that of the spring herring, the adults being somewhat larger than in the case of the latter. He points out that some herring spawn later than October, even as late as December, so that it is impossible to separate the broods with certainty. He also remarks that the spring herring, between six months and a year old, are not definitely separated in size from the smallest autumn herring of the preceding autumn; and as he took the smallest specimens only for his measurements, we must conclude that the average size of spring herrings at one year old is greater than 5·4 inches; we may, perhaps, put the average size at 6 to 6½ inches, and the maximum at 7.

Meyer proceeds to discuss the amount of growth in the second year, and the age at which puberty is attained in the herring. In his collection, the smallest ripe herrings were 20 cm. long (7·9 inches) while those of 21 to 22 cm., were not rare. Ljungmann states that some herrings off the coast of Sweden are ripe at 17·5 or even 16 cm. length. Meyer argues that, taking 20 cm. as the limit, the year-old fish have only 6 or 7 cm. to add to their length in order to reach it. But he regards it as impossible that the young of the spring-spawning herring should become autumn-spawning herring or *vice versâ*, and since the majority of the herrings which spawn for the first time are more than 20 cm. long, he believes they spawn first at two years old. Meyer does not mention the consideration that an increase of half the total length may, and generally does

mean a doubling of the weight; unfortunately the weight of the fish does not enter into his calculations, but I have no doubt he is perfectly right in his conclusion.

In another paper published separately in octavo in 1878, under the title "Biological Observations made in the Artificial Rearing of Herring of the Western Baltic," Meyer records the increase in size of some larval herrings which were hatched in captivity and kept alive till they were five months old. Some increase in length took place in the first two days, when the largest larvæ measured 9·2 to 9·3 mm. After the eleventh day the number of the larvæ began to be diminished rapidly by death, and the growth was retarded. On the forty-seventh day after fertilization, the young fish measured only 1·2 cm., while according to the observations of the free specimens in the Schlei the length should have been 1·7 cm. The water was now supplied unfiltered and abounding in Copepoda and other small pelagic animals, whereupon the young fish began to grow with very great rapidity, and at the end of five months were as large as their free-living brethren in the Schlei. The lengths observed in the free and the captive specimens were as follows:

Age from fertilization of the eggs.		Length of fry living free in the Schlei.		Length of herrings reared in captivity from Schlei eggs.
1 month	...	1·7—1·8 cm.	...	—
2 months	...	3·4—3·6 „	...	1·7—1·9 cm.
3 „	...	4·5—5·0 „	...	3·0—3·5 „
4 „	...	5·5—6·1 „	...	4·8—5·4 „
5 „	...	6·5—7·2 „	...	6·5—7·0 „

Thus it will be seen that the young fish in captivity, when they obtained suitable food in abundance, made up for lost time, and at the end of five months were as large as the fish living under natural conditions. From the remarkable rapidity with which these young herrings, after being stunted for a time by want of nourishment, caught up in growth with the free-living fish of the same age, Meyer draws the conclusion that the rate of growth in the herring depends largely on the quantity of food available, and as the latter must be greater in summer than in winter, the rate of growth of the fish must vary at different seasons of the year and in different years, so that only an average rate of growth can be determined.

At Plymouth I have only once seen a number of half-grown herring captured. This was on May 16th, 1889, when I watched a ground-seine being hauled on the south shore of the Cattewater. Some hundreds of herring were brought on shore, and I secured a sample of twenty-four, which measured 11 to 14 cm. (4·3 to 5·5 inches) in length. Now the spawning of herring at Plymouth takes place principally in Bigbury Bay in January and February. I

have observed the evidence of this in ripe and spent herrings brought to market almost every year, but paid particular attention to it in 1888 and 1889. In 1888 I found the spawning continued to the middle of March, and on April 9th, 1891, I examined six ripe herring taken eight miles off Dodman Point in Cornwall, and sent to the Laboratory by Mr. Dunn. In these last specimens the ovaries were burst and the eggs dead in the body-cavity. Mr. Dunn thought that the oviducts were obstructed, and that the eggs had died during the life of the fish, but the condition observed might have been merely due to rough handling at capture. In any case this is an indication that some herrings are spawning on the south-west coast in April, and others may be spawning in May. On the other hand, I have met with no indication whatever that there are any herrings spawning on our south-west coast in autumn. I can only conclude that the herrings above mentioned taken in May were about one year old, though the smallest, 11 cm. long, are smaller than the smallest found by Meyer to be one year old.

In September and October 1890, Professor Weldon measured a number of herring brought to the Laboratory, and taken in seines in the Cattewater and Hamoaze. The total lengths were—

From Cattewater in September, twenty-three specimens measured 17·5 to 21·8 cm. (6·9 to 8·6 inches).

From Hamoaze on October 10th, eleven specimens measured 19·4 to 27·7 cm. (7·6 to 10·9 inches).

From Hamoaze October 14th, thirty-two specimens measured 12·8 to 21·8 cm. (5·0 to 8·6 inches).

There is here a great range in size; it is possible that the smallest, those 5 inches long, were only nine months old, having been hatched in the preceding January, and that the largest, about 26 or 27 cm. long, were in their third year. But I think it is almost certain that the majority, ranging from 19 to 23 cm. in length, were one and three quarter years old, and would complete their two years in the following spawning season, January to March.

These herrings taken in Hamoaze and Cattewater are locally known as habour herring; but adult herrings of a considerable range in size occur in great abundance in Plymouth Sound every autumn and winter, though they always leave the Sound for the open coast before spawning. I see no reason at present to suppose that the herring which ascend the estuaries are of a different race from those which remain in the Sound, although perhaps the younger individuals penetrate further into brackish water than the older.

It is of considerable interest to study the records published in the Reports of the Scottish Fishery Board of young herring taken in

the sprat and whitebait fisheries, in relation to the conclusions summarised above as to the rate of growth of herring in the Baltic. These records were collected for an entirely different purpose, namely, to ascertain the destruction of herring fry entailed by the fisheries mentioned, but they afford valuable evidence on the growth and distribution of young herring. The first of the papers to which I refer is a *Report on the Sprat Fishing on the East Coast of Scotland in the winter of* 1883–84, by the late Mr. J. Duncan Matthews, Second Annual Report of the Fishery Board for Scotland. We find from this paper that in December, January, and February samples were taken at random from the fish taken by the sprat boats using "circle nets" in the Firth of Forth. Of 1671 fish examined in December, 12·8 per cent. were herrings $3\frac{1}{4}$ to $5\frac{1}{4}$ inches long, the percentage in the several samples ranging from 1·5 to 76·4. In January and February the percentage of herrings was considerably smaller, and the size a little greater, namely, from $3\frac{1}{2}$ to $5\frac{3}{4}$ inches. Now there is a thoroughly investigated spawning ground about the Isle of May at the mouth of the Firth of Forth, where herrings spawn every year from the end of January to the end of March, or even later. It is obvious that the size of the largest of the young herrings just mentioned agrees exactly with that of the Baltic spring herrings when one year old. But the question arises, are not the smallest, $3\frac{1}{4}$ inches, too small to be derived from the spring spawning in the Firth of Forth? If spawned in March then in December they would be nine months old, and the size of herring at nine months given by Meyer is 3·9 inches. The agreement is, therefore, very close, and we may conclude that the herring measured by Matthews were derived from the spawn shed at the Isle of May in the previous spring. The autumn spawning on the coast of Scotland takes place in August and September, and there is no great fishery at this time in the immediate neighbourhood of the Firth of Forth. Moreover, young herring hatched in August would be less than 3 inches long in December.

A similar examination with similar results was made of the sprat fishing in the Firth of Tay. The samples were taken in every month from November to February, from the fish captured by the fixed bag-net, and the percentage of young herrings in the samples varied from three to eighty. The herrings were between $3\frac{1}{4}$ and $5\frac{1}{2}$ inches in length. But we have no definite indication of spring spawning at the mouth of the Tay. It is possible enough that the young herring taken in the Tay were originally derived from the same spawning beds as those in the Forth, namely, the ground around the Isle of May. However, there is no doubt that herrings spawn in spring at various places along the east coast of Scotland,

as well as at the Isle of May, although except at the latter place observations on the subject are vague and indefinite.

We pass on now to another paper, namely, one by J. C. Ewart and J. Duncan Matthews in the Fourth Report of the Scottish Fishery Board, on the *Nature of Thames and Forth Whitebait*. The whitebait fishing in the Forth is not, from the present point of view, of great importance. The authors inform us that it is carried on in the Forth between Alloa and Kincardine in the winter months, and the fish captured vary very little in kind; 2600 specimens were examined in samples of about 200 each during December, January, and February, and 99½ per cent. of the whole number consisted of sprats, only about half a dozen herrings being found among them.

The results of the examination of Thames whitebait were very different. These results may be conveniently tabulated thus:

Month.	No. examined.	Percentage of herrings.	Length of herrings.
February	1400	7	Some under 2 inches.
March	1200	5	Some nearly 4 inches.
April	800	14	12 per cent. of the herrings under 1½ inches without scales.
May	600	30	40 per cent. of the herrings 2 inches long and completely scaled; 60 per cent. 1½ to 1¾ inches, and only partly scaled.
June	800	87	60 per cent. of the herrings were fully scaled and from 2 to 2¼ inches long; 40 per cent. 1 to 1½ inches, scaleless, or nearly so.
July	600	75	1½ to 2½ inches; 80 per cent. under 2 inches.
August	500	52	2 to 3 inches.

The remainder of the samples in every case consisted of course of young sprats, and with these I shall deal in discussing the growth of that species. The observations on the herring are extremely interesting and instructive, notwithstanding the fact that the observers were not attending to the question of the rate of growth, and have not therefore given as complete an account of the sizes and conditions as that question demands. The authors of the paper merely remark that the young herring would appear to be developed from spawn deposited during the spring months. We see from the above table that Ewart and Matthews place the limit of size between what we may call larval herring (those without scales and without the silvery livery) and the fully-developed herring at 2 inches, and this agrees with Meyer's observation that the fully-developed young fish were 1·8 to 2·2 inches long. The change is completed in the third month of age according to Meyer.

In February and March the number of larval herring was extremely small, the total number of herrings in a catch being 7 and

5 per cent. and only a few of these under 2 inches. The appearance of the fry can scarcely be said to have commenced, only a precocious individual or two having spawned. In April the fry just begin to appear, 14 per cent. herrings are caught, but only 12 per cent. *of these* are scaleless larvæ. These must have been one to two months old. The larger herrings, over 2 inches long, taken at this time we need not consider at present. In May we have 30 per cent. herrings and 60 per cent. of these are larvæ; that is, 18 per cent. of the total catch are larval herrings. In June we find that 34·8 per cent. of the total catch are larval herring. In July, according to the figures given, the number of larval herring is increased to 60 per cent. of the total catch, while in August there are no larval forms at all. I am obliged to conclude that there is a mistake in the figures for July; probably the number of larvæ declines in that month, and it ought to be "80 per cent. of the herrings caught were over two inches" instead of "under." Making this correction we find the larval herrings were 15 per cent. of the total catch.

If we write down the total number of young herrings under 3 inches, the number of scaleless forms, and the number of scaled forms, all as percentages of the total catch, side by side we get—

	Total number.	Larval forms.	Scaled forms.
April . . .	14	1·6	12·4
May . . .	30	18	12
June . . .	87	34·8	42·2
July . . .	75	60 (15)	15 (60)
August . . .	52	0	52

Assuming that the alteration I have made is correct we find that the number of larval herrings reached a maximum in June, and that these were almost entirely absent in April and August. It is not clear that the 12·4 per cent. of scaled herrings in April were not over 3 inches long and derived from some spawning in the previous year. Leaving these aside, therefore, we find the scaled young under 3 inches long reach a maximum in July, and slightly decrease in August. But the latter decrease is doubtless only apparent, many of the larger individuals of this season's brood having changed their locality and being no longer caught in the whitebait nets.

If we had any reliable information concerning a spring spawning of herring at the mouth of the Thames, we could reckon from the time of this spawning the age of the herring fry taken as whitebait. But I have been unable to find anywhere any record of observations on the spawning of herring in this neighbourhood in spring. All that is stated in Holdsworth's work on Deep Sea Fishing and

Fishing Boats, and Day's History of British and Irish Fishes, is that the herring spawns at Ramsgate in October and November. I can, therefore, only assume the correctness of Meyer's conclusions as to the rate of growth, and from the size of the herring fry measured by Ewart and Matthews, calculate the period at which the spawning occurred from which they were derived.

The larval herring occurring in June were about two months old, some more and some less. This shows that the spawning took place most abundantly in April, while the larval forms taken in May and July must have come from spawn deposited in March and May. Thus all the eggs shed in March and April had become scaled young herrings over 2 inches long in July, constituting 60 per cent. of the catch of the stow-nets, while the 15 per cent. larval forms taken with them came from the last eggs of the season deposited in May. In August no larval forms still unmetamorphosed were left, all the young herrings had undergone their transformation from the naked transparent larval condition to the scaled silvery little fish similar to the adult herring except in size.

There must be then a spring spawning of herrings somewhere near the mouth of the Thames, taking place in March, April, and May. The larger young herring taken in March and April are probably derived from the autumn spawning which takes place off Ramsgate in October and November. Now if we take October as the principal month of the autumn spawning, it is just six months from that month to April, the principal month of the spring spawning, which is a confirmation of the conclusions we have drawn as to the occurrence of the latter. It is surprising that no direct observations have ever been made on this spring spawning of herrings at the mouth of the Thames.

Clupea sprattus, the Sprat.

The character of the spawn of the sprat, and the period at which spawning takes place, have been determined in several localities by direct observation, and there are also a certain number of observations on record from which we may draw some conclusions as to the rate of growth of the species.

The paper on *Whitebait,* by Messrs. Ewart and Matthews, so largely used in the previous discussion of the growth of the herring, also supplies valuable observations on young sprats; 2600 specimens of whitebait procured from the Firth of Forth, between Alloa and Kincardine, in December, January, and February, consisted almost entirely (99½ per cent.) of young sprats measuring 1⅜ to 2¾ inches in length. The authors themselves point out that in a previous

paper, Matthews had published evidence concerning the spawning season of the sprat which would make these whitebait sprats six to eight months old. These authors do not always bear in mind that the spawning season of the sprat may differ in different places, but Matthews states in the earlier paper (*Sprat-fishing*, Second Report, Scottish Fishery Board), that he received ripe sprats from Stonehaven, Girvan, and the Firth of Forth only in May and June. I myself took the pelagic eggs of the sprat in the lower part of the Firth of Forth in May and June. Thus we have in this case, the maximum growth of the sprat, that of one spawned in June, and measuring $2\frac{3}{4}$ inches in the following December, $2\frac{3}{4}$ inches in six months, and the minimum, that of one spawned in May, and measuring $1\frac{3}{4}$ inches in the following February, $1\frac{3}{4}$ inches in nine months. The authors do not give separate measurements for the separate months of observation. If we take the mean, both of time and size, we have a length of $2\frac{1}{16}$ inches at seven and a half months of age; and the paper itself states that over 70 per cent. of the sprats examined were from 2 to $2\frac{1}{4}$ inches. The herring at seven and a half months, according to Meyer's results, measures about $3\frac{1}{2}$ inches.

The observations on the sprats in the Thames whitebait are mor detailed, though by no means so much so as the present subject requires. I have tabulated them as follows:

Month.	Total.	Percentage of sprats.	Size of sprats.
February ...	1400	93 ...	2 to 3 inches.
March ...	1200	95 ...	2 to $2\frac{1}{2}$ inches.
April ...	800	86 ...	2 inches average.
May ...	600	70 ...	$2\frac{1}{2}$ inches.
June ...	800	13 ...	1 to $2\frac{1}{4}$ inches, the smaller without scales.
July ...	600	25 ...	8 per cent. of the sprats under $1\frac{1}{4}$ inches, without scales.
August ...	500	48 ...	1 to $1\frac{1}{2}$ inches.

