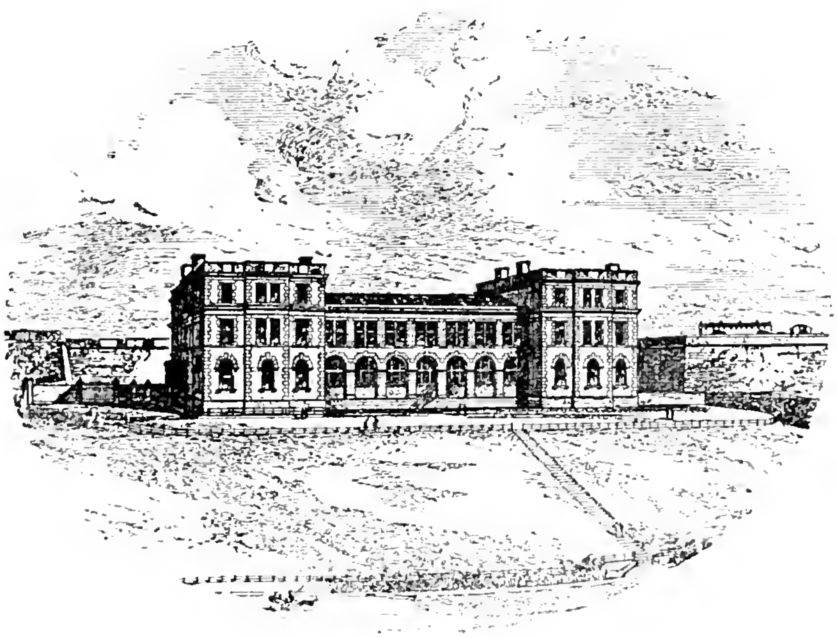
Journal

OF THE

MARINE BIOLOGICAL ASSOCIATION

OF

THE UNITED KINGDOM.



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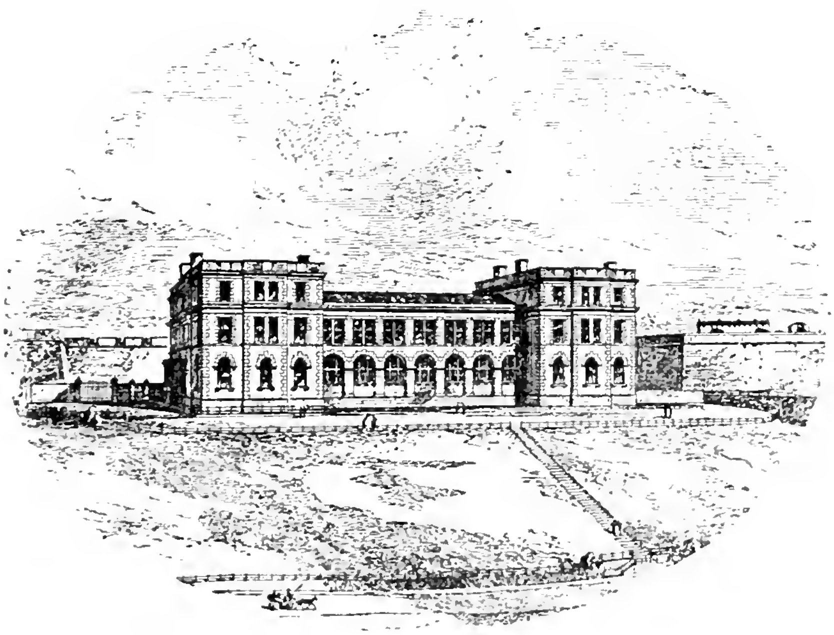

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The Periodic Growth of Scales in Gadidæ as an Index of Age.

By

J. Stuart Thomson, F.L.S.

(With Plates I.-VIII., and one Figure in the text.)

TABLE OF CONTENTS.

I. Introduction.

This work is a continuation of my preliminary paper on the same subject, which was published in a former number of the Journal of the Association (vol. vi., p. 373, January, 1902).

I must firstly express my indebtedness to those who have aided me in my work. I am signally indebted to Mr. Garstang, who, about two years ago, suggested that I should endeavour to extend to marine fishes this newly revived though really old hypothesis, that the age of certain fishes might be determined by means of annual rings on their scales, an hypothesis which Dr. Hoffbauer had previously shown to be true for some fresh-water fishes, such as the carp. To Dr. E. J. Allen I am indebted, not only for placing all the possible facilities of the Plymouth Laboratory at my disposal, but also for reading the manuscript and proof-sheets. For the latter I am all the more indebted to Dr. Allen, in that, as I write, I am just on the point of leaving this country to take up a new biological appointment at Cape Town. I would further express my obligations to Professor McIntosh, Dr. T. Wemyss Fulton, and Dr. H. M. Kyle, who generously helped me in securing additional specimens. I must add that without the aid of a Government Grant, awarded through the Royal Society, this work could not have been accomplished in its present form.

This paper consists of two parts: the first part contains a review of the literature on fish scales, more especially so far as that bears on the subject of my investigation; the second part is composed of statistics dealing with the size, the number of growth-lines and annual rings in scales from fish of all sizes, and captured at the various seasons of the year. The accumulation of the necessary statistics for this second portion of my work has been an arduous and lengthy task, involving, as it has done, exact measurements of hundreds of scales and a more superficial observation of thousands of others.

II. Summary of Literature.

I may firstly notice that, shortly after the invention of the microscope, Borello wrote a brief description of the microscopic appearance of a fish scale, and added a diagrammatic figure of the same.*

About a hundred years later, Hooke, in his *Micrographia*, gave a very brief description, but a fairly exact figure, of the scales of the sole.†

We are indebted to Leuwenhoeck for several interesting notes on the development and structure of scales.‡ In regard to the growth of scales, his first idea was that each year the scales increased in size by adding a new zone or circle to the pre-existing scale. Later, however, he abandoned this view, as in examining certain scales he observed that those of old fishes are very thick, much thicker than they would necessarily be if their mode of increase was simply by the addition of a new circle or zone each year.

He came to the conclusion that the portion which he had at first taken for a new zone disposed round the primitive scale was simply the most external part of a new scale, the part which exceeded the old scale in size, and that all these scales were intimately welded together.

* Borello, 1566. [For detailed references see Literature, p. 106.]
† Hooke, 1667. ‡ Leuwenhoeck, 1696.

In order to explain the formation of superimposed scales, Leuwenhoeck believed that the growth of scales, as that of hair, feathers, horns, and trees, ceases for a very short period at the end of the first year, and that scales are afterwards formed beneath and add themselves to the first. As the scales of a two-year-old fish exceed those of a one-year-old fish in size and dimensions, it follows that the scale of a two-year-old fish is partly covered by the first-year scale and extends beyond it. The same takes place for the following years, and thus the scales of a ten-year-old fish are composed of ten scales, secondarily superimposed the one upon the other, and fused so intimately with one another that they cannot be easily separated without tearing the scale into pieces. If, in the scales of fishes, new scales did not weld themselves each year to the old scales, then the scales of very large fish would of necessity be very thin and fragile. Leuwenhoeck restated these views in a later paper.*

Réaumur made a study of the silvery substance of scales, sometimes known as "l'essence d'Orient." † He stated that this substance consists of a mass of an infinite number of small and very irregular bodies. These bodies are extremely thin, but of great solidity. He found this substance present almost solely on the internal surface, not on the external surface, of the scale. He held that this substance is covered over by membrane, and contained in vessels or tubes which extend in a direction transversely perpendicular to the length of the scale. Réaumur affirmed that this silvery matter contributed directly to the growth of scales. He agreed with Leuwenhoeck that each scale is composed of an indefinite number of layers, of which the largest are those nearest the body of the fish. Speaking of the concentric lines, Réaumur wrote "that they occupy the border of each layer, of which they mark the limit, and that they indicate the different degrees of growth in scales, just as the analogous markings indicate the growth of shells."

As to the radiating grooves in scales, Réaumur believed that they lodged blood-vessels. He also gave a good description of the scales of the lateral line, pointing out that scales from that region have a small canal on their external surface. These small canals abut end to end, thus forming a continuous channel, which apparently serves to carry away the mucus formed on the bodies of various fishes.

Roberg reproduced a figure of the scale of the eel, previously given by Leuwenhoeck.‡

In his Memoir on the Carp, Petit dealt with the following points in connection with their scales, but only in a very brief manner: the mode in which scales overlap each other, the dimensions of scales in different regions of the body, the mode in which scales are enclosed in the skin, the furrows (*sillons*) on the upper surface of the scale, the silvery matter on the lower surface, etc. He, however, gave a much more detailed description of the scales of the lateral line.§

A few observations on scales are found in the writings of Schaeffer. He also gives figures of scales from five different species of perch. He notes the external characters of scales, and their variation in different parts of the body, but does not go into their detailed structure nor development.‖

* Leuwenhoeck, 1716. † Réaumur, 1716 and 1718. ‡ Roberg, 1717.
§ Petit, 1733. ‖ Schaeffer, 1761.

Broussonet demonstrated the presence of scales in a number of genera of fish in which their existence had either previously been denied or held in doubt, for example Cepola, Remora, Ammodytes, Anguilla, Scomber. His descriptions are very brief, and the paper is not of great importance.*

We owe to Heusinger the first attempt at a classification of fish by means of their scales.† He divided fishes provided with scales into five groups:—

I. Fish with small scales entirely hidden in skin (Anguilla, Muræna, Blennius, Muræenophis).

II. Fish with scales properly so called (Carp, Esox, Salmo).

III. Fish with scales strongly toothed at their free margins (Chætodon).

IV. Fish provided with osseous scales (Knochenschuppen). These scales resemble those of Group II.; but they have so much calcareous matter as to resemble hard teeth. They are not usually imbricated, but are isolated or simply contiguous; their surface is frequently furnished with spines (Lepidosteus and several species of the genera Trigla, Cottus, Silurus, Gasterosteus, etc.).

V. Fish with osseous plates (Knochenplatten). These plates form a solid cuirass round the fish (Ostracion, Diodon, Syngnathus, Hippocampus, Accipenser, etc.).

Selachians are not comprised in the preceding five groups. Heusinger places them in a separate division characterised by the "mode of conformation of the spiny formation," whose structure approaches to that of teeth.

Heusinger also gives a succinct description of true scales, and in regard to their structure agrees with Agassiz in regarding each scale as composed of superimposed lamellæ or layers.

Kuntzmann's paper‡ is of importance chiefly because it contains the germ of an idea which Agassiz later developed more fully in his *Classification des Poissons.* In his paper Kuntzmann opposes the views of Schaeffer, who had emphasised the differences between scales of the same fish. Kuntzmann held "that though one does not easily find absolutely similar scales on the same species of fish, yet the scale of each species has some characteristic feature, and that an examination of scales may enable one to acquire a more exact knowledge of species, and that one may identify some genera and even some species simply by an examination of their scales." He compares scales to the leaves on plants, in which, although there is frequently quite a degree of variation among the leaves of the same species, still one may often recognise the species of plant by means of its leaves.

Kuntzmann experimented with scales in regard to their indestructibility in water, and showed that after prolonged immersion in water they were not softened to any marked degree.

He opposed the opinion of Leuwenhoeck as to the concentric lines on the upper surface of the scale indicating the age of the fish. He maintained that the scales of an old carp do not show a larger number of concentric lines than those of the young carp (see Hoffbauer). As to the mode of scale growth, Kuntzmann agreed in the main with the views of Réaumur. He regarded the small quadrangular plates (described by Réaumur) on the internal surface of

* Broussonet, 1787. † Heusinger, 1823. ‡ Kuntzmann, 1824.

the scale as a precipitate, a deposit of mucus, which contributed directly to the formation of scales. He differed, however, from Réaumur as to the situation of these quadrangular plates later, affirming that they were contained between two membranes on the internal surface of the scale, and not in vessels. He held that growth does not take place at the edge, but over the entire scale, and that this mode of growth is a consequence of the structure which the scale shows at the time of its first formation, for the scales of a young fish and those of an old fish are not essentially different except in size. He thinks that this mode of formation allows one to explain the difference between scales of different species, especially the difference of the concentric lines, which may be wide or narrow, straight or curved, entire or interrupted in the different species.

Kuntzmann worked out a classification of scales into seven classes, remarking at the same time that quite gradual transitions existed between these classes, and that certain scales might equally well be placed in one class as in another. His classes are the following:—

I. *Membranous scales* (*hautigen Schuppen*). Scales which do not show concentric lines (*Gadus lota*).

II. *Semi-membranous scales* (*halbhautigen*). Scales with a membranous posterior portion, but with the anterior portion marked out by incomplete concentric lines, crossed over by other lines running longitudinally (*Clupea harengus*).

III. *Simple scales* (*einfachen*). Scales with concentric lines covering their entire surface without those lines forming any definite design by other lines crossing over them (*Salmo salar*).

IV. *Scales with a design* (*gezeichneten*). Scales in which the concentric lines on the scale surface form a regular design due to the arrangement of the same (*Muræna anguilla*).

V. *Scales divided into several regions* (*gefelderten*). Scales on which there exist numerous ornaments which parcel out the scale into four well-defined fields. These diverse fields, usually triangular in shape, meet at a point, which is usually at the same time the centre of the concentric lines (*Cyprinus carpio*).

VI. *Scales with prickles.* These scales are also frequently divided into four fields. The posterior field bears spines on a more or less extended portion of its surface, or sometimes only at its free border. These spines fall off on prolonged maceration, showing that they are not really portions of the scale, but arise from the skin which covers the scales. These spines also fall off naturally at certain seasons, and others take their place. "This fact seems to establish a kind of moulting, such as occurs in Amphibia." Examples—The scales of *Scorpæna.*

VII. *Spinous scales* (*gedornte*) are also divided up into several areas or fields. The spines are in this case, however, true prolongations of the scale, and do not become detached on maceration. Example:—*Perca lucioperca.*

Kuntzmann gives a short description of each type of scale with a corresponding figure. Although the preceding classification is interesting, yet it leads to an artificial comparison.

Ehrenberg described the crystals of silvery matter previously described by

Réaumur. Along with his description there is an analysis of this substance by Rose.*

Agassiz expressed himself in the following manner in regard to the structure and development of scales :—†

"Scales are contained in mucous cavities or in small sacs formed by the 'chorion,' to which, however, they do not adhere by vessels. They are formed of lamellæ, of horny or calcareous layers, superimposed the one on the other, which are secreted at the surface of the chorion ; these layers attach themselves successively to the inferior surface of the preceding, to which they weld themselves by layers of hardened mucus. In order to obtain a true idea of this development, it is necessary firstly to observe it in those genera of fish in which the scales appear to show these arrangements in the simplest state, for example, in the Eels, the Blennies, Cobitis, and Leuciscus. It is easy to assure oneself that the concentric lines of the anterior border and those of the posterior border are continuous the one with the other."

In order to support his theory, which after all is none other than that of Leuwenhoeck, Agassiz appealed to the following :—

"After having macerated scales for some time in water, one can easily," he says, "divide them up in a large number of layers or plates of greater or less thickness, and of different size, but all of which have the form of the scale. These plates are superimposed in such a manner that the smallest occupy the centre of the scale, and form its interior part, while the largest, bordering the preceding, are successively welded to their inferior face. Thus one sees that the concentric lines which are visible on the exterior surface of scales are simply the borders of plates which compose them."

The radiating grooves (*sillons rayonnants*) Agassiz regarded as channels at the margin of the external surface, which connect one layer with another, and multiply during the growth of the scale. In this work Agassiz introduced his well-known classification of fish into four orders according to the nature of their scales, the Placoid, Ganoid, Ctenoid, and Cycloid orders.

Mandl,‡ well known as the opponent of Agassiz, held widely different views in regard to scale structure and development from those of all the authors previously mentioned.

He attempted to establish the existence of an internal life and true organisation within the scale. According to him, most scales are composed of two superimposed layers, superior and inferior. The superior layer shows the structure of cartilage with corpuscles, the inferior layer consists of lamellæ which recall the structure of fibrous cartilage.

In the *superior layer* he describes longitudinal canals, cellular lines, and corpuscles.

Longitudinal Canals. Under the term "*longitudinal canals*" he describes the grooves which radiate out from the centre to the periphery of the scale. According to Mandl, these lines show all stages of formation, from that of a simple groove to that of a perfectly formed canal. These canals lead to a common point, the focus, which is a centre of nutrition, a point where tissue

* Ehrenberg, 1833. † Agassiz, 1834. ‡ Mandl, 1839.

is found developing. Mandl thought that these canals serve for the transport of nutritive material from the skin towards the centre of nutrition, in other words, that they fill the rôle of true vessels containing nourishment.

The Cellular lines. Under this term Mandl discusses the concentric lines or ridges parallel to the contour of the scale. He does not agree with previous authors in regarding these lines as the projections of secreted and superimposed layers. According to him, these lines owe their origin to special cells which originally form themselves on the superior surface of the scale; gradually these cells amplify and elongate, and finally come to represent cellular lines.

Corpuscles. Mandl is the first author to describe definite corpuscles in the tissue of scales. He describes those corpuscles as of a yellowish colour, and of an oblong, more or less elliptical form. They diminish in size towards the edge of the scale, showing there only a granulated appearance similar to that which one notices sometimes in the vicinity of the longitudinal canals. These corpuscles are usually arranged in a very regular way, sometimes crossing one another in such a manner as to form a cross. Under the action of acids they become transparent.

These corpuscles are contained in a definite tissue which is situated above the inferior surface of the scale. This tissue is an amorphous tissue like that in which the corpuscles of bone are deposited. The tissue constituting the superior layer of scales thus approaches that of cartilage with non-ossified corpuscles.

Inferior layer of scale. Beneath the layer with corpuscles is found the inferior layer, which is a fibrous layer built up of fibrous lamellæ, in which the fibres cross one another at regular angles, but in which the fibres all follow the same direction in the same lamella. This arrangement approaches that of fibrous cartilage. This inferior layer is thickest at the focus (*foyer*) of the scale, and thinnest at the borders; it is this which forms the foundation of the longitudinal canals in the vicinity of the border of the scales.

Mode of scale formation. Mandl endeavours firstly to establish a distinction between the formation of the superior and inferior layers of scales. According to him, the superior layer, composed of cells, corpuscles, and of the fundamental substance which contains them, develops by growth, which takes place at the periphery round the cellular lines.

The inferior lamellæ increase by the formation of new lamellæ beneath the preceding. The elements necessary for the formation of these lamellæ are brought by the longitudinal canals. The old lamellæ being the smallest, this explains why the thickness of the scale ought to increase in degree as one approaches the focus (*foyer*).

"Si nous voulons appliquer les résultats que nous avons obtenus dans l'étude de la structure intime des écailles, à l'explication de la manière dont elles se forment, nous verrons tout d'abord qu'il importe de bien distinguer la formation de la couche supérieure, et celle de la couche inférieure. La première, composée de cellules et de leurs bases avec le tissue qui contient les corpuscles, prend son développement par des accroissements qui ont lieu dans la périphérie, autour des lignes cellulaires; au moyen, de pareits accroissements, ils forment, non-seulement plusieurs lignes cellulaires, mais les canaux longitudinaux eux-mêmes se trouvent allongés. Il est très probable que ces lignes cellulaires ne se forment pas, seulement, l'une après l'autre, mais que plusieurs lignes sont produites simultanément ; nous en trouvons une preuve dans les écailles, qui dans leurs accroissement successifs, conservent les espaces marginaux, et dont les lignes cellulaires ou les cellules sont ainsi séparées en plusieurs groupes, nous citerons par exemple les écailles de cobitis fossilis. Mais cet accroissement dans la périphérie n'expliquerait nullement, la grande épaisseur du milieu ; nous en trouverons la cause dans la formation de la couche inférieure. Nous avons vu que celle-ci est composée de plusieurs lamelles. À chaque accroissement se forment toujours des nouvelles lamelles : les canaux longitudinaux, qui parcourent toute l'écaille, apportent les sucs nécessaires pour qu'une formation uniforme d'une nouvelle lamelle puisse s'opérer dans toute l'étendre de l'écaille. Il s'ensuit, que les anciennes lamelles étant plus petites, l'épaisseur doit s'augmenter, à mesure que l'ou se rapproche du foyer."

As to the use of scales for purposes of classification, Mandl says that up to the present "we have found definite and characteristic forms for each family," and that further research on a sufficient number of individuals would decide whether this might also be applied to genera and species. Mandl's views were thus totally at variance with those of Agassiz, and the latter answered in a letter addressed to l'Académie des sciences,* in which he attacks the results announced by his opponent. Agassiz concludes this letter by saying that the description which he had previously given of the structure of scales was correct, and that Mandl's method of viewing the subject was altogether wrong.

Mandl replied to Agassiz's letter by a counter letter, also addressed to l'Académie.† He reiterated that scales are organised bodies, and consist of true living tissue capable of nourishing itself and growing by intussusception. He replied to each of Agassiz's criticisms by a new affirmation to the opposite effect, and accused Agassiz of having badly understood or misinterpreted some of his points.

In the same year Agassiz published a fairly extended memoir,‡ in which he takes up the facts as stated by Mandl, one by one, and subjects them to the severest criticism.

After some points relating to the structure of the skin, Agassiz deals with the following:—

(*a*) Longitudinal canals, (*b*) cellular lines, (*c*) the corpuscles, (*d*) the fibrous layer, (*e*) the focus, (*f*) the teeth.

Firstly, Agassiz denied the existence of true longitudinal canals, and the rôle of these so-called canals as having the function of nourishing the scale.

As to the cellular lines, Agassiz emphatically denied the presence of cells, and wrote that Mandl had been deceived by an optical illusion. As to the corpuscles, Agassiz maintained that they are not situated in the thickness of the scale, as stated by Mandl; but on the contrary, close to the superior and inferior surfaces, for if one slightly scrapes one of these surfaces or, after a slight

* Agassiz, 1840. † Mandl, 1840. ‡ Agassiz, 1840.

maceration, raises some of the lamellæ, the corpuscles disappear. Agassiz thought that the corpuscles beneath are lamellæ incompletely formed, and those above are lamellæ which have been broken down through the friction of scales against one another. As to the fibrous layer, Agassiz believed that this layer, which Mandl described as serving for the foundation of the cellular substance of scales, has as little existence as the cells themselves; in other words, that its supposed existence was founded on an error of observation, as all fibrous tissues (tendons, cellular tissue, etc.) produce gluten on boiling, yet well-cleaned scales never produce that substance. Agassiz maintained that scales do not show two distinct layers, but that the superior and inferior layers have the same composition. He thought that the fibres described by Mandl were due to a tearing of the younger and less consistent inferior lamellæ, which gave rise to the appearance of fibres; but which was none the less an optical illusion. According to Agassiz, the focus is simply the oldest part of the scale, in which the superior lamellæ have been worn away by friction or exfoliation. Altogether, Agassiz maintained that the material which Mandl had brought forward as to the detailed structure of scales was quite erroneous. Agassiz's idea as to the mode of scale formation may be summarised as follows:—

"The scales of fishes are epidermic secretions, analogous to that of nails. As in nails, the scales are composed of exceedingly thin lamellæ of a horny nature, superimposed the one on the other in the order of their formation. The secreting organ is the epidermic pouch, in which the scales are ensconced at their anterior borders. The newly formed lamellæ are very soft, but of the same composition as the oldest lamellæ. The pouch increases in such a manner that the newly formed lamellæ are always larger than the older. The concentric lines are reflexed parts of the borders of superimposed lamellæ, and these lines are more numerous in old than in young fish. Scales disintegrate or waste chiefly round the focus by friction of the scales among themselves or by exfoliation. The focus and corpuscles on the external surface are simply results of this wearing down; one does not find them in non-imbricated scales, as in those of the eel, for example. By means of sections one sees that scales are composed of lamellæ, and that there are marks which correspond to concentric lines. The so-called teeth or notches are simply indentations of the posterior border of the lamella."

In the following year, Peters* gave a critical review and summary of the observations of Mandl and Agassiz. This author firstly gave some general considerations on the structure of the skin of fishes. In a fresh-water fish, one finds the following layers in the skin covering the scales:—

1. An epidermis composed of squamous cells (the latter being very abundant in the mucus of fishes).

2. A layer of pigmented cells.

3. The skin proper, a layer composed of fibrous connective tissue containing fatty globules.

4. An exceedingly thin membrane immediately on the external surface of the scale, but distinct from the skin. On this membrane are seen concentric

* Peters, 1841.

grooves and longitudinal ridges corresponding to the concentric ridges and longitudinal grooves on the scale. This membrane consists of thin crossed fibres, the intercrossing of which results in the indentations of the concentric ridges. The constituent fibres swell strongly under the action of acetic acid, a character which evidently belongs to fibres of connective tissue. The superior or external portion of the scale shows, moreover, a very fine inseparable layer, which shows the presence of fibres under the action of acetic acid, and which it is difficult to destroy by combustion. These intimate connections between skin and scale enable one to see how, during growth, the appearance of the scale surface may be modified without exfoliation taking place.

According to Peters, the scale is not formed in the epidermis, but in the skin itself; in that case the scale cannot be simply a horny secretion of the epidermis.

Peters agrees with Mandl in admitting the existence in all scales of a very soft lamellated inferior layer consisting of fibrous cartilage; he disagrees with Agassiz as to the number of lamellæ corresponding to the number of concentric striæ on the upper surface. He held that Agassiz had not sufficient proof of the non-existence of cartilage in scales, and did not believe in his statement as to the horny nature of scales.