The number of small scaleless sprats gradually increased during the last month, until 90 per cent. of the samples consisted of these.

The young sprat undergoes a metamorphosis from the naked larval form to the silvery scaled form like the herring, and we see that the young larvæ which began to appear in the Thames in June reached 8 per cent. of the total number of sprats in July, and 90 per cent. of "the samples" in August. It seems as if the total catch was meant by the latter expression, but the meaning may be,

as seems more probable, that 90 per cent. of the sprats alone were young larval forms. We may, I think without much error, assume that the larval sprats were about two months old, as in the case of the herring, and it follows that the spawning of the sprats took place chiefly in June, but occurred also in April and May. I do not know at present to what extent the larger fish are separated from the total catch of the stow-nets before the whitebait are sent to market. But at any rate we know of only one spawning season for sprats, which extends over three or four months, and, therefore, the sprats taken in February, measuring 2 to 3 inches, were doubtless spawned between April and June in the previous year. Thus they were seven to ten months old. Again we may reasonably argue that the sprats taken in April and May before the larvæ of the season had begun to appear, were derived from the previous year's spawning, and were, therefore, about one year old, so that the average size of year-old sprats is not much above 2½ inches. Unfortunately, the size of the year-old sprats taken in June and July is not given; those of 2¼ inches, taken in June must have been a year old, but larger ones may have been picked out before the samples of whitebait were taken. It is clear in any case that a great number of sprats do not exceed 2¼ to 2½ inches at the age of one year, but what the maximum growth may be is not determined.

My own observations on young sprats at Plymouth are not numerous; I have only obtained specimens on the following occasions:

November 21st, 1889, thirty-three specimens 5·5 to 6·6 cm. (2·2 to 2·6 inches) taken in shrimp-trawl in Cawsand Bay.

December 4th, 1889, four specimens, 5·7 to 6·2 cm. (2·2 to 2·4 inches) a sample from a large number killed in the Millbay Docks by blasting under water when I was present.

April 3rd, 1891, thirteen specimens, 8·5 to 9·8 cm. (3·3 to 3·8 inches), caught in a bucket from the side of a boat off Rame Head; sample from a much larger number.

At Plymouth the sprat commences to spawn at the end of January, and the floating ova are found in February, March, and April, so that I think the above specimens registered above were a little less and a little more than a year old respectively.

The only evidence at present available as to the size at which sprats become sexually mature is that of Matthews in his paper in the second Report of the Scottish Fishery Board. He states that of the sprats he obtained from the Forth, only one was 6 inches long, and only two or three 5½ inches, all those near maturity measuring 4 to 4½ inches. It appears, therefore, that small as the adult sprat is it does not reach its mature size in one year, that it is 4 inches

long or very nearly so before it begins to spawn, and does not exceed 3 inches when one year old. It is therefore a probable conclusion that, like the herring, the sprat begins to breed when it is two years old.

Pleuronectes microcephalus, the Merry-sole.

Mr. Holt gives 8 inches as the length of the smallest ripe female of this species obtained by him on the west coast of Ireland.

On March 30th, 1892, I measured two ripe females at Plymouth obtained from a trawler, their lengths were 20·8 and 22·8 cm., or 8·2 and 9·0 inches. The minimum size of mature females is about the same, therefore, on the south coast of England as on the west coast of Ireland. In my previous paper I recorded the length of the smallest ripe male, namely 6·4 inches.

Clupea pilchardus, the Pilchard.

In the preceding number of this Journal I discussed very briefly the early growth of the pilchard, while describing some young stages of the fish which I had taken in the tow-net. I have now to record some further evidence concerning the life-history of this species. Last summer small-meshed drift-nets were obtained for the purpose of the anchovy investigation, and when these were shot from time to time during the autumn and winter, besides other fish a considerable number of small pilchards were taken in them. For details as to nets see paper on *Experiments on the Relative Abundance of Anchovies off the South Coast of England* by Mr. Calderwood, in the present number, p. 10. The number and size of the pilchards taken at each shot of these nets in November and December 1891, and January 1892, are shown in the following table.

Date.	Locality.	Number.	Length.		Weight.	
			Centimetres.	Inches.	Grammes.	Ounces.
1891						
Nov. 3	1 mile south of Mewstone	507	13·0 to 16·2	5·1 to 6·4	14·2 to 30·5	·5 to 1·07
		40	18·3 to 22	7·2 to 8·7	59·6 to 84·8	2·09 to 2·9
Nov. 4	Off Rame Head	19	13·0 to 16·5	5·1 to 6·5	—	—
		7	17·8 to 21·6	7·0 to 8·5	—	—
Nov. 5	Bigbury Bay	188	13·0 to 16·2	5·1 to 6·4	—	—
Nov. 6	South of Mewstone	242	13·0 to 16·5	5·1 to 6·5	—	—
		26	20·8 to 24·5	8·2 to 9·6	—	—
Nov. 16	7 miles south of the Eddystone	114	13·0 to 15·5	5·1 to 6·1	—	—
Nov. 17	8 miles south-west of Start Point	49	13·9 to 15·4	5·5 to 6·0	—	—
		9	21·0 to 23·4	8·2 to 9·2	—	—
Nov. 19	10 miles south of Eddystone	8	As usual	—	—	—
		4	„	—	—	—

Date.	Locality.	Number	Length.		Weight.	
			Centimetres.	Inches,	Grammes.	Ounces.
1891						
Nov. 23	3 miles off Rame Head	1	13 cm.	5·1	—	—
		10	22·1 to 24·1	8·7 to 9·5	—	—
Nov. 24	West of the Eddystone	136	13·0 to 16·6	5·1 to 6·5	—	—
		6	18·4 to 20·2	7·2 to 7·9	—	—
		19	21·5 to 25·2	8·4 to 9·9	—	—
Nov. 27	6 miles off Looe	35	12·7 to 15·0	5·0 to 5·9	—	—
		9	20·9 to 22·8	8·2 to 8·9	—	—
Dec. 15	Whitsand Bay	2	13·9, 14·1	5·5	—	—
Dec. 16	South-east of Mewstone	8	13·5 to 14·4	5·3 to 5·6	—	—
		3	22·9 to 23·7	9·0 to 9·3	—	—
Dec. 17	Near Bolt Head	45	13·5 to 15·6	5·3 to 6·1	—	—
		18	Adult	—	—	—
Dec. 22	10 miles south-east of the Eddystone	13	13·8 to 16·2	5·4 to 6·4	—	—
		3	19·2 to 20·3	7·5 to 8·0	—	—
1892						
Jan. 12	14 miles south-south-east of Plymouth Sound	2	13·5, 13·6	5·3	—	—

As far as I have been able to discover, young pilchards 13 to 16 cm. in length have not been taken in recent years in any considerable numbers on the coast of Devon or Cornwall. There is a factory at Mevagissey where ordinary full-grown pilchards are preserved in oil and tinned in the same manner as French sardines, and Mr. Dunn, who has been for many years connected with this factory, assured me, not only that no such small pilchards had ever been prepared in the factory, but that a deliberate attempt had been made to procure such fish and had not succeeded. A seine of the kind used in the French sardine fishery was obtained from France and several trials made with it, but, instead of half-grown pilchards of the required size, only very young specimens 2 or 3 inches long were captured. Nevertheless it would seem, from the facts here recorded, that small pilchards in all respects similar to the French sardines are to be taken on the English coast.

It will be seen from the table that the young pilchards were most plentiful in November, and scarce in December and January, and that they were taken in considerable numbers in November from the Mewstone to a distance of seven miles south of the Eddystone. If there are any facts or considerations which serve to indicate with more or less probability the age of these young fish, we obtain some light on the question of the rate of growth of the pilchard. In previous papers in this Journal I have shown that the spawning period of the pilchard near Plymouth extends from June to October, but the spawning takes place principally in June, July, August, and September. Therefore the pilchards 13 to 16·5 cm. long in

November must have been either from two to five months old, having been hatched in the summer of the same year, or from fourteen to seventeen months old, having been hatched in the summer of the previous year. It is obvious that the pilchard could not reach a length of 13 cm. in two months, and we have observations on the growth of the young herring, and on the Mediterranean sardine at Marseilles, which show that it could not grow to such a size even in five or six months. Marion's conclusions concerning the sardine at Marseilles are quoted in my paper on the pilchard in the previous number of this Journal; he estimates the length of the year-old fish at 14 cm. I see no reason to suppose that the pilchard at Plymouth grows twice as fast as the sardine at Marseilles. Meyer, after a series of very careful and successful observations, found that the herring in the Baltic at five months old was 6·5 cm. to 7·2 cm. long, and we have no reason to think that the pilchard grows twice as fast as the herring. It is nearly certain, therefore, that the pilchards taken at Plymouth in November and measuring 13 to 16·5 cm. in length, were a little more than a year old, being derived from the spawn of the preceding year. But if this be so, where were the young pilchards derived from the spawn shed in the previous summer of the same year?

I had not seen any very young pilchards, that is specimens less than 13 cm. long, since July last when I took the stages described in the previous number of this Journal. At the end of October I was at Mevagissey and discussed the pilchard question with Mr. Dunn. He told me that young pilchards only 2 to 3 inches long were always on the coast between September and Christmas, and that he knew this because he found them at that period in the whitings' stomachs. He gave me several specimens measuring 5 to 8 cm. in length which he said were taken some years ago in a mackerel seine in September. At Plymouth in November I opened the stomachs of many whiting but found no young pilchards in them. But on opening the stomachs of some mackerel I found the kind of fish for which I was searching. On November 5th I opened twelve mackerel, 10 to 11 inches long, bought on the fish-quay; in one of these were two pilchards 6 and 8·5 cm. long which were sufficiently intact to be identified with certainty; in another was a pilchard 9 cm. long, while in two others were half-digested fish which were probably also young pilchards of similar size. On November 6th I opened thirty-three mackerel, in seven of which there was food in the stomach, in each case consisting of one or two more or less digested fish 5 to 7 cm. long, apparently pilchards. In one of these mackerel there were remnants of several fish in the condition of *poutines nues*, and these were certainly clupeoids and probably pilchards.

It is thus conclusively demonstrated that in November last, when the year-old pilchards were taken in our nets, the mackerel were feeding on younger pilchards 6 to 9 cm. in length (2·3 to 3·5 inches) which were derived from spawn shed the previous summer.

It seems probable that the pilchards which are 13 to 16 cm. long in November would reach the adult condition at a length of 20 or 22 cm. by the following summer, and would then breed for the first time. I have not yet definitely ascertained that pilchards do breed at the size just mentioned. I measured five ripe females in June, 1891, and they were from 23·7 to 24·8 cm. long, weighing from 5 to 5¾ oz. But probably if a large number of ripe specimens were measured many would be found to be less than 23 cm. long. I have measured samples of the ordinary adult pilchards taken for the market at various times of the year. For instance, in—

August, 1891, I measured fourteen specimens taken six or seven miles off shore in Whitsand Bay; eleven were females 21 cm. to 25·3 cm. long, in all of which the ovaries were small, and in many apparently recently emptied; the other three were males 21·3 and 21·4 cm. long.

November 3rd, 1891, I measured six specimens from a large catch taken off Plymouth Sound: they were 21 cm. to 22·5 cm. in length, two females, 4 males; the generative organs in all very small.

The largest pilchard I have seen was brought to me in December, 1890, and measured 27½ cm. = 11 inches in length; it weighed 8½ oz., and its generative organs were extremely small and rudimentary, as though it had become sterile from old age.

In my preceding paper on the pilchard in this Journal, and in an article in Nature, January 14, 1892, I have referred to Professor Pouchet's Reports on observations on the sardine made at Concarneau on the coast of Brittany. I propose here to give a more extensive account and criticism of Pouchet's records, comparing them with those I have made at Plymouth, in order to see if they confirm, supplement, or modify the conclusions I have suggested above as to the rate of growth. The records in question date from the year 1887, only a few scattered observations having been made before that time. I will give here a list of the publications in which these records are contained:

(1) *Rapport sur le Fonctionnement du Laboratoire de Concarneau en* 1887 *et sur la Sardine,* par M. G. Pouchet. Ministère de l'Instruction publique et des Beaux-Arts. Paris, Imprimerie Nationale, 1888.

(2) *Le Régime de la Sardine sur la Côte Océanique de France en* 1887, par M. G. Pouchet. Comptes Rendus, 20 February, 1888.

(3) *Rapport sur le Laboratoire de Concarneau en* 1888 *et sur la Sardine,* Journ. de l'Anat et de la Phys., 1889.

(4) *Sur la Croissance de la Sardine océanique,* Comptes Rendus, 29 July, 1889. Tome cix, No. 3.

(5) *La Question de la Sardine,* Revue Scientifique, 11 Juin, 1887.

(6) *Le Régime de la Sardine,* Revue Scientifique, 24 Août, 1889.

(7) *Rapport sur le Laboratoire de Concarneau en* 1889 *et sur la Sardine,* Journ. de l'Anat. et de la Phys., 1890.

(8) *Nouvelles observations sur la Sardine océanique,* Comptes Rendus, 7 Avril, 1891. Tome cxii.

In the first document in this list (1) we find in the general report the following argument:

Admitting that the *sardine de dérive* (*i. e.* the full-grown sardine, which is in all respects the same as the English pilchard), which is fished at the end of winter, is sometimes almost ready to spawn, it is impossible to admit that the *sardine de rogue,* which is taken during the following six or seven months, is derived from the spawning of these large sardines in the same year. Judging from the data furnished by Coste and others concerning the growth of the salmon and trout, and by H. A. Meyer as to the growth of the herring, we may in all probability attribute to the sardine an increase of 1 centimetre per month. Thus, the ordinary *sardine de rogue,* 10 to 12 centimetres long, would be about one year old.

Annexe E of this same report contains a tabular record of the results of the examination of sardines at Concarneau from May 8th to October 23rd, 1887. In this appendix no information is given concerning the limits of size or the general character of the whole catch for any particular day; each entry consists merely of the dimensions and other particulars of one or a few specimens examined at a certain date. From the 8th to the 26th of May inclusive, seventeen fish were examined; these were from 17·6 to 22·5 cm. in length; with the exception of one, the smallest, these were all adult sardines, and in some of them the generative organs were approaching maturity. The *sardine de rogue* had not yet made its appearance. On May 27th a specimen was 16·0 cm. long. In June four specimens are recorded, 14·8 to 16·8 cm. long, weighing from 25 to 42 grammes. In July fourteen specimens examined; two of these were adult, 18·2 to 20·5 cm. long; the rest were from 12·0 to 17·9 cm. On the 6th and 29th of August two very small specimens are recorded, measuring only 9·8 and about 10·5 cm.; the other nine examined this month were from 12·0 to 15·1 cm. Even the smallest of these, 9·8 cm. long, was probably too large to be derived from the same year's spawning, and represents the spawn shed late the preceding year. In September sixteen specimens

were examined; the lengths, when given, are from 13·5 to 17·0 cm., the weight from 9 grammes to 46 grammes. In October, of eighteen specimens examined two were adult, measuring 19·5 and 19·8 cm., of the rest the lengths are rarely given, but the weights are from 15 to 58 grams.

If we exclude from the above records the fish which I have specified as adult, and which are probably two years old, and also bear in mind that the spawning period of the pilchard extends from the end of May to the beginning of November at Concarneau, doubtless as at Plymouth, I think we may fairly conclude that the French *sardine de rogue,* measuring from 12 to 17 cm. in length, is the product of the previous year's spawning, and is about one year old.

In Appendix D of the same report, where a *résumé* of observations on the year's fishing is given by M. Bovier-Lapierre, the size of the fish being indicated only by weight, it is stated that the year 1887 was remarkable, firstly for the abundance of the fish, secondly for the constant mixture of fish of different sizes, thirdly for the small size of part of the fish.

In the paper (2) published in the Comptes Rendus a fact is mentioned which is not sufficiently indicated in the Report, namely, the appearance in great numbers at the commencement of June of sardines too small for the market, and weighing only three or four grammes. The length of these is unfortunately not stated, but can be calculated at 7 or 8 cm., so that these also were too large to be derived from the same year's spawning, and would seem to indicate merely a late spawning of the previous year.

The article in the Revue Scientifique, No. 5, in the list of Pouchet's papers contains nothing bearing upon the growth of the sardine beyond what I have noticed in the other two papers.

In the Report for 1888 (No. 3 in the list) we have voluminous documents on the sardine. As in the preceding Report we have actual measurements and details of a few sardines examined at short intervals during the season. The drift fishing was continued till May 29th, and was then succeeded by the fishing *à la rogue,* that is with cod-roe bait. The individuals examined at the Laboratory in April and May were nine in number; three of these were adult, 19·0 to 19·5 cm. in length (that is to say, were the *sardines de rogue* of the preceding year, and now nearly two years old). The rest were 10·7 to 14·0 cm. long, evidently the produce of the previous summer's spawning. In May measurements of several adult individuals are given (*sardines de dérive*), but there are also a few *sardines de rogue* measuring about 15·0 cm. The records for the rest of the summer are similar to those of the preceding year, the *sardines de rogue* varying from 14 to 16 or 17 cm. The general

characters of the fishery for the summer season are thus described: the fish appeared first at the south at Sables d'Olonne (May 9th), and then progressively at more northern centres, arriving at Douarnenez on June 10th. Similarly, the fishery terminated first in the south on October 10th, continuing in the north a month later. The dimensions of the fish were remarkably uniform, the diminution in size usually observed about July not having occurred in 1888. On the other hand, a slight increase in the average size, quite sensible and general, was observable from the commencement to the termination of the fishery. A peculiarity of the year was the absence of fish from the 1st to the 20th of July. Pouchet points out that the observations on individual sardines made in the Laboratory prove that the *sardine de rogue* is a young fish which has never spawned, nearly mature ovaries being found only in the *sardine de dérive*. He adds that unfortunately the incessant displacement of the *sardine de rogue*, and its final disappearance in autumn, deprive us of the principal elements necessary to approach the interesting problem of its rate of growth, and of the age of those which visit the French coast in summer. With this opinion I am unable to agree; it seems to me that although we cannot actually observe the increase in size in given individuals, or even a given shoal, yet since we know pretty accurately the extent of the spawning period, we can judge with sufficient certainty from which spawning season fish of a particular size taken at a particular period of the year are derived.

Neither in the Report for 1888 nor in that for 1887 are there any actual observations as to the range of size of the fish caught on particular days throughout the season, but only, as I have already mentioned, measurements of two or three specimens made several times a month. There is not even anything to indicate whether the individual fish selected represented the minimum, maximum, or average size of the fish caught. In this Report for 1888 a substitute is presented for the data to the absence of which I refer, namely, the records obtained by a sardine-curer of the average size of the fish used in each week, expressed by the number of fish required to fill a box of a certain size known in the trade as the *boîte d'un quart*, and measuring $12 \times 10 \times 2$ cm. These records extend over several years, and include several different fishing stations. In these tables the highest figures represent the smallest fish, because of course the smaller the fish the larger the number required to fill a box whose size is fixed. The actual size represented by the figures is not easy to ascertain with any certainty, but some approximation to it may be made by means of relations given by Pouchet.*

* Thus the weight of fish in a box is 123 grammes; this amount of fish when fresh

The character of the fishery, what Pouchet calls the *régime*, varies to a certain degree from year to year; but in the several places named, such as Quiberon, Kernevel, Concarneau, Douarnenez, there is considerable similarity in the same year. The size of the fish taken in different years at the same month varies, but usually the number to the box is ten to fourteen in July, and seven to eight in October. But the fishing begins in June, or the end of May, and the fish taken in these months is usually larger than that taken in July, giving only seven to nine to the box. The smaller fish which usually appears in July is called the *poisson de Juillet*. In some years the diminution in July is not observable, the fish gradually increasing in size from the beginning to the end of the season, and appearing to grow in size on the fishing ground. In other years again, for instance in 1887, extremely small fish, twenty to twenty-six to the box, made their appearance in September and October on the whole coast, with the exception of the Bay of Douarnenez, into which they did not penetrate.

I reproduce here the table of relations between the number of fish to the box and the weight of the single fish, as given by Pouchet, with an additional column showing approximately the corresponding length of the fish.

Number of sardines to the quarter box.	Weight of each sardine.	Corresponding length of sardine.
33—35	7·3 grams.	10·0 cm.
28—30	8·6 „	10·5 „
24—25	10·2 „	11·3 „
20	12·5 „	11·5 „
18	13·8 „	12·0 „
16	15·6 „	12·5 „
15	16·6 „	12·8 „
14	17·2 „	13·0 „
13	19·2 „	13·4 „
12	20·8 „	13·7 „
11	22·7 „	14·0 „
10	25·0 „	14·5 „
9	27·7 „	15·0 „
8	31·2 „	15·5 „
7	35·7 „	16·2 „
6	41·6 „	17·0 „
3	83·3 „	21·4 „

With these relations may be compared the actual lengths and

would weigh twice as much, or 250 grammes nearly. Therefore if we divide 250 by the number of fish to a box we get the average weight of a single fresh fish. For instance, 12 to a box means fish each of which weighs 20·8 grammes. Again, Pouchet gives a curve of the relation between the weight and length of the sardine based upon actual observations, and from this we find that a weight of 20·8 grammes correspond to a length of about 13·6 cm., a result which agrees with my own observations.

weights ascertained by myself from the specimens taken at Plymouth on November 3rd, 1891.

14·25 grms.	...	13·0 cm.	30·55 grms.	...	16·2 cm.
17·65 „	...	13·7 „	59·60 „	...	18·6 „
21·80 „	...	14·3 „	55·50 „	...	19·0 „
23·50 „	...	15·0 „	74·70 „	...	19·4 „
30·95 „	...	15·8 „	69·40 „	...	19·7 „
32·70 „	...	16·0 „	84·40 „	...	21·4 „
34·15 „	...	16·1 „	84·85 „	...	21·8 „

It will be seen that the differences between the proportions observed by me, and those taken from Pouchet, are not very great, the lengths in the latter being a little too small in proportion to the weight. However, we may take the lengths of the fish corresponding to the number to a box, as given above, to be approximately correct, and interpreting the annual records in Pouchet's reports by their means, we may try to discover what are the biological facts underlying the industrial statistics.

But before offering my own interpretations and criticisms, I must quote those of Pouchet himself, who devotes a special short appendix in the Report for 1888 (Annexe D) to the subject of the growth and the age of the sardine. Pouchet regards this question, as he regards all others concerning the life history of the sardine, from the most sceptical point of view possible, insisting that no calculation, without the observation regularly followed of the same individuals, can give us exact information concerning the growth of any species of animal, as the growth, whether in weight or length, may describe the most irregular curves. He refers to what he said in the previous Report, for 1887 as to the probability that the *sardine de rogue* is about one year old, that it has never spawned, and that from October onwards it begins to show indications of the development of the genital organs. He then discusses the apparent increase in size of the fish in the same locality, as shown by the industrial records. This gradual increase presents itself more frequently in the Bay of Douarnenez as though the fish which entered the bay remained there and grew ; but, on the other hand, sudden changes of size show that the fish even there very often depart and give place to new shoals. Pouchet takes the records of the years in which this gradual increase was most regular, and translating the figures into weight and lengths of individual fish, compares the results with one another, with the following results :

DOUARNENEZ, 1888.

15 to box to 9 to box.
16·6 grms. to 27 grms. = 11 grms.
12·5 cm. to 14·8 cm. = 2·3 cm.

} 15th August to 10th October. 56 days.

BELLE-ISLE, 1888.

15 to box to 8 to box.
16·6 grms. to 30 grms. = 14 grms.
12·5 cm. to 15·0 cm. = 2·5 cm.
} 10th September to 30th November. 81 days.

LE CROISIC, 1888.

12 to box to 9 to box.
20 grms. to 27 grms. = 7 grms.
14·0 cm. to 14·5 cm. = 0·5 cm.
} 15th August to 15th October. 61 days.

QUIBERON, 1884.

12 to box to 6 to box.
22 grms. to 40 grms. = 18 grms.
13·0 cm. to 17·7 cm. = 4·7 cm.
} 15th June to 21st September. 98 days.

KERNEVEL, 1869.

12 to box to 7 to box.
20 grms. to 34 grms. = 14 grms.
14·0 cm. to 16·5 cm. = 2·5 cm.
} 24th July to 22nd November. 121 days.

These are sufficient to show the irregularity of the results obtained in this way. I have copied the figures as given by Pouchet. Pouchet thinks that the growth of a pelagic species like the pilchard ought to be very uniform, because they inhabit water of uniform temperature, and their microscopic food is always sufficient. He thinks that the inequality of the above results must be due either to the character of the records from which they are derived, or to the fact that the differences of size in the records represent displacements of the fish and not the growth of stationary fish. There is doubtless much reason for this judgement, but I am sorry to be obliged to point out that the calculation of these results offered as samples is marred with serious errors. Thus, the period chosen at Belle Isle for 1888 is 10th September to 30th November, and it is said that the record for the latter day is eight fish to the box, whereas the table for 1888, from which the figures are taken, ends at November 14th, and gives no figures for November 30th, the figure 8 occurring on October 27th.

The figure 12 as the number per box at two places is translated into weight 20 grms., length 14·0 cm.; at another into weight 22 grms., length 13·0 cm., as though the length of the fish decreased as the weight increased. The lengths given as corresponding to the weights do not agree with the graphic on another page of the report.

Pouchet's industrial records occasionally show two features which are worthy of attention, namely, the appearance of smaller fish in July, and the appearance of still smaller specimens in September and October. This '*poisson de Juillet*' is represented by the figures 11 to 13, so that its size is 13·4 to 14·0 cm., and its weight 19·2 to 22·7 grms. Its occurrence is indicated by Pouchet in the

years 1873, 1874, 1875, 1876, and a trace of it in 1878, that is in five years only out of twenty-five of which he gives the "*régime.*" In the years in which it occurred the fish caught in June were 15 to 17 cm. long. But in many years, in which the diminution in July is not observable, the fish caught in June are no larger than the *poisson de Juillet;* for instance, in 1877, 1878, 1879, 1883, 1884. Such facts as these, it seems to me, are not surprising when we consider that the pilchard has a spawning period of five or six months, and that its movements are probably not regular. Probably fish 15 or 16 cm. long, caught in June, are fish hatched unusually early in the preceding season, while those of 13 to 14 cm. are produced from a later spawning. In some years the fish are throughout the season of unusually small size, and this may be due to a scarcity of food in the preceding winter. The very small fish occurring in 1887 in September and October were 11·0 to 11·5 cm. long, and probably were derived from eggs shed the preceding May and June, having grown unusually fast.

I quite agree with Pouchet that it is impossible to obtain from the industrial records satisfactory evidence of the actual increase in size of the sardine from the beginning to the end of the fishing season. The data we have to deal with, even when the calculations are arithmetically correct, as Pouchet's are not, are such distant approximations, and it is so evident that in most cases we are not comparing the average sizes of the same shoals, that no great importance can be attached to the difference in size shown between the fish in different months. All that can be said is that usually a difference of 2·5 to 3·5 cm. in length is the result of comparing the sizes of the fish given for July and October.

The subject of the nets used in the French fishery deserves some mention. Unfortunately Professor Pouchet does not give a complete account of them; but he states in one place that the mesh is measured by the length occupied by five knots, that is a length equal to four times the side of one mesh, and I find from the figures he gives that the mesh of the nets used varies from $\frac{4}{10}$ths to $\frac{6}{10}$ths of an inch. I gather that the nets here referred to are drift nets used with the bait or rogue, for it is stated that the fishermen change their nets to suit the varying size of the fish, which they would not need to do if they were using a suitable seine. Thus, some of the nets used in the French fishery have the same mesh as those we have been using at Plymouth. It must be remembered that Professor Pouchet only refers to the fish caught by the fishermen; he denies that there are ever any still smaller fish a few weeks or months old in the waters where the fishery is carried on, but as the nets used could not catch these smaller fish of 3 to 7 or

8 cm. in length the absence of the latter is of course not proved. Seines are also used in the French fishery, but not generally, and their introduction has given rise to a great deal of agitation, the majority of the fishermen with their usual conservatism asserting that the greater efficiency of the seines, which secure very large catches, upsets the regular working of the industrial organisation, and will lead to the extermination of the sardine.

In Pouchet's Report for 1889 we have the *régime* of the *sardine de rogue* for that year exhibited and discussed in the usual manner. The table of the season appears to be taken, like that for 1888, from the trade journal published at Nantes, and gives the average number of the fish per box for every day of the season. In the Report it is pointed out that the constant phenomena evident in this, as in all seasons, are—1st, that the fish is always smaller at the south of the fishing area, namely, towards Sables d'Olonne, than in the north towards Concarneau ; 2nd, that the fishing begins first in the south and extends progressively towards the northern stations, and ceases in the same order. Thus, the fishing commenced at Sables on May 3rd at Douarnenez on June 15th, was over at Sables on the 15th September, and on the coast of Finisterre continued till the 15th November.

The peculiar features of the season were the following :—Up to the 15th August the fish continued of the same dimensions, then on the coast of Finisterre very small fish came in, which might be regarded as the *poisson de Juillet*, appearing some weeks later than usual. These fish showed themselves from the south to the north progressively. If we look at the figures for Concarneau we find the size of the fish in July was 8 to 10, that is 14·5 to 15·5 cm. long, 25 to 31 grammes in weight. The small fish were taken only on three or four days in August, and were 26 to 30 to the box, that is about 8·6 grammes in weight, and 10·5 cm. long. Small as these seem to have been, and difficult as it is to judge of their real size by such an unsatisfactory method, it seems to me that they must have been derived from a late spawning of the previous year.

In this same Report Pouchet gives a complete record of his observations on the condition of the generative organs in the adult sardines, the chief result of which is that he found mature eggs only in specimens over 19 cm. in length, and only in April, 1890, and May, 1888.

In my endeavours above to deduce the age of the *sardines de rogue*, whose sizes are recorded by Pouchet, I have assumed that the spawning period at Concarneau is practically the same as at Plymouth. Pouchet's observations show that some pilchards spawn at Concarneau in April ; but they give no indication of summer or

autumn spawning. At Plymouth I have evidence that spawning goes on in every month from June to November inclusive; it may be that some pilchards spawn both at Concarneau and at Plymouth also in April and May, or it may be that spawning commences earlier in the Bay of Biscay than further north in the English Channel, or it may be that the individuals found to contain some mature ova by Pouchet, would not have actually spawned till near the end of May. In any case, we have at present no indication that there are two spawning periods, or more than one maximum and minimum of spawning activity in the species.

In the note in the Comptes Rendus of April, 1891, Pouchet merely summarises the results of the observations in his last report, which I have already reviewed. After studying the researches continued for several years at Concarneau, we cannot help being surprised that so much careful and systematic work should have contributed so little to the elucidation of the life-history of the sardine. The reasons for this failure are, it seems to me, of two kinds :—1st, the adoption by Professor Pouchet of preconceived ideas concerning the mode of life of the species, and the relation between this mode of life and the sardine fishery; 2nd, the employment of inadequate and unsuitable methods, and want of experience in the investigation of the history of marine fishes in general. I cannot help thinking that results of greater value would have been obtained if the actual weights and measurements had been ascertained in the Laboratory of large samples of the fish caught, if the *régime* of the fishery had been expressed in scientific rather than industrial terms. It seems also probable that if pelagic collecting had been carried on with sufficient frequency and suitable instruments in the summer off the French coast, the eggs and alevins of the pilchard would have been obtained in abundance in all stages.