As to the corpuscles, he maintained that these were found, not on both surfaces of the scale, as stated by Agassiz, but only on the inferior surface. He regards the corpuscles as special elements, and not as being due to incompletely formed lamellæ or to the wearing down of these thin layers. Corpuscles of some solidity show a granular appearance towards the border of the scale, and give rise to the asperities existing on the posterior border of many scales (Perch). Towards the centre of the scale one finds beneath the elliptical forms quadrangular corpuscles which are arranged in regular series, and give rise to spines. These spines are not, as Mandl supposed, comparable to true teeth. Peters believed that scales could not afford a proper basis for a rational classification, showing that two kinds of scales, cycloid and ctenoid, occur in the same fish (*Pelamys sarda*).

As to the superior or external layer of the scale, Peters realised much difficulty, especially in attempting to explain the origin and meaning of the concentric lines and radiating canals.

The superior layer, he said, does not usually show any distinct elements, though sometimes one can recognise in it the same fibres and the same corpuscles as in the inferior layer; but never with the same degree of distinctness and clearness. He did not believe that the concentric striæ represented the borders of superimposed lamellæ or plates of the scale, in as much as the striæ are not always parallel to the free border, but are sometimes perpendicular to it. For example, in *Alepocephalus rostratus* the striæ are only disposed concentrically in the posterior third of the scale, while in the remainder of their extent they run straight forward, parallel the one to the other. He agrees with Agassiz in refuting the statement of Mandl in regarding the radiating canals as serving for the nutrition of scales, and regards them rather as sutures rendering growth possible in all directions. He adds that these sutures are not only found running out from the centre in the direction of the periphery, but sutures are sometimes disposed concentrically (Ophidium, Sudis, Rypticus, Heterotis, etc.).

Peters denies the existence of osseous corpuscles in ordinary scales, but admits the fact of their presence in Polypterus and Lepisosteus.

In his paper on the embryology of the salmon, Vogt brings forward some facts relating to the development of scales.* He states that the scales do not show themselves till three months after hatching; that the concentric plates, so numerous in the scales of the adult salmon, are relatively few in number in the young fish; but that the lines which indicate the borders of different plates are just as continuous in the young as in the old scale, and thus in no way indicate formation from isolated cells. He notes that the central focus is frequently smaller in the young as contrasted with the adult worn scale.

Müller issued a paper on Ganoids and natural classification of fishes.† In part of this paper the author deals with some points relating to the taxonomic value of the characters of scales. He held that the differences between the scales of Cycloids and Ctenoids is of little importance, and can only be useful for purposes of classification in a very limited way. ‡ Later Vogt issued another paper, § in which he discusses the value of the characters of scales in distinguishing different orders of Ganoids.

In the *Manual of Comparative Anatomy*, by Siebold and Stannius,|| the latter makes some statements regarding scales. He writes that scales cannot be regarded as horny epidermic formations, and that it is impossible to ignore the presence of a substance on the lower scale surface possessing a fibro-cartilaginous texture and the existence of osseous corpuscles in some scales. He does not admit that scale growth takes place only by means of superimposed layers, and regards it as doubtful whether it would be right to take the different forms of scales exclusively as a basis for classification.

In a paper by Dareste on the classification of Plectognathes, we find some observations on the scales of fishes belonging to this order.¶ In regard to the integuments of Diodons and Tetrodons, he writes that in these we have not scales, but spines, which are fixed in the skin by roots of a horny nature. The spinous portion is very closely analogous to the ivory of teeth, and contains as in these tubules which radiate out in all directions. The integument of Triodons differs from that of Diodons and Tetrodons in possessing true scales, comparable on the whole to those of osseous fishes. The external border shows indentations similar to the ctenoid condition as described by Agassiz. The cuirass of Ostracions results from the union of rhomboidal plates placed side by side, and which possess an inferior layer of a horny nature and a superior layer of osseous substance possessing calciferous tubes which recall the structure of teeth.

Dareste, in another paper on *Blochius longirostris*,** gives some considerations on the value of scales as characters in classification. He would not give them the rôle of dominating characters.

Williamson published an important paper on the structure and development of the scales and bones of fishes.†† Writing in 1873, Baudelot claims

* Vogt, 1842. † Müller, 1844. ‡ Muller, 1843. § Vogt, 1845.
|| Siebold and Stannius, 1849. ¶ Dareste, 1850.
** Dareste, 1850. †† Williamson, 1851.

that the latter paper is "one of the most important which has been published on the scales of osseous fishes."

Williamson brought forward important general views relating to the mode of composition of the scales and of the other hard parts in fishes. He endeavoured to show that scales, teeth, chondrified and membranous bones, etc., are not really formed of tissues of an entirely different nature, but of tissues which pass the one into the other by gradual transitions. Williamson commences his paper by a critical review of Mandl and Agassiz's work. He regarded Mandl's view of scale formation as given on page 7 as being more correct in some respects than that of other writers, but as being built upon a false foundation on account of his having mistaken solid calcareous granules for cells. He regarded Mandl's description of the inferior layer as correct, but denied the existence of longitudinal canals as described by him.

Williamson points out that although Agassiz at first refuted Mandl's statement as to their being two layers in scales, he subsequently acknowledged that each scale really consisted of two different strata. Williamson regarded Agassiz's views to be as little tenable as those of Mandl. He says that while Agassiz regarded the lower layer of the scale "as a horny substance, an exuded secretion from the sac into which he considers the lower and anterior portions of the scale to be fitted," it is really a fibrous substance.

He says that Agassiz has failed "to detect the existence of two distinct structures in the upper or calcified part of the scale," and that in regarding the corpuscles in the middle of the scale not as true corpuscles, but rather as due to some solution of continuity between the upper and lower tissue, he has quite mistaken their character. According to Williamson, cycloid and ctenoid scales consist of three layers, inferior, median, and superior.

The *inferior layer* consists of numerous membranous laminæ arranged in parallel horizontal lines. These laminæ are most numerous in the centre of the scale, and decrease in number as we approach the periphery, until finally only one is present. Each of these membranous laminæ is composed of numerous fine fibres, all of which run parallel with one another in the same lamina. Numerous isolated lenticular calcareous bodies are to be observed imbedded amongst these membranous laminæ. These calcareous bodies arise as a result of the calcification of the membranous laminæ, and appear firstly as small calcareous atoms, which grow in size by the addition of successive concentric laminæ to their external borders. "The growth in size of cycloid and ctenoid scales takes place by the successive addition of membranous lamellæ on the inferior face of those which have been previously formed, each new plate being larger than the preceding."

The median layer of the scale is mainly built up of a mass of similar lenticular calcareous bodies which unite with one another as they increase in size, frequently also losing their original lenticular shape during this process of coalescence.

This median layer of the scale decreases in thickness as one proceeds from the centre to the periphery until at last it disappears altogether, the calcareous layer being not only thicker, but now consolidated towards the centre of the scale. After the calcareous granules have become fused and consolidated together, the median layer thus formed is split up into horizontal laminæ which agree in their direction with the membranous laminæ previous to calcification. The laminæ also exhibit a number of vertical cleavages or fissures. "The middle layer then is produced by the formation and coalescence of the small lenticular bodies, through the agency of which the calcification of the membranous laminæ is effected. This calcification permeates the entire extent of the upper and earlier-formed lamellæ, whilst, with the exception of a few isolated granules, it has been confined to the margins of those which are inferior and of more recent growth."

The superior layer of the scale differs both in structure and in mode of origin from the median and inferior layer. This superior layer is the one by various modifications of which all the ridges and tubercles seen on the surfaces of scales are produced. In vertical section it frequently shows an undulating outline and has traces of a lamellar formation (the lamellæ being homogeneous and devoid of structure), the more external being parallel with the upper surface of the section. The radiating lines (nutrient canals of Mandl) are produced simply by the absence of superficial tissue along their course. While these radiating lines are not nutrient canals, as was supposed by Mandl, neither do they pass through the entire calcareous portion of the scale and reach the underlying soft tissues, as was maintained by Agassiz: they only do so at the margin of the scale, where the median layer is not yet developed; but towards the centre, where the median layer exists, these grooves do not pass through it. The ridges intervening between these radiating lines are of some thickness, and are transversely subdivided by a large number of small ridges. These ridges are really the concentric lines seen on the surfaces of most cycloid and ctenoid scales. The superior layer of the scale covers the entire surface of the scale even to its extreme periphery, but the median ceases to exist at some little distance from the margin. The growth of the superior layer is effected at its upper surface by the calcification of a thin superficial membrane which covers the scale at the same time that the corresponding though different process is adding to the lower surface of the median layer. He says "it thus becomes manifest that these concentric ridges are not lines of growth, as thought by M. Mandl, but the result of a peculiar arrangement of the superficial tissue of the scale, a conclusion which accords with that arrived at by M. Agassiz." After a description of the scales of the carp, pike, salmon, perch, he says, "The question which now suggests itself is, what relation does the superior investing membrane bear to the inferior fibrous portion?"

To this question, however, he is unable to give anything more than hypothetical answers (see page 654, Williamson) and continues, "Be the process of its genesis what it may, we have here demonstrative evidence of the existence of such a superficial film of soft membrane as is essential to my hypothesis, accounting for the peculiar structure and growth of the uppermost layer." He further regarded the substance of the superior layer as probably identical with the ganoin existing in Lepidosteus, Lepidotus, and their allies.

Leydig gives a description of the structure of scales,* in which his reference to the corpuscles of Mandl is the most important point raised. These are

* Leydig, 1851.

sometimes situated freely side by side, or the one above the other, sometimes they increase directly to form the asperities and teeth on the posterior border of scales (*Perca fluviatilis*, *Acerina cernua*), sometimes they fuse together at their margins, forming a united mass, a layer of the scale. Leydig asks of what nature these corpuscles are which on fusing come to produce scales. In considering the rôle of these corpuscles in the production of scales, he considers them as analogous to the free globules of Czermak, which on fusing together produce dentary substance.

According to him, the grooves on the scales of the lateral line show a different texture from the rest of the scales. They are rather true osseous products superadded to the scales. In another paper Leydig gives observations on the structure of scales in *Polypterus bichir*,* which does not specially deserve attention in a paper dealing mainly with cycloid scales. In a later work Leydig deals with the subject of the corpuscles in scales of various genera;† but this consists in the main of a reproduction of his previous work in the first paper mentioned.

Hollard issued a monograph on the family Balistidæ.‡ The disposition of tubercles and spines on the scales, their grouping and mode of formation, have chiefly engaged his attention so far as he takes up the subject of scales in this monograph. Hollard§ published a second monograph on the Ostracions, in which he gave a detailed description of the tegumentary and scale systems in this family. He held that the spines on scales are of value for purposes of specific classification.

Steenstrup issued a paper in which there is an interesting note in direct connection with the main subject of my paper.‖ He says, "The scales of osseus fishes, Cycloid, Ctenoid, and Ganoid, persist during the entire life of the fish. They grow with the growth of the animal. The scaly covering of fish is consequently composed of the same number of scales during the entire life of the animal. This is so true, that allied species may be distinguished with certainty by the number of scales in each longitudinal line." Steenstrup states that the case is very different in cartilaginous fishes, that placoid scales do not grow with the fish. Their size never exceeds certain limits, and their existence is only temporary. They fall off continually and give place to others.

Owen gives a brief note regarding the scales of the tunny, and a description accompanied by a figure of the scales of the eel.¶

Blanchard published a work on the fresh-water fishes of France.** In this work he does not give any detailed description of the internal structure of scales, but he gives figures and descriptions of their external appearance for a number of species. He finds it difficult to agree with Agassiz's idea of the mode of scale growth by the successive addition of new plates or laminæ to the inferior face of previously existing ones, and in regarding the concentric lines as the edges of those plates, as, according to Blanchard, the number of concentric striæ is as great in very small as in very large fish of the same species. Blanchard brought forward a novel idea as to the function of scales, namely, that they fulfil a rôle in the respiratory function, varying in degree in

* Leydig, 1854. † Leydig, 1866. ‡ Hollard, 1853, 1854.
§ Hollard, 1857. ‖ Steenstrup, 1861. ¶ Owen, 1866.
** Blanchard, 1866.

different types, but notably developed in the Cyprinidæ, for example, in which the scales are penetrated by canals through which water may easily percolate.

We are indebted to Dr. Salbey for an interesting paper on the structure and mode of growth of fish scales.* In this work Dr. Salbey commences with some points on the structure of the skin, in which he reviews facts already known, then he gives a brief description of the four types of scales (Placoid, Ganoid, Ctenoid, and Cycloid) established by Agassiz, and lastly he deals with the external characters, internal structure, and mode of growth in the Cycloid and Ctentoid types. According to Salbey, there are two layers in scales, (1) an external or superior layer and (2) an internal or inferior layer. The superior layer develops at the expense of the superficial layer of the skin by the deposition of calcareous salts at the interior of this layer. The inferior layer is composed of superimposed lamellæ, indefinite in number. These lamellæ, are not homogeneous but are of two kinds. They are arranged in such a manner that a comparatively thin lamella is found between every two thicker lamellæ. These thin and thick lamellæ differ in character. The thick lamellæ are colourless and calcareous in their nature, the thin lamellæ are yellowish and composed of a conjunctive substance, a kind of cement (*Kittsubstanz*). Thus the arrangement of lamellæ is that of a conjunctive layer disposed between every two calcareous layers. In making sections the conjunctive layer resolves itself into fibrous elements, the individual elements of which appear to follow the same direction. The number of superimposed lamellæ has no definite relation to the age of the fish, as seen by a comparison of the number of lamellæ on fish of the same species, but of very different ages. He thinks, however, that as the lamellæ of older fish are thicker, and as the difference in colour between lamellæ does not appear, it is probable that conjunctive lamellæ calcify during progressing years and fuse with adjoining calcareous lamellæ. From this occurrence, it would result that the number of lamellæ, while really being greater in the older fish, does not appear to be so, on account of the lines of separation between the old lamellæ having disappeared. On the preceding characters Dr. Salbey builds the following interpretation of scale growth. In the membrane situated at the inferior part of the scale there takes place a periodic deposit of calcareous matter. This membrane, impregnated with calcareous salts, represents the inferior lamella of the scale. Between this calcified inferior lamella and the skin there appears a new layer of conjunctive substance. After a varying lapse of time, this new layer calcifies itself in its turn and so on. This mode of growth may serve to explain, says the author, how it comes about that the inferior layer of the scale is the largest, and why there is a softer layer present at the inferior part of the scale. This softer layer is merely a layer of conjunctive substance, which has been deposited upon the most inferior layer between that and the skin. Besides these facts relating to the layers of scales, Salbey deals with the concentric lines, the grooves, the focus, and corpuscles.

Concentric lines. The concentric lines have not any connection with the lamellæ which compose the scale, as one may easily show by vertical sections. These lines or ridges only belong to the superficial layer, and thus one under-

* Salbey, 1868.

stands how they may abruptly disappear, and how new striæ may interpose themselves between previously existing striæ.

The grooves. These represent channels carved out of the surface of the superior layer; and the conjunctive substance mentioned above constitutes their foundation. Besides the grooves directed from the periphery towards the centre of the scale, there exist in Ophidium and other fishes grooves concentrically arranged. "These varied grooves may contribute to the enlargement of the scale at the surface, and permit through the intermediation of the conjunctive substance, which calcifies slowly, a continued deposition of calcareous salts in the lamellæ, which are not in direct connection with the skin, and in the conjunctive substance of the scale."

The focus. Regarding the focus of the scale, Salbey agrees with Peters in rejecting Agassiz's idea as to its formation by a process of exfoliation or wearing down of the oldest layers of the scale. It is natural, he says, that the projections which are nearest the centre of the scale should be smaller and less apparent than those which are situated nearer the periphery, because at the central point, where the superior layer of the scale is thinnest, as it was formed at a period in the early life of the fish, the projections or crests would not be so distinct and pronounced as those in peripheral parts formed during the later life of the fish. The presence of skin at the surface of the scale does not allow of any other explanation, and in order to believe that a wearing down has there taken place, it is necessary to suppose that a destruction of the epidermis and of the skin has taken place at this part. The focus is nothing else than the oldest part of the scale. It is also the thickest part of the scale, because there we have the greatest number of lamellæ at the internal face of the scale.

Corpuscles. Salbey does not bring forward any important facts as to the corpuscles of scales. He agrees with Leydig in regarding them as ossified globular bodies.

Teeth. Regarding the teeth of scales, Salbey rebuffs the opinion of Peters, according to whom these parts develop from the corpuscles of scales. He also disagrees with Mandl, who regarded these appendages as true teeth. He considers these small teeth as integral parts of the superior layer. These minute teeth appear successively at the posterior border of the scale as that grows; it is because of this mode of growth that the points formed in the last part appear perfectly preserved, while those which during the progress of growth become carried further forward are very small and much broken by external friction.

Carpenter devotes several pages to the structure of scales in osseous, ganoid, and placoid fishes.* On the subject of osseous fishes, he deals in a very concise manner with the scales of the eel, carp, and sole.

Regarding the cycloid and ctenoid divisions established by Agassiz, he considers this sharp division as having little harmony with the general organisation of the types which it has the aim of separating.

Vaillant also takes up the question of the value of cycloid and ctenoid characters as propounded by Agassiz for purposes of classification.† He shows the great variation which occurs in the scales of Percidæ, not only in different

* Carpenter, 1868. † Vaillant, 1872.

individuals of the same species, but on different regions of the body on the same individual. Owing to this variation he regards Agassiz's division into cycloid and ctenoid as of little value.

The next work which I have to notice is a lengthened and interesting paper by Baudelot, in three parts.*

Part I. is concerned with a historical review of the literature relating to scales previous to the year 1873, of which I have made ample use in the foregoing pages. Part II. contains a detailed study of a certain number of types of scales, considered from the point of view of structure and development. Part III. has a number of facts on the value of the characters found in scales in relation to classification.

Part II. consists of two sections, of which the second section gives a synthetic summary of the facts propounded in the first section.

In Section I. he treats of the following:—

Analytical study of types of scales.

1. *Perca fluviatilis*, with eight figures.
2. *Phoxinus lævis*, with one figure.
3. *Esox lucius*, with two figures.
4. *Clupea harengus*, with one figure.
5. *Anguilla vulgaris*, with five figures.
6. *Ophidium barbatum*, with two figures.
7. *Gadus merlangus*.
8. *Cyprinus carpio*, with eight figures.
9. *Pleuronectes solea*, with five figures.
10. *Thynnus vulgaris*, with seven figures.
11. *Mugil capito*, with eleven figures.
12. Hypostomum, with fourteen figures.

In this analytical study of the foregoing types of scales, he devotes much attention to the corpuscles of scales.

In the second and synthetic section of Part II. he treats of the following:—

1. The connection between the scales and integument.
2. The form of scales and their mode of orientation.
3. The size of scales.
4. The ridges on scales.
5. The spines on scales.
6. The grooves on scales.
7. The perforating canals in scales.
8. The internal lacunæ of scales.
9. The focus or centre of growth.
10. The tissue of scales.
11. The formation and growth of scales.

1. *The connection between the scales and integument.* The scales of cycloid and ctenoid fishes are usually contained in small dermic sacs, and are more or less visible to the exterior; but in some cases they are not so, being deeply buried in the skin (Anguilla, Ophidium, Lota, etc.).

* Baudelot, 1873.

When scales are provided with spines, as in Ctenoids, the points of these may be seen piercing the epidermis, and so appearing freely at the surface. The degree with which scales adhere to the skin is subject to great variation in different fish. In the herring, for instance, scales are very easily detached; but in *Dactylopterus volitans*, etc., they are only separated from the skin with much difficulty. Scales are never entirely free in the dermic pouch, as they are always connected with its walls by fibrils of connected tissue, usually of extreme fineness. In imbricated scales the free portion has a more or less intimate connection with the skin, and so in extracting scales from the body of the fish, the free portion carries with it débris of the skin, from which it is frequently difficult to separate it. In certain varieties of carp (mirror carp, leather carp), in which, as one knows, scales may disappear on more or less extended parts of the body, the scales show very varied connections with the skin. On certain parts one meets with very large scales much imbricated, on other parts the scales are still larger, but scarcely covered over, or even entirely isolated. Extremely small scales are also found, which are completely enclosed in the depths of the skin. The imbrication of scales ought to be considered so far as a phenomenon of mechanical arrangement intimately connected with the greater or lesser development of scales and with the degree of their separation.

2. *The form of scales and their mode of orientation.* The form of scales is extremely variable. These variations occur not only in different species, but in different regions of the body of the same fish. In each fish the large scales covering the median region of the flank may be considered typical, that is to say, they possess in the largest measure and with most constancy all the proper characters of the species. Scales from the dorsal and ventral surface, from the head and fins, frequently show more or less marked deformations, and seem to lose some of their characteristic features. Scales oval at one place may change into a circular form at another place, polygonal scales to circular ones, elliptical to a more or less irregular form.

Lobes at the margins of scales, spines, concentric ridges, and grooves may vary considerably in number, and even disappear altogether in different parts of the body. "Nothing is more variable than the external characters of scales, and as in a tree one does not find two leaves exactly identical, so is it in regard to the scales of fishes; but the particular features of scales, as of leaves, do not all vary at the same time, and thus there generally remain several general characters of resemblance which scarcely allow us to confound the scales of one species with those of another." The simultaneous presence of cycloid and ctenoid scales was pointed out by Baudelot in the following:—*Trigla lineata*, *Sargus Rondeletti*, *Perca fluviatilis*, *Pleuronectes solea*, *Pleuronectes flesus*, etc.

The form of scales appears somewhat to depend upon their connection with one another, their juxtaposition; thus scales isolated in the skin tend to have a rounded or circular form (Lota, Anguilla, Ophidium). On the contrary, where scales are large and much pressed the one against the other, they most frequently take a polygonal form. The orientation of the long axes of scales in relation to the axis of the body is usually fairly constant in those fish in which there is a regular and distinct imbrication of scales. In fishes in which the scales are isolated and completely enclosed in the skin (Anguilla, *Ophidium barbatum*, etc.) the long axis of the scale does not usually show any fixed position as regards its direction.

It appears probable that the reciprocal pressure exercised by scales the one upon the other, contributes so far in bringing about a similar mode of orientation among them.

3. *The size of scales.* The size of scales is extremely variable. They even show varying dimensions on different parts of the body of the same fish. For instance, the scales on the flanks are larger than those near the caudal fins. Scales gradually diminish in size from the median region of the side towards the tail or anus. Scales are also reduced in size in various parts of the head, in the opercular and preopercular regions and in the suborbital region. Baudelot gives tables showing the variation in size in different regions of the body for the perch, pike, and mullet. These tables show in what proportions the size of scales varies with the age and size of the fish mentioned. Growth is continuous but unequal in scales from different regions of the body. One finds very great variation in the size of scales in different species of the same family of fish, and certain varieties of the same species show extreme differences in the relative sizes of their scales. For example, the so-called mirror carp has very much larger scales than those of the ordinary carp. In another variety, the leather carp, the scales have become very rudimentary or have entirely disappeared.

4. *The ridges on scales* (crêtes de l'écaille). In cycloid and ctenoid fishes the surfaces of the scales show linear projections which are usually parallel to the external contour of the scale. Baudelot describes the arrangement of these under the term "crêtes de l'écaille." Though these ridges are almost constantly present, yet in several types of fishes they disappear more or less completely, for example, in *Dactylopterus volitans* and the tunny. In the tunny one finds some scales provided with as many ridges as usual, others with ridges only at the margins, and others in which these ridges are completely wanting. In the eel, scales do not show ordinary ridges on their surfaces; these are replaced by reliefs of a quite distinct appearance, but really of the same nature as the ridges.

In regard to the disposition of ridges on the scale surface there is considerable variation in different fishes. In certain types of scales, those of the salmon for example, the ridges run parallel to the contour of the scale in a perfectly regular manner, thus forming a series of continuous reliefs which may truly be termed "concentric ridges." In other types of scales, those of the pike, some Cyprinidæ and Pleuronectidæ, for example, the concentric ridges show some degree of regularity in the peripheral portion of the scale, but as they approach the centre of growth they lose their uniformity, become interrupted at various points, bent in various directions, intersected by secondary ridges, and finally appear like a "veritable labyrinth." In regard to this point there are the greatest differences between scales of the same fish.

In many scales the characters of the concentric ridges undergo a greater or less change in the posterior region of the field; sometimes they may entirely disappear (herring, shad), sometimes they become very rare, they separate the one from the other, lose their regularity, enlarge at certain points, or become covered by tubercular projections (carp and other Cyprinids).

In some fishes these ridges assume a peculiar mode of orientation. Instead of following a course parallel to the contour of the scale, they take a direction more or less perpendicular to this line, remaining, however, parallel to one another (Alepocephalus, herring, shad). The particular disposition observed in the herring, etc., is not an isolated fact, but the expression of a more or less general fact which appears in various degrees. The number of concentric ridges is not the same in the different regions of the scale. It is usually much greater in the anterior than in the lateral field, and in the lateral than in the posterior field (perch, pike, minnow); this fact helps to prove that all the ridges do not originate round the circumference of the scale. The number of ridges may show the greatest variations in scales of the same fish; the number appears to be in proportion to the extent of the scale. Thus in large scales from the flanks the ridges are relatively numerous, in very small and rudimentary scales from other regions of the body (caudal fin, opercular region) these ridges are extremely reduced in number. "*Variations in the number of ridges are not usually great in scales from the same region. In fishes of the same species, but of different age, the number of ridges increases proportionately with age, and consequently also with the dimensions of scales." It is easy to verify this fact by comparing scales from the same region in fish of very different size.*

From this point of view, Baudelot made observations on scales of the pike, perch, and minnow to determine the differences in number from simple to double, triple, quadruple, and so onwards.