However this may be, it is very desirable that the number and character of young pilchards occurring in the neighbourhood of Plymouth throughout the year should be ascertained, and for this purpose I have suggested that our small-meshed nets should be shot three or four times every month during the present season. It would be still better if we had a fleet of nets of various different meshes, so as to take fish of various sizes.

The position and extent of the region where the French sardine fishery and preserving industry are carried on are indicated in the map appended to this paper, in which the situation of all the localities mentioned can be seen at a glance.

Engraulis encrasicholus, the Anchovy.

The Dutch ichthyologist, C. K. Hoffmann,* when investigating the anchovy in the Zuyder Zee, captured a number of the young of this species at short intervals in August, September, and October. Their numbers and sizes were as follows :

Date.	Number.	Length.
Aug. 4	10	4·2—5·2 cm.
„ 8	9	3·2—5·5 „
„ 10	10	4·5—6·5 „
„ 12	9	4·5—6·5 „
„ 14	9	3·8—7·2 „
„ 19	6	5·5—7·0 „
„ 20	8	6·0—7·5 „
„ 22	7	6·0—8·0 „
„ 24	10	3·5—6·0 „
„ 25	7	5·5—7·0 „
„ 26	6	4·5—6·5 „
„ 27	6	5·5—8·0 „
„ 28	6	6·2—8·0 „
Sept. 4	6	7·0—10·0 cm.
„ 5	5	5·0—7·0 „
„ 8	8	5·5—7·5 „
„ 9	9	6·0—7·5 „
„ 10	7	6·0—8·5 „
„ 22	5	8·0—9·5 „
„ 24	6	7·0—9·5 „
„ 26	6	9·0—9·5 „
Oct. 9	8	7·0—9·0 „
„ 12	5	9·5—10·5 „
„ 14	6	8·5—11·0 „
„ 17	8	8·5—11·5 „
End	6	10·0—12·0 „

Hoffmann proceeds to state that the average length of the sexually mature spawning anchovy is 15 cm., but ripe specimens of only 13·0 to 13·5 cm. are not altogether rare. The conclusion which he draws from his observations, and which he emphasises by means of italics, is the following :—" The anchovy comes in shoals into the Zuyder Zee in order to spawn ; those which are not captured depart after spawning, except a few which remain behind. The young brood remain during the first months of their life in the Zuyder Zee ; they grow very fast, and at the end of October have already reached a length of 12 cm. ; then, and not till then, the young depart."

At the time when Hoffmann formed this conclusion the larval stage of the anchovy was unknown, and the fertilised eggs had not been seen. But Hoffmann had himself observed that the anchovies in the Zuyder Zee were sexually ripe in the latter half of June and in July. In the last week of July all the anchovies he obtained had just shed their spawn. He argues that temperature has a very great influence, not merely on the time of development of the eggs of fishes, but on their rate of growth, and that the anchovy grows very fast on account of the high summer temperature of the water of the Zuyder Zee. He refers to Meyer's result concerning the spring herring in the Baltic, namely, that the young hatched in April and May reach a length of 3·5 to 4·2 cm. in two or three months.

* *Bijdrage tot de kennis der levenswijze en der voortplanting van de ansjovis*, Verslag van den Staat der Nederlandsche Zeevisscherijen over 1885, Bijlage ii.

Ehrenbaum,* in a paper just published, has criticised Hoffmann's observations and conclusions, and shows that it is much more probable that the young anchovies examined and measured by the latter were in their second year. In this opinion I entirely agree with Ehrenbaum. We know now, from the researches of Wenckebach and others, carried out subsequently to Hoffmann's, that the anchovy spawns in the Zuyder Zee only in June and July, and we know that the herring does not commence its metamorphosis until it is two months old, when it is 3·4 to 3·6 cm. long. Without very clear evidence to the contrary, which Hoffmann did not obtain, we must suppose that the anchovy would commence its metamorphosis at the same age and a much smaller size, seeing that the adult anchovy is only about half the size of the herring. The anchovy larvæ of the year in the Zuyder Zee at the beginning of August would be only two to eight weeks old, and therefore still in the larval state, without scales, the oldest having a length of about 2·0 cm. Therefore, even the smallest of the specimens recorded by Hoffmann must have been a year old. According to Hoffmann's view the anchovy would reach in about four months the same length as the herring takes ten months to attain to, although the herring is so much the larger fish. Hoffmann's observations prove in fact conclusively the very opposite of the proposition he maintains, namely, that just after the spawning time of the anchovy, year-old specimens are obtained, which are incapable of reproduction, and even at the end of the following October these anchovies are smaller than the smallest mature individuals. Hence it is clear that the anchovy breeds for the first time like the herring and sprat and the flat-fishes, when it is two years old.

In 1890 a Report on the Zuyder Zee Fishery by Dr. P. P. C. Hoek was published by the Dutch *Collegie voor de Zeevisscherijen*, and a chapter of this Report is devoted to the fishes of the Zuyder Zee. This chapter, with slight modifications, was also published in English in the *Tijdschrift der Nederlandsche Dierkundige Vereeniging* for 1890. Somewhat to my surprise I find that Dr. Hoek accepts Hoffmann's conclusions concerning the growth of the anchovy. Hoek's observations were as follows:—On July 6th he took an anchovy larva of about 1·5 cm. in length. He does not say how the larva was identified, merely referring to its characteristic shape. The larva is evidently still without scales, at the stage when the permanent dorsal, caudal, and ventral (or anal) fins have recently been defined, and the primordial fin-membrane has disappeared. It is difficult to judge from the figure whether the permanent fin-rays have appeared,

* *Die Sardelle* (*Engraulis encrasicholus*, L.), Mittheilungen der Sektion für Küsten und Hochseefischerei der deutschen Fischerei Vereins, Jahrgang 1892.

or the temporary finer rays still remain. The figure shows the specimen in a somewhat shrunken condition. The stage of this specimen is somewhat earlier than that of the pilchard larva figured by me in Plate X, vol. ii, Part 2 of this Journal. This anchovy larva must have been not more than one month old, having been hatched in June. On September 19th Hoek obtained some small anchovies measuring 6·2 to 8·5 cm., and estimates their age at two and a half to three months, an age at which the herring measures 4·5 to 5·0 cm.

Hoffmann has also described specimens believed by him to be larvæ of the anchovy.* His identification was based on the fact that the number of the vertebræ was forty-eight. Günther gives the vertebræ in the sprat as forty-seven to forty-nine. Möbius and Heincke forty-six to fifty; the latter authors give the number in the anchovy as forty-six to forty-eight. Matthews found the number in the sprat to be forty-eight. But Hoffmann says he found always forty-nine to fifty vertebræ in the sprat in the Zuyder Zee, and forty-eight in the anchovy. The clupeoid larvæ he took were captured on July 27th to 31st, and varied in length from 16 to 30 mm. The smaller of these might easily have been anchovies hatched in June; that the largest were anchovies in much more doubtful; but even if they were, it would by no means prove that young anchovies hatched in June could reach a length of 8·0 cm. in August.

Reference has previously been made in this Journal† to Hoffmann's theory concerning the relation between the summer temperature of the air in the region of the Zuyder Zee and the variations in the annual catch of anchovies from that body of water. The theory is that an unusually warm summer in one year is followed by an unusually large catch of anchovies in the following year. The explanation of the supposed sequence is that the warm summer means a very abundant production of eggs and young larvæ of the anchovy; the high temperature ensures an abundance of food for the young fish, and also favours their healthy development and growth. The young thus survive in unusual abundance, to depart for the open sea in autumn and return in the following summer, and give rise to a successful fishery. It may be suspected that the theory itself owed its origin partly to Hoffmann's mistaken belief that the anchovy reached its adult size and condition in one year. That belief having been proved to be unfounded, some other explanation of the connection between summer temperature and fishery must be sought, supposing the connection really to exist. Ehrenbaum remarks that the theory is equally consistent with his own view that the young

* Verslag Nederlandsche Zeevisschereien over 1886, Bijlage iv.

† Vol. i, N. S., p. 334.

anchovies observed by Hoffmann were in their second year. This is to some extent true, for if we suppose that in a cold summer many of the yearling fish would be starved or killed by the cold, of course fewer would survive until the fishery of the following summer, when they would reach the adult condition. But in this case the temperature of the summer two years before the fishery would also have a great influence, since the fish would then be hatched and reared, and Hoffmann's theory only refers to the immediately preceding year. Ehrenbaum mentions that Dr. Hoek has come to conclusions unfavourable to Hoffmann's theory, having found that the exceptions to it are very numerous. In fact, if we examine Hoffmann's records we find that though the years in which the fishery has been unusually productive have always been preceded by an unusually warm summer, the unusually warm summers have by no means always been followed by an abundance of anchovies. For instance, in the years 1861 and 1884 there was no great difference in the summer temperature; both were above the mean, while in 1862 the catch was 9,413 ankers, and in 1885 104,275 ankers. In 1883 the temperature was much below the average, and in the following year the catch was 30,318 ankers. If we compare the magnitude of the catch with the temperature in the same summer we find that a high temperature is usually accompanied by a small catch, and a low temperature by a large catch, and this rule seems to have as few exceptions as Hoffmann's. On the whole, it seems clear that the conditions which determine the number of anchovies which enter the Zuyder Zee are more complicated than Hoffmann's theory supposes, and that much labour and ingenuity will still be required before their exact nature and influence are ascertained.

Clupea alosa and C. finta, the Shads.

My attention was directed to the rate of growth of the anchovy and the shads by the perusal of Ehrenbaum's paper on the anchovy, to which I have already referred. With regard to the anchovy, I am in complete agreement with him; but he seems to me, in correcting Hoffmann as to the growth of that species, to have fallen into an equal error in the opposite direction with regard to the shad. He says there is one clupeoid, namely, *Alosa vulgaris* and *finta* (why he calls these two, one, I do not know), which, according to Metzger and Hoek, grows about as fast as the anchovy according to Hoffmann. Metzger supposes that the shads hatched at the end of May reach in the first autumn a length of 6·0 to 10·0 cm. Hoek found at the end of July young shads which were 4·5 cm. long. Ehrenbaum

himself has taken in the Elbe young shad of the following dimensions :

Middle of August . . .	5·4—7·8 cm.
First week in October . .	6·9—8·6 „
Middle of October . . .	7·7—9·6 „
Middle of November . .	8·0—12·4 „

Ehrenbaum calls these specimens *Finten*, so that I suppose they were identified as *Clupea finta*. He says that Hoek has recently altered his former opinion, and now concludes that these young specimens, which have already reached the permanent form, that is, have finished their metamorphosis at the end of July, cannot be derived from the spawn of the same year, but are already a year old, and Ehrenbaum agrees with him. He goes on to state that in the summer of 1891 he observed the spawning of the *Finte* in the Elbe in the second half of May, and then obtained eggs with well-developed embryos, and also larvæ with large yolk-sacs. Towards the end of May he captured numerous larvæ of 8 to 9 mm. in length, which retained a trace of the yolk, and on the 17th June larvæ of 9 mm. to 1·4 cm. He obtained no more larvæ, but in August got the specimens above mentioned, which were taken in nets, and were already fully scaled and had the form of the adult. He concluded from this that the young larvæ hatched in the river migrate to the sea as soon as the yolk has been absorbed, only returning to the river in the following year, at the size mentioned. This conclusion is obviously erroneous. Supposing all the specimens to belong to the species *Clupea finta*, though it is not proved that they were not *Clupea alosa*, we have to consider what is the size of the former species when full grown. Day says it attains to 16 inches in length, so that it is somewhat larger than the herring. Meyer has shown that the spring herring spawned in April and May, have by the end of July for the most part completed their metamorphosis, and are then 4·5 to 5·5 cm. long. What is there then to prevent the shad spawned in May from completing its metamorphosis by the middle of August, and reaching a length of 5·4 to 7·8 cm.? The herring, according to Meyer, is 8·4 cm. long and upwards by the middle of November, and yet Ehrenbaum maintains that specimens of the twaite shad, a larger fish when full grown, which are 8·0 to 12·4 cm. long in November, are eighteen months old. He compares his observations on the shad with Hoffmann's on the anchovy, and concludes that the shad takes eighteen months to reach the same length that the anchovy reaches in seventeen, regardless of the fact that the adult anchovy is scarcely half the length, and much less than half the weight of the adult twaite shad.

The observations and conclusions of Metzger and Hoek, to which Ehrenbaum refers, are contained in a Report on the *Ankerkuil* and *Staalboomen* fishery of the Hollandsch Diep, and Haringvliet,* which names are applied to different portions of the broadest estuarine channel at the mouth of the Maas or Meuse. In the Report itself observations on the young of *Clupea alosa* and *Clupea finta* are recorded in separate tables.

The observations of young *C. alosa* are—

Date.	Number.	Length.
April 27, 1887 ...	15 ...	10 —11·6 cm.
„ 27, 1887 ...	25 ...	9 —12·5 „
May 18, 1887 ...	9 ...	8·8—11·4 „
June 18, 1886 ...	10 ...	11·5—13·5 „
„ 18, 1886 ...	8 ...	11·0—12·0 „
„ 21, 1886 ...	1 ...	25·5 „
„ 22, 1886 ...	4 ...	9·6—13·6 „
July 28, 1886 ...	1 ...	16·0 „
October 21, 1886 ...	8 ...	7·2— 8·0 „
„ 21, 1886 ...	7 ...	7·5— 9·3 „
„ 21, 1886 ...	20 ...	9·0—11·3 „
„ 21, 1886 ...	35 ...	9·0—14·3 „
„ 22—24, 1886 ...	3—25 ...	5·8— 8·7 „
„ 23—24, 1886 ...	5—9 ...	7·2—10·0 „

The figures in the table do not exactly agree with those mentioned in the text (p. 121), although they apparently refer to the same observations; the differences are not great, but sufficient to puzzle the reader. In the text it is mentioned that specimens of 3·5 to 3·8 cm. in length were taken on 22nd and 23rd of July, 1886, and these are not included in the table at all. It is stated that the shad enters the river in April and May, that it is believed to spawn in the higher parts of the Rhine and its tributaries, but that it is not known whether some individuals may possibly spawn in the lower part of the river. The time of spawning is not absolutely ascertained; according to Kröyer and Nilsson the spawning takes place in June and July; according to Day between the beginning of May and the middle of June. It seems to me likely enough that the spawning may be continued from the end of April until July. Metzger and Hoek state that 60 and 70 cm. is no uncommon length for the shad, that is 2 feet and upwards. In the Report proper, the authors conclude that the fish of 3·5 and 3·8 cm. taken at the end of July were from the spawn shed the same year, and were therefore about two months old. Those taken in November under 6·0 cm. long are also supposed to have been hatched in the

* Published separately and also as Supplementband II of the Tijdschrift der Nederlandsche Dierkundige Vereeniging. Leiden, 1888.

previous spring. I find that the German version of the Report is not always an accurate rendering of the Dutch. As I understand the latter, it says (p. 120) that like most of those taken in October, November, April, and May, so also those taken in June, 1886, were derived from the spawning of the year preceding that in which they were taken; that is, they were a year old or more. But the question is raised whether the fish of 7·2 cm. taken in October were of the same age as those 14·2 cm. taken in the same month.

My own opinion is that the specimens taken in April, May, and June, except the one 25·5 cm. long, were about a year old, having been hatched in the spring of the preceding year; but I cannot help thinking that these were all unusually small specimens, which had not reached the normal size of yearling shad. Hoek and Bottemane themselves estimate the age of specimens 25 to 31 cm. in length, taken in May, June, and July at two years, and, according to this specimen, one year old ought to be about 17 to 20 cm. in length. I consider that the specimens taken in October and November are all derived from the spawning of the spring of the same year, not, as the authors conclude, from the spawning of the preceding year.

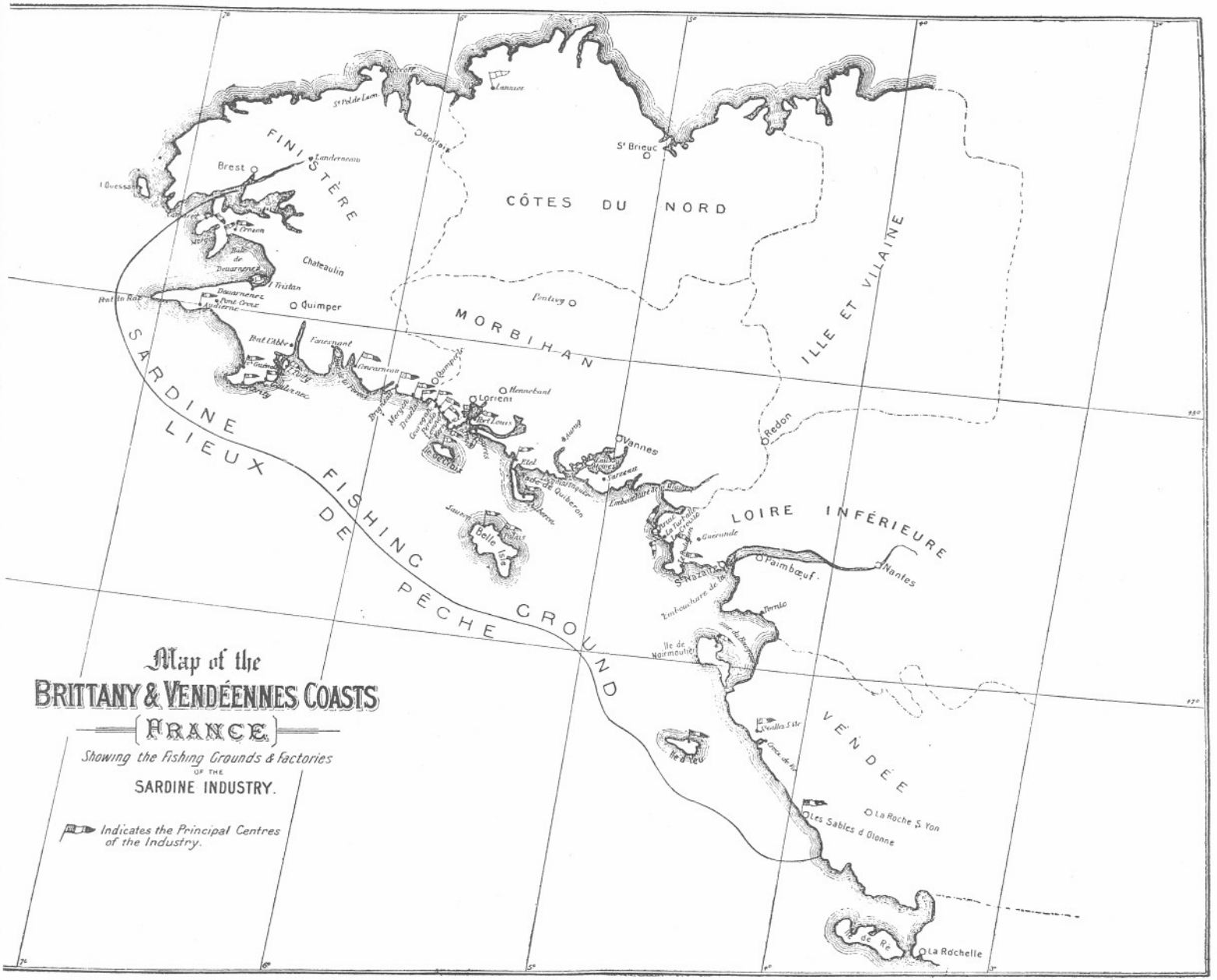
The observations on *Clupea finta* in the same Report are tabulated as follows:

April 27, 1887	...	93 specimens	... 8·9— 9·2 cm. long.
May 18, 1887	...	4 „	... 7·2— 8·4 „ „
June 18, 1886	...	8 „	... 7·7—10·0 „ „
„ 18, 1886	...	1 „	... 8·9 „ „
„ 18, 1886	...	3 „	... 9·7 „ „
„ 22, 1886	...	6 „	... 9·1—11·2 „ „
„ 22, 1886	...	13 „	... 10·5—12·0 „ „
October 4, 1886	...	5 „	... 9·0—11·5 „ „
„ 21, 1886	...	12 „	... 6·7— 8·9 „ „
„ 21, 1886	...	3 „	... 6·3— 8·7 „ „
„ 21, 1886	...	17 „	... 9·0—15·0 „ „
„ 21, 1886	...	18 „	... 10·0—12·3 „ „
„ 22—24, 1886	...	27 „	... 5·4—10·0 „ „
November 23—24, 1886	...	3—8 „	... 5·8—10·4 „ „

The special discussion of these observations is given in the Report proper. My own interpretation is that all those in the first of the two parts into which I have divided the table are from the spawning of the previous year, while of those in the second part of the table the greater number are from the spawning of the preceding spring of the year in which they were captured. The largest of those taken in October, those over 12 cm. in length, may very possibly be in their second year.

In an appendix to the report by Hoek, specially devoted to the fish larvæ and young fish observed, that zoologist gives reasons

which incline him to modify the opinion expressed in the Report proper concerning the age of young fish about 4·5 cm. long, which already had acquired the permanent form of the adult, and which were taken towards the end of July, 1886. The length of these fish is given in the body of the Report as 3·5 to 3·8 cm. Hoek argues that if the shad (*C. alosa*) spawns, as Kröyer and Nilsson say, in June and July, these fish must be a year old, and mentions in support of the latter conclusion that the sea-herring takes seven to nine months before it undergoes its metamorphosis from the larval form to that of the adult. This latter fact is taken by Hoek from the results of Meyer and Heincke, published in the Reports of the *Commission zur Untersuchung der deutschen Meere in Kiel.* But it seems to me that, in the first place, Hoek has somewhat exaggerated the statements of Meyer and Heincke. It is true that the latter observers found that some herring larvæ hatched in autumn and winter did not attain to the perfect form until June and July; but the German investigators do not suggest that the eggs from which these larvæ came were shed in October, but later in November and December; and Meyer further points out that the water is then very cold, and that the eggs take many weeks to hatch, so that the larvæ taken in June are more probably four or five months old, reckoning from the time of hatching, than seven to nine months. Another important consideration overlooked by Hoek is that these larvæ of the autumn, or sea-herring, are 5 to 6 cm. long before they have completed their metamorphosis, while the young shad to which Hoek refers had already attained to the perfect and permanent form at 4·5 cm. What probability is there that the young of so large a fish as the shad when 4·5 cm. long should be five to seven months older than the larva of a herring 5 to 6 cm. long? Then again the shad is hatched in spring in warm water, why then should its growth be compared with that of the winter herring, whose eggs and larvæ are produced at the coldest time of the year, rather than with the growth of the spring herring?



Map of the BRITTANY & VENDÉENNES COASTS (FRANCE)

Showing the fishing Grounds & factories OF THE SARDINE INDUSTRY.

Indicates the Principal Centres of the Industry.

On some Young Specimens of Centrolophus pompilus (Art.) from the Coast of Cornwall.

By

Ernest W. L. Holt.

On the 24th June, 1891, a mackerel boat, which had been fishing off the Runnistone, brought in several fish of the above species. They excited a good deal of interest among the local fishermen, to whom they were quite unknown. A coastguardsman, who had seen them abroad, I forget where, declared them to be "pilot-fish," a diagnosis with which some of the fishermen, to whom the true pilot-fish, *Naucrates ductor*, appeared to be known, could by no means agree. It appears, however, that from a certain similarity of habits the name is occasionally applied to the form before us, usually known to British naturalists as the black-fish.

I believe that about six or eight black-fish were brought ashore on this occasion, of which, by the kindness of Mr. J. C. James of Newlyn, I managed to secure four. They were all small specimens, the total lengths being $13\frac{3}{4}$ inches, $13\frac{1}{2}$ inches, $12\frac{5}{8}$ inches, and $12\frac{5}{8}$ inches. Before preserving them I examined the contents of their stomachs, which consisted of a considerable number of young pollack, about 3 inches long; in fact, the stomachs were quite distended with them. I also endeavoured to ascertain their sex, and concluded that they were all immature males. Hermaphroditism has been recorded by Syrski in this species (cf. Max Weber, U. Hermaph. b. Fischen. Ned. Tijdsch., Jaarg. v, 1884, p. 37),* but it does not appear whether this is a normal or abnormal condition.

The colouration of the black-fish appears to be highly variable. Couch draws special attention to this point, noting the difference between Risso's description of Mediterranean specimens and the condition in British examples that had come under the notice of himself and earlier observers. That this, however, is not wholly attributable to climatic influences, as Couch seems to have supposed, may be inferred from an examination of Bonaparte's figure (Faun,

* I am indebted to Prof. G. B. Howes for this reference.

Ital. Pesc.), in which the colours are shown nearly as dark as those met with in British specimens. Indeed, the colours in my own specimens bear a closer resemblance to those in Bonaparte's figure than to the condition described by Couch, and the dull neutral hue shown in his figure (British Fishes, vol. ii, pl. xc) is altogether wanting, though the example from which it was drawn was about the same size as my own. Of the uniform brown colour, stated by Day (Fish. Gt. Brit., vol. i, p. 112) to be usual in this species, there is no trace ; but Buckland's description is fairly applicable.

The following notes were taken before the fish were placed in spirit. In the two larger specimens the head is a very dark violet-grey above, minute lighter specks marking the muciferous pores ; between the eye and the upper jaw the colour is sapphire blue,* due to irridescence, with grey pores. Similarly, the under side of the head is blue, dark grey bands marking the course of the hyoid and the edge of the opercular membrane. The iris is white, speckled with grey, becoming yellowish towards its inner margin, and grey towards the circumference. The gill covers are dark violet-grey with lighter streaks. The body is a violet black along the dorsal region, shading very gradually to a silver grey ventrally, almost white on the ventral surface of the abdomen. Small ovoidal silver-grey flecks occur on the sides above and below the lateral line, most abundantly in the deepest region of the fish, *i. e.* at about the level of the commencement of the dorsal fin. In the largest of the two specimens these flecks are very faintly marked.

The dorsal fin is black, dotted with minute grey specks about the base, due to the fact that the scales covering this region are grey with black edges. No such conspicuously lighter band, as is shown in Day's figure (op. cit., pl. xl, fig. 2), occurs in any of my specimens. The base of the pectoral is grey, the distal region black. The pelvic has black rays, and a bluish-grey membrane. In the anal, the basal region is silver grey, shading into black at the distal margin.

The colours of the two smaller specimens agree generally with the above description, but are paler. In one, the greater part of the body below the lateral line is silver grey. There is no blue iridiscence on the cheeks of either, and the lower jaw is very pale and lacks the darker bands. The flecks on the sides are more plainly marked than in the larger specimens, and are probably of a transitory nature, disappearing as the fish increases in size. Day notes that these markings, which he describes as yellow, are absent in some specimens, but does not mention the sizes of the fish he

* Couch notes that whilst he was drawing his specimen the side on which it was laid turned to a fine blue.

examined. Risso speaks of young examples having dark transverse bands, so that it appears that, as is usual in fishes, there are several phases of colouration.

The records of the occurrence of the black-fish on the British coasts, as collated by Day, are pretty numerous, the greater number having come, like the specimens before us, from the coast of Cornwall; from the same authority we learn that its range extends southwards to Madeira, and into the Mediterranean, whilst it has occurred so far north as the coast of Northumberland.

Day quotes an interesting observation of Mr. Dunn, that of about a dozen taken near Mevagissey, every one could be traced to the neighbourhood of a large fish, generally a shark. The only shark that I heard of was a young thresher, *Alopias vulpes* (Gmel.), about 15 feet long, which was brought into Penzance a few days previously from the neighbourhood of the Scilly Islands, and exhibited in the market at a penny per head as a young whale. The Runnistone is no great distance from the Scillies, but six or eight black-fish seem rather a large escort for one shark, and it might be supposed that the habits of the thresher would render it a companion more lively than agreeable. It may be mentioned that the stomach of the thresher contained about a bucketful of pilchards.

Experiments on the Relative Abundance of Anchovies off the South Coast of England.

By

W. L. Calderwood,

Director of the Laboratory of the Marine Biological Association.

By a resolution of the Council of the Association, passed on the 25th March, 1891, it was determined to proceed as speedily as possible with the inquiry into the relative abundance of anchovies on the south coast of England.

Mr. Cunningham* had already drawn attention to the presence of anchovies, had described their specific characters and habits and recorded the various "takes" which had come more especially under his notice. It was shown that at Dover the sprat fishers captured very considerable numbers; that at Torquay, one fifth of the fish, taken in the sprat nets, consisted of anchovies, and that off Plymouth and the fishing ports of Cornwall the fish were already fairly well known.

Men fishing for pilchards, herrings, and mackerel, occasionally found anchovies entangled in their nets, and since no net was used of a mesh small enough to catch them in the proper manner, it was very naturally supposed that, given a net of the correct mesh, anchovies might be taken in such numbers that a regular fishery could be established.

On this account, therefore, the Council determined to make the experiment, and Mr. Cunningham and myself took the work on hand at once.

In order that we might have a thorough knowledge of the various methods employed in the capture of this fish in other countries, I wrote to Prof. Marion, of Marseilles, Señor Vale, of the Spanish Fishery Department, Madrid, and to Dr. Eisig, of Naples.

Mr. Cunningham had previously written to Dr. P. P. C. Hoek, of Helder, Zuyder Zee.

* *Anchovies in the English Channel*, Journal of the Marine Biological Association, vol. i (N.S.), pt. iii, p. 328.

In each case I received a most courteous reply giving all the information desired.

On the south of France the anchovy is fished in the same way as the sardine, by means of the drift-net. Each boat carries 200 fathoms of net made up of four pieces. Each piece or *band* is from 8 to 10 or 12 metres wide. The mesh varies slightly in each band, the largest being sixteen to the *pan* (a pan being equal to ·25 metres) the smallest—in which the anchovies are taken—eighteen to the pan. The net is shot at a great distance from the shore and the boat made fast to it as in this country. A net of this description costs 1200 francs (£50).

On the south coast of Spain anchovies are fished for in two ways, one a drift-net method similar to what has already been described, the other by using a seine-net worked in shallow water, the shoals of fish being surrounded and dragged on shore.

Signor Raffaele, writing from Naples, also describes a drift and a seine-net in use round the coasts of Italy and Sicily. The drift-net is 600 metres in length and 20 to 30 metres in height (say 656 × 26 yards). It is shot in a line parallel to the shore, and can be arranged at different depths, towards the surface at night and in the early morning, but at a greater depth during the heat of the day. It is composed of three pieces, and has a mesh varying from 1 to 2 cm.

The drift-net may therefore be considered the most important system in France, Spain, and Italy, the seine-net being used as a convenient method when a sandy shore exists.

Raffaele adds that pilchards are taken along with anchovies by the shore seine-nets of Italy.

In the Zuyder Zee, where the water is very shallow, three methods are used. A long net only about four feet deep, having the ends kept extended by means of poles, is moored in favourable localities. In order that it may maintain its proper position it is corked and leaded in the ordinary manner. Near Bergen op Zoom immense screens are constructed of willows and poplars. These appear to act similarly to leaders in a salmon bag-net, as openings at certain places allow of the anchovies being netted. Also a curious kind of trawl is used. The net is similar in shape to an otter-trawl or Thames stow-net. It is dragged along by two boats sailing a parallel course before the wind.