New ridges are formed successively at a very slight distance from the border of the scale by a partial calcification of the external layer. This calcification shows itself firstly as a simple track of calcareous molecules in the membranous zone which exists at the margin of the scale. This track of molecules represents a calcigenous centre round which the calcareous substance accumulates.

From the thickening of this calcareous track there results firstly a slight projecting part, which in raising itself soon constitutes a ridge. This enlarges little by little at its base by the addition of calcareous molecules and finally unites with adjoining ridges, so as to form a continuous calcareous investment on the surface of the scale. This mode of formation of ridges may be easily followed in the scales of the sole, in the membranous zone which constitutes the border of each of the lateral fields; and it is also obvious in the scales of many other types of fishes.

The ridges of the scale surface examined under a very high power show their free borders to be sometimes smooth, but in other cases crenated in such a manner as to present fine denticulations. These denticulations may be seen in the scales of the mullet, perch, and burbot, but the asperities are not uniformly present on all the ridges of the same scale, and they may be completely absent in the marginal ridges. In many scales (burbot, mullet) the concentric ridges appear to offer a marked inclination towards the centre of the scale. This inclination shows itself by a more or less pronounced difference in the degree of obliquity of the two planes corresponding to the two opposed faces of the concentric ridge. Tranverse sections, that is to say, sections perpendicular to the surface of the scale, also show this point. The separation of the ridges is not great, and does not appear to vary with age; the latter point evidently proves that the scale does not grow at all points on its surface. The distance separating the ridges from one another may remain the same in the different regions of the scale; but this is by no means constantly the case. In the sole, for example, the ridges are much closer in the anterior than in the lateral part of the scale; and in most cycloid scales the ridges of the posterior region show a greater degree of separation than those of the lateral and anterior regions (minnow, Cyprinus, etc.).

"*It is also not uncommon to find in the same area of the scale successive zones in the extent of which the ridges show different degrees of separation.*" (See figures of carp scales.)

From the following facts, Baudelot concludes that the ridges do not represent by any means the borders of superimposed plates or lamellæ, as many zoologists had supposed; but that these ridges, whether they be concentric lines or not, are nothing else than reliefs corresponding to lines of calcification at the external layer of the scale.

(1) The ridges only very rarely affect a complete arrangement in the form of concentric lines.

(2) These ridges may be perpendicular to the contour of the scale.

(3) These ridges may show the most irregular arrangement, become folded up against one another, entangled in all directions, or even form a sort of network of irregular meshes.

(4) The ridges are appendages to the superficial layer of the scale.

(5) They originate at the margin of the scale as points of isolated calcification.

(6) They show a marked inclination towards the centre of the scale.

5. *The spines* (spinula). Under this heading Baudelot discusses the small spinous projections seen in the posterior portion of ctenoid scales. The variation in the form of those appendages is very great, affording transitions from simple denticulations to true teeth. In the tunny, for example, we find quite simple denticulations or cuttings in the posterior border of the scale which cannot be regarded as distinct organs, but simply as projecting lobes of the free border of the scale. At a further stage (some species of Sargus) denticulations project from the concentric ridges of the posterior field. This is really only a more marked phase of the microscopic denticulations already mentioned in connection with the concentric ridges. In a still further developed stage the spines cover the entire surface of the posterior field, and are conical, pointed, or truncated. Notable variations of this form are seen in different fishes; for instance, in the mullet the spines are plates, with the external surface raised in slightly projecting cones; but on the other hand, in the perch the spines are much elongated, and appear as true spines much tapered at their extremities.

In a fourth case, as in the sole and some other Pleuronectids, the spines are long, rounded, and drawn out at their extremities as in the last case; but they are not solid, but hollowed out internally into a more or less spacious cavity. In the fifth degree, the spines have the same external form as in the last case; but they are not composed of homogeneous tissue similar to that of the scale, but of dentine, in which canaliculi extend from the central canal to near the surface. Such a structure is found, for example, in the spine of Hypostoma. As to the dimensions of spines on scales and their growth, he says that in passing from the free border to the centre of the scale they gradually lose their volume, but in a transitional manner. The dimensions of spines increase with the age of the fish in a marked degree. The number of spines also varies in different regions of the body and with age. By a comparison of scales from the same fish one finds that the number of spines varies only slightly in points from the same or adjoining regions of the body; but those scales from different regions show considerable variations as to the number of spines. There are, however, exceptions to this rule (dab). The number of spines as of concentric ridges is usually greatest in scales from the median region of the side.

In those regions in which scales tend to be rudimentary, they also tend to lose their spines, and thus become cycloid. The fact seems almost certain, that there does not appear to be a single ctenoid fish in which one would not meet cycloid scales on certain points of its body. Baudelot brings forward some facts to show that new spines form themselves behind those already existing on the posterior border. The spines and concentric ridges are homologous productions, and growth of both takes place in the same direction. According to Baudelot, then, spines are products of the same nature as the concentric ridges; they are ridges which have become very prominent, and cut into transversely in such a manner as to constitute a series of prolonged spines, each with a distinct base. In support of this hypothesis he brings forward the following facts:—

In many scales, such as those of the perch and mullet, the edge of the concentric ridges presents a series of very distinct microscopic indentations, and in some ctenoid scales the spines are so small as to represent only stronger indentations of the ridges of the posterior region which have become very prominent. In many cycloid scales, such as those of the carp, the posterior region shows a series of tubercles arranged with as much regularity as spines, and which present the greatest analogy to these structures. These tubercles are, however, only partial thickenings of concentric ridges. In the same fish scales become altered and pass from the ctenoid to the cycloid condition, and in that case it frequently happens that the spines become replaced by simple ridges, a substitution which is a clear proof of the homology of spines and concentric ridges. Among Pleuronectidæ, in which some are ctenoid (sole, dab), and others are cycloid (brill, flounder), the scales of cycloid forms frequently show in the posterior area, instead of rows of spines, distinct islets of calcareous matter, each supporting a fragment of concentric ridge. When these islets of calcareous matter become straitened and more regular, they evidently result in spines.

6. *The grooves* (sillons) *on scales.* This term has been given to very narrow grooves or trenches which are supposed to have been excavated at the expense of the superficial layer of the scale. These grooves are not present in

all scales; those of the salmon and lote, for example, do not possess them. They may be limited to one region of the scale, or be present over the entire surface. From a general point of view, they may be divided into two categories:—(1) Those which radiate from the centre of growth towards the periphery are termed *radial or radiating grooves* (carp, perch). (2) Those which have a direction parallel to the contour of the scale, and therefore perpendicular to the radiating canals, are termed *transverse or concentric grooves* (Ophidium, whiting). Those two kinds (*radiating and concentric grooves*) may be present simultaneously in the same scale; but in the majority of scales only the *radiating or radial grooves* are found. In most cases they only occupy the anterior region of the scale (perch, pike), but they may occupy the posterior as well as the anterior areas (carp), or they may be present over the entire surface of the scale, anterior, posterior, and lateral (loach, minnow, whiting). When the concentric grooves and radiating grooves are present in the same scale, two cases present themselves: firstly, that in which the two kinds of grooves are found in two different areas of the scale (several Pleuronectids), in which case the radiating grooves exist in the anterior and posterior area, and the concentric or transverse grooves in the lateral areas; or secondly, that in which the radiating and concentric grooves exist in the same area of the scale, by which means *the scale surface is divided up into numerous plates or divisions, which occasionally form a regular series of plates radiating from the centre to the periphery* (Ophidium, whiting, eel).

While in a general way one may separate the grooves into these two categories, namely, radiating and transverse grooves, there are many scales in which the grooves lose their usual symmetry and affect a more or less irregular arrangement. Sometimes the grooves show up to a certain point the usual radiating arrangement and then anastomose with each other, thus forming on the scale surface a species of plexus of irregular webs (Labridæ, Mormyridæ). The grooves of the anterior area also frequently anastomose with those of the posterior area in the region of the centre of growth (Cyprinus, Labrus). In the herring and shad there are grooves in the anterior part of the scale which originate on the lateral border, and extend across the anterior area, keeping more or less parallel with one another.

As regards form, the grooves show extremely varied characters: sometimes they take the form of a simple line, resembling a fissure or line of break on the external surface of the scale (herring, shad, transverse grooves of Ophidium, whiting); sometimes they appear as a species of ravine, narrowed at the base and cut out perpendicularly at the sides; at other times they have the appearance of a wide trench of little depth and flat at the base; sometimes the grooves lose their regularity, become narrowed at some points and enlarged at others, constituting species of small depressions (*lacules*) with sinuous and irregular contours; sometimes a groove may be interrupted at certain places, and then one has a series of small cavities or depressions (*lacules*) lying in the same straight line and in the same direction. The edges of grooves are usually irregular and jagged, but they also frequently show rounded lobes, due to the presence of calcareous globules.

The radiating grooves do not usually extend over the entire distance from the border of the scale to the centre of growth; a certain number of them do extend over all this distance, but the others usually only run over a portion of the radius. Some of the radiating grooves commence at the periphery and stop almost immediately, others extend a little further, and others still further without reaching the centre of growth. Ridges may also be seen commencing at only a short distance from the margin of the scale, sometimes terminating at the centre of the scale, and at other times terminating after a short passage. It is clear that there occur grooves whose course is reduced, as they only extend over a minimum portion of the radius. Grooves occupying the median portion of the anterior area are, as a rule, longer than those at the sides or lateral areas of the scale. This also holds true for the grooves in the posterior region of the scale. When the radiating grooves are wide, regular, and very close together, the scale surface appears as if it had been cut into a series of bands or triangular tongues, with the apices turned towards the centre of growth (see anterior region of scale of sole).

The concentric or transverse grooves are situated between the concentric ridges, and are more or less parallel to them. These grooves are, as a rule, only found on a limited part of the scale surface, and they occur more frequently in the periphery than in the part surrounding the centre of growth. These concentric grooves may be very narrow (whiting, Ophidium) or very wide (lateral areas in various Pleuronectids). When very wide concentric grooves co-exist with radiating grooves equally wide, the surface of the scale becomes divided up into calcareous areas of varying size. These areas may be irregular (posterior area of various Pleuronectids, scales of *Gadus molva*), or they may be regularly rounded and in the form of small medallions (scales of eel). The number of radiating grooves varies much in different scales from the same fish; these variations become very apparent in comparing scales from different regions of the body, rudimentary with well-developed scales. In extremely rudimentary scales grooves may not exist. In scales from the same region of the body the number of radiating grooves does not vary to nearly the same extent. The number of grooves of an individual scale is capable of varying with age. As regards the transverse or concentric grooves, there does not appear to be any doubt that these grooves, which are situated between the concentric crests, are formed at the same time as the latter. In regard to the radiating grooves, it appears that they multiply during the growth of the scale, at least in a very large number of cases.

If the number of grooves in scales increases with age, it may also become reduced. This fact appears true for the transverse grooves, as in scales in which these grooves are found (whiting, Ophidium) one usually finds them much more pronounced towards the periphery than towards the centre, where they may completely disappear. As to reduction in the number of radiating grooves, Mandl observed that they disappeared in old fish belonging to the genus Abramis, and in other old scales they evidently disappear in the area round the centre of growth. Baudelot remarks that "up to the present time (1873) the grooves on scales have not been explained in a satisfactory manner." Mandl regarded them as canals serving for purposes of nutrition of the scale; Peters as suture lines which rendered possible the growth of scales. Williamson held that they were erosions effected at the expense of the superior layer of the scale. Vogt thought the radiating lines as difficult to explain in young as in adult scales, and Blanchard regarded them as canals which had connection with the supposed respiratory function of scales. Dr. Salbey thought that they were excavations of the superior layer aiding the growth of the scale in surface extent. It appeared necessary to Baudelot to abandon all these interpretations of the grooves on scales. From his observations he held the following view: "The grooves of scales ought to be considered as lines or zones of non-calcification, that is to say, as lines to the level of which the calcification of the exterior layer of the scale has not taken place." The exterior layer has centres of calcification which later unite with each other as these centres extend. "When the union of the centres of calcification takes place from the centre of growth towards the periphery and occurs at the same time in the transverse direction, that is to say, parallel to the external contour of the scale, there result radiating grooves; when, on the contrary, the union of calcigenous centres takes place parallel to the contour of the scale, without having taken place at the same time in the radial direction, transverse or concentric grooves result. When the union of calcigenous centres fails to take place both in the radial direction and transversal direction (parallel to the external contour of the scale) at the same time, there results the simultaneous existence of radiating and concentric grooves. Lastly, when the union of calcigenous centres takes place without order and symmetry, the surface of the scale shows grooves arranged in a more or less irregular manner. It is hardly necessary to add that when the union of centres of calcification takes place completely in all directions, there is no further trace of grooves at the surface of the scale."

7. *The perforating canaliculi.* Under this term Baudelot described for the first time extremely small canals which traverse the scale through and through from the upper to the under side. Baudelot firstly observed these perforating canaliculi in the carp; but found them later in many other fish scales, both cycloid and ctenoid. These perforating canaliculi are only found in the posterior area of the scale. In some types of scales they are easily observed, in others only with difficulty. In the scales of the carp the perforating canaliculi open externally in connection with the radiating canals of the posterior area, and traverse the scale through to the under side in a slightly oblique direction, and terminate internally on the inferior surface of the scale. This internal opening or ostiole is usually nearer the posterior border than the external ostiole, and further, if one takes a line down the middle of the scale, one finds that the internal ostiole is further from this axis than the external ostiole. In *Mugil cephalus* the canaliculi round the centre of growth present certain peculiarities which are noteworthy. They traverse the scale more obliquely, and have a larger diameter. At the external surface these canaliculi open into grooves or trenches and pass on towards the large canal, which in Mugil occupies the centre of each scale. The grooves in connection therewith anastomose with each other, and gradually enlarge as they approach the median canal, where they terminate by bending into a spout-like or canalicular orifice. The large canal in the centre of the scale should be considered as a species of collector in connection with the nearest adjacent canaliculi.

As to the mode of formation of these canaliculi, Baudelot remarks that he has not a sufficiently large number of facts to give a satisfactory answer to this question. He says, however, that where radiating canals exist, the canaliculi form themselves on their course, at their free extremities on the posterior border of the scale. At the extremity of the radiating groove there firstly appears a small depression; later by the mode of growth of the surrounding tissue this depression deepens more and more, and finally closes in at the posterior end, forming an aperture like a minute pierced gap across the lamina of the scale, which is very thin at this point. As the scale increases by the addition of new layers to its internal face, each gap become gradually converted into a narrow canal, in which the length varies with the thickness of the scale and with the distance of the canaliculi from the posterior border.

As to the nature and function of the perforating canaliculi, Baudelot throws out certain hints. He believes that the canaliculi give passage to a filamentous cord, which is either of the nature of connective tissue or a nerve-fibre. He is inclined to believe that it is of the latter nature, and if this is true, that there might be grounds for establishing a connection between the perforating canaliculi and the canals which traverse the scales of the lateral line. The scales of the lateral line receive nerve-fibres on their deep surface, and in their interior nervous structures have been demonstrated.

In Mugil, in all those scales showing similar passages to those of the lateral line, a certain number of perforating canaliculi anastomose with the median canal of each scale.

In the pike, many of the scales have a similar trench to those of the lateral-line scales. This trench, hollowed out at first, may be considered as analogous to the depressions which represent the first stage in the formation of the perforating canaliculi. In a sparoid fish showing a disjointed and equitant lateral line he found a scale which showed at its centre of growth a duct which penetrated obliquely from the internal to the external face of the scale. This duct, while much narrower than the median canal of the lateral line, was at the same time very much larger than the perforating canaliculi of adjoining parts, that is to say, a kind of transition between the two kinds of canals. From the preceding facts, which he throws out in passing, Baudelot thinks that if they are confirmed by later researches, a clear resemblance between scales of the lateral line and other scales would become apparent. This would also explain why in certain types all scales or a large number of them may revert to the characteristic features of scales from the lateral line.

8. *The internal lacunæ of scales.* Certain scales possess lacunæ developed in their interior. In *Holocentrum longipenne*, for example, some of the perforating canaliculi show lateral diverticula which spread out horizontally in the scale substance. These diverticula constitute a system of lacunæ. In the scales of Hypostoma internal lacunæ are well developed, and constitute a vast system of anastomosing canals, in which the cavity communicates with those of the spines. In *Dactylopterus volitans* the scales are hollowed out in their central portions by large irregular lacunæ which communicate with each other. In the tunny the scales present remarkable lacunæ. In this case these lacunæ, which occupy all the median portion of the scale, form a species

of spongy tissue, limited at each side, namely, on the external and internal faces, by a thin plate of compact tissue. As to the mode of development of these lacunæ, Baudelot admits the absence of all knowledge; but he thinks that the "presence of these lacunæ in the tissue of certain scales establishes a clear analogy between the structure of these productions and that of osseous tissue." The lacunæ of the scales of the tunny and of Dactylopterus, for example, resemble very completely the lacunæ seen in the ossified connective tissue of the rays in the fins of various fishes (Gasterosteus, etc.). Ramifying lacunæ, such as are found in the scales of Holocentrum, can be observed with exactly similar characters in the operculum and suboperculum of the same fish, and as in the scales, the lacunæ of the opercular bones communicate with the exterior by ducts analogous to the perforating canaliculi. "These facts seem to show that the phylogeny of scales and that of osseous tissue should be associated."

9. *The focus or centre of growth.* Under this term one understands that more or less central part of the scale around which growth first takes place. In the rigorous meaning of the word the focus ought to be represented by a point which corresponds to the exact spot of origin of the scale; but in using this term zoologists have given this word a wider meaning, namely, that region of the scale in which formation first takes place in the life of the fish, and which is characterised by the absence of or irregularity of the concentric ridges. In some scales the focus is smooth or only very slightly roughened; in others its surface is marked by projecting calcareous reliefs, granulations, or tubercles, either laid down in lines or without any definite order; in others, again, ridges analogous to concentric ridges occur, which by their indefinite arrangement form an inextricable network, or a network of irregular meshes. The focus, as a rule, shows no grooves; but in some cases the radiating grooves are prolonged to the focus, sometimes retaining their original characters, sometimes, however, becoming interrupted from point to point, and thus forming small superficial lacunæ which are not disposed in any regular order. When these grooves reach the centre of growth (focus) they frequently anastomose with those of the opposed border. It is frequently difficult to define the precise limits of the focus, owing to the fact that an insensible transition is effected to the surrounding parts. The dimensions of the focus, however, show very great variations, not only in scales of different types of fish, but in scales from the same fish.

In the perch, minnow, and pike, Baudelot has shown how the dimensions of the focus may vary in the scales of the same fish: by the side of scales in which the focus is almost nil, one may meet with others in which the focus attains the size of one-half to two-thirds the total diameter of the scale. This fact alone is sufficient to demonstrate that the size of the focus is not proportioned to that of the scale. Some scales possess a very large focus, those of Labrus and Crenilabrus for example; others, on the contrary, possess a very small focus. The position of the focus in relation to the centre of the scale is very variable from one type to another. In some fish the focus occupies nearly the centre of the scale; this is the case, for example, in the lote, minnow, and eel; this fact appears more especially true when scales are small, rounded and concealed in the depths of the skin. In the majority of scales the focus is carried backwards a greater or less distance from the centre of the scale, for example, in the perch, sole, brill, carp. In some cases the focus has been carried so far backwards that it is situated at the posterior border of the scales, as in several species of gobies. It is much more rare to find the focus carried forward from the centre of the figure; this is met with in the scales of the tench (*Cyprinus tinca*). Baudelot states that the scale increases at its periphery, and that there is not any true growth at the focus by intussusception; but only a process of simple repair, which may modify the configuration of the calcareous reliefs or cause their disappearance by transforming, for example, a surface primitively covered with regular concentric ridges into a granular surface with tubercles or with vermiform ridges.

Agassiz and Vogt regarded the focus as the result of the wearing down of the central portion of the scale. Peters successfully refuted this interpretation by observing that the frictional or wearing-down process could not take place owing to the fact that the scales are contained in pouches of the dermis, which would protect them. In order to explain the existence of the focus, Baudelot points out that scales frequently show zones with irregular ridges alternating with zones with normal and regular concentric ridges, and he concludes that the cause which produces this regularity or irregularity of the disposition of the ridges is itself very unstable, and he holds that it is some such cause which produces the focal region; in short, this hypothesis supposes a change in the mode of distribution of reliefs during successive epochs of the life. Baudelot held, however, that he had not a sufficient number of facts either to confirm or negative this hypothesis, and left the matter in abeyance.

10. *The tissues of scales.* Scales are composed of two substances: (1) *fundamental organic substance;* (2) *inorganic substance.* The fundamental organic substance belongs to the group of connective tissues (dermal); the inorganic substance consists of calcareous concretions of phosphate and carbonate of lime. The fundamental organic substance is more or less transparent and homogeneous in appearance, and is readily broken up into folia which are composed of elementary fibrils. By dissection or through the action of reagents, such as soda or potash, it is easy to separate the component folia of scales from one another. These folia are extremely thin, are superimposed the one upon the other like the leaves of a book, which become smaller as they approach the external face of the scale. The scale is more or less like a cone with a large base, and in which plates or folia are piled the one on the top of the other from base to summit. These folia separate from one another most readily in the median portion of the scale, but not so readily at the periphery, at which region, indeed, they adhere to one another so intimately that it becomes difficult to isolate them without tearing them and getting fragments of several adjoining folia. Isolated folia are somewhat transparent, flexible, and membranous. They are not entirely homogeneous, as with a high power they show in their thickness a fine striated appearance. At the periphery of the lamellæ, where rents have been made, the tissue shows itself decomposed into fibrils or into bundles of fibrous tissue. The striæ of adjoining lamellæ do not follow the same direction, but cross at angles to one another. At the

focus the striæ of adjacent folia cross each other usually at right angles; but this is not the case at the periphery, where they cross at very varied angles, sometimes forming vortices in which it is difficult to follow the direction of the striæ.

The inorganic substance of scales consists of corpuscles of carbonate and phosphate of lime scattered in the depths of the folia of the organic fundamental substance.

There has been much difference of opinion as to the distribution of these calcareous corpuscles. Mandl maintained that the corpuscles were contained in a special tissue situated above the inferior surface of the scale. Agassiz held that these corpuscles are lodged near the superior and inferior surfaces of the scale. Peters believed that the corpuscles are found on the inferior surface of the scale, but never on the superior surface, as Agassiz had maintained. Williamson made use of sections, and was the first to recognise the presence of corpuscles in the entire thickness of the scale.

Baudelot agreed with Williamson in the main points, and after an analysis of the scale, layer by layer, enunciated the following more detailed points:—

"(1) In the most internal folia of scales the corpuscles are few in number or entirely absent.

"(2) In the folia following the most internal the corpuscles become rapidly very numerous, and their number increases as one proceeds from the internal to the external surface of the scale.

"(3) Near the external surface of the scale, the corpuscles are so numerous that they form a sort of compact web in the thickness of the fundamental organic substance.

"(4) The external calcareous investment of scales is simply a conglomeration of fused calcareous corpuscles."

In other words, calcification of the folia of scales is more advanced as one approaches the external surface of the scale, and this one can readily understand, as it is on the internal surface that the formation of new tissue takes place. In each of the more internal folia of the scale calcification is more pronounced towards the periphery than in the focal region. In the focal region the corpuscles are less numerous, usually isolated and separated from one another by spaces completely deprived of calcareous deposits. Towards the periphery of the folia, on the other hand, the corpuscles are very abundant and become massed together throughout the fundamental substance. In the most *external* folia of the scale, in which the calcification is much more advanced, the corpuscles are seen to be numerous throughout the entire extent of the folia.

The corpuscles are not of the same volume at all points of the same lamella. In the focal region they are relatively large; but as one proceeds from the focus to the periphery they gradually diminish in size until they become of extreme delicacy. The volume of the corpuscles is not the same in the various folia of the scale; thus in the most recent and internal folia the corpuscles, where they exist, are usually much smaller than in the more external folia. The size of corpuscles seems to vary with the age of the scale; for example, in the scale of a young fish the largest corpuscles are much smaller as compared with the largest corpuscles of a scale from an older fish.

The long axis of corpuscles does not present a uniform direction throughout the extent of the scale. The direction of the long axis generally agrees with the direction of the fibres of the folia to which the corpuscle belongs. It has already been noticed that fibres of consecutive folia of the scale cross one another frequently at right angles, and the same thing has taken place for the corpuscles which belong to these folia. Corpuscles of one, two, or several consecutive folia frequently become fused together. Corpuscles represent products of a crystalline nature, and exhibit a series of concentric lines which succeed one another from the centre to the periphery. This is not true for all corpuscles, as some have the appearance of vitreous substances, are perfectly homogeneous, and show no trace of concentric lines.

Baudelot concludes from his observations that the corpuscles are crystalline deposits effected in the tissues of the scales, and more or less modified by this tissue. They are of the same nature as the artificial products, studied firstly by Rainey* and then by Harting.†

11. *The formation and growth of scales.* Scales only appear subsequently to hatching, sometimes a long time after this has taken place; for example, in young eels measuring 7–8 centimetres in length they have not yet appeared. The scale originates as a spot of dermal calcification, which extends little by little, and thus comes to constitute a small solid lamella, which represents the primitive scale. The first lamella, once formed, sometimes remains closely united to the surrounding tissue, sometimes acquires a certain mobility; but this mobility is never complete, and the scale always retains intimate connections with the dermis by its internal surface and by its margins, and the external surface itself frequently shows adhesions at the free margin. The young scale grows by the addition of new layers of increasing size, which add themselves successively to its internal face. This mode of growth explains how it is that the scale is considerably thicker towards the centre, and much thinner and less calcified at the periphery. At the internal surface of the scale, and at its margins, tracts of connective tissue are found, by means of which the scale adheres to the pouch in which it is contained; but at the external border, on the other hand, the line of demarcation between scale and dermal pouch becomes more and more marked. As to the subsequent progress of calcification, one can establish that it extends from the exterior towards the interior, and from the periphery of the scale towards the centre. In each layer the calcification is more complete on the border than in the central portion. These calcifications unite with each other, and constitute the calcareous crust of the scale surface.

As to the concentric ridges and spines, these appear successively on the borders of the scale as that gradually extends itself. One has to admit that

* "On the mode of formation of the shells of animals, of bone, and of several other structures, by a process of molecular coalescence, demonstrable in certain artificially formed products." Rainey, 1858.

† Harting, "Further Experiments and Observations." *Quart. Journal of Microscop. Science*, n.s., vol. i. (1861) p. 23.

all ctenoid scales are cycloid at the beginning of their formation. Growth does not take place equally in all scales of the same fish, as one may observe scales of different sizes in different parts of the body. Although scales, as a rule, form themselves by the successive addition of new layers to their internal surface, there are some scales, such as those of the tunny and *Dactylopterus volitans*, which present difficulties. These scales show internally a spongy tissue, hollowed out into lacunæ of varying size. The structure of these scales affords, according to Baudelot, a connecting link between the tissue of scales and osseus tissue with internal lacunæ, such as one observes in the opercular skeleton of various fishes (Gasterosteus).

In the third part of his monograph, Baudelot takes up the question of "scales considered from the point of view of classification." He considers this question in relation to the following points:—(1) Connection of scales with the integument. (2) The form of scales. (3) The dimensions of scales. (4) The presence or absence of scales. (5) The ridges on scales. (6) The spines on scales. (7) The grooves on scales. (8) The perforating canaliculi and interior lacunæ of scales. (9) The focus of scales. (10) The tissue of scales. In summarising the results derived from a consideration of these points, he concludes that none of these characters of scales taken by themselves can serve as a basis for the classification of fishes, that the most important of all of them, the cycloid and ctenoid character, does not possess the degree of importance which many zoologists have attached to it, and that the other characters noticed are of still less value. Although each character by itself is of little value, yet the characters of scales as a whole ought not to be neglected in establishing natural groups. He recognises that in order to put such a programme into execution a much more precise knowledge is necessary of the external characters, structure, and mode of development of scales in a large number of types of fishes. In this connection he refers to Steeg's paper as a useful essay on scales from the point of view of classification.*

The next paper which I must notice is that by Ryder on the mechanical genesis of the scales of fishes.† He says in his introduction "that fourteen years previously he had suggested that the slow metamorphosis of the forms of the crowns of the teeth in man, in the course of a vast number of successive generations, might be ascribed to the continuous, slow, and cumulative action of mechanical strains and pressures in definite directions, resulting in the production of permanent stresses and consequent changes in the forms of the crowns, especially of the molar series. . . . The present paper is an attempt to apply somewhat analogous reasoning to a somewhat simpler, but no less interesting problem in morphogenesis." Scales take their origin from a continuous subepidermal matrix, a basement membrane. This basement membrane is thickest on the dorsal and lateral aspects of the body, as seen in sections of the young, for example, in *Batrachus tau*, a scaleless form. It is "seen in larval stages of scale bearing forms, and may be continuous with a very thin basal membrane from which the primordial fin-rays of embryo fishes seem to be partly differentiated. . . . Such a matrix appears to be co-extensive with the entire epidermic layer of the young in many types of fishes, just at the time when the scale commences to be developed."

* Steeg, 1857. † Ryder, 1892.

Ryder's hypothesis seeks to account for the arrangement of scales in longitudinal and oblique rows in two directions, and for their state of imbrication. Scales are arranged in oblique rows showing two directions: (1) a direction from above downward and backward; (2) in the reverse direction, from below upward and backward. The scales may thus be enumerated in three different directions: (1) in a downward and forward direction; (2) in a downward and backward direction; and (3) starting from any scale in any oblique row, they may be counted either forward or backward longitudinally in the direction of the long axis of the fish. In archaic types, the number of scales in a longitudinal row on the sides of the body corresponds very exactly with the number of muscle-plates or somites of the body. The myocommata, or sheets of connective tissue intervening between the successive muscle-plates are attached with great firmness to the deeper layers of the skin or corium. The structural arrangements at the time of scale development noted above, affect and modify the subsequent growth of the scale matrix. During the swimming movements of the fish the entire integument is thrown into definitely circumscribed areolæ, the central portions of which remain in a passive condition, while the periphery is wrinkled and folded as a result of the action of the lateral muscles of the fish. In this way each and every one of the dermal and epidermal areolæ are circumscribed by the action of the fish in the normal act of swimming. In each of the circumscribed areolæ a scale develops; the continuity of its development with its fellows across the margins of the areolæ is prevented by the continual bendings or flexures to which the dermis is there subjected owing to the action of the muscles. As it is impossible to state clearly the details of Ryder's paper without also giving his drawings, I will content myself with quoting several of his sentences.

"It will be clear that in the case considered the arrangement and imbrication of the body is determined by the actions of the segmentally arranged muscles of the body. In other words, whatever has determined the development of somites has also, in the most clear and direct manner, determined the segmentally recurrent and peculiar trilinear and imbricated arrangement of the scales of many fishes. It may be urged that heredity has determined the number, arrangement, and the development of the somites, and therefore the development of the scale is also a sequence of hereditary influences working thus indirectly. This view of the case may be admitted without invalidating the conclusion that given the growing mechanism here described, the development of the scale would, under any circumstances, have been interfered with at the parts where the integument was being continually flexed, wrinkled, or folded, as it is around the integumentary areolæ wherein the scales are formed, as has been here proved to correspond with the facts."

Ryder summaries "two conclusions of prime importance:—

"(1) The scales of fish bear a segmental relation to the remaining hard and soft parts, and are either repeated consecutively and in oblique rows corresponding to the number of segments, or they may be repeated in rows as multiples of the somites, or segmental reduction may occur which may effect the arrangement of the scales so as to reduce the number of rows below the number of somites indicated by the other soft and hard parts.

"(2) The peculiar manner of interdigitation of the muscular somites as indicated by the sigmoid outline of the myocommata, as seen from their outer faces, and the oblique direction of the membranes separating the muscular cones, has developed a mode of insertion of the myocommata upon the corium which has thrown the integument into rhombic areolæ during muscular contraction. These areolæ are in line in three directions, and the folds separating them, particularly at their posterior borders, are inflected in such a manner by muscular tensions, due to the arrangement of muscular cones, as to induce the condition of imbrication so characteristic of the squamation of many fishes."

The next paper which I must notice is a very important one by Dr. Klaatsch.* While acknowledging my indebtedness to and appreciation of this lengthened paper, I must at the same time agree with Ussow (see p. 202) in regarding some portions of Dr. Klaatsch's work, for example, the section on the "Structure of the teleostean scale from the histogenetic standpoint," as wanting in complete clearness.

The teleostean scale, its arrangement and position in the skin. The scales of Teleosteans are represented by more or less circular plates of hard substance, which exhibit considerable variation in their form. This variation is, however, insignificant in comparison with the general agreement which typical teleostean scales show with one another. Klaatsch chooses the cycloid scale as representative of the ordinary teleostean scale, not only because it presents simple conditions, but because it supplies a suitable object for placing the skin-covering of Teleosteans in line with that of Selachians and Ganoids. As examples of such scales, one may think of such as those of the salmon or of Esox. One distinguishes in such scales two layers: (1) *an outer homogeneous layer* and (2) *an inner fibrillar layer.* Each scale is in its anterior half arranged with regard to others in an imbricated fashion, namely, the anterior half of each is covered by three scales, one of which is anterior and dorsal to it, a second anterior and ventral, and a third directly anterior. The centrum of the scale is usually covered over, and scales surround the body in oblique rows.

For the arrangement of scales in the skin, he gives a figure and description of a transverse section through the skin of a young specimen of *Cobitis fossilis.*

Under the epidermis, which contains a large number of mucus cells, the dermis is seen to be raised in a series of projections, each of which corresponds with the posterior free end of a scale. Each scale lies in an oblique direction from behind forwards, and becomes enclosed in a compartment of the dermis, the so-called "scale pocket." In this scale pocket one distinguishes an outer and an inner wall. The outer wall consists in its posterior part of loose connective tissue containing numerous chromatophores; in the anterior part the outer wall is composed of tense connective tissue, which is similar to the inner wall of the adjoining anterior scale pocket.

The fibrous projections of this connective tissue of the outer wall of the scale pocket unite themselves at the anterior border of the scale with the deepest layer of the dermis, in which the fibres have a course parallel to the surface of the body. The inner wall of the scale pocket in its posterior part unites with the outer wall of the adjoining posterior pocket. Further forwards it is

* Klaatsch, 1890.

built up of the fibrous processes of the deep dermis layer. Near the scale its condition changes, as immediately towards the inside of the same, numerous cells are found in a ground substance only slightly developed and not fibrillated. The fibres of the deep dermis layer have a similar arrangement to that of Ganoids and Selachians.

One may easily ascertain this by observing a piece of skin from the surface. The fibres of one layer of fibrous bundles cross those of the next higher or deeper layer in such a way that, in relation to the long axis of the fish, the anterior and posterior angles of intersection are greater than right angles. The fibres surround the body in a diagonal direction to the body axis, corresponding to the rows of scales. Towards the musculature the dermis is bordered by a layer of cells which resemble the other cells of the dermis, but lie closer to one another. In this part chromatophores are also seen. Underneath the dermis the musculature only shows young fibres similar to those seen in immature forms. As regards number, the scales have nothing at all to do with the myocommata. Several scales are usually found on a myocomma; the relation to metamery suggested by Salbey does not exist.

The development of the teleostean scale has hitherto not been worked out; one only finds a few incomplete references to this subject. The first who takes any notice of the subject is C. Vogt, in his "Embryologie des Salmones," who mentions "poches épitheliennes," in which the scales are formed. According to him, these pockets are simply folds of the epidermal membrane. This point will be referred to further on.

Later Leydig devoted some attention to the structure of scales, but did not concern himself with their ontogeny. He says, "The scales of most of our fresh-water fishes appear partly as ossifications of flattened skin continuations which one generally terms scale pockets." He regards scales as fusion products, "peculiarly developed calcareous globules, concretions, or scale corpuscles," such as one finds on the lower side of scales in many Teleosteans.

Baudelot held the same view as that of Leydig. Although Baudelot's work appeared in 1873, he does not make any note as to the part which cells take in scale formation; "according to him, the scale is simply a conglomerate of calcareous concretions or scale corpuscles, with whose measurements he fills many pages of an extensive treatise."

Development of scales in the trout. Klaatsch followed the development of cycloid scales mainly in the trout; but he also made use of Esox and several Cyprinoids for some of the earliest stages. The following are the results of his investigations:—

In the trout the first formation of scales appears several months after hatching. Trout 2 cm. in length show no scales, but somewhat older ones show the commencement of scale formation. Scales firstly originate in the anterior and median region of the trunk near the lateral line, and their formation extends from this region caudalwards, as well as ventrally and dorsally.

For this reason trout 3 cm. in length are suitable specimens for the study of scale formation, since older and younger stages occur near one another, the younger being more posterior. Before scale formation commences, the skin of a trout shows a thin epidermis and relatively very fine dermis. In the just hatched trout, the dermis is represented as a homogeneous layer of little consistency. Within this lies a cellular layer resembling epithelium. This epithelial layer is that described by Hatschek as the "bordering epithelium of the dermis."

At the stage in which the first foundation of the scale appears the skin is about ·03 mm. thick. Of that thickness the epidermis occupies about one-half, and consists of four to five layers of cells, of which the most external layer is somewhat flattened. In the remaining part of the epidermis the cells are somewhat cubical and show the presence of nuclei. Mucus cells with sickel-shaped compressed nuclei are also seen, and a thin basal membrane separates the epidermis from the dermis. The outer surface of the epidermis is smooth.

The dermis consists of a small number of lamellæ lying horizontally upon one another. So long as there is no trace of scales, the lamellæ in the dermis extend nearly to the epidermis. The dermis cells, which as in earlier stages lie in small numbers between its lamellæ, show somewhat flattened nuclei. The cells become rather more numerous immediately beneath the basal membrane of the epidermis, and the nuclei here are slightly more circular in form than those of the other dermis cells. Chromatophores are also seen at this part; but of blood-vessels there is no trace in the dermis. Chromatophores are also to be seen situated above the bordering epithelium of the dermis. Internally to this last follows the musculature, the most external portion of which is made up of only young stages of muscle-fibres. The first foundation of the scale appears as an aggregate of dermis cells lying beneath the basal membrane of the epidermis; but neither the basal membrane nor the epidermis itself takes any part in the formation of the scale. The cells which gather together to form the scale foundation are distinguished from the other cells of the dermis in possessing larger nuclei and a better-developed protoplasmic body. This cell-mass, the foundation of the scale, resembles epithelial tissue. Each scale germ presses upward on the basal membrane of the epidermis as a slightly arched papilla. During this upward growth of the scale germ the upper surface of the epidermis remains smooth; but at the places where a scale germ is situated the epidermis is reduced from five to two or three layers of cells. In transverse section the scale germs are seen as papillæ, whose highest points are not exactly at the centres of the masses of cells, but are situated slightly caudalwards. These cell-masses (scale germs), which approach the circular form in surface view, stand free from one another in regular rows, diagonal to the body axis. Later the entire cell-mass spreads itself out horizontally, and its elements arrange themselves in two slightly flattened layers. Between those two layers there appears *a thin layer of strongly refractive substance.* In transverse section it is seen that the formative cells lay down the new substance, alternately on the outside and on the inside, producing what looks like a slightly undulated plate. The form of the plate is approximately circular, corresponding to the form of the cell-mass. These plates can be isolated and represent small scales. The strongly refractive substance later on shows itself to be the hard substance of the scale: at what period this plate impregnates itself with lime salts Klaatsch has not investigated. The formative cells which give rise to the scale are known as *scleroblasts*, and they correspond to similar elements in Selachians and Ganoids. At this period the minute scales appear as circular discs, which lie adjacent to one another in regular order; but they do not as yet show any special covering. The scales so far lie parallel to the upper surface of the body, and do not project nearly so strongly into the epidermis as they do later; but at the posterior end of each scale the epidermis projects inwards, as can be seen in tranverse sections. In the strips of skin intervening between the scales, cells of the dermis lie embedded in great numbers in a ground substance consisting of a few irregularly arranged fibrillæ.

Above the anterior end of the scale several elements penetrate between the basal membrane of the epidermis and the scale, adding themselves to the scleroblasts already present there, and resembling the scleroblasts in their appearance. An increase of the dermis cells internally to the scales also takes place. As the scale was originally enveloped symmetrically on all sides by formative cells, a change in the distribution of scleroblasts is the more noteworthy. On the upper or more external surface of the scale they lie closer to one another than on the lower or more internal surface; but they lie particularly close to one another at the posterior part of the scale. As the latter portion of the scale is specially active in growth, the highest point of the scale germ becomes displaced entirely in the caudal direction. The slight inward invagination of the under surface of the epidermis, continued here from previous stages, becomes gradually considerably enlarged; but the epidermis by this infolding gains as little as previously any part in scale formation. Contemporaneously all layers of the skin grow in thickness, and the epidermis comes thereby to consist of a large number of layers of cells. In the dermis also that part situated between the lamellæ and the scales undergoes a great degree of cell proliferation. The scale comes thereby to lie on a layer of loose connective tissue, by which it is separated from the deeper part of the dermis, in which the ground substance had already undergone a lamellar differentiation. At the same time there takes place an increase of dermis cells between the epidermis and the scales, and new elements thus become added to the scleroblasts on the upper surface of the scales, while the uppermost or most external layers of the dermis separate scales and scleroblasts from the epidermis. The scales thus become enveloped on all sides by loose connective tissue, from which the scleroblasts receive new auxiliaries. The posterior end of the scale shows as yet no connective tissue covering. The result of this mode of growth is that the scale always inserts itself deeper in the epidermis. The scales, along with their envelopes of connective tissue, have the appearance of papillæ which press the epidermis before them in an oblique direction caudalwards. The epidermis during this process does not become uneven on the external surface, but, on the other hand, is thrown into folds on the internal surface. Klaatsch regards these folds as equivalent to the "epithelial pockets" described by C. Vogt. A section shows the corresponding epidermic processes running out pointed in front and extending far underneath the posterior border of each scale. The position of the scale in the skin now undergoes an important change. The posterior border of the scale becomes pressed against the upper surface, and the anterior end expanding underneath the epidermic continuations, becomes sunk towards the interior. From the original horizontal position the scale passes into a position oblique to the upper surface. The consequence of this change of position is that the scale, not being hindered by adjoining structures, can increase the extent of its surface in an oblique direction. A necessary result of further growth is that scales push themselves under adjoining anterior scales by their anterior borders, so that they begin to cover one another like tiles. In order to understand further changes it is necessary to bear in mind that all layers of the skin increase continuously in thickness. The deep lamellar layer of the dermis takes, in antithesis to early stages, a stronger growth, and in this development it is the outer layer next the scales which undergoes a change. The epidermis also grows, as well as the continuations of the same underneath the posterior part of each scale. In this inward growth of the epidermis no tissue change takes place; for instance, one finds in these continuations similar mucus cells to those in the rest of the epidermis. This growth of the epidermic continuations is not to be regarded as a process proceeding from the upper skin alone, but as the result of growth taking place in the entire skin. In this connection the constant increase of the scale at its posterior border is of significance. The anterior border of the scale inserts itself always deeper in the loose connective tissue of the dermis, whose stronger development towards the upper half of the deep dermis has already been noticed. It therefore happens that the scale does not lie next to the deep dermis; but it gives rise to an appearance as if the scales had pushed themselves between the lamellæ. This takes place because the loose connective tissue underneath the scale gradually becomes differentiated in a similar manner to that which had taken place earlier in the deeper part of the dermis, and in this case also lamellar fibrillated bundles are formed. These lamellæ do not, however, lie parallel to the surface of the body, but parallel to the scale. The lamellæ form themselves in the same manner as the scales, growing stronger towards the anterior part; the dermis layer situated between the scales becomes so arranged that connective tissue septa exist between the scales. These septa, which are the inner walls of the scale pocket, are connected externally with the epidermic continuations, and internally they grade imperceptibly into the deep layer of the dermis. By the foregoing means the scale pockets come into complete formation. These scale pockets appear consequently as a result of scale growth. In this two different processes operate together: on the one hand the scale becomes separated from the epidermis by growing connective tissue, and so an outer wall to the pocket is formed in its anterior part; on the other hand the floor of the pocket and the posterior part of its outer wall is formed by the ingrowth of the scale into the loose portion of the dermis and by the development of the same. The floor of the scale pocket is of special significance in the development of the scale. The tissue of the dermis which produced the floor of the scale pocket retains immediately underneath the scale its indifferent state. Here there lie cells in a ground substance which is not yet broken up into fibrillæ. When the same prove themselves active as scale formers, they lead to the formation of a deep scale layer, which shows in its histological relationship much peculiarity. A superficial view of the latest stages shows how the scales gradually insert themselves underneath the three next anterior, until we arrive at the condition found in older fish. The median point of the scale becomes distinctly prominent by the formation of concentric ridges. It remains uncovered for a considerable time, until it also becomes overlaid by the posterior border of the next anterior adjacent formations.

Structure of teleostean scales from the histogenetic standpoint. The dermis cells which take part in scale formation are large elements with well-developed nuclei, each of which shows a distinct nuclear membrane, and also, as a rule, a large nucleolus. These cells lie at first so close to one another that they mutually affect one another in shape. From a circular form they pass over into a polygonal one. While the cells on the internal surface of the scale become disconnected from one another on the first separation of scale substance, different cell layers come into formation on the external surface. Above the deepest scleroblasts immediately overlying the young scale a layer of cells extends which easily allows itself to be lifted up *in continuo.* At the margins of the scale the original condition persists, as here the cells of the outer as well as the inner surface unite themselves into an almost complete covering for the scale substance.

The superficial scleroblast layer presents a very characteristic structure. Its polygonal-shaped elements simulate a flat epithelium. Between the protoplasmic parts, which stain deeply in carmine or hæmatoxylin, there exists a network which does not stain. This network appears like a system of intercellular spaces, and there is nothing so far to prove that the clear strips between the cells are an intercellular substance. The further changes of these cells clear up the meaning of the intervening substance. The cells undergo a process of change which seems to take place for all in a similar manner. Each cell extends itself in one direction, which is not quite determined in relation to the entire scale. It attains thereby a lengthened form, and the nucleus comes to have a more peripheral situation in the cell. The nuclei of adjoining cells during this process come to lie nearer one another. In all the cells a part containing the nucleus becomes distinct from a part in which there is no nucleus. In the latter part the protoplasm loses at one place its power of taking on stains, and in this part there appears a clear circular spot which resembles a nucleus in size and general form. There is no internal structure in this clear spot, which afterwards expands in the direction of that part of the cell farthest from the nucleus, and finally unites with the clear network between the cells.

The different stages correspond with a process of cell-metamorphosis: the clear strips between the cells, owe their origin like the clear spots in the cells above described, to a substance which has become differentiated from the rest of the protoplasm.

This substance unites with that part of the scale already existing. The nucleus and a part of the protoplasm are preserved. The substance derived from the cells is thus a secretory product. Klaatsch says, "An dem vorliegenden Objekte, welches für die Untersuchung des scleroblastischen Processes in Flächenbilde sich vortrefflich eignet, konnte ich nichts wahrnehmen, was zu Gunsten der Annahme spräche, dass Zellen *in toto* in das Produkt aufgingen; die Kerne zeigten keine Veränderung, ich sehe daher in der Bildung der Hartsubstanz einen Abscheidungsprocess." This product, the substance of the scale, is thus an intercellular substance hardened by the deposit of lime salts, and the described cell layer is simply a layer of scleroblasts, which are only distinguished by regularity of arrangement and by sharp marking of individual stages of the scleroblastic processes from the deeper cells of a similar kind with which they are continuously dependent at their borders. The nearer the scleroblasts are towards the margin the more do they show (though here no longer separable into layers) an increase of their cell-body in a tangential and a decrease in the radial direction in relation to the entire scale. As in other Physostomi, ridges are formed on the external surface of the scales of the trout. These ridges have a concentric arrangement on the scales of this fish, which is not, however, a general rule for superficial reliefs. In the trout the cells concerned arrange themselves so that they correspond exactly with the concentric ridges. One might expect that the superficial scleroblast layer would cover the deeper cell layer with its product, so that the constituent parts of the last would be taken up into the interior of the scale substance. This does not, however, take place in the trout. The cells arrange themselves as they pass through the changes described, so that they come to lie on the external surface of the ridges and contribute to the enlargement of these. They elaborate, as it were, the upper relief surface of the scale, for which the deeper cells had only supplied the foundation.

In the older stages and in the mature condition of all the scleroblasts there remain only the nuclei and small masses of protoplasm. One sees the cells lying on the surface of the scale; if one takes a scale from a living fish, for example from one of the Cyprinoids, and observes it in a fixing fluid, say chromic acid, then one easily recognises circular nuclei surrounded by protoplasmic masses which extend in fine continuations. A similar condition to that in the trout appears in other Teleosteans; in many Clupeoids, for example in *Elops saurus, Albula conorhynchus*, cells are found perfectly similar in their arrangement to those in the trout and surrounded by scale substance; these represent true osseous cells adjoining the concentric ridges. In other forms there are numerous osseous cells present in the scales.

In Osteoglossum, for example, the wealth of bony cells, and in consequence the thickness of the cell-containing layer, is very apparent. In this form a true cell-containing osseous tissue constitutes an essential part of the scale; in the trout scale, so far as it has hitherto been observed, a similar tissue must be recognised. Its scleroblasts are osteoblasts; whether these become enclosed by their product or not is of subordinate significance, as in related forms sometimes the one, sometimes the other is the case.

Originally the outer and the inner surfaces of the scale are alike in regard to their scleroblasts. On the inner surface, however, the scleroblastic processes gradually take another direction. As the outer and inner scleroblasts gradually pass into one another at the margin of the scale, and as both originate from the same cell material, no sharp separation can be drawn between them.