Considering the conditions existing in the south-west coast of England we decided upon the drift net as being the most likely to render good results, and, having received estimates for the making of an anchovy net, I ordered from Mr. Matthias Dunn, of Mevagissey, five nets, each to be 120 yards long and 30 score deep

= 60 fathoms × 5 fathoms, with sixty-four rows to the yard—bringing the mesh a trifle over half an inch.

Our whole net, then, was about 50 yards shorter than that described for the south of France by Prof. Marion, but was 30 feet deep, while the French net is only about 11 feet. When corked and leaded, complete, and ready for use the net cost £62 10*s*.

The order was given on the 12th May, 1891, and the net received on the 26th of August.

The autumn and summer seasons, as everyone knows, were extremely unsettled, and the long-continued gales often rendered fishing quite impossible for several weeks at a time. We, therefore, had a most unfortunate start in this our attempt to ascertain if it was possible to institute an entirely new fishery for England. For instance, on receiving reports that anchovies were seen off Mevagissey, in Cornwall, I sent a boat at once, but a gale springing up just before the destination was reached, the anchovies disappeared, and a week was spent lying wind-bound in harbour. During very many weeks the boat could not leave Plymouth on account of heavy weather, and often when the attempt was made it was found impossible to shoot the nets.

The first trial was made on the 4th of September, 1891, and the nets were finally taken on shore on 14th January, 1892. During that period the nets were shot twenty-two times. The results yielded considerable numbers of sprats, pilchards both large and small, a few mackerel and herring, but anchovies only in limited numbers.

That several shoals of anchovies were present I feel satisfied, on account of the numerous reports received, accompanied in many cases by specimens.

To aid us in determining the best localities, I put an advertisement up on the fish quay, asking that information might be given to the fishermen of the Association when anchovies had been seen or caught. In my record of the anchovy experiments I come upon many entries relating to reports of this kind, and after deducting a proper percentage for the somewhat large grain of salt with which almost every fishermen deems it necessary to flavour his remarks, I am inclined to come to the conclusion that, although our own fishing proved unsuccessful from a commercial point of view, there were nevertheless large shoals of anchovies off the coast of Devon. To take an extract from my diary :

"November 9th. Roach reports this morning that a boat fishing mackerel on Saturday night (7th) about twenty miles south of Salcombe, caught 20,000 mackerel, 1000 Acanthias, and was amongst anchovies in such numbers that a net to mesh them could not have

been taken on board. The skipper's remark was that 'you could have loaded a ship with them.'

"Received twenty anchovies from another boat, fishing a little further west." And again:

"November 21st. Mayflower out fishing four miles west of Eddystone. Took twenty anchovies large, ... using our nets. Boats fishing pilchards closer inshore took anchovies in considerable numbers. . . . . A boat fishing herring close to where our nets were shot took 100 anchovies."

An interesting point is the enormous size of the anchovies on our coasts. The following figures will suffice to give an idea of the large fish met with. It is the record of the catch in which our largest anchovy was taken, and I am not aware that any anchovy of such a size has ever been previously recorded.

The largest was $8\frac{1}{8}$ inches long and measured $3\frac{1}{4}$ inches in girth, the other measurements are in inches.

$7\frac{3}{8}$	...	$7\frac{1}{2}$	...	$6\frac{3}{8}$	...	$7\frac{1}{4}$
$7\frac{1}{2}$	...	7	...	$7\frac{3}{8}$	...	$7\frac{3}{8}$
$7\frac{1}{2}$	...	7	...	$7\frac{1}{2}$	...	
$7\frac{3}{4}$	...	$7\frac{3}{8}$	...	$7\frac{1}{8}$	...	
$6\frac{3}{4}$	...	$7\frac{3}{4}$	...	$7\frac{3}{8}$	...	

The smallest anchovy captured was about the size of those usually found in bottles and tins of the retail dealer; it measured a trifle over 5 inches ($5\frac{1}{10}$). The average size is $7\frac{1}{4}$, yet in the previous year so many were brought to the Laboratory measuring only 5 or $5\frac{1}{4}$ inches, that the average then must have been considerably less.

An interesting feature in the use of the small meshed nets was the capture of small pilchards or sardines. Mr. Cunningham has prepared a statement upon them which will be found in his paper in this number, under the title *Rate of Growth of some Sea Fishes* (Section *The Pilchard*, p. 244).

In reading this account of our endeavours it must be borne in mind that in a expanse of open sea like the English Channel, one boat with one net runs a comparatively poor chance of meeting with great success. Men fishing for herring or mackerel have the assistance, it may be, of three or four hundred crews in enabling them to find out where the fish are, and where they are not. We, on the other hand, were looking for fish which no one else was looking for, and had to grope in the dark. It appears, however, that November is the month during which most anchovies will be found off the coast of Devon and Cornwall, and as the autumn season arrives we shall hope to try again with greater success.

Report on Physical Investigations.

By

H. N. Dickson, F.R.S.E.

The unusually severe weather of the last eight months has made it impossible to continue the observations in the Channel with any degree of regularity; only two trips have been made since that in June, of which a preliminary report was published in the last number of the *Journal*. The first of these, in November, included station VIII of the previous cruise, off the Bill of Portland in mid-channel, and the previous stations XIII and XIV, in Start Bay, also station I off Bolt Head. Besides these, soundings were taken at an additional station in mid-channel, south of Start Bay, and at four points in Start Bay itself, near land. The cruise was unfortunately interrupted by a gale which necessitated taking shelter for thirty-six hours in Portland Roads.

The second trip was made on March 1st and 2nd, with the view of obtaining temperature observations as nearly as possible at the annual minimum. After sounding at stations I and XIV, and making an unsuccessful attempt at station XIII, we were again compelled to return to Plymouth by unfavourable weather.

As regards temperature observations, the additional data show that in November the distribution is extremely uniform, and in general the temperature is rather more than 2° F. warmer than in June. In March, again, the few observations obtained indicate a general fall of about 8° F. since November. In neither case was the abnormal distribution found in Start Bay in June reproduced (see previous paper, *Journal* M. B. A. ii, 2, p. 159) and its reappearance next summer may be looked for with interest, as it seems to suggest that in the western portion of the Bay, a large mass of water is partially cut off from the general circulation, and subjected to the heating action of the sun's rays without mechanical mixing.

During the cruise in November, sixteen samples of bottom and

surface water were collected. These have been subjected to the most careful examination of which the resources of the Laboratory will permit. The total halogen, calculated as chlorine, and the alkalinity of each sample has been determined, as well as the density both by Buchanan's hydrometer and the Sprengel tubes. The examination of these samples has shown that the water over the area under consideration is normal Atlantic water throughout. The mean value of "D" *i. e.* the ratio of the excess of density of sea-water at 0 °C. over that of distilled water at the same temperature, to the amount of chlorine in the sea-water, is 1·4553, with the limits 1·450 and 1·457, a result in complete accordance with the value found by Dr. Gibson for what he believed to be Atlantic water, contrasted with water from other areas, as for example the Arctic Ocean, which gave a markedly higher value. The close agreement of these determinations, made under considerable disadvantages, affords strong proof of the importance of a thorough examination by a chemical specialist of a limited number of samples of water from the great oceans of the globe. It seems possible to determine, once for all, the values of D for each of the great oceanic basins, and from these to ascertain at any time the source of supply of special currents in any particular area.

The chlorines of twenty-seven of the samples collected in June last were determined before the publication of the previous paper, but were not included in it, as it was then intended to make a series of density determinations with the Sprengel tubes. It was, however, found impossible to make these determinations, and a comparison was therefore made between the Sprengel tube determinations of the second series and the densities of the same samples as found by the hydrometer, reduced to 15·56° C. as compared with pure water at 4° C., and then again reduced to 0° C. and referred to pure water at 0° C., by the help of Dittmar's tables. The results thus calculated differed from the Sprengel-tube values by −0·00013, giving a correction almost identical with Dittmar's "hydrometer error." It would seem, however, that the numerical agreement is accidental, and these experiments have led to a more extended investigation at present in progress. Accepting the correction +0·00013 for the present, and applying it to the hydrometer determinations of the June samples, the mean value of D is 1·4550 with the limits 1·453 and 1·457, a further confirmation of Dr. Gibson's results.

So far as the present inquiry is concerned, it may therefore be assumed that the water of the English Channel is Atlantic water pure and simple, and the alkalinity determinations do not show any variation in its "strength" by dilution with fresh water or otherwise. The chief interest accordingly centres round the temperature

observations, which although already very suggestive, are still too few in number to merit detailed discussion.

Considerable progress has already been made in collecting material for investigating the mixture of waters in the local estuaries at different states of the tide, but the results are not yet ready for publication.

Meteorological Observations at M.B.A. Laboratory, Plymouth, 9 a.m. and 9 p.m.

{ Lat. 50° 21′ 49″ N. / Long. 4° 8′ 21″ W. }

Height of cistern of barometer above mean sea level 125·93 feet.
„ rain gauge „ „ 117·67 „
„ „ „ ground 0·62 foot.

Month.	Mean barometer at 32° F. and sea level.	Temperature.				Dew point.	Elastic force of vapour.	Relative humidity per cent.	Wind.									Cloud amount mean.	Sunshine hours.	Ozone 0—10.	Rainfall inches.	Rainy days.	Rainband 0—8.
									Direction. No. of days.								Mean force, 0—12						
		Mean max.	Mean min.	Dry bulb.	Wet bulb.				N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.						
1891																							
October .	29·727	57·1	46·7	52·0	49·6	47·3	·331	84·6	2	6	1	2	7	7	3	1	2	2·7	5·5	118·68	4·5	8·385	21	—
November .	29·831	50·4	41·1	45·2	43·6	41·6	·268	87·5	8	7	1	1	3	6	2	1	1	1·8	6·5	59·57	4·4	4·190	19	3·3
December .	29·993	50·0	42·1	45·8	44·4	42·7	·284	89·5	2	1	2	3	4	10	4	2	3	2·5	6·6	55·32	5·6	5·170	23	3·4
1892																							
January .	29·924	44·6	36·0	39·6	38·2	36·2	·217	87·8	4	7	0	2	1	5	6	4	2	1·3	6·5	67·79	4·5	1·866	12	2·9
February .	29·802	47·1	38·8	42·5	40·7	38·3	·238	85·9	3	6	2	4	3	4	2	3	2	1·9	6·8	86·17	4·1	3·120	15	3·1
March . .	30·023	45·4	34·5	39·5	36·4	32·0	·187	75·0	1	16	5	1	2	2	1	0	3	1·2	5·4	157·70	4·6	1·171	7	—

Observations of the Temperature of the Surface of the Sea off Plymouth.

THE observations given below are by Mr. William Roach (Series I), Associate Member M. B. A., and by Mr. H. Roach (Series II), the fisherman of the Association. The observations are taken partly in Plymouth Sound and partly on the fishing grounds a few miles to the eastward. A careful comparison of the two sets during the same periods does not show any *local* differences, and as the observations are true sea temperatures throughout, it is unnecessary to state the positions more definitely.

It has been thought best to give the results in the form of ten-day means, as being most convenient for use in connection with fishery statistics.—H. N. DICKSON.

	SERIES I.		SERIES II.	
Date.	No. of obs.	Temp.	No. of obs.	Temp.
1891.				
July 21—30 ...	18	57·4°		
July 31—Aug. 9	15	57·2		
Aug. 10—19 ...	18	58·0		
Aug. 20—29 ...	18	58·8		
Aug. 30—Sept. 8	13	58·9		
Sept. 9—18 ...	18	58·7	7	58·6°
Sept. 19—28...	11	57·9	6	58·0
Sept. 29—Oct. 8	9	57·4	7	57·3
Oct. 9—18 ...	3	56·8	4	56·6
Oct. 19—28 ...	8	54·4	9	54·1
Oct. 29—Nov. 7	9	52·1	7	52·9
Nov. 8—17 ...	8	50·3	5	51·8
Nov. 18—27 ...	6	52·7	5	51·8
Nov. 28—Dec. 7			3	49·8
Dec. 8—17 ...			4	49·4
Dec. 18—27 ...				
Dec. 28—Jan. 6				
1892.				
Jan. 7—16 ...	9	45·8	6	46·8
Jan. 17—26 ...	15	44·8		
Jan. 27—Feb. 5	2	46·5	8	46·5
Feb. 6—15 ...	15	46·4	7	46·7
Feb. 16—25 ...	10	44·1		

Monthly Reports on the Fishing in the Neighbourhood of Plymouth.

By

W. L. Calderwood,
Director of the Laboratory of the Marine Biological Association.

Introductory Statement.

In these reports I shall not take into consideration the minor methods of fishing which are practised in the locality, such, for instance, as eel spearing, mullet trapping, shrimp and prawn fishing, but shall confine myself to the most important branches, in which the beam trawl, drift and seine nets, and long lines are employed, and I shall also include crab and lobster fishing.

With reference to the class of boats employed in this neighbourhood, the **trawlers**, compared to those of the North Sea, are not of large size. The average boat is about forty-three tons. They are usually rigged as ketches (dandy-rig), but the smaller ones sometimes as cutters. The dandy-rig is preferred because with it there is not the very large mainsail and heavy boom of the cutter, and also because, like the yawl, where the mizzen mast is stepped behind instead of before the stern-post, the vessel can be more easily brought under easy canvas in heavy weather. These vessels only carry four men and a boy as crew, and therefore the question of ease in handling becomes one of great importance. Steam trawling is not practised from Plymouth, nor do the sailing trawlers fish in the "fleeting" system common in the North Sea, where many boats belong to one company and remain on the fishing grounds it may be for weeks, while their fish is carried to market by special steamers.

At Plymouth each trawler is worked independently, goes out to the fishing grounds east of the Eddystone, Mounts Bay, or Bristol Channel, and returns with its catch. The mesh of the trawl-net varies from four inches at the mouth to an inch and a half at the cod end, and therefore can take very small fish.