The scales retain for a lengthened period of their ontogeny the structure of a thin bony plate, whose growth takes place especially at the margins and at the external surface. Not until the time when the scales have reached the condition of being a tile-like covering does a considerable increase of volume commence on the inner surface. The scale has here received, by the formation of a scale pocket, a connective tissue foundation. It appears that this lower layer gradually differentiates itself so that it becomes similar to the deep lamellar dermis layer, but that close to the scale a layer of cells persists, which continues in an indifferent condition, in so far as the tissue surrounding it still shows no fibrillar structure. This cell material on the floor of the scale pocket becomes a matrix for the so-called lower scale layer. In its fibrillar structure and the lamellar layering of the fibrillæ the lower scale layer agrees with the dermis tissue; by the total absence of cells it differs from that tissue. We cannot, however, assume from the first factor that the lower scale layer owes its origin to a development of connective tissue fibrils, for this is contradicted by the second factor and by the genesis of the layer. If previously differentiated dermis tissue of the scale pocket were included directly in the substance of the scale, there must exist a connection between scale and scale pocket in order that both of these may pass directly the one into the other. Secondly, the cells already occurring in the dermis tissue must be found again in the interior of the scale after the inclusion of the tissue in the interior of the scale. Neither of these occurs; in the interior of the lower scale layer there is no trace of cells or cell remains, and the scale is separated from the dermis tissue by an indifferent zone.

From the previous histogenetic facts one gains the following ideas as to the histological structure of scales:—

The outer layer consists of bony tissue. This layer is homogeneous and is deficient in any special structure, except for a slight lamellar layering (see, for example, Williamson, 1851, plate xxviii., fig. 9, of the Carp). The chemical composition consists of amorphous phosphate of lime and carbonate of lime. The formative cells of this layer are situated chiefly on the upper surface. They represent that which Williamson has described as a membrane, on which the growth of the layer depends. The scleroblasts form the superficial relief of scales. If they become enclosed in their own secretory product, then bone corpuscles are found in a great variety of conditions as regards number and arrangement. On the addition of hydrochloric acid the entire layer dissolves, but somewhat slowly. There is no difference in reaction with this acid between a piece of fish bone from the internal skeleton and the external scale layer; both develop at first rapidly and then more slowly carbon di-oxide.

The lower scale layer consists of fibres united into bundles, the fibres all running parallel within the bundles. The bundles of one layer again lie fairly parallel to one another, and cross those of the next higher and deeper layers at acute angles. There are usually three different systems to be distinguished in a scale, which cut one another at similar angles. This tissue agrees with tense connective tissue, and especially with that of the deep dermis layer. Consequently it appears right, as most authors do, to regard the lower scale layer as the connective-tissue part of the scale, yet no one has placed the peculiarities of this tissue in a clear light. This should be done in two directions: firstly, in regard to the adjoining connective tissue of the scale pocket; secondly, in regard to the external scale layer. As regards the first point, development has taught that the lower scale layer does not represent pre-existing connective tissue of the scale pocket which has become annexed to the scale. In regard to the deeper-situated connective tissue, this questionable layer must be defined as tense connective tissue without cells, whose formative cells probably originated from the connective tissue of the scale pocket. "The development of this peculiar tissue can only be fully understood by taking into consideration phylogenetic factors extending far backwards. Its peculiarity may, however, be partly explained by reference to the development of the entire dermis. As Hatschek has shown, and as I also find in the trout, the dermis consists originally of a layer, the formative cells of which lie only on the inner side. The formation of the fibrillar structure of the layer is independent of cells, which only arrive later in its interior. The dermis cells return likewise to an embryonic stage in the course of scale formation, and it is conceivable that events which govern the formation of the entire dermis repeat themselves in detail."

Regarding the relation of the lower to the upper layer, it is of significance that the upper layer exists for a long time alone, and that it is not till later, when the covering of the scale has completed itself, that the other part of the scale first appears. There exists indeed a genetic relationship between both layers, and the external bony layer has indeed occasioned the formation of the second. But now as it is a matter not simply of a connective-tissue lower layer of the original scale, but of an integral portion of the entire structure, it follows that a sharp separation between both layers is as little tenable as a separation between the formative cells of both surfaces. At the margins of the scale the layers cohere intimately with one another. As the lower layer becomes impregnated with calcareous salts, a closer coherency is by that means given to both layers.

This impregnation with calcareous salts never takes place in the lower layer to the same extent as in the upper layer; the substance remains little capable of resistance against alkalies; but Klaatsch believes that a sclerotic-like formation takes place, though in lesser degree. The calcareous concretions which Mandl has described thus appear in the lower layer. They are ovoid, layered bodies which are largest in the centre of the scale. Immediately beneath the outer layer they lie so thick and congregate so intimately together that Williamson has made a special third layer out of that part. Leydig referred to them as "Kalkkugeln." He overrated their significance in scale formation. "Now they again gain significance, but in another sense to that which the earlier authors thought. These formations appear as the lower scale layer gradually becomes changed by a sclerotic-like formation. The scale represents a plate, which consists of an outer and an inner layer. The outer is bony tissue, the inner owes its origin to connective tissue, 'das in den Sclerosirungsprocess einbezogen worden ist; sie besteht aus theilweise sclerosirten Bindegewebslamellen, zwischen denen keine Zellen liegen.'"

In a later paper Klaatsch* returns to the question of the development of the teleostean scale, and comes to the conclusion that it follows the same course as that of the bones of the head, which he now describes. He points out that his former work requires correction as regards the origin of the elements which form the scale. The scleroblasts in reality arise from the

* Klaatsch, 1894.

ectoderm, and not from the connective-tissue layers. Those beneath the scale (the lower scale layer) are budded off from the ectodermal invagination, which grows in under the posterior end of the scale.

To Ussow we are indebted for a paper on the development of the cycloid scale of Teleosteans.* This author differs in a number of points from Klaatsch's views on the same subject. I shall endeavour to give a summary of Ussow's paper.

The scale of Teleosteans is built up of two layers, the structure of which is not agreed upon by the various authorities. Hofer, for instance, considers the *first and outermost layer of the scale* to be composed of a form of dentine which he terms "*hyalodentine*," and speaks of the transformation of this special tissue into common dentine. *The second and innermost layer* of the scale is, according to Hofer, formed from the dermis.

Klaatsch, from the presence of minute osseus bodies in the first layer of the scale, holds that this layer is built of ordinary bony tissue. He believes that the second layer of the scale is formed out of connective tissue which is developed from the scale pocket.

Leydig and Baudelot regarded the scales of Teleosteans simply as a conglomeration of calcareous concretions or little scale bodies.

In regard to literature dealing with the development of scales, Ussow cites the following three papers:—

(1) Klaatsch, "Zur Morphologie der Fischschuppen and zur Geschichte der Hartsubstanzgewebe."

(2) Hofer, "Ueber den Bau und die Entwicklung der Cycloid und Ctenoid schuppen." *Berl. Gesellschaft für Morphologie und Physiologie in München.* 1889.

(3) Maria Sacchi, "Sulla struttura del tegumento negli embryoni et avanotti del Salmo lacustris." *Red. del Inst. Lombardo*, vol. xx. Milano. 1887.

The species which Ussow selected for the study of scale development were the following:—In the family Cobitidæ, *Cobitis tænia*, *Cobitis barbatula*, *Cobitis fossilis;* in the family Cyprinidæ, *Leucaspius delineatus*, *Leuciscus rutilus*, *Carassius vulgaris.*

As the origin and development of teleostan scales takes place from the mesoderm elements of the dermis, Ussow first gives some notes on the epidermis and dermis of *Cobitis tænia* as an example. In young examples of *Cobitis tænia* the skin is imperfectly developed and the epidermis is thicker than the dermis. In such young stages (embryos 4 cm. long) mucus cells are present in the epidermis in great number. The dermis consists at this stage of numerous fibres and cells embedded in an intermediate ground substance. In older forms the epidermis becomes much thicker and the mucus cells increase in number. The dermis also becomes thicker at the expense of connective-tissue fibres which cross under one another almost at right angles; these fibres, surrounding the body of the animal, lay themselves down in diagonal lines in relation to its longitudinal axis. The dermis is separated from the muscles by an epithelial layer of cells, not clearly marked

* Ussow, 1897.

out in all, which Hatschek termed the "*marginal epithelium of the cutis.*" According to some authors, the dermis is separated from the epidermis by a thin membrane, a distinct and independent structure, sometimes termed the ground membrane. Toldt, in his "*Lehrbuch der Gewebelehre,*" however, says, "It has now been almost generally accepted, not as an independent structure, but as a modification and thickening of the upper layer of the connective tissue ground substance." Ussow thinks that this membrane as an independent structure does not occur in the families Cobitidæ and Cyprinidæ, but simply that a transition substance of connective tissue devoid of fibres lies between the epidermis and the dermis.

The first stage in the development of a scale consists of fairly distinct and prominent aggregations of mesoderm elements in the upper half of the dermis, immediately beneath the epidermis. The cells forming such a papilla, as we may call these aggregations, differ at least in the beginning from the other cells of the dermis, and no ground substance is developed between them. This papilla gradually grows out in a horizontal direction, pushing the epidermis before it slightly upwards. When the papilla has reached a certain stage, a change takes place in its constituent cells. All cells excepting the lower become more circular in form and their nuclei gradually become more transparent; the lower cells, on the contrary, are, as before, highly coloured and their nuclei are spindle-shaped. In the next stage a *separation of the elements of the papilla into two layers, an upper and under, becomes distinctly observed. Between these two layers a thin strip of highly refractive substance stands out prominently.* At the commencement this strip does not extend throughout the entire length of the papilla, and one may see, in sections, that it is thickest at the centre, and gradually thins out towards its border, until at the end of the section of the papilla the strip is not visible.

The secretion of this refractive substance thus does not commence with the peripheral elements, but with the cells found towards the centre of the papilla. In further development, the substance of the first layer of the scale shows itself throughout the entire length of the section of the papilla, and the strips also become broader; meanwhile the papilla grows out in a horizontal direction. In this way a round curved plate originates, lying parallel to the upper surface of the body of the fish close beneath the epidermis. The upper and lower surfaces of this plate are formed out of scleroblast cells (the formative cells of the scales). The upper layer of scleroblasts simulates in its appearance a flat epithelium with clear spaces between its component cells. Later, each of the constituent cells changes, its nucleus comes to lie towards one end, and a circular colourless space appears at the opposite end. Klaatsch held that the clear spots within the cells fuse with the clear spaces between the cells; but Ussow did not observe any such fusion in his preparations. Klaatsch's description of these processes does not appear at all clear to Ussow. Klaatsch says that the cell structure on the external surface of the scale shows differentiation into several layers of cells, and that these cells build up the substance of the first layer of the scales. The question would naturally arise, how it is that the cells of the lower row do not become covered by the product of the upper cells. It would seem that the lower cells would become quite changed by the product secreted on them; but according to Klaatsch this does not take place, for he says, "An dem vorliegenden Objecte, welcher für die Untersuchung der scleroblastischen Processes in Flächenbilde sich vortrefflich eignet, konnte ich nichts wahrnehmen, was zu Gunsten der Annahme spräche, dass Zellen *in toto* in das Product aufgingen; die Kerne zeigten keine Veränderung, ich sehe daher in der Bildung der Hartsubstanz einen Abscheidungsprocess." In regard to the above, Ussow reiterates, "Alles das ist mir ganz unklar."

According to Ussow, the further development of the first layer of the scale takes place in the following manner:—

The cells overlying the substance of the first layer of the scale already secreted appear to waste themselves down more rapidly than the lower cells from the product secreted by them, so in the following stages one frequently sees a transparent strip of homogeneous substance in the position of the future scale; underneath this transparent strip and immediately united with it lies a row of scleroblasts with easily observable nuclei; on the upper side of the clear strips, on the contrary, one only sees three or four cells, the size of whose nuclei as compared with those of the lower scleroblasts is distinctly smaller. In still later stages one only meets with one or two such nuclei, and those much smaller than the nuclei of the lower scleroblasts. In section-cutting also it is easily seen that the overlying nuclei readily become loosened from the clear strips of the first layer of the scale, while, on the contrary, those elements lying beneath the clear strips form part of the latter, and never loosen themselves from it. In following stages the size of the underlying scleroblasts decreases, and at length there only remain, as in the case of the overlying cells, long extended, closely adjacent nuclei without trace of plasma, on which the first layer of the scale is formed.

Summary of preceding development.

(1) The cells of the papilla arrange themselves in two layers, the upper and under; between these two layers there appears a thin strip of refractive substance, the substance of the first layer of the future scale.

(2) The cells of the upper layer (the over-lying scleroblasts) use themselves up in the formation of scale material (its first layer) more rapidly than those of the under layer (the underlying scleroblasts); in consequence of this, one gets the stage of a plate with cells of the lower layer apparently enclosed therein.

(3) The first layer of the scale is apparently the product of the scleroblasts, that is to say, it is due to the change of the plasma of the latter into dentine-like substance.

About this time, when the first layer of the scale is quite complete, the change of its position in the dermis commences. Its posterior end (that turned towards the tail of the animal) raises itself gradually and presses on the epidermis; the anterior end, on the contrary, becomes sunk in the deeper layers of the dermis. This change in the position of the scale comes about through *the formation of the so-called "scale pockets."* Between the plates of scale substance there exist free portions of the dermis which lie close on the epidermis in these intervening spaces, and contain small aggregations of ordinary connective-tissue cells. By degrees the number and size of the cells increases, and there arise between them thin connective-tissue fibrils. Sections seem to show, without any doubt, that these fibrils of connective tissue in the scale pocket are directly formed at the expense of cells of the dermis, and are their immediate elongation. The developing connective tissue of this intervening part grows, as it were, between the epidermis and the anterior end of the scale, the horizontal position of the last gradually changing into an oblique position; the posterior end of the scale cuts into the epidermis, and envelops itself in this as in an envelope. The large development of connective tissue, the formation of the scale pocket, is thus the cause of the change in the position of the scale from a horizontal to an oblique position. The connective-tissue pocket itself appears as a newly developed connective-tissue layer, which lies between every two scales, the layer surrounding the scale on all sides (at least on the lower two-thirds). Owing to their oblique position in the skin of the fish, the scales can extend themselves in all directions without hindering one another in their growth.

When the first layer of the scale and the beginning of the connective-tissue pocket have already been formed, a layer of transparent, quite homogeneous substance appears at the border of the dermis underneath the scale; this layer contains pear-shaped nuclei, which increase very rapidly during the development of this layer; nucleoli are, as a rule, not observed. Klaatsch regarded this layer simply as cells of the dermis. According to Ussow, however, they are the lower elements of the papilla still remaining behind; during the entire development of the first layer of the scale they retained the characteristic spindle-shaped form of the basal elements of the papilla; but at this time they commence to increase in size and number, and between them a transparent intervening substance comes into appearance; further, one finds in longitudinal sections that this developing second layer enters into close connection with the first layer.

In this second layer one also finds nuclei which are plainly distinguishable by their size and pear-shaped form. No striation, no fibrils, are at first to be seen in the layer. At a later stage, however, we find a scale, which now consists of two distinct layers, the upper already known as the hyalodentin layer, and the lower without cells, but with fine striæ parallel to the upper surface of the scale. How does this striation originate? From what are those longitudinal fibres of the second layer formed? Klaatsch says the following: "In order to understand the structure of the second layer of the scale, one must know the formation of the entire dermis." According to Klaatsch, the dermis at the commencement of development consists of a layer on whose inner side lie the formative cells. The breaking down of the dermis into fibrillæ does not depend on those cells, which only penetrate into it much later. In the development of scales, the process which took place in the development of the entire dermis repeats itself, but in lesser degree. But the possibility of a direct appearance in the scale of the dermis of the connective-tissue pocket, already differentiated into fibrils, Klaatsch denies: he asks, "Where then do the connective-tissue cells disappear, for one finds no cells in the second layer of the scale (in the trout)." Ussow says, "I think my preparations show fairly clearly that the second layer develops itself anew, and is not merely a part of the connective tissue of the scale pocket. As concerns H. Klaatsch's explanation, it is not at all clear to me, because the development of the dermis is also not clear." H. Klaatsch says that threads arise in the dermis without any participation of its cells; but literature seems not wholly to confirm this view, as we read, "Die Fäden aus Zellen entstehen, indem sie aus dem Plasma der letzteren hervorwachsen (Ranvier)." Ussow then proceeds to note the varying opinions of different authorities in regard to the origin of the fibrils of connective tissue, and he concludes his remarks on this subject with the following sentence:—

"*Eine genauere Vorstellung von dem histogenetischen Vorgange der Fibrillenbildung auf Grund direkter Beobachtung zu geben, ist nun freilich schwierig und wir sind nach wie vor auf mehr speculative Erörterungen angewiesen.*"

In his preparations, Ussow sees something quite different to that described by Klaatsch. According to Ussow, the first phase of development of the second layer of the scale begins with a great numerical increase of the mesoderm elements underlying the first layer of the scale, then a transparent intermediate substance appears between them, firstly in a small degree, then always more and more, by which process the cells now become quite sunk in the intermediate substance. Ussow points out that in one of his figures (6u) one sees the dermis developing, which consists of cells embedded in a ground substance, and that this figure much resembles the figure showing the development of the second layer of the scale. He regards it as possible, as Klaatsch did, that in the development of the dermis these cells pass later towards the margins of the ground substance, and that the breaking up of the dermis into fibrillæ does not depend on these cells. But he asks if one can conclude either from his own or from Klaatsch's preparations that the fibrillæ originate without participation of the cells.

He says, "Mir scheint es, man kann nur sagen, dass man die Erscheinung der Schraffirung nur dann konstatiren kann, wenn die Kerne allein in dieser zweiten Schicht nach unten gegangen sind (fig. 7q), aber das heisst doch nicht, dass das Zerfallen in Fibrillen ohne jede Theilnahme der Zellen geschah, um so mehr als während der ganzen Entwicklungszeit der Zwischensubstanz der zweiten Schicht die Zellen in diese Zwischensubstanz versenkt waren und nicht an ihren inneren Rändern lagen; das letztere scheint mir geradezu unverständlich zu sein; diese Schicht ist so dünn, dass an welchen der inneren Ränder—den oberen oder den unteren—man auch diese zellen versetzen möchte, sie doch in der Schicht der Zwischensubstanz liegen würden."

He gives the following summary as to the development of the second layer of the scale:—

(1) "The formation of the layer of intermediate substance precedes the formation of the second layer of the scale; the intermediate substance contains large nuclei embedded in it, whose plasma cannot be distinguished from the intermediate substance itself; that the position of the formative cells is on the inner side of the strips of intermediate substance cannot be urged, in consequence of the insignificant width of that layer.

(2) "Such a substance with large nuclei we find firstly on the floor of the pocket, then beneath the first layer of the scale closely bordering on it.

(3) "This intermediate substance is formed at the expense of the basal elements of the papilla. As to the possibility that the fibrillæ of the second layer of the scale may develop themselves at the expense of the intermediate substance by immediate breaking down into such, without participation of the cells, one can say nothing definite, for the reason that there is no possibility of distinguishing the plasma of the formative cells from the intermediate substance itself."

The reliefs on the surface of scales. Ussow has only studied the formation of these reliefs in cycloid scales. In perfectly developed scales this relief has most frequently the form of rolls or cylinders, which cover the entire surface of the scale and run parallel to its border. In sections the rolls generally appear as small elevations of transparent homogeneous material, the appearance of which does not differ from that of the first layer of the scale. One finds a cell on such a roll or often behind it. The question might at once be asked, Where do these cells come from? Klaatsch says that these cells make their appearance out of the connective tissue of the scale pocket, and that as they penetrate into the intermediate space between the epidermis and the scale (in its upper part which has penetrated into the epidermis) as well as between the lower part of the scale and the pocket, they arrange themselves on the external surface of the scale in curved rows, and form, always in front of themselves, the substance out of which the rolls are made. Ussow saw such aggregations of cells in his sections, but in distinctly later stages than those figured by Klaatsch, namely when the reliefs at the sides of the scale are already completely formed; but at the stage when those reliefs occurred for the first time, no such cell aggregations existed. Ussow regards it as very possible that these cells later take part in the formation of the reliefs, but he believes that the commencement of their formation arises at the expense of the peripheral elements of the papilla, and that for the following reasons: "Commencing with the stage of a plate of scleroblasts, one finds in all subsequent sections the following formation: at the ends of the scales one observes masses of cells which differ in form and colouring from the scleroblasts of the plate, and are similar rather to the peripheral and basal elements of the papilla; they are, namely, much smaller than the scleroblasts and stain more deeply; in a word, they are cells which have taken no part in the formation of the scale, as the cells which form the scale change their form and appearance, their nuclei become larger, get a pear-shaped form, and are not so intensively stained. In following stages, tooth-like projections formed of transparent substance become observable at the ends of the plate, where the cell-masses were situated; behind each tooth lies a cell, or more properly only its nucleus, for the plasma has apparently been spent in the formation of the roll or cylinder which appears as a tooth in transverse section."

In connection with cycloid scales, Ussow believes that the teeth or small spines are not in any true sense comparable to rudimentary forms of the spines of placoid scales either in internal structure or development, but that there is merely an external resemblance. He holds that these spines are built of the same substance as that of the entire upper substance of the scale, that is to say, according to Hofer, of hyalodentin.

Ussow concludes his paper in the following words:—

"The scale of Teleosteans is a plate consisting of two layers. The upper layer (including the relief) consists of homogeneous tissue without any structure (frequently one can, however, observe on focussing a slight striation running parallel to the upper surface of the scale). This layer originates at the expense of the mesoderm elements of the dermis, at the expense of the so-called scleroblasts; its inorganic portion consists of amorphous calcium phosphate. The tissue of this layer is an ordinary simple bony tissue.

"The lower layer of the scale also originates at the expense of the same mesoderm elements. It is formed in part out of indurated (sclerosirten) connective-tissue fibrillæ, between which no cells exist (in the species investigated by me). One terms its tissue a tense connective tissue."

The next paper which I notice, that by Hoffbauer* on the "Age-determination of carp by means of their scales," bears more distinctly on my own contributions on the scales of marine fishes than any of the papers previously mentioned. Dr. Hoffbauer's work is that from which my investigations had their origin, and I would therefore lay all due stress upon it. This author showed that carp bred in pond or aquarium, for all of which he had exact knowledge as to their age and history, possessed in their scales a means of age-determination.

The scale of a carp shows the following structure:—There are two distinct areas, firstly, a non-transparent part covered by the upper skin, and situated towards the tail of the fish, which may be termed the posterior field or area; and a transparent part enveloped in the scale pocket, which may be called the anterior field or area. Only the anterior area comes into consideration in the determination of age. This anterior field, as distinguished from the posterior, shows fine lines which run approximately parallel to the margin of the scale, and apparently take their origin from a more or less median point lying back towards the posterior area of the scale. This median point is the centre of growth, and constitutes the oldest portion of the scale, characterised by the absence of lines or striæ. He describes these lines or striæ in the anterior area of the scale as concentric lines or striæ, which show much similarity in their arrangement to the annual rings seen in the transverse sections of trees. The concentric lines consist of ridge-like elevations of the upper surface of the scale, in consequence of which the upper surface is rougher to the touch than the under surface. The formation of these concentric lines has a very close connection with the growth of the scale. According to Baudelot, the lines are due to the fact that the lower surface of the scale, consisting only at first of a small thin plate (the centre of growth), gradually lays down lamellæ which always become larger in peripheral circumference, and on their free projecting margins concentric lines form themselves. It was at one time believed that a new lamella was formed each year, and that the concentric lines were the thrown up projecting margins of individual lamellæ; for example, that a twelve-year-old fish had twelve individual lamellæ and twelve concentric lines corresponding to the number of lamellæ. In a previous paper Hoffbauer showed that this accepta-

* Hoffbauer, 1899.

tion was incorrect (Allgem. Fischerei-Zeit, 1898, Nr. 19), as firstly the number of lamellæ is not the same as that of the concentric lines, and secondly the total number of concentric lines is much greater than the number of years. The number of concentric lines which form themselves at the free margin of the lamella stands, however, in direct relationship with the growth of the latter. As a result of this, the comparative distance of the concentric lines from one another also changes; it is greatest at the time of greatest growth, that is to say, in the summer.

He gives a diagrammatic transverse section of the scale of a two-year-old carp. He notes the difficulty of investigations dealing with the compounding of the lamellæ, that is to say, their number in relation to the size of the scale and their relation as a foundation for the concentric lines, as the hardness of their material renders it difficult to secure intact sections. In addition to the concentric lines, there are also radial lines on the surface of scales, the arrangement of which he considers to be of some service in the determination of age. He notes the presence of scales which differ in their structure from that described above. This variation from the normal consists of an expansion of the centre of growth so that it sometimes comes to occupy quite an extensive area, and there is a corresponding reduction of the number of concentric lines; but other scales from the same carp will show usually the normal arrangement. This deformity shows itself in very intensively developed carp, whose quick growth is expressed in the structure of the scale which does not form concentric lines to the usual extent.

Age-determination from the scale. The hypothesis upon which, in the first place, his method rests is the mode of the carp's life.

"It is clear, that in an animal which has a so-called winter sleep, whose means of nourishment decreases in autumn at the commencement of colder days, and whose body-weight remains the same in winter-time even under the most favourable circumstances, while in warm months much growth takes place as a result of a rich supply of nourishment, this reaction makes itself evident in a corresponding manner by changes in the structure of the body. We find that this phenomenon is shown, not only in every animal with such a mode of life, but it is true also in the plant world."

He believes that this change in the nourishment of the fish in summer as contrasted with winter shows itself in the scale as well as in other organs of the body; but the former is particularly well adapted in its structure to show the effect of the change.

He says, "As I have now investigated hundreds of carp scales with the most favourable results, I may indeed accept with complete assurance the truth of my hypothesis."

He acknowledges that one finds individual scales from which age-determination would be difficult, and that there are other scales which would tend to make the inexperienced worker very doubtful; but the uncertainty disappears after observing several scales from the same fish, as among them some would be found showing more distinct demarcations.

He then describes the superficial structure of a scale taken from a carp at the end of its second summer, namely, in late autumn, as illustrated by a photomicrograph. The means of determining the age is, as previously mentioned, found in the arrangement of the concentric lines on the scale surface. The best way to observe the arrangement of those lines is to begin at the centre of growth, and to pass straight outwards to the median border of the anterior area. The first lines round the centre of growth are rather irregular and interrupted, and are comparatively widely separated from one another; then follow more regular lines, which lie close to one another until they run into a bordering zone appearing somewhat darker. This zone marks the end of the first year's growth. In the second zone (the second year's growth) the arrangement of the concentric lines shows a repetition of that occurring in the first year, namely, firstly, irregular lines comparatively separated from one another; secondly, more regular lines with little separation between them. In scales of carp observed at the end of the third summer, a third zone shows itself similar in general arrangement to the last. "The number of concentric lines within a year's zone is, in individual scales from a scale row of the same carp, running, for example, close above or beneath the lateral line, approximately the same. Their number only decreases at those places where the scales themselves become smaller, as at the gill-slit and at the tail; the number is also only subject to slight fluctuations in corresponding scales on the right and left sides of the same individual fish; in corresponding scales from different individuals it can, however, vary considerably, according to more or less intensive growth within a year."

He gives a statistical table to bring out these points, in which he shows the number of concentric lines in individual scales in the row of scales dorsal to and above the lateral line in the direction from the gill-slit to the tail. The structure described above is seen in all normally formed scales, that is to say, from carp living under favourable and natural conditions. He, however, also considers less favourable conditions. The fish's growth may have an irregular course, it may grow faster or slower. For example, what influence has illness, or want of food, or both of these, for one or several years upon the method of age-determination.

But, "in this case, the structure of the scale does not leave us in a difficulty; on the contrary, we gain from it, in a manner, a self-registering, infallible control over the mode of life of its bearer." He takes a case to show this point. He commences with the most unfavourable case: the case of a carp in its third summer which had grown slowly all its life in consequence of less food. This mode of life showed itself in the arrangement of concentric lines at an equal distance from one another within a period of growth. As a result of this, the border separating one year from another becomes more indistinct. As a rule, one sees a divergence of the concentric lines at the age border where the posterior area meets the anterior area at the right and left of the concentric lines. If one follows this divergence towards the front margin of the anterior field, then the separation area between one year and another becomes more distinctly marked out than one had hitherto supposed, or rather observed. Besides this, the radial lines also aid one in age-determination. It is frequently the case that at the border between one zone and another, either several radii of the previous year's zone end, or new radii of the succeeding year's zone begin. Lastly, the total number of concentric lines is a sure way of dispelling all further doubts on the subject.

One does not need a detailed observation such as the above to distinguish a slow-growing carp of three summers from a well-grown carp of two summers, as superficially the difference in the distance of the concentric lines, in such a two-year carp of approximately the same size, is distinctly greater at its chief period of growth, and besides this, the age border between the first and second year is also much more distinct. With practice one can in a similar way distinguish between a slow-grown carp of two summers and a quickly grown carp of one summer. The age-determination of rapidly grown carp offers no difficulty, the difference in the distance of the concentric striæ appears distinctly prominent at the time of the growth period. One may lay down the following general rule in regard to the relationship of the concentric lines:—

"*Je intensiver das Wachstum der Karpfen, respektive seiner Schuppe. um so grosser wird der Abstand der konzentrischen Streifen von einander und umso unregelmässiger, unzusammenhängender ihr gegenseitiger parallel Verlauf.*"

He shows, from his figures that from spring until the height of growth in the summer months a steady increase of the distance of the concentric striæ appears, which finally are represented as zigzag lines partly anastomosing with each other. In autumn the lines become much closer to one another, until finally they become extremely close and regular. In some cases in the first year's zone, in consequence of a great expansion of the centre of growth, concentric lines are not formed in spring-time, but only in summer-time.

Under some circumstances, however, an intensive growth may take place in spring-time, as shown in fig. 6 (Hoffbauer). This figure shows that the concentric striæ at the commencement of the second year have a very regular course and are at a great distance from each other. In other figures he shows how much the centre of growth may expand; thus in fig. 8, representing the scale of a one-summer carp, only twenty irregular concentric lines have been formed at the conclusion of the growth period, while under normal conditions fifty to sixty and more are to be seen. Further, in fig. 9 the first year's zone is altogether without concentric lines, which only commence their formation at the beginning of the second year. Even the second year's zone may have no concentric lines, as he shows in his tables giving the number of concentric lines; this is, however, a rare occurrence.

The remainder of his paper is taken up with a consideration of photomicrographs of scales from carp bred in pond or aquarium, for all of which he had exact knowledge as to their age and history, and to my mind these figures show in a very clear and interesting manner the truth of this mode of age-determination. He shows that in carp, the scales of which were periodically examined, the increase in the dimensions of the size of the scales, the number of concentric lines formed in them, and the amount of separation between the lines, corresponded with the known facts as to whether the fish were slowly or quickly gaining weight, and this in a very striking manner. He says, "Die Unterschiede sind so deutlich erkennbar, dass wir uns eine bessere und untrugliche Orientirung gar nicht verschaffen können." He further takes up the case of two carp of the same brood and of equal weight; one of these was put into an aquarium, the other into a pond at the same time, their scales being first examined. The carp placed in the pond naturally gained weight more quickly than that placed in the aquarium, and on the scales of both being examined some time later, those from the pond showed an increase of scale surface, with widely separated concentric lines, while those from the aquarium showed little increase of scale surface and closely situated concentric lines. The increase in the case of the pond fish he ascribes to the supply of plankton food from the water. Another interesting case is that of carp whose growth was partly disturbed for a time by an accidental drying up of the water in the pond in which the carp was living. On the scales of this carp being examined some time after the renewal of the supply of water, the effect of the partial drying up and subsequent renewal of the water appears marked out in the scales, the adverse condition by dark closely situated lines lying close together, the normal condition by clear and more widely separated lines. During the partial drying up of the pond, the fish were probably deprived of their wonted nourishment.

In conclusion, he deals with the case of an invalid carp. When this carp was caught it appeared thin and poorly nourished. On examination this appeared to be due to a swelling in the anal region. The scales seemed clearly to show at what time this swelling had effected a disturbance in the growth of the animal. He concludes his first paper on this subject by saying that age-determination from the scales will not probably be so easy in carp older than three years, as the older the carp becomes the larger and thicker do its scales become, and consequently they are not so transparent, and recognition of the concentric striæ becomes more difficult, especially in the first year's zone surrounding the centre of growth.

In the following year Dr. Hoffbauer issued a second paper, a continuation of the last noticed. His subject is now somewhat wider, namely, "Further contributions on the structure of fish scales for determination of the age and course of growth."* In this paper Hoffbauer strengthens his position by means of further results and statistics, and also replies to certain criticisms by Dr. Walter (*Jahresberichtes in der Fischerei Zeitung*, Bd. iii., 1900, Nr. 19). Walter had allowed the general correctness of Dr. Hoffbauer's observations, but had regarded them as less certain and easy of recognition for practical men than for Dr. Hoffbauer.

Hoffbauer regards Walter's position as largely due to unnecessary methods which he employed in cleaning scales, by which the characteristic features of the scale became less apparent.

In this second paper Hoffbauer, in addition to extending his observations on the scales of the two varieties of carp treated of in his first paper, includes those of *Carassius carassius*, L., *Micropterus salmoïdes*, and *Perca lucioperca* in his observations with equally good results.

In January, 1902, I published a preliminary paper on the same subject as my present contribution.†

From this paper I quote the following paragraphs :—

"The formation of these annual rings results from the fact that the lines of growth on the scale surface are comparatively widely separated from one another in that portion of the scale formed during the warmer season of the year; but much less widely separated in that part built up during the colder

* Hoffbauer, 1901. † Thomson, 1902.

season. Thus by following the arrangement of the lines of growth on scales, it is a simple matter to observe the starting-place of any year's growth by the comparatively wide separation of the growth-lines at that portion of the scale, and in this way the surfaces of scales appear mapped out by annual rings. These annual rings supply us with an index as to the age of the fish, and may be roughly compared to the rings in many trees. The annual rings in the stems of trees are due to seasonal nutritive conditions, and the rings on the scales of fishes are probably the result of seasonal environmental conditions, such as food, temperature, etc. In more detail, the alternate occurrence of comparatively rapid and slow areas of growth in scales is probably the result of the variations in food, temperature, etc., which are associated with the alternation of summer and winter. For example, the abundant supply of food (plankton, etc.) during the warmer season of the year probably has much connection with the comparatively rapid growth of the scale at that time as compared with the slow increase during the colder season, when there is a decrease in the supply of food.

"These facts appear to possess both scientific and economic importance, since they permit the extension to marine fishes of a new system of age-determination by means of these annual rings on scales, a system which has recently been shown and demonstrated by Dr. Hoffbauer for the carp.

"I hope to illustrate clearly the mode of formation of annual rings in Gadoid scales by the aid of the figure on the accompanying plate.

"The figure [Plate II., Fig. 1, of the present paper] represents the scale of a pollack, 28·5 centimetres ($11\frac{1}{2}$ inches) in length, captured towards the end of October. A minute translucent area (see Fig. 1, C) devoid of any lines is situated towards the narrower and more internal end of the scale; and around this area, which is the first portion of the scale to be formed, are grouped numerous excentric lines of growth similarly disposed to the excentric layers in the starch grains of the potato.

"The excentric lines of growth on this scale, however, are arranged in such a manner (see figure) as to map out its surface into two main regions, namely, an internal area, which is the entire growth of the first year, and an external part, the summer growth of the second year. One understands how these two areas appear so distinctly if one follows the lines of growth outwards from the translucent area to the broader and more external part of the scale. One may firstly observe that there are nineteen lines comparatively widely separated from one another, which indicate the growth of the first summer, and secondly, ten lines less widely separated, indicating growth of the first winter. External to these there follows an area showing much more widely separated lines of growth, which indicate the scale growth of the second summer.

"The difference between the lines of growth formed during the second summer and those of the preceding winter is so apparent as to clearly define the termination of the first year's growth. The widely separated lines of the second summer number nineteen, and as the pollack from which this scale was taken was captured in October, it appears that in this scale the number of lines formed during the second summer exactly agrees with the number formed during the first summer."

I must conclude my review of the literature of scales, so far as it bears on the subject of my investigations, with a notice of a preliminary paper by Dr. Marett Tims.* This paper deals with later stages of scales than those of Klaatsch and Ussow.

The scales observed by Marett Tims were from several species of Gadidæ—*Gadus virens*, *G. luscus*, *G. pollachius*, *G. callarias*, etc. As this paper is very brief, I content myself mainly by quoting several of his sentences.

"The formed scale is a compound structure consisting of a fibrous stratum, upon the upper surface of which are situated numerous 'scalelets,' arranged in lines radiating from a more or less homogeneous centrum. It is the presence of these structures that gives the 'sculptured' or 'ringed' appearance to the scales; but these terms, though frequently applied, are misleading."

"The fibres (of the fibrous stratum) are arranged in definite layers: (1) a superficial, in which the bundles are concentric; (2) a deep layer, in which the individual bundles interlace with one another at right angles, each set running diagonally to the long axis of the scale. A third layer, the fibres of which form an irregular network, is possibly present, but it is much more difficult to demonstrate."

"The scalelets, placed upon the upper surface of the fibrous stratum, are themselves covered with a delicate epidermis. . . . They consist of flattened, imbricated, calcareous plates."

He infers from reactions with borax-carmine and acid that in the earlier condition the scalelets "are more thoroughly calcified, or rather, perhaps, that in the later stages they contain a larger amount of organic material, and thus stain more readily."

"Between the radiating lines of scalelets the deeply stained fibrous stratum is seen, resembling the spokes of a wheel.

"In an early stage, before the scalelets become imbricated, the fibres may also be noticed as transverse bands passing between the individual plates of a row.

"On examining a section of an undecalcified scale, the scalelets are seen to be for the most part implanted in sockets on the upper surface of the fibrous stratum with a varying inclination. Those at the centrum appear to have fused, forming a horizontal plate, while at the periphery of the scale they are almost perpendicular. In a section through the skin of a green cod about 4 cm. long the individual scalelets are quite isolated. Each consists of a basal plate, from the upper surface of which projects a minute spine, thus resembling a small placoid scale.

"Such a condition is only evident in material from which acid has been rigidly excluded. The condition does not appear to have been previously noted; the figures given by Klaatsch and others being similar to those which I obtained from material which has been passed through acid alcohol, and which do not show the true nature of the scale."

If the forecasts of the results of this paper are true, they necessarily invalidate many ideas previously held as to the nature of scales, and must also introduce quite a new set of terms in their description. I prefer, however, to keep cautiously to the older and more established views and terms until

* Marett Tims, 1902.

Dr. Marett Tims's facts may be affirmed by the publication of his detailed paper, to which I look forward with much interest.

[Since Mr. Thomson left for South Africa, Mr. A. W. Brown, of St. Andrews, has been good enough to send me a reprint of a note communicated by him to the Royal Society of Edinburgh (*Proceed. Roy. Soc. Edinburgh*, 1902–3, p. 437), entitled "Some Observations on the Young Scales of the Cod, Haddock, and Whiting before Shedding." This note is as follows:—

"During the winter of 1902–3, I conducted observations upon the scales and their condition, in several of the gadoid fishes. Investigation was commenced in October, 1902; but it was not until the beginning of March 1903 that the first appearance of the young scale took place. In stained specimens, it can be recognised as a deeply staining 'nucleus,' lying beneath the old scale, just under its centre. Such an appearance was found in cod, haddock and whiting of all ages from one to three or four years; and, in all, the young scale is clearly recognisable, underlying the old. As soon as these fishes have spawned, they appear to shed their scales, the epidermis first peeling off. An examination of a few large haddocks, eight pounds weight and over twenty-seven inches in length, showed that in January the ovary was black, shrunken, and not in spawning condition. I am inclined to think that these fish are past the age for spawning. I examined very carefully this class of haddock right on till April. In every case I found that the scales showed evidences of hard wear, and in some cases were frayed. In these fishes no traces of the replacing scales were found, and the probable conclusion is that no further shedding of the scales takes place after the close of the reproductive period.

"It has been suggested that the annual rings of growth may be traced upon the gadoid scales; but I find that upon the cod, haddock, whiting, green cod, and pollack, of one to three years of age, scales may be obtained from different parts of the body showing ninety, sixty, or thirty rings, according to the part selected.

"I have been enabled to trace back the first appearance of the new scale to the month of February, when it may be recognised as a dark tip growing upon a small papilla.

"By the middle of April, the epidermis on the head commences to peel off, and, probably somewhat later, over the body. The details of this process will have to be followed in sections; but sufficient evidence is to hand to make it probable (1) that gadoid fishes shed their scales immediately after spawning; (2) that after the age limit of spawning is reached no further shedding of scales takes place; (3) that the concentric rings of the scales do not represent annual increments, but must have other causes."

Mr. Thomson had heard verbally of this communication, but had not seen the note. He states that the presence of minute scales amongst the larger ones in the trout was described and figured by Klaatsch in 1891, and their presence in Gadidæ has been known to him for two years. He refers to these small scales in another part of this paper (p. 57), and does not attach to them the same significance as that given them by Mr. A. W. Brown. —E. J. A.]

III. Statistical Section.

This section of my paper is chiefly concerned with measurements of the surface size, enumeration of the lines of growth and annual rings for scales of the following: pollack, poor-cod, whiting, haddock, and cod.

The area of the body from which scales were generally selected for examination was the median region of the flanks, that is to say, slightly posterior to the pectoral fin, and either slightly above or below the lateral line.

In the majority of cases I have given data in the tables for half a dozen scales from the same fish, three of which were taken from the right side, and the other three from the left side of the body.

Scales from any part of the body show annual rings, though scattered among the normally developed scales are some minute scales mentioned by Klaatsch, to which I will later refer. Of the five species mentioned above, that which shows annual rings in the scales least satisfactorily is the whiting; so much is this the case that at times their determination becomes a matter of real difficulty, and it is only after a comparison of the lines of growth in scales from a number of specimens that one attains any degree of certainty in the matter. The other species mentioned show annual rings remarkably clearly, much more so, indeed, than is brought out in the photomicrographs. The coal-fish (*Gadus virens*) and the Norwegian whiting-pollack (*Gadus Esmarkii*) also show annual rings very distinctly (see plates), and I only regret that want of time prevents my giving statistics for these two species. In regard to the cod, *Gadus callarias*, L., from photomicrographs which I have taken, it appears that the system would also be applicable to this species; but not having a complete series of this fish, I have only given a few figures, and more exclusively confined my attention to Gadidæ of the English Channel.

In passing, I may say that I approached the subject of the age of fishes with an unbiassed mind, as I had little previous knowledge as to the ideas of either practical or scientific men on this subject, and it was only after I had compiled my own statistics on age-determination that I compared my results with those arrived at by other workers by different methods (see Cunningham, Fulton, etc.).

The determination of the years of large and aged fish from their scales is a much harder task than in the case of younger fish, as the scales of the former have, firstly, become much thicker and less transparent, and secondly, the scales of such are frequently more or less disintegrated. As an illustration of this one may notice the photomicrograph of a scale of a pollack 31 inches in length, which appears to possess 8 annual rings (see Plate IV.).

That in the life of fish, as in trees, there will be good years and bad years is more than probable, and as this variation in metabolism expresses itself in the stems of trees, one might, reasoning from analogy, expect a similar change in the scales of fishes. That such an effect does take place appears probable from my figures and photomicrographs.

In regard to locality of capture, as my work was mainly done at Plymouth, most of the fish examined were from the western portion of the English Channel, chiefly from the bays of Devon and Cornwall. Few of the fish examined were captured by the ocean-going trawlers, as in fish caught by this method the scales were, as a rule, completely rubbed off by the time the fish came to hand.

If, as in the case of a few whiting, etc., the fish examined were captured at other localities, I have stated that such is the case in the column of notes.

The haddocks examined were caught in the North Sea, off the Firth of Forth, in Aberdeen Bay, and off the Shetlands.

The cod, only a very few statistics about which I am able to give, were brought in at St. Andrews.

A friendly critic has suggested that annual rings would either not be found, or would not be clearly marked, in scales from fish of deep water, on account of the fact that in this case fish are not exposed to the same seasonal variation in temperature as in shallow water; in other words, is it not probable that the growth of fish living in deep water will be less accelerated in the summer and less arrested in the winter than in forms living in shallow water. In order to determine if such was the case, I compared scales from a series of haddock (10–15 inches in length) captured in comparatively shallow water (8–14 fathoms) at Aberdeen Bay with another series (10–16 inches) caught in deep water (60–80 fathoms) seven miles off the Shetlands. The result of my observations was that annual rings were as clearly marked in the scales of haddocks from deep water off the Shetlands as in those from shallow water of Aberdeen Bay, excepting that in the older stages of the former the rings appeared very slightly less clearly defined.

The weights of fish in the statistical tables must be slightly allowed for as not being exactly accurate, as in most cases the fish were weighed after having been for some time in spirit or formalin.

THE OCCURRENCE OF MINUTE SCALES.

In my observations on the skin of Gadidæ I noticed the presence of minute scales situated near the larger and better developed. These minute scales I found chiefly in the younger stages of the fish. In older stages of the animal they appeared to be almost entirely covered over by the larger ones, and to lie in such positions that their growth would apparently be much hindered by the latter. The small scales do not appear to be arranged on the skin in the regular manner characteristic of the larger scales, and they do not possess many lines of growth. According to my opinion, these minute scales never grow to any size, and can always be distinguished from the better-developed and more regularly arranged scales. In the early stages I believe that the diminutive scales lie freely and are not covered over by the larger scales; but as these larger scales grow, they cover over the smaller scales and hinder their growth, consequently the latter either remain small or disappear altogether. That these minute scales grow and later take their place alongside of the larger scales I do not believe. We have also to remember in this connection that the exact number of scales in a row on the fish has been regarded as sufficiently constant for use in the determination of species.

Klaatsch has referred to these small scales in two connections, firstly, in the development of the trout, and secondly, in a comparison of the teleostean with the placoid scale. He also gives a figure of these small scales in a young trout. In his section dealing with the development of trout scales he says that at the same place in a fish one finds scales which are by no means similarly advanced in development. Between such large scales as already partly cover one another, small scales are very frequently found which are in the earliest stages of development. In older animals such an irregularity does not occur.

In his section dealing with a comparison of the teleostean and placoid scales, he says that the arrangement of the rhomboid scales on the skin of the trout is similar to the arrangement of the rhombic basal plates of the dogfish; both of them are arranged in oblique rows. There is a further point of similarity. As in Elasmobranchs, new scales originate in the trout between the well-developed scales; thus one finds lying between the older scales of the trout even in later stages quite young scale foundations. This irregularity in the early development soon ceases in the trout.

The Pollack *(Gadus pollachius)*.

The following tables give detailed measurements of the surface size, number of lines of growth, and annual rings for scales of pollack, which varied from about $1\frac{3}{4}$ inches to 33 inches in length. According to Cunningham, on the coast of Cornwall the spawning of the pollack commences in February or March, and the young of the year are found in April. In that month they are from $\frac{8}{10}$ to 1 inch in length, and he estimates their age at approximately six weeks.

In 1901 I found fish of the latter size, at the beginning of May, possessed of extremely minute scales without any lines of growth.

Pollack $1\frac{3}{4}$–$2\frac{3}{4}$ inches in length, caught on 8th July, would thus be about three months old, and these show, on an average, 3–4 lines of growth, thus giving a formation of 3–4 lines in two months.

Cunningham further says, "In October I have taken a number in Cawsand Bay, $3\frac{4}{5}$–$4\frac{2}{5}$ inches long, and I have no doubt these were hatched in the preceding spring."

I have examined Cunningham's actual specimens, and the scales of these give on an average 15 lines of growth, and their structure bears out his statement, and gives a formation of approximately 2–3 lines of growth per month.

Two months later, in December, there are an average 18 lines of growth, giving an addition of 1–2 lines of growth per month. One would naturally expect to find fewer lines of growth during these winter months. In another sentence Cunningham says, "The pollack caught in Plymouth Sound in June and July are 12–15 inches long, and are probably in their third year."

This is also brought out in my table. It will be seen there that a fish 15 inches long captured in the middle of June has 2 annual rings and 7 young lines of growth occurring on its scales.

If growth for the third year started in the middle of April, this again would give a formation of about 3 lines per month.

In the following detailed tables dealing with the pollack, I have given a comparison of scales from four different regions of the body in two cases, firstly, that of a young fish (3·79 inches), and secondly, that of an older fish (15·19 inches). The four regions of the body from which scales were examined in these two cases were the following:—

(1) The anterior region, laterally, slightly posterior to the eye.
(2) The median region of the flanks, that part of the body which has the greatest depth vertically beneath the first dorsal fin and posterior to the pectoral fin. This has been the usual area from which I have examined scales throughout my investigations.
(3) Region vertically beneath the posterior part of the second dorsal fin, adjoining the lateral line.
(4) Region vertically beneath the third dorsal fin, adjoining the lateral line.

In a comparison of scales from these four regions the following facts may be noticed:—

(1) That commencing with the anterior area and proceeding backwards to the posterior area, the number of lines of growth increases in both the young and older fish.
(2) That proceeding in the same direction, the length of the scale increases in a similar manner.

(3) That the length of the axis AB[1] or AB[II] (axis from centre of growth to posterior end of scale) increases in a corresponding way.

(4) That in young fish the broadest scales are those taken from the median region of the flanks (second region); but in the case of the older fish the broadest scales are those from the third region, namely, vertically beneath the second dorsal fin.

I have selected that region vertically beneath the first dorsal fin as the area from which I usually take scales for examination for several reasons: firstly, that it is the area from which previous workers have taken scales; secondly, that this is, according to Klaatsch, Ussow, etc., the region in which scales first develop; thirdly, that in the case of fish in which the scales have been rubbed off by mechanical friction, this area appears to retain them longer than others. This may be because it is partly protected by the pectoral fin.