The boats using **drift-nets** for catching herrings, mackerel, and pilchards, are invariably rigged as luggers. They are of various sizes, not exceeding twenty-five tons. The nets for mackerel, set by one boat, may reach two to three miles, but the pilchard and

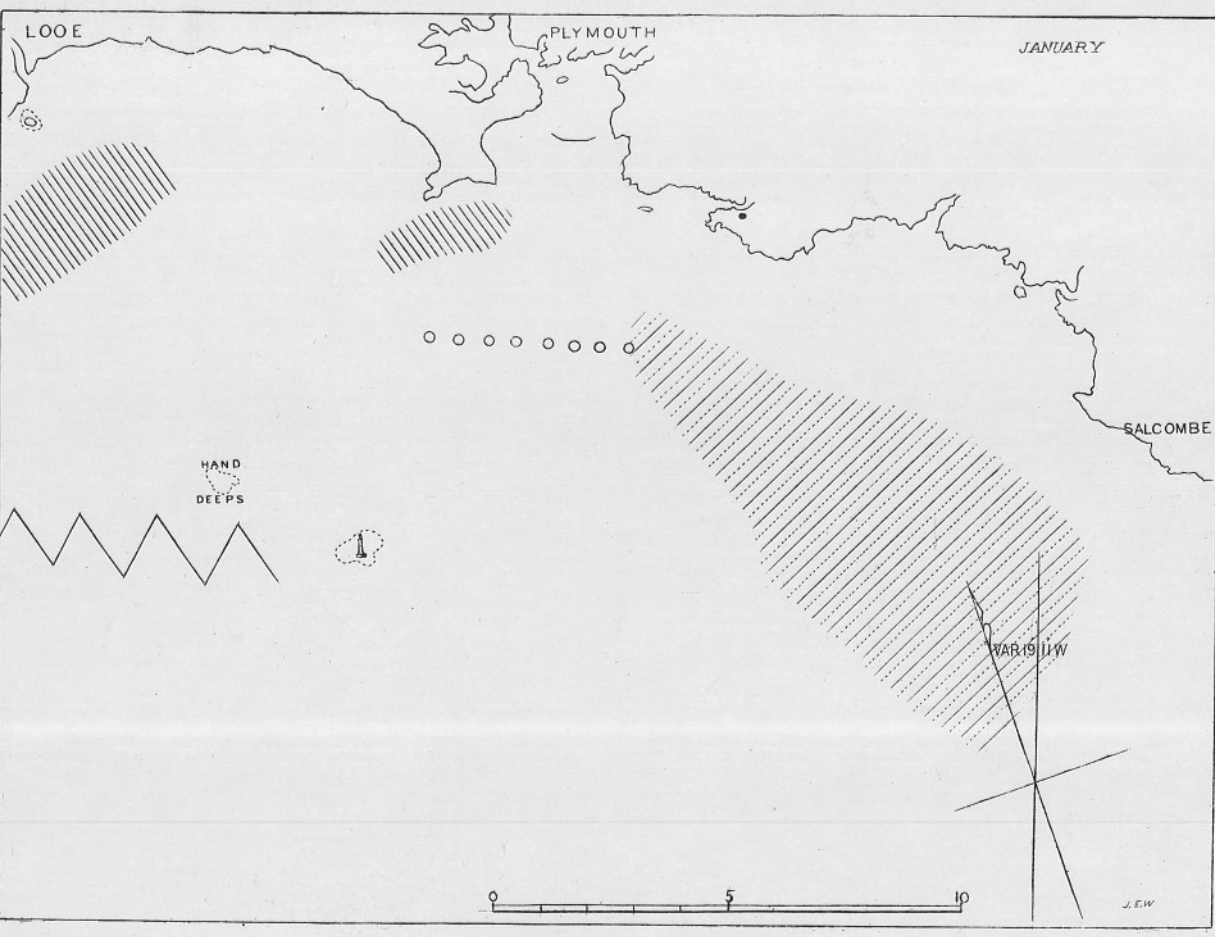
herring nets are smaller, and do not much exceed one mile in length. The large luggers carry five men and a boy.

The boats employed in **long-line fishing**, or, to use the local term, in "bultering," are the most numerous. They are rigged either as luggers or cutters, a mainsail without a boom always being used in the latter case, and vary from twenty-five tons down to quite small rowing boats. A certain intermingling of classes takes place between the long-line boats or "hookers" and the drift-net boats, because at certain seasons a large lugger may fish by net and at another by line. In this case she carries the same crew for working the lines as she did when employing nets. A boat, however, which carries a large fleet of mackerel nets seldom has a long line on board at the same time. She may abandon one style of fishing and take up the other, but it is reserved for the herring and pilchard boats to carry both at the same time and set either. The boats which use only the long line and never venture far out into the open Channel after the shoals are of about twelve tons. These form the class of hookers proper, and work round the Hand Deeps and Eddystone. After them comes the swarm of little boats which may use set-lines, hand-lines, moored herring-nets, or shrimp trawls; but of all the boats fishing out of Plymouth the small hookers probably render the best account of themselves, not only because the price of the "take" has to be divided amongst fewer hands, but because the expense of keeping up a small boat of the kind required is comparatively insignificant; and, since they do not go far from land, the fish can be more quickly caught and put in the market.

For Customs purposes the limits of the port of Plymouth are from the river Erme, eight miles east of Plymouth Sound, to the river Seaton, ten miles west of Plymouth Sound. In this district there are 257 boats registered under the Sea Fisheries Acts. 180 belong to Plymouth proper, 10 to Stonehouse and Devonport, 29 to Cawsand, and 38 to Yealm. The boats are registered as follows:

Trawlers	72
Drift-net boats . . .	36
Hookers	149
	257

The fishing-boat harbour at Plymouth is, however, never without a considerable number of boats hailing from other ports. Brixham trawlers fishing in the west, or round in the Bristol Channel, land their fish here; and any Grimsby, Yarmouth, or Lowestoft boats, fishing on the south coast, find their market and harbour at Plymouth.


LOOE
PLYMOUTH
JANUARY
SALCOMBE
HAND
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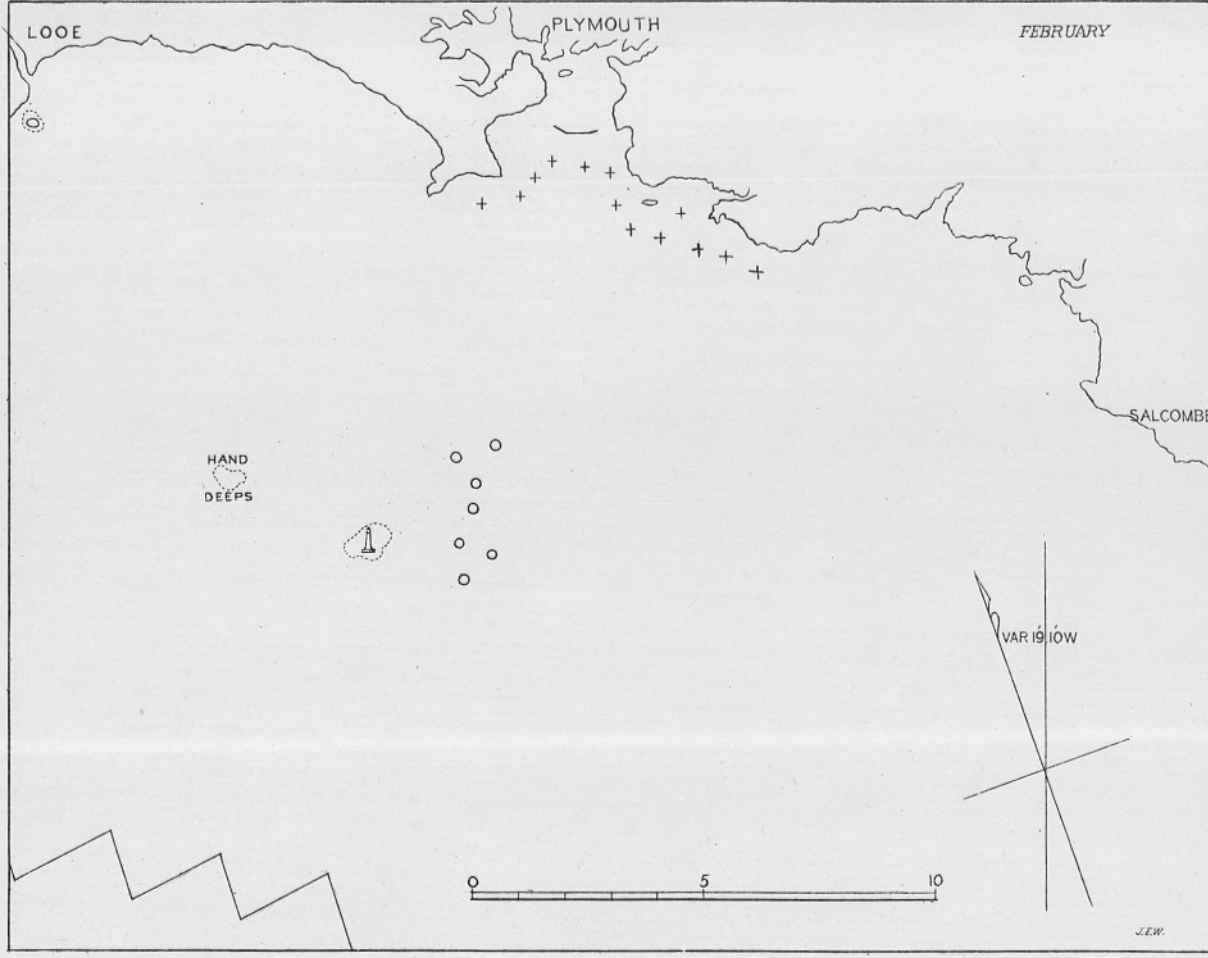
LOOE
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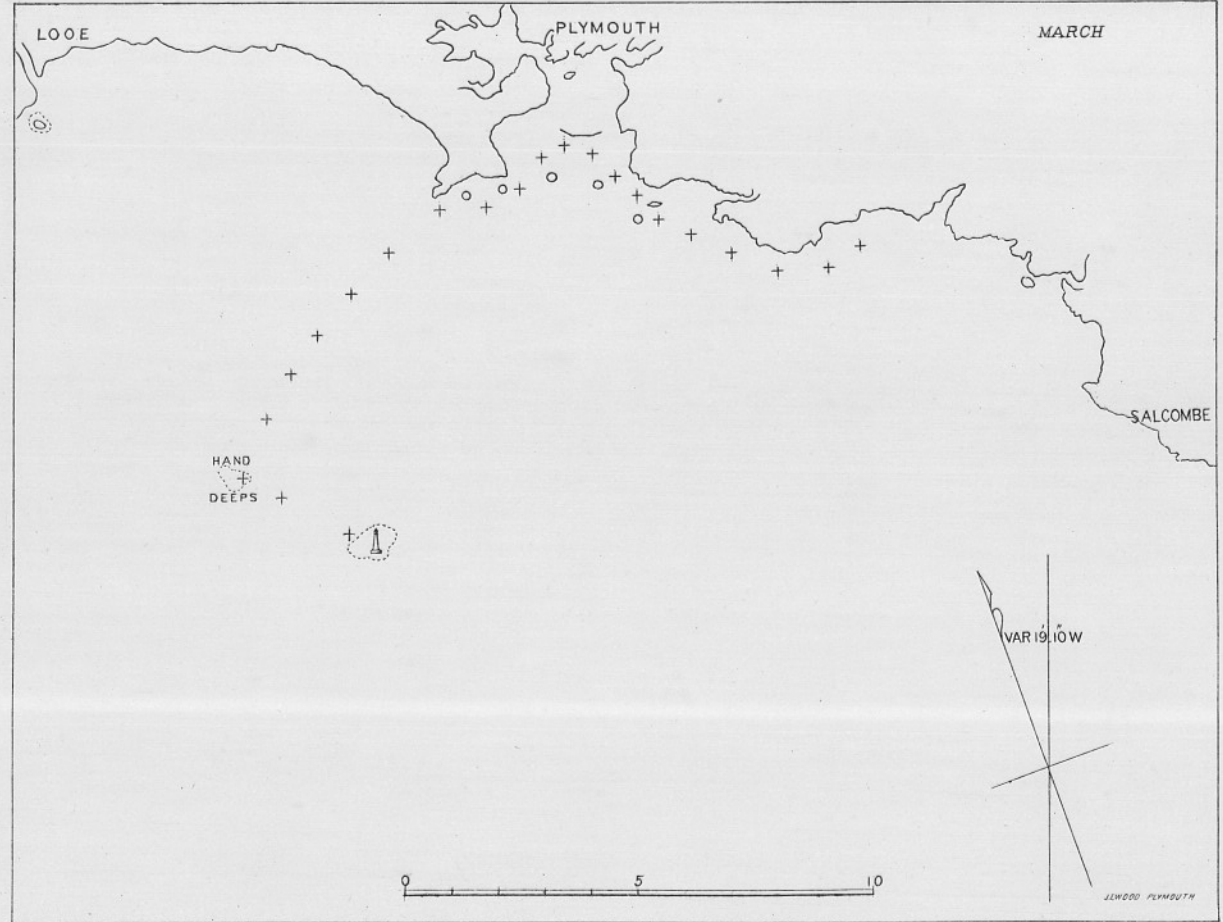
LOOE
PLYMOUTH
MARCH
SALCOMBE
HAND
DEEPS
VAR 19° 10' W
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5
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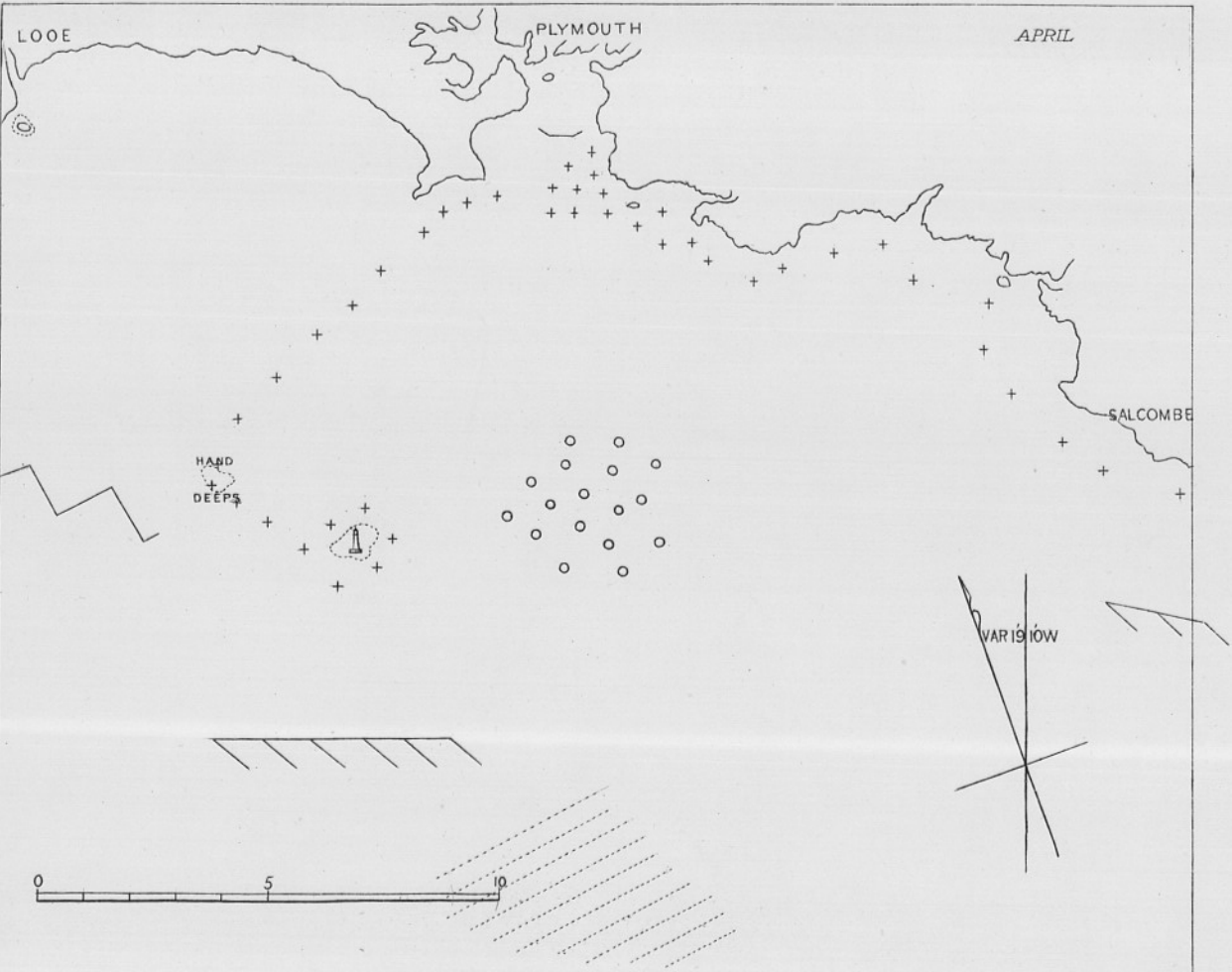
JEWOOD PLYMOUTH


LOOE
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APRIL
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HAND
DEEPS
VAR 19 10W
0
5
10

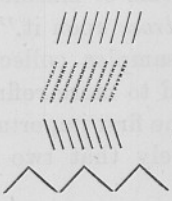
It is in the winter months, however, when the herring and mackerel season is at its height, and the Cornish boats arrive from Fowey, Looe, and Penzance, that the neighbourhood of Plymouth assumes its busiest aspect. The drift-net fleet alone is then composed of between three and four hundred sail.

In order that the fishing prosecuted around Plymouth may be known, and the various fishing grounds worked upon at different times of the year clearly demonstrated, I have thought it advisable to attempt the construction of monthly charts, each one showing, as nearly as possible, the average condition for that month. It must, of course, be understood that in these charts it is impossible to show all the minor fluctuations of the fishing.

There must always be a certain number of boats which, not succeeding in one place, try others, it may be far removed from the locality in which the majority of boats are fishing; or the shoals of fish themselves may suddenly alter their positions, so that the boats have for some days to scatter in all directions in search of them. Still, the fishing of one month is so distinct from that of another, and the alterations take place in such regular order, that it seems to me to be quite possible to construct charts which will represent exactly what grounds may be expected to be worked over in any particular season.

In this, the first attempt at anything of the kind for this locality, I do not say that the markings or positions of the various fishing boats may require no alteration, since it is possible or probable that some exceptional condition may be included in what is only meant to be an average condition; but a basis will, at all events, have been constructed from which to work.

Key to Symbols used in Monthly Fishery Charts.



= position of herring boats.

= ,, of mackerel boats.

= ,, of pilchard boats.

= ,, of trawlers.

o o o o = ,, of whiting boats.

+ + + + = ,, of crab and lobster boats.

NOTES AND MEMORANDA.

THE *Bulletin of the United States Fish Commission* for 1889 contains a report upon a physical investigation of the waters off the southern coast of New England in the schooner *Grampus* during the summer of 1889, by Professor W. Libbey of Princeton College. This forms the first instalment of a series which promises to throw much light on the relations of temperature and salinity to the distribution of fishes and their food, and was itself directly suggested by researches upon the shad and the menhaden.

The observations cover the area between lat. 39° N. and lat. 41° 10′ N., and long. 70° W. to long. 71° 30′ W., soundings being obtained as nearly as possible every 10′ along lines 10′ apart. At each station a very complete series of temperature observations was made, and samples were collected at surface, bottom, and in the deeper soundings at an intermediate point. The specific gravities of these samples were determined by means of a Kilgard salinometer.

The temperature profiles along meridians of longitude are of great interest, extending as they do from near the coast over the edge of the continental plateau into deep water. The bathy-isothermal line of 50° F. shows a remarkable curvature off the continental platform, which the report says "would seem to point to a mechanical intrusion of cold water from the surface of the continental platform." The conclusion is confirmed by the specific gravity observations; and the report goes on to say, "The existence of this body of warm water off the continental edge may offer an explanation of the richness of this particular spot in all forms of marine life, as shown by the successful dredging of the *Albatross* upon it."

It is much to be desired that the samples collected should be subjected to analytical examination, and to more refined determinations of density, as in this case it is of the first importance to identify the waters surveyed, and it seems likely that two distinct kinds are present.—H. N. D.

THE following papers contain the results of work done at the Plymouth Laboratory and published elsewhere than in the Journal of the Association during the two years last past. They form a

continuation of the list published in Journ. Mar. Biol. Ass., i, pp. 364, 365.

Benham, Dr. W. B.—"The Nephridium of Lumbricus and its Blood-Supply, with Remarks on the Nephridia of other Chætopoda," Quart. Journ. Micr. Sci., xxxii, 293.

Cunningham, J. T.—"On some Disputed Points in Teleostean Embryology," Ann. Mag. Nat. Hist., 1891, 203.

Cunningham, J. T.—"An Experiment concerning the Absence of Colour from the Lower Sides of Flat Fishes," Zoologischer Anzeiger, 1891, 27.

Cunningham, J. T.—"Spermatogenesis in Myxine glutinosa," Quart. Journ. Micr. Sci., xxxiii, 169; Zool. Anzeiger, 1891, 22.

Driesch, Dr. Hans.—"Tektonische Studien an Hydroidpolypen," parts i and ii, Jenaische Zeitschrift, xxiv, 189 and 657 (N.F. xvii); part iii, Jenaische Zeitschrift, xxv, 467 (N.F. xviii).

Garstang, W.—"Note on a New and Primitive Type of Compound Ascidian," Ann. Mag. Nat. Hist., 1891, 265, and Zoologischer Anzeiger, 1891, 22 (preliminary note).

Greenwood, Miss M.—"On the Action of Nicotine on Certain Invertebrates," Journ. Physiology, xi (suppl.).

Harmer, S. F.—"On the British Species of Crisia," Quart. Journ. Micr. Sci., xxxii, 127.

Harmer, S. F.—"On the Origin of the Embryos in the Ovicells of Cyclostomatous Polyzoa," Proc. Camb. Phil. Soc., vii.

Harmer, S. F.—"On the Regeneration of Lost Parts in the Polyzoa," Rep. Brit. Ass., 1890.

Johnson, Prof. T.—"Observations on Phæozoosporeæ," Ann. Bot., v.

Johnson, Prof. T.—"The Callosities of Nitophyllum versicolor," Journ. Roy. Dublin Soc., 1892.

Minchin, E. A.—"Note on a Sieve-like Membrane across the Oscula of a Species of Leucosolenia," Quart. Journ. Micr. Sci., xxxiii, 251.

Ridewood, W. G.—"The Air-Bladder and Ear of British Clupeoid Fishes," Journ. Anat. Phys. (London), xxvi, 26.

Robinson, Miss M.—"On the Nauplius Eye persisting in some Decapoda," Quart. Journ. Micr. Sci., xxxiii, 283.

Weldon, Prof. W. F. R., F.R.S.—"The Renal Organs of Certain Decapod Crustacea," Quart. Journ. Micr. Sci., xxxii, 279.

Weldon, Prof. W. F. R., F.R.S.—"The Formation of the Germ-layers in Crangon vulgaris," Quart. Journ. Micr. Sci., xxxiii, 343.

An important prosecution, the first of its kind, we believe, to have been taken under the Sea Fisheries Regulation Act, 1888, was instituted in March last by the Kent and Essex Fishery Committee

of the County Council against the East and West India Dock Company, for depositing sludge dredged from the docks on ground alleged to be good trawling ground for flat-fish and shrimps, contrary to the Bye-laws of the Committee. The defendants were fined £10 and costs, and an application to the magistrates to state a case on the question of jurisdiction was granted.—G. H. F.

A TRAWL-NET which seems likely to prove useful to yachts, and to any vessels for which a beam-trawl is prohibited by its size and weight, has been brought to my notice by the patentee, Mr. John Thurlow, of 26, Cleves Road, Eastham. It consists essentially of the ordinary otter-trawl with the addition of a third otter-board, set so as to skid upwards and to keep the gape of the net open. It thus disposes of one of the objections to the ordinary otter-trawl, that the upper edge of the net being immediately over the foot-rope, fish can escape upwards (cf. Holdsworth, Deep-sea Fishing and Fishing Boats, p. 372), a possibility here prevented by the third otter-board coming as far forward as does a trawl-beam over the foot-rope. The inventor will supply specimens and models of the net if desired.—G. H. F.

Gadus esmarkii (Nilss.).—I took a female, about three parts ripe, from the stomach of a halibut, trawled on or about the 31st January on the south-western flat, a ground which lies due west of the coast of Northumberland, between long. 1° and 3°, but chiefly to the westward of long. 2° 30′, and thus within the British area as defined by Canon Norman (Ann. and Mag. Nat. Hist., 1889, p. 345). The soundings are from 30 to 50 fathoms cable. Another halibut contained, on the same occasion, the remains of two small gadi, which were probably of the same species. The Norway pout has been shown by Dr. Günther (Deep-water Fishes, P. R. S. E., vol. xv, No. 127, p. 212) to be common enough in certain localities on the west coast of Scotland, and I have shown that it is by no means rare on the west of Ireland (*vide* Scien. Proc., R. D. S., 1892, pt. 4). Its range must now be extended to the east coast of England.—E. W. L. H.

Phycis blennioides (Brünn).—Two fork-beards were received during March from the ground to the north-west of the Great Fisher Bank, lat. 57° 40′ N., long. 2° 20′ E., 40 fathoms, and lat. 57° 45′ N., 46 fathoms. The first was a female with ovaries but little advanced, containing slightly opaque ova, the largest ·15 mm. in diameter. The other specimen had had its viscera removed by its captor, with a view to its better preservation. The fork-beard seems to be

rather rare on the North Sea grounds, since the Grimsby fishermen are quite unacquainted with it. The specimens I have alluded to were regarded as hybrids between a tusk and a haddock.—E. W. L. H.

A specimen 18¼ inches in length has also been received at Plymouth. It was taken on a whiting hook, 5 miles from shore on hard ground.—W. L. C.

Sebastes norvegicus (Ascau).—The Norway "haddock" seems to be rather common in the deep water about the Fisher Bank, but has no vernacular name amongst the Grimsby fishermen.

Crystallogobius Nilssonii (Düb. and Kor.).—Mr. Cunningham's remarks on the distribution of this form, in the last number of the Journal, will be remembered. I have recently been able to show that it is very generally distributed, at depths from 10 to 35 fathoms, along the west coast of Ireland (loc. cit., p. 284), and am now able to record it from the "Head" ground, 15 to 20 miles E.S.E. of Flamborough Head, 29 fathoms, having trawled a perfect specimen there on the 19th March. I have seen fragments, which I suppose to belong to the same species, adhering to the nets of boats returning from other grounds, and suspect that the use of suitable nets would show that it is pretty common. The fishermen told me that they considered such fish as my specimen to be young haddocks, but the resemblance to a young herring or sprat is more obvious.

E. W. L. H.

Arnoglossus laterna (Walb).—I received a specimen from 35 miles off Flamborough Head, 33 fathoms, on the 20th February. The species does not seem to have been recorded from the east coast of England, though it occurs in Norwegian waters, and has been taken off the coast of Banffshire.—E. W. L. H.

Raia alba (Lacép.).—On the 29th of February, when looking over a very large "take" of skates landed on the Plymouth Barbican, I was fortunate enough to notice a fair-sized specimen of this our largest, though seldom observed, British species. It measured 6 feet 2½ inches extreme length, and 5 feet 1 inch across the wings. The colour in the dorsal surface was a dull brownish grey. The ventral surface was a dead white on every part except where the extreme margin of the fins showed a translucent red. The specimen was a female, but had the characteristic sharp teeth seen in both sexes of this species. On the under side, from the level of the mouth to the tip of the snout, there was a thick covering of spines, and fully half-

way from the tip of the snout to the outer angle of the wings ran a band of spines embedded in the flesh, the points projecting inwards as do the spines seen on the dorsal surfaces of the wings of male skates generally. This band was about 2 inches broad. The body was extremely thick, being to the grey skate what the body of a halibut is to that of a turbot. The tail was not long in proportion to the body, and was provided with spines in a somewhat unusual manner. Starting from the body, three rows were visible, but the outer one rapidly developed into a band similar to, though narrower than, that described for the anterior margin of the wings. These spines were, however, not embedded in the flesh of the tail. The skin of the back was not so smooth as in *R. batis*, nor so rough and shagreen-like as in *R. macrorhynchus*.

Raia alba, the white skate, is mentioned in Couch under the names Burton skate and Bordered ray. The latter name arises on account of the appearance of the young.

About ten days after noticing the large example, the fisherman of the Association brought in a young specimen. The name bordered ray would be appropriate in this case. The spines are again present between the region of the mouth and the snout and down the anterior margin of the wings, but on the tail are three rows of large spines only, a central row of fifteen, and on each side a marginal row of eleven, much curved and pointing directly backwards. The colour of the back is a light olive-brown, of the under side white centrally, shading through yellow into a broad dirty brown-coloured border. The under surface of the tail is also like the border to the wings. These young bordered rays were said by Thompson to be plentiful in Portland Roads. The adult skate is recorded on the south coast, from Weymouth (Goose), Lyme Regis (Jarrell), off Cornwall and Plymouth (Day). It appears only to frequent deep water, but must deposit its eggs in shallower water, the young being found in this situation.—W. L. C.

Young Lobsters.—On the 30th March I received from Mr. Dunn, of Mevagissey, an associate member of the Association, three lobsters of a very interesting size. They were all alive, and measured as follows :—9·6 cm., a male ; 11·5 cm., a female ; 13·1 cm., a female, the measurements in each case being from the tip of the rostrum to the end of the telson.

I am not aware that anyone has ever recorded the capture of a lobster of adult form so small as 9·6 cm., or roughly $3\frac{3}{4}$ inches long.—W. L. C.

A New British Nemertine.—On March 22nd a nemertine worm was

trawled off Stoke Point in about 25 fathoms, which corresponds to the description given by Hubrecht* of *Carinella polymorpha*.

Hubrecht's description is as follows:—"Differing from the foregoing species (*C. annulata*) by the form of the head, which is still wider and more hammer-shaped, as well as by colour, which is always a uniform reddish or orange-brown."

This species is synonymous with *Valencinia splendida* of de Quatrefages, and *Tubulanus polymorpha* of Renier. It has never, I believe, been found before on the British coasts. Its geographical extension, as given by Joubin,† is Banyuls, Roscoff, Bréhat (de Quatrefages), Naples (Hubrecht), Adriatic (Dewoletzky), ocean and Mediterranean (Vaillant). McIntosh, in his monograph, describes a worm from the island of Herm, which is perhaps identical with this species, but which he regards as a variety of *Carinella annulata*.

Neither Hubrecht nor Joubin mentions the existence of extremely faint lines, which are quite similar in position to those of *C. annulata*, except that the median ventral line seems absent. They are so faint that it is with great difficulty that they can be seen at all, and they in no wise interfere with the uniformity of the orange-brown colour, which seems, except on very minute inspection, to be uninterrupted. In the *Carinella* from the island of Herm, McIntosh mentions the existence of a pale lateral line on each side, and faint traces of transverse bars on the dorsum.—T. H. R.

Culture of Sea Fish.—From the Annual Report of the Newfoundland Fisheries Commission for the year 1891, presented to the Legislature March, 1892, the following interesting extracts are taken. Speaking of the Dildo hatchery, the Report says:—"By July 25th there were 616 codfish in the wells. The total number of ova stripped from these fish was 78,950,000. Of these, 39,650,000 were rejected, and 39,650,000 were hatched and planted in a healthy condition. This gave the satisfactory yield of 50·2 per cent. During the month of December an important improvement, which had been in contemplation from the first, was carried out at Dildo—namely, the construction of a salt-water pond, in which the codfish will be placed to spawn in the natural way, instead of undergoing the process of stripping. This pond is 47 feet in length and 23 in breadth, and is most substantially built of stone and Portland cement. There is a specially constructed collector and other apparatus to gather up the ova as they are extruded from the fish, and fertilized;

* Hubrecht, *The Genera of European Nemerteans*, Notes from the Leyden Museum, No. 4, vol. i.

† Joubin, *Sur les Turbellaires des Côtes de France*, Arch. Zool. Exp., 2 ser., vol. viii.

and they are then conveyed to the hatchery. Mr. Neilsen anticipates that he will be able to hatch 70 to 90 per cent. of the ova, instead of 50 per cent. as at present, by this improved method. Such results have been recently attained at Flödevig hatchery in Norway, where, partly through Mr. Neilsen's recommendation, it was adopted two years ago. . . . The total number of lobster ova obtained was 18,505,600 ; and of these 10,274,300 were hatched and planted." This is the most extensive hatching of sea fish yet accomplished.—W. L. C.

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, Dr. 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 £4000.

The ASSOCIATION IS AT PRESENT UNABLE TO AFFORD THE PURCHASE AND MAINTENANCE OF A SEA-GOING STEAM VESSEL, but has determined upon the purchase of a Sailing Trawler, 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. II, 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, M. B. A. Laboratory, Citadel Hill, Plymouth.