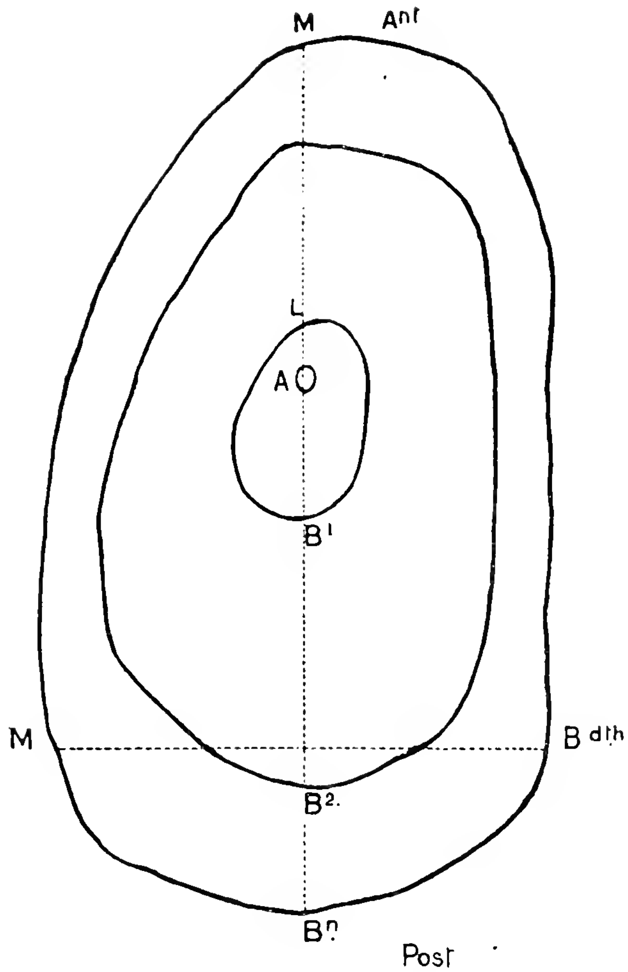

Fig. 1. Diagram of a pollack's scale with three annual rings to show the mode of measurement adopted in the statistical tables.

Ant = anterior end of scale; Post = posterior end of scale; MB^n = length of scale; MB^{dth} = maximum breadth of scale; AB^n = long axis from centrum to posterior end of scale; LB^1 = total length of 1st year's growth; AB^1 = long axis from centrum to posterior end of Ring I; $B^1 B^2$ = long axis from end of Ring I to end of Ring II in posterior direction; $B^2 B^n$ = long axis from end of Ring II to end of Ring III in posterior direction.

Enumeration of the lines of growth is taken throughout from the centrum in the posterior direction; they are more numerous towards the latter than towards the anterior end of the scale. In the tables the signs + and − are used in connection with the occurrence of annual rings; for example, if no annual rings are as yet formed the term − 1 is used; if one annual ring is complete, and there are additional lines of growth present, the sign 1 + is used.

TABULAR RESULTS OF EXAMINATION OF POLLACK SCALES.

FISH.			SCALES.					REMARKS.
Length.	Weight in grms.	Date of capture.	Total length in mm.	Maximum breadth in mm.	Length of A B in mm.	Number of excentric lines.	No. of annual rings.	
4·4 cm. = 1·73 in.	·64	July 8, 1901	·15	·12	·09	2	1	Scales taken from left side of the body of the fish.
,,	,,	,,	·23	·11	·14	3	,,	,, ,, ,, ,,
,,	,,	,,	·20	·13	·09	3	,,	,, ,, ,, ,,
,,	,,	,,	·18	·07	·11	2	,,	,, right ,, ,,
,,	,,	,,	·15	·12	·07	2	,,	,, ,, ,, ,,
,,	,,	,,	·16	·13	·08	1	,,	,, ,, ,, ,,
—	—	—	·18	·11	·10	2	,,	Average for preceding ½-dozen scales, all from same fish.
4·8 cm. = 1·88 in.	·78	July 8, 1901	·23	·16	·14	2	– 1	Left side.
,,	,,	,,	·23	·13	·11	1 + 1 forming	,,	,,
,,	,,	,,	·18	·10	·09	1 + 1 forming	,,	Right side.
,,	,,	,,	·22	·12	·13	2	,,	,,
—	—	—	·22	·13	·12	2	,,	Average for preceding 4 scales, all from same fish.
5·4 cm. = 2·12 in.	1·08	July 8, 1901	·25	·14	·16	2 + 1 forming	– 1	Left side.
,,	,,	,,	·22	·13	·14	2	,,	,,
,,	,,	,,	·28	·18	·16	3	,,	Right side.
,,	,,	,,	·28	·11	·20	3	,,	,,
—	—	—	·26	·14	·17	3	,,	Average for preceding 4 scales, all from same fish.
5·9 cm. = 2·32 in.	1·45	July 8, 1901	·34	·20	·22	4	– 1	Left side.
,,	,,	,,	·33	·21	·22	4	,,	,,
,,	,,	,,	·30	·22	·17	4	,,	Right side.
,,	,,	,,	·34	·22	·21	4	,,	,,
—	—	—	·33	·21	·21	4	,,	Average for preceding 4 scales, all from same fish.

6·1 cm. = 2·40 in.	1·67	July 8, 1901	·26	·18	·18	3	– 1	Left side.
,,	,,	,,	·30	·20	·18	3	,,	,,
,,	,,	,,	·30	·21	·18	4	,,	Right side.
,,	,,	,,	·30	·20	·19	3	,,	,,
—	—	—	·29	·20	·18	3	,,	Average for preceding 4 scales, all from same fish.
6·4 cm. = 2·51 in.	1·95	July 8, 1901	·39	·24	·25	5	– 1	Left side.
,,	,,	,,	·43	·26	·26	5	,,	,,
,,	,,	,,	·35	·21	·22	4	,,	Right side.
,,	,,	,,	·35	·25	·19	5	,,	,,
—	—	—	·38	·24	·23	5	,,	Average for preceding 4 scales, all from same fish.
7 cm. = 2·75 in.	2·35	July 8, 1901	·39	·22	·23	5	– 1	Left side.
,,	,,	,,	·38	·23	·22	5	,,	,,
,,	,,	,,	·32	·24	·22	5	,,	Right side.
,,	,,	,,	·38	·26	·23	5	,,	,,
—	—	—	·37	·24	·23	5	,,	Average for preceding 4 scales, all from same fish.
9·15 cm. = 3·60 in.	6·60	Dec. 4, 1889	·60	·36	·48	15	– 1	
,,	,,	,,	·65	·37	·44	16	,,	
,,	,,	,,	·62	·37	·41	16	,,	
,,	,,	,,	·61	·35	·38	15	,,	
,,	,,	,,	·61	·34	·41	15	,,	
,,	,,	,,	·65	·35	·46	17	,,	
—	—	—	·62	·36	·43	16	,,	Average for preceding ½-dozen scales, all from same fish.
9·25 cm. = 3·64 in.	6·22	Oct. 2, 1890	·735	·405	·495	15	– 1	The scales being taken at the deepest region of the body, immediately above or below the lateral line (usual area).
,,	,,	,,	·78	·375	·51	15	,,	
,,	,,	,,	·735	·375	·51	15	,,	
,,	,,	,,	·78	·435	·51	15	,,	
,,	,,	,,	·69	·375	·51	15	,,	
,,	,,	,,	·75	·405	·51	15	,,	
—	—	—	·745	·395	·5075	15	,,	Average for above.

TABULAR RESULTS OF EXAMINATION OF POLLACK SCALES—*continued.*

FISH.			SCALES.					
Length.	Weight in grms.	Date of capture.	Total length in mm.	Maximum breadth in mm.	Length of A B in mm.	Number of excentric lines.	No. of annual rings.	REMARKS.
9·50 cm. = 3·74 in.	6·67	Dec. 4, 1889	·61	·39	·49	15	– 1	Right side. This fish is comparatively light for its length, and scale is small.
,,	,,	,,	·62	·34	·41	14	,,	,,
,,	,,	,,	·63	·41	·41	14	,,	,,
,,	,,	,,	·55	·28	·39	14	,,	Left side.
,,	,,	,,	·66	·35	·43	14	,,	,,
,,	,,	,,	·59	·34	·42	14	,,	,,
—	—	—	·61	·35	·43	14	,,	Average for preceding ½-dozen scales, all from same fish. Some of the scales of this fish were disintegrated.
9·65 cm. = 3·79 in.	5·45	Oct. 2, 1890	·86	·39	·60	19	– 1	Right side.
,,	,,	,,	·68	·43	·45	14	,,	,,
,,	,,	,,	·67	·40	·43	13	,,	,,
,,	,,	,,	·61	·38	·45	13	,,	,,
,,	,,	,,	·71	·42	·50	14	,,	Left side.
,,	,,	,,	·72	·39	·48	14	,,	,,
,,	,,	,,	·73	·40	·48	14	,,	,,
,,	,,	,,	·70	·40	·43	14	,,	,,
—	—	—	·71	·40	·477	14	,,	Average for preceding 8 scales, all from same fish.
9·65 cm. = 3·79 in.	6	Oct. 2, 1890	·49	·09	·28	8	– 1	The following 24 measurements have been made for purposes of comparison of scales from four different regions of the body. Scales taken immediately posterior to eye.
,,	,,	,,	·49	·19	·35	7	,,	
,,	,,	,,	·52	·22	·34	9	,,	
,,	,,	,,	·39	·09	·24	7	,,	
,,	,,	,,	·47	·19	·25	7	,,	
,,	,,	,,	·38	·17	·28	7	,,	
—	—	—	·45	·158	·29	7	,,	Average for preceding ½-dozen scales.

9·65 cm. = 3·79 in.	6	Oct. 2, 1890	·62	·41	·42	12	−1	Scales taken from the usual area, namely, from the median region of the flanks, immediately below the lateral line and posterior to the pectoral fin.
,,	,,	,,	·68	·38	·45	12	,,	
,,	,,	,,	·77	·45	·50	15	,,	
,,	,,	,,	·75	·45	·53	15	,,	
,,	,,	,,	·69	·50	·41	14	,,	
,,	,,	,,	·72	·51	·50	15	,,	
—	—	—	·71	·45	·47	14	,,	Average for preceding ½-dozen scales.
9·65 cm. = 3·79 in.	6	Oct. 2, 1890	·87	·46	·68	18	−1	From same fish, near lateral line, vent. to 2nd dors. fin.
,,	,,	,,	·86	·44	·56	17	,,	,, ,, ,, ,,
,,	,,	,,	·95	·30	·67	19	,,	,, ,, ,, ,,*
,,	,,	,,	·75	·35	·49	16	,,	,, ,, ,, ,,
,,	,,	,,	·88	·45	·58	18	,,	,, ,, ,, ,,
,,	,,	,,	·83	·41	·55	17	,,	,, ,, ,, ,,
—	—	—	·86	·40	·59	18	,,	Average for preceding ½-dozen scales.
9·65 cm. = 3·79 in.	6	Oct. 2, 1890	·77	·34	·49	17	−1	From same fish, near lateral line, vent. to 3rd dors. fin.
,,	,,	,,	·94	·51	·61	18	,,	,, ,, ,, ,,
,,	,,	,,	·99	·40	·68	20	,,	,, ,, ,, ,,
,,	,,	,,	1·04	·37	·73	20	,,	,, ,, ,, ,,
,,	,,	,,	·83	·39	·61	20	,,	,, ,, ,, ,,
,,	,,	,,	·95	·38	·67	19	,,	,, ,, ,, ,,
—	—	—	·92	·398	·63	19	,,	Average for preceding ½-dozen scales.
9·85 cm. = 3·87 in.	9·25	Dec. 4, 1889	·81	·47	·58	20	−1	
,,	,,	,,	·78	·44	·56	21	,,	
,,	,,	,,	·70	·54	·59	19	,,	This scale was unusually broad.
,,	,,	,,	·83	·40	·63	22	,,	
,,	,,	,,	·85	·50	·62	22	,,	
,,	,,	,,	·78	·44	·54	19	,,	
—	—	—	·79	·465	·59	21	,,	Average for preceding ½-dozen scales, all from same fish.

* Abnormal as to breadth.

TABULAR RESULTS OF EXAMINATION OF POLLACK SCALES—*continued.*

FISH.			SCALES.					REMARKS.
Length.	Weight in grms.	Date of capture.	Total length in mm.	Maximum breadth in mm.	Length of A B in mm.	Number of excentric lines.	No. of annual rings.	
10 cm. = 3·93 in.	9·45	Dec. 4, 1889	·76	·43	·55	18	– 1	Right side.
,,	,,	,,	·77	·35	·68	22	,,	,,
,,	,,	,,	·80	·49	·61	21	,,	,,
,,	,,	,,	1·20	·50	·68	19	,,	Left side.
,,	,,	,,	·79	·38	·56	18	,,	,,
,,	,,	,,	·84	·42	·58	19	,,	,, A few scales from this fish were in a dis- [integrated condition.
—	—	—	·86	·43	·61	20	,,	Average for preceding ½-dozen scales, all from same fish.
10·15 cm. = 3·99 in.	7·5	Dec. 4, 1889	·73	·40	·48	18	– 1	
,,	,,	,,	·70	·45	·46	17	,,	
,,	,,	,,	·73	·43	·53	20	,,	
,,	,,	,,	·79	·42	·54	19	,,	
,,	,,	,,	·67	·41	·45	17	,,	
,,	,,	,,	·84	·40	·61	21	,,	
—	—	—	·74	·42	·545	18	,,	Average for preceding ½-dozen scales, all from same fish.
10·20 cm. = 4·01 in.	8·20	Dec. 4, 1889	·60	·31	·42	14	– 1	Right side.
,,	,,	,,	·65	·38	·47	16	,,	,,
,,	,,	,,	·74	·42	·51	18	,,	,,
,,	,,	,,	·70	·40	·54	17	,,	Left side.
,,	,,	,,	·73	·43	·54	18	,,	,,
,,	,,	,,	·65	·35	·48	17	,,	,,
—	—	—	·68	·38	·49	17	,,	Average for preceding ½-dozen scales, all from same fish.

10·25 cm. = 4·03 in.	8·92	Oct. 2, 1890	·94	·45	·65	15	– 1	Left side.
,,	,,	,,	·88	·48	·62	16	,,	,,
,,	,,	,,	·95	·46	·65	16	,,	,,
,,	,,	,,	·85	·42	·58	16	,,	Right side.
,,	,,	,,	·87	·51	·58	16	,,	,,
,,	,,	,,	·89	·49	·57	17	,,	,,
—	—	—	·90	·47	·61	16	,,	Average for preceding ½-dozen scales.
10·35 cm. = 4·07 in.	8·30	Oct. 2, 1890	·77	·42	·56	16	– 1	Left side.
,,	,,	,,	·81	·44	·55	16	,,	,,
,,	,,	,,	·90	·51	·545	16	,,	,,
,,	,,	,,	·82	·44	·59	17	,,	Right side.
,,	,,	,,	·75	·40	·54	16	,,	,,
,,	,,	,,	·82	·45	·57	15	,,	,,
—	—	—	·81	·44	·56	16	,,	Average for preceding ½-dozen scales, all from same fish.
10·45 cm. = 4·11 in.	8·45	Oct. 2, 1890	·90	·48	·63	17	– 1	Left side.
,,	,,	,,	·91	·50	·61	17	,,	,,
,,	,,	,,	·85	·42	·53	16	,,	,,
,,	,,	,,	·83	·49	·58	16	,,	Right side.
,,	,,	,,	·77	·44	·50	16	,,	,,
,,	,,	,,	·82	·48	·55	16	,,	,,
—	—	—	·847	·47	·566	16	,,	Average for preceding ½-dozen scales, all from same fish.
10·55 cm. = 4·15 in.	8·10	Oct. 2, 1890	·88	·50	·61	16	– 1	Left side.
,,	,,	,,	·91	·49	·61	15	,,	,,
,,	,,	,,	·80	·34	·57	14	,,	,,
,,	,,	,,	·78	·48	·51	15	,,	Right side.
,,	,,	,,	·88	·45	·57	15	,,	,,
,,	,,	,,	·79	·42	·57	15	,,	,,
—	—	—	·84	·417	·58	15	,,	Average for preceding ½-dozen scales, all from same fish.

TABULAR RESULTS OF EXAMINATION OF POLLACK SCALES—*continued.*

FISH.			SCALES.					REMARKS.
Length.	Weight in grms.	Date of capture.	Total length in mm.	Maximum breadth in mm.	Length of A B in mm.	Number of excentric lines.	No. of annual rings.	
10·75 cm. = 4·23 in.	6.95	Oct. 2, 1890	·84	·43	·55	16	– 1	Left side.
,,	,,	,,	·83	·43	·57	16	,,	,,
,,	,,	,,	·78	·40	·51	15	,,	,,
,,	,,	,,	·84	·45	·57	15	,,	Right side.
,,	,,	,,	·89	·49	·58	16	,,	,,
,,	,,	,,	·85	·50	·58	16	,,	,,
—	—	—	·84	·45	·56	16	,,	Average for preceding ½-dozen scales.
10·80 cm. = 4·25 in.	8·33	Oct. 2, 1890	·79	·37	·51	14	– 1	Left side.
,,	,,	,,	·78	·45	·52	15	,,	,,
,,	,,	,,	·85	·49	·58	15	,,	,,
,,	,,	,,	·80	·47	·56	16	,,	Right side.
,,	,,	,,	·85	·48	·55	15	,,	,,
,,	,,	,	·88	·54	·61	15	,,	,,
—	—	—	·825	·466	·55	15	,,	Average for preceding ½-dozen scales.

11 cm. = 4·33 in.	9·35	Oct. 2, 1890	1	·48	·67	16	– 1	Left side.
,,	,,	,,	·93	·44	·675	16	,,	,,
,,	,,	,,	·97	·44	·69	11	,,	,,
,,	,,	,,	·89	·40	·63	15	,,	Right side.
,,	,,	,,	·95	·43	·61	15	,,	,,
,,	,,	,,	·88	·42	·57	15	,,	,,
—	—	—	·936	·44	·641	15	,,	Average for preceding ½-dozen scales, all from same fish.
11·75 cm. = 4·62 in.	12·20	Dec. 4, 1889	·81	·40	·56	19	,,	Right side.
,,	,,	,,	·75	·45	·52	17	,,	,,
,,	,,	,,	·77	·43	·52	17	,,	,,
,,	,,	,,	·86	·37	·63	18	,,	Left side.
,,	,,	,,	·84	·40	·58	19	,,	,,
,,	,,	,,	·92	·53	·65	19	,,	,,
—	—	—	·83	·43	·58	18	,,	Average for preceding ½-dozen scales, all from same fish. A few scales from this fish were in a disintegrated condition.

TABULAR RESULTS OF EXAMINATION

FISH.			SCALES.					YEAR I.		
Length in cm.	Weight in grms.	Date of capture.	Total length in mm.	Maximum breadth in mm.	Length of A B[n] in mm.	No. of lines in A B[n]	No. of rings.	Total length in mm.	Length of A B[1] in mm.	No. of lines in A B[1]
28·5 = 11·22 in.	Not ascertained.	End of Oct or begin. of Nov.	2·20	1·30	1·75	49	– 2	1·30	·85	29
,,	,,	,,	2·40	1·30	1·71	46	,,	1·22	·89	26
,,	,,	,,	2·53	1·40	1·70	48	,,	1·30	·90	29
,,	,,	,,	2·92	1·50	1·81	49	,,	1·40	·93	29
,,	,,	,,	2·68	1·30	1·72	49	,,	1·27	·87	28
,,	,,	,,	2·74	1·35	1·76	48	,,	1·25	·87	29
,,	,,	,,	2·72	1·58	1·75	48	,,	1·30	·90	28
,,	,,	,,	2·51	1·26	1·78	49	,,	1·33	·93	29
—	—	—	2·58	1·37	1·75	48	,,	1·29	·89	28
35·5 = 13·97 in.	530	July 4, 1901	3·28	1·40	2·32	57	2 +	·78	·52	24
,,	,,	,,	2·40	1·25	1·63	53	,,	·70	·46	20
,,	,,	,,	3·17	1·58	2·05	60	,,	·91	·59	24
,,	,,	,,	3·07	1·67	1·90	59	,,	·85	·54	23
,,	,,	,,	2·99	1·43	1·81	60	,,	·88	·56	23
,,	,,	,,	3·30	1·72	2·25	63	,,	·94	·67	24
,,	,,	,,	3·09	1·06	2·30	58	,,	·82	·65	24
,,	,,	,,	3·13	1·66	2·00	55	,,	·88	·57	20
—	—	—	3·05	1·47	2·03	58	,,	·85	·57	23
38·6 = 15·19 in.	535	June 18, 1901	2·37	·95	2·21	47	2 +	·7	·57	12
,,	,,	,,	2·63	·74	2·34	48	,,	·68	·55	15
,,	,,	,,	2·42	·75	2·32	50	,,	·72	·59	16
,,	,,	,,	2·17	·87	1·94	50	,,	·66	·53	16
,,	,,	,,	2·29	·65	2·07	46	,,	·54	·41	16
,,	,,	,,	2·91	·87	2·74	49	,,	·62	·49	14
—	—	—	2·47	·81	2·27	48	,,	·65	·52	15
38·6 = 15·19 in.	535	June 18, 1901	3·58	1·53	2·22	65	2 +	·91	·68	25
,,	,,	,,	3·23	1·45	2·21	59	,,	·84	·61	23
,,	,,	,,	3·30	1·75	2·06	59	,,	·90	·64	23
,,	,,	,,	3·90	1·50	2·51	63	,,	·95	·66	25
,,	,,	,,	3·50	1·69	2·29	61	,,	·88	·65	24
,,	,,	,,	4·02	1·73	2·52	62	,,	1·00	·70	25
—	—	—	3·92	1·61	2·30	62	,,	·91	·66	24
38·6 = 15·19 in.	535	June 18, 1901	4·08	1·84	2·44	70	2 +	1·21	·83	28
,,	,,	,,	3·96	2·00	2·14	64	,,	1·19	·69	27
,,	,,	,,	3·89	2·00	2·38	68	,,	1·15	·84	28
,,	,,	,,	4·03	1·83	2·38	71	,,	1·12	·75	29
,,	,,	,,	3·88	1·84	2·30	64	,,	1·15	·80	29
,,	,,	,,	4·09	2·10	2·45	71	,,	1·20	·88	30
—	—	—	3·99	1·99	2·35	68	,,	1·17	·80	29
38·6 = 15·19 in.	535	June 18, 1901	3·85	1·87	2·37	69	2 +	1·22	·86	32
,,	,,	,,	3·81	1·75	2·49	68	,,	1·22	·90	29
,,	,,	,,	4·33	1·95	2·64	72	,,	1·33	·91	32
,,	,,	,,	4·09	1·72	2·59	73	,,	1·30	·97	31
,,	,,	,,	4·30	1·93	2·39	69	,,	1·16	·85	30
,,	,,	,,	4·46	1·75	2·97	74	,,	1·49	1·12	34
—	—	—	4·14	1·83	2·57	71	,,	1·29	·94	31

OF POLLACK SCALES—*continued.*

YEAR II.		YEAR III.		
Length of B1 B2 in mm.	No. of lines in B1 B2	Length of B2 Bn in mm.	No. of excentric lines	REMARKS.
·86	20	...	...	
·82	20	...	...	
·82	19	...	...	
·88	20	...	...	
·85	21	...	...	
·89	19	...	...	
·85	20	...	...	
·85	20	...	...	
·85	20	...	...	Average for preceding 8 scales, all from same fish.
1·00	28	·80	5	Right side.
·95	28	·22	5	,,
1·16	30	·30	6	,,
1·08	30	·28	6	,,
1·07	31	·18	6	Left side.
1·28	33	·30	6	,,
1·35	29	·30	5	,,
1·20	29	·25	6	,,
1·14	30	·31	6	Average for preceding 8 scales, all from same fish.
				The following 24 measurements have been made for purposes of comparison of scales from four different regions of the body in an older fish.
1·2	30	·17	5	Scale from left side of body, posterior to eye.
1·6	28	·22	5	
1·3	29	·25	5	
1·15	28	·22	6	
1·40	27	·25	6	
1·17	28	·32	7	
1·30	28	·24	6	Average for preceding ½-dozen scales.
1·12	32	·43	8	Scales from left side of body, median region of flanks, viz. proximity of pectoral fin.
1·00	30	·33	6	
1·10	31	·34	6	
1·40	31	·45	8	
1·38	31	·26	6	
1·50	30	·32	7	
1·25	31	·36	7	Average for preceding ½-dozen scales.
1·28	34	·33	8	Scales from left side of body laterally, vertically beneath second dorsal fin.
1·14	30	·31	7	
1·24	35	·30	5	
1·28	36	·35	6	
1·20	30	·30	5	
1·17	33	·40	8	
1·22	33	·33	7	Average for preceding ½-dozen scales.
1·26	31	·25	6	Scales from left side of body, vertically beneath third dorsal fin.
1·27	34	·32	5	
1·37	34	·36	6	
1·28	36	·34	6	
1·17	34	·37	5	
1·51	34	·34	8	
1·31	34	·33	6	Average for preceding ½-dozen scales. Numerous scales in this region were disintegrated.

TABULAR RESULTS OF EXAMINATION

Fish.			Scales.					Year I.		
Length in cm.	Weight in grms.	Date of capture.	Total length in mm.	Maximum breadth in mm.	Length of A Bⁿ in mm.	No. of lines in A Bⁿ.	No. of rings.	Total length in mm.	Length of A B¹ in mm.	No. of lines in A B¹.
44·40 = 17½ in.	721·01	Apl. 30, 1901	3·76	2·06	2·35	69	3 +	·77	·54	19
,,	,,	,,	4·43	2·25	2·61	73	,,	·80	·58	22
,,	,,	,,	4·06	2·35	2·28	73	,,	·81	·55	22
,,	,,	,,	3·80	1·97	2·23	68	,,	·83	·51	21
—	—	—	4·01	2·16	2·37	71	,,	·80	·55	21
60 = 23·62 in.	1922·70	Apl. 30, 1901	4·99	2·75	3·18	90	4 +	·86	·65	20
,,	,,	,,	4·40	2·65	2·53	80	,,	·89	·64	25
,,	,,	,,	6·29	3·40	3·26	93	,,	1·21	·69	24
,,	,,	,,	6·53	3·43	3·51	102	,,	1·50	·73	26
—	—	—	5·55	3·06	3·12	91	,,	1·12	·68	24

Fish.			Scales.					Year I.			Year II.	
Length in cm.	Weight in grms.	Date of capture.	Total length in mm.	Maximum breadth in mm.	Length of A Bⁿ in mm.	No. of lines in A Bⁿ.	No. of rings.	Total length in mm.	Length of A B¹ in mm.	No. of lines in A B¹.	Length of B¹ B² in mm.	No. of lines in B¹ B².
83·82 = 33 in.	4184·70	June 13, 1901	8·49	4·35	5·09 ?	119	8 +	1·21	·76	26	1·22	25

N.B.—All the scales of this fish which were examined were seen to be more or less disintegrated. The measurements above were taken from one of the least disintegrated scales; but on account of the fact that many of the excentric lines had disappeared in the median plane (A Bⁿ), the measurements interrogated, and the excentric lines in connection

OF POLLACK SCALES—*continued.*

YEAR II.		YEAR III.		YEAR IV.		YEAR V.		REMARKS.
Length of $B^1 B^2$ in mm.	No. of lines in $B^1 B^2$.	Length of $B^2 B^3$ in mm.	No. of lines in $B^2 B^3$.	Length of $B^3 B^4$ in mm.	No. of ex-centric lines.	Length of $B^4 B^5$ in mm.	No. of ex-centric lines in $B^4 B^5$.	
1·23	30	·52	18	·06	2	...	...	
1·28	30	·67	19	·08	2	...	...	
1·09	30	·56	19	·08	2	...	...	
1·06	27	·57	17	·09	3	...	...	
1·17	29	·58	18	·08	2	...	...	Average for preceding 4 scales.
1·00	28	·66	17	·67	19	·20	6	Several scales were disintegrated.
·80	22	·45	12	·54	18	·10	3	
·90	25	·82	20	·75	22	·10	2	
·95	24	·85	23	·85	27	·13	2	
·91	25	·70	18	·70	22	·13	3	Average for preceding 4 scales.

YEAR III.		YEAR IV.		YEAR V.		YEAR VI.		YEAR VII.		YEAR VIII.		YEAR IX.	
Length of $B^2 B^3$ in mm.	No. of ex-centric lines in $B^2 B^3$.	Length of $B^3 B^4$ in mm.	No. of ex-centric lines in $B^3 B^4$.	Length of $B^4 B^5$ in mm.	No. of ex-centric lines in $B^4 B^5$.	Length of $B^5 B^6$ in mm.	No. of ex-centric lines in $B^5 B^6$.	Length of $B^6 B^7$ in mm.	No. of ex-centric lines in $B^5 B^6$.	Length of $B^7 B^8$ in mm.	No. of ex-centric lines in $B^7 B^8$.	Length of $B^8 B^9$ in mm.	No. of ex-centric lines in $B^8 B^9$.
·35?	12	·37?	12	·42?	11	·41?	9	·51?	11	·40?	10	·20?	3

therewith, were taken in a more lateral direction. At the same time the scale as observed laterally showed fairly conclusively *eight annual rings* plus a few excentric lines, evidently the growth of the early summer of 1901.

The following table gives a summary of the more detailed tables along with other results, with special reference to annual rings and lines of growth. It may serve to bring out some interesting points. The case of the fish with an asterisk, for example, 27·62 cm. in length, deserves notice. This fish only shows the following lines of growth: year I., 13; year II., 13; year III., 18.

We have evidently here to deal with a rapidly grown fish, and this fact has expressed itself in the formation of the scale, in the small number of lines of growth for the first and second year. The more intensive the growth the smaller the number of the lines of growth. To compare with this we might take the case of a slower growing pollack, 44·40 cm. The scale of such a pollack shows the following lines: year I., 21; year II., 29; year III., 18; year IV., 2. It is probable that in the first case the fish grew quickly in years I. and II., and in year III. about the normal.

SUMMARY OF EXAMINATION OF POLLACK SCALES,

With Special Reference to the Annual Rings and Lines of Growth.

Length of fish. cm.	Length of fish. inches.	Weight in grms.	Date of capture.	No. of ann. rings.	Average number of lines of growth (excentric lines) in years. 1	2	3	4	5	6	7	8	9	Notes.
2·5	nrly. 1·0	40	May	–1	0	–	–	–	–	–	–	–	–	About 6 weeks old.
4·4	1·73	64	July	,,	2	–	–	–	–	–	–	–	–	,, 3 months old.
4·8	1·88	78	,,	,,	2	–	–	–	–	–	–	–	–	,, 3 ,,
5·4	2·12	1·08	,,	,,	2–3	–	–	–	–	–	–	–	–	†,, 3 ,,
5·9	2·32	1·45	,,	,,	4	–	–	–	–	–	–	–	–	,, 3 ,,
6·1	2·40	1·67	,,	,,	3	–	–	–	–	–	–	–	–	,, 3 ,,
6·4	2·51	1·95	,,	,,	5	–	–	–	–	–	–	–	–	,, 3 ,,
7·0	2·75	2·35	,,	,,	5	–	–	–	–	–	–	–	–	,, 3 ,,
9·15	3·60	6·60	Dec.	,,	16	–	–	–	–	–	–	–	–	,, 8 ,,
9·15	3·60	not taken	,,	,,	not taken	–	–	–	–	–	–	–	–	,, 8 ,,
9·25	3·61	6·22	Oct.	,,	15	–	–	–	–	–	–	–	–	,, 6 ,,
9·50	3·74	6·67	Dec.	,,	14	–	–	–	–	–	–	–	–	,, 8 ,,
9·65	3·79	5·45	Oct.	,,	14	–	–	–	–	–	–	–	–	,, 6 ,,
9·65	3·79	6·0	,,	,,	14	–	–	–	–	–	–	–	–	,, 6 ,,
9·85	3·87	9·25	Dec.	,,	21	–	–	–	–	–	–	–	–	,, 8 ,,
9·85	3·87	not taken	,,	,,	not taken	–	–	–	–	–	–	–	–	,, 8 ,,
10·0	3·93	9·15	,,	,,	20	–	–	–	–	–	–	–	–	‡,, 8 ,,
10·15	3·99	17·5	,,	,,	18	–	–	–	–	–	–	–	–	§,, 8 ,,
10·15	3·99	not taken	,,	,,	not taken	–	–	–	–	–	–	–	–	,, 8 ,,
10·20	4·01	8·20	,,	,,	17	–	–	–	–	–	–	–	–	,, 8 ,,
10·25	4·03	8·92	Oct.	,,	16	–	–	–	–	–	–	–	–	,, 6 ,,
10·35	4·07	8·30	,,	,,	16	–	–	–	–	–	–	–	–	,, 6 ,,
10·45	4·11	8·45	,,	,,	16	–	–	–	–	–	–	–	–	,, 6 ,,
10·55	4·15	8·10	,,	,,	15	–	–	–	–	–	–	–	–	,, 6 ,,
10·75	4·23	6·95	,,	,,	16	–	–	–	–	–	–	–	–	,, 6 ,,
10·80	4·25	8·33	,,	,,	15	–	–	–	–	–	–	–	–	,, 6 ,,
11·0	4·33	9·35	,,	,,	15	–	–	–	–	–	–	–	–	,, 6 ,,
11·75	4·62	12·20	Dec.	,,	18	–	–	–	–	–	–	–	–	‖,, 6 ,,
11·75	4·62	not taken	,,	,,	not taken	–	–	–	–	–	–	–	–	,, 8 ,,
14·60	5·75	,,	Sept.	,,	20	–	–	–	–	–	–	–	–	,, 5 ,,
14·92	5·87	,,	,,	,,	20	–	–	–	–	–	–	–	–	,, 5 ,,
14·92	5·87	25	April	1+	18	4	–	–	–	–	–	–	–	,, 1 yr. 6 wks. old.

† See Pl. I., Fig. 1. ‡ See Pl. I., Fig. 3. § See Pl. I., Fig. 2. ‖ See Pl. I., Fig. 4.

SUMMARY OF EXAMINATION OF POLLACK SCALES—*continued.*

Length of fish. cm.	inches.	Weight in grms.	Date of capture.	No. of ann. rings.	Average number of lines of growth (excentric lines) in years. 1	2	3	4	5	6	7	8	9	Notes.
15·24	6·0	not taken	April	1 +	not taken	–	–	–	–	–	–	–	–	About 1 yr. 6 wks. old.
15·55	6·125	,,	,,	,,	,,	–	–	–	–	–	–	–	–	,, 1 ,, 6 ,,
15·55	6·125	,,	Sept.	– 1	19	–	–	–	–	–	–	–	–	,, 5 months old.
16·83	6·625	,,	May	1 +	27	5	–	–	–	–	–	–	–	,, 1 yr. 6 wks. old.
16·83	6·625	,,	Sept.	... – 1	22	–	–	–	–	–	–	–	–	,, 5 months old.
16·83	6·625	,,	,,	– 1	20	–	–	–	–	–	–	–	–	,, 5 ,,
16·83	6·625	,,	,,	,,	24	–	–	–	–	–	–	–	–	,, 5 ,,
17·14	6·750	,,	,,	,,	20	–	–	–	–	–	–	–	–	,, 5 ,,
17·14	6·750	,,	May	1 +	not taken	–	–	–	–	–	–	–	–	,, 1 yr. 6 wks. old.
17·46	6·875	,,	Sept.	– 1	23	–	–	–	–	–	–	–	–	,, 5 months old.
17·46	6·875	,,	,,	,,	21	–	–	–	–	–	–	–	–	,, 5 ,,
17·46	6·875	,,	,,	,,	23	–	–	–	–	–	–	–	–	,, 5 ,,
17·46	6·875	40	April	1 +	25	4	–	–	–	–	–	–	–	,, 1 yr. 6 wks old.
17·78	7·0	not taken	,,	,,	not taken	–	–	–	–	–	–	–	–	,, 1 ,, 6 ,,
18·09	7·125	55	,,	,,	21	8	–	–	–	–	–	–	–	,, 1 ,, 6 ,,
18·09	7·125	not taken	Sept.	– 1	23	–	–	–	–	–	–	–	–	,, 5 months old.
18·66	7·37	55	April	1 +	25	3	–	–	–	–	–	–	–	,, 1 yr. 6 wks. old.
18·66	7·37	not taken	Sept.	– 1	24	–	–	–	–	–	–	–	–	,, 5 months old.
19·05	7·5	,,	,,	,,	23	–	–	–	–	–	–	–	–	,, 5 ,,
19·05	7·5	,,	,,	,,	26	–	–	–	–	–	–	–	–	,, 5 ,,
19·68	7·75	,,	April	1 +	not taken	–	–	–	–	–	–	–	–	,, 1 yr. 6 wks. old.
19·68	7·75	,,	Sept.	– 1	24	–	–	–	–	–	–	–	–	,, 5 months old.
20·0	7·87	65	April	1 +	29	4	–	–	–	–	–	–	–	,, 1 yr. 6 wks. old.
20·0	7·87	75	,,	,,	26	5	–	–	–	–	–	–	–	,, 1 ,, 6 ,,
20·63	8·12	80	,,	,,	25	5	–	–	–	–	–	–	–	,, 1 ,, 6 ,,
20·63	8·12	not taken	May	,,	26	3	–	–	–	–	–	–	–	,, 1 ,, 6 ,,
20·63	8·12	,,	April	,,	not taken	–	–	–	–	–	–	–	–	,, 1 ,, 6 ,,
20·95	8·25	,,	,,	,,	,,	–	–	–	–	–	–	–	–	,, 1 ,, 6 ,,
21·27	8·37	,,	April	,,	,,	–	–	–	–	–	–	–	–	,, 1 ,, 6 ,,
21·27	8·37	,,	May	,,	29	–	–	–	–	–	–	–	–	,, 1 ,, 6 ,,
21·90	8·62	,,	April	,,	27	5	–	–	–	–	–	–	–	,, 1 ,, 6 ,,
21·90	8·62	,,	,,	,,	not taken	–	–	–	–	–	–	–	–	,, 1 ,, 6 ,,
21·90	8·62	,,	May	,,	25	6	–	–	–	–	–	–	–	,, 1 ,, 6 ,,
22·86	9·0	105	April	,,	24	8	–	–	–	–	–	–	–	,, 1 ,, 6 ,,
23·49	9·25	100	,,	,,	28	6	–	–	–	–	–	–	–	,, 1 ,, 6 ,,
23·81	9·37	115	,,	,,	25	7	–	–	–	–	–	–	–	,, 1 ,, 6 ,,
24·13	9·5	115	,,	,,	not taken	–	–	–	–	–	–	–	–	,, 1 ,, 6 ,,
24·44	9·62	not taken	May	,,	28	5	–	–	–	–	–	–	–	,, 1 ,, 6 ,,
24·44	9·62	,,	April	,,	not taken	–	–	–	–	–	–	–	–	,, 1 ,, 6 ,,
24·44	9·62	,,	,,	,,	,,	–	–	–	–	–	–	–	–	,, 1 ,, 6 ,,
24·76	9·75	,,	,,	,,	,,	–	–	–	–	–	–	–	–	,, 1 ,, 6 ,,
24·76	9·75	,,	May	,,	25	8	–	–	–	–	–	–	–	††,, 1 ,, 6 ,,
25·08	9·87	,,	,,	,,	23	4	–	–	–	–	–	–	–	,, 1 ,, 6 ,,
25·08	9·87	,,	,,	,,	26	8	–	–	–	–	–	–	–	,, 1 ,, 6 ,,
25·08	9·87	,,	April	,,	not taken	–	–	–	–	–	–	–	–	,, 1 ,, 6 ,,
*27·62	10·87	175	,,	3	*13	*13	18	–	–	–	–	–	–	,, 3 years old.
28·5	11·22	not taken	Nov.	– 2	28	20	–	–	–	–	–	–	–	,, 1 yr. 7 mths. old.
28·57	11·25	,,	April	2 +	not taken	–	–	–	–	–	–	–	–	,, 2 yrs. 6 wks. old
28·57	11·25	,,	May	,,	18	24	2	–	–	–	–	–	–	,, 2 ,, 6 ,,
29·84	11·75	,,	April	,,	not taken	–	–	–	–	–	–	–	–	,, 2 ,, 6 ,,
30·6	12·0	,,	,,	,,	,,	–	–	–	–	–	–	–	–	,, 2 ,, 6 ,,
31·11	12·25	265	,,	2 + 6 l.g.	,,	–	–	–	–	–	–	–	–	,, 2 ,, 6 ,,
31·11	12·25	not taken	,,	,, ,,	,,	–	–	–	–	–	–	–	–	,, 2 ,, 6 ,,
31·11	12·25	,,	,,	2 + 4 ,,	,,	–	–	–	–	–	–	–	–	,, 2 ,, 6 ,,
31·11	12·25	,,	,,	2 + 8 ,,	,,	–	–	–	–	–	–	–	–	,, 2 ,, 6 ,,
31·11	12·25	,,	,,	,, ,,	–	–	–	–	–	–	–	–	–	,, 2 ,, 6 ,,
31·75	12·50	,,	,,	2 + 1 – 2	–	–	–	–	–	–	–	–	–	,, 2 ,, 6 ,,
31·75	12·50	,,	May	2	25	24	–	–	–	–	–	–	–	,, 2 ,, 6 ,,
31·75	12·50	,,	April	2 +	not taken	–	–	–	–	–	–	–	–	,, 2 ,, 6 ,,
31·75	12·50	,,	,,	,,	,,	–	–	–	–	–	–	–	–	,, 2 ,, 6 ,,

* See text, p. 74. †† See Pl. I., Fig. 5.

SUMMARY OF EXAMINATION OF POLLACK SCALES—*continued*.

Length of fish. cm.	Length of fish. inches.	Weight in grms.	Date of capture.	No. of ann. rings.	Average number of lines of growth (excentric lines) in years. 1	2	3	4	5	6	7	8	9	Notes.
32·06	12·62	not taken	April	2 +	not taken	–	–	–	–	–	–	–	–	About 2 yrs. 6 wks. old.
32·06	12·62	,,	May	,,	22	19	5	–	–	–	–	–	–	,, 2 ,, 6 ,,
32·38	12·75	,,	April	2 + 7 l.g.	–	–	–	–	–	–	–	–	–	,, 2 ,, 6 ,,
32·38	12·75	,,	,,	,,	–	–	–	–	–	–	–	–	–	,, 2 ,, 6 ,,
32·38	12·75	,,	,,	2 + ... ,,	–	–	–	–	–	–	–	–	–	,, 2 ,, 6 ,,
32·38	12·75	,,	,,	2 + 4 ,,	–	–	–	–	–	–	–	–	–	,, 2 ,, 6 ,,
32·75	12·89	315	Oct.	– 3	not taken	–	–	–	–	–	–	–	–	,, 2 ,, 6 mths.
33·02	13·0	not taken	April	2 + 4 l.g.	–	–	–	–	–	–	–	–	–	,, 2 ,, 6 wks. old.
33·02	13·0	,,	,,	2 + 8 ,,	–	–	–	–	–	–	–	–	–	,, 2 ,, 6 ,,
33·02	13·0	,,	,,	2 +	not taken	–	–	–	–	–	–	–	–	,, 2 ,, 6 ,,
33·02	13·0	,,	,,	,,	,,		–	–	–	–	–	–	–	,, 2 ,, 6 ,,
33·02	13·0	325	,,	,,	,,		–	–	–	–	–	–	–	,, 2 ,, 6 ,,
33·02	13·0	not taken	,,	,,	,,		–	–	–	–	–	–	–	,, 2 ,, 6 ,,
33·02	13·0	,,	,,	,,	,,		–	–	–	–	–	–	–	,, 2 ,, 6 ,,
33·02	13·0	,,	,,	,,	,,		–	–	–	–	–	–	–	,, 2 ,, 6 ,,
33·65	13·25	,,	,,	,,	,,		–	–	–	–	–	–	–	,, 2 ,, 6 ,,
33·65	13·25	,,	,,	,,	,,		–	–	–	–	–	–	–	,, 2 ,, 6 ,,
33·65	13·25	,,	,,	,,	,,		–	–	–	–	–	–	–	,, 2 ,, 6 ,,
33·65	13·25	,,	,,	,,	,,		–	–	–	–	–	–	–	,, 2 ,, 6 ,,
33·97	13·37	315	,,	,,	,,		–	–	–	–	–	–	–	,, 2 ,, 6 ,,
34·29	13·50	not taken	,,	,,	,,		–	–	–	–	–	–	–	,, 2 ,, 6 ,,
34·29	13·50	,,	,,	,,	,,		–	–	–	–	–	–	–	,, 2 ,, 6 ,,
34·29	13·50	,,	,,	,,	,,		–	–	–	–	–	–	–	,, 2 ,, 6 ,,
34·61	13·62	,,	May	,,	22	21	5	–	–	–	–	–	–	,, 2 ,, 6 ,,
34·61	13·62	,,	April	,,	–	–	–	–	–	–	–	–	–	,, 2 ,, 6 ,,
34·92	13·75	,,	,,	,,	not taken	–	–	–	–	–	–	–	–	,, 2 ,, 6 ,,
34·92	13·75	370	,,	,,	,,		–	–	–	–	–	–	–	,, 2 ,, 6 ,,
34·92	13·75	not taken	,,	,,	,,		–	–	–	–	–	–	–	,, 2 ,, 6 ,,
34·92	13·75	,,	,,	,,	,,		–	–	–	–	–	–	–	,, 2 ,, 6 ,,
34·92	13·75	,,	,,	2 + 9 l.g.	,,		–	–	–	–	–	–	–	,, 2 ,, 6 ,,
34·92	13·75	,,	,,	2 +	,,		–	–	–	–	–	–	–	,, 2 ,, 6 ,,
34·92	13·75	,,	,,	2 + 4 l.g.	,,		–	–	–	–	–	–	–	,, 2 ,, 6 ,,
35·5	13·97	530	July	2 +	23	30	6	–	–	–	–	–	–	,, 2 ,, 6 ,,
35·56	14·0	not taken	April	2 +	not taken	–	–	–	–	–	–	–	–	,, 2 ,, 6 ,,
35·56	14·0	,,	,,	2 + 5 l.g.	,,		–	–	–	–	–	–	–	,, 2 ,, 6 ,,
35·87	14·12	,,	,,	2 +	,,		–	–	–	–	–	–	–	,, 2 ,, 6 ,,
35·87	14·12	,,	,,	,,	,,		–	–	–	–	–	–	–	,, 2 ,, 6 ,,
35·87	14·12	,,	May	,,	,,		–	–	–	–	–	–	–	,, 2 ,, 6 ,,
35·87	14·12	,,	April	,,	,,		–	–	–	–	–	–	–	,, 2 ,, 6 ,,
36·83	14·50	,,	,,	,,	,,		–	–	–	–	–	–	–	,, 2 ,, 6 ,,
36·83	14·50	,,	,,	,,	,,		–	–	–	–	–	–	–	,, 2 ,, 6 ,,
37·46	14·75	470	,,	,,	26	25	5	–	–	–	–	–	–	,, 2 ,, 6 ,,
38·6	15·19	535	June	,,	24	31	7	–	–	–	–	–	–	,, 2 ,, 6 ,,
38·73	15·25	not taken	April	,,	not taken	–	–	–	–	–	–	–	–	,, 2 ,, 6 ,,
*41·40	17·50	1922·70	,,	3 +	21	29	18	2	–	–	–	–	–	,, 3 ,, 6 ,,
44·40	17·50	not taken	,,	,,	not taken	–	–	–	–	–	–	–	–	,, 3 ,, 6 ,,
45·72	18·0	,,	May	,,	,,		–	–	–	–	–	–	–	,, 3 ,, 6 ,,
48·26	19·0	,,	April	,,	,,		–	–	–	–	–	–	–	,, 3 ,, 6 ,,
48·26	19·0	,,	May	,,	20	29	21	3	–	–	–	–	–	,, 3 ,, 6 ,,
57·15	22·50	,,	,,	4 +	not taken	–	–	–	–	–	–	–	–	,, 4 ,, 6 ,,
60·0	23·62	1922·70	April	,,	24	25	18	22	3	–	–	–	–	,, 4 ,, 6 ,,
60·32	23·75	not taken	,,	5 +	not taken	–	–	–	–	–	–	–	–	,, 5 ,, 6 ,,
63·50	25·0	,,	May	6 + 7 10 l.g.	,,		–	–	–	–	–	–	–	,, 6 ,, 6 ,,
64·77	25·50	,,	April	5 +	,,		–	–	–	–	–	–	–	,, 5 ,, 6 ,,
78·74	31·0	,,	Apl. or May	8 +	,,		–	–	–	–	–	–	–	,, 8 ,, 6 ,,
80·01	31·50	not taken	April	7 +	,,		–	–	–	–	–	–	–	,, 7 ,, 6 ,,
83·82	33·0	4181·70	June	8 +	26	25	12	12	11	9	11	10	3	,, 8 ,, 3 mths.
96·52	38·0	not taken	April	10 +	not taken	–	–	–	–	–	–	–	–	,, 10 ,, 6 wks. old.

* See text, p. 74.

The following two tables are summaries of the more detailed tables and of other results, giving the ages of a number of fish in a more convenient and concise form. The first of these tables may serve to bring out exceptions or variation, namely, that in some cases pollack of approximately the same size may be of a very different age.

The second of these tables is a more general one, and serves rather to bring out the more general facts as to the size of pollack in relation to age.

POLLACK.

No. taken.	Length of fish in cm.	Age of fish.
7	2–7	First summer.
21	9–11·75	,, winter.
2	14·60–14·92	,, summer (late).
3	14·92–15	Second spring.
1	15·55	First summer (late).
1	16·83	Second spring.
4	16·83–17	First summer (late).
1	17·14	Second spring.
3	17·46	First summer (late).
3	17–18	Second spring.
1	18·09	First summer (late).
1	18·66	Second spring.
4	18·–19	First summer (late).
24	19–25	Second spring.
1	27·62	Fourth ,,
1	28·5	Second winter.
19	28·–32	Third spring.
1	32·75	,, winter.
25	33·–34	,, spring.
1	35·5	,, summer.
9	35·–37	,, spring.
1	38·6	,, summer.
1	38·73	,, spring.
2	44·40	Fourth ,,
1	45·72	,, ,,
2	48·26	,, ,,
1	57·15	Fifth ,,
1	60·0	,, ,,
1	60·32	Sixth ,,
1	63·50	Seventh ,,
1	64·77	Sixth ,,
1	78·74	Ninth ,,
1	80·01	Eighth ,,
1	83·82	Ninth summer.
1	96·52	Eleventh spring.

POLLACK.

Summarised Table of Age.

Length of fish in cm.	Age of fish.
2–19	First summer
9–11·75	,, winter.
14·92–25	Second summer.
28·5	,, winter.
28·0–38·6	Third summer.
27·62–48·26	Fourth ,,
57·15–60·0	Fifth ,,
60·32–64·77	Sixth ,,
63·50	Seventh ,,
80·01	Eighth ,,
78·74–83·82	Ninth ,,
96·52	Eleventh ,,

NOTE.—Summer is here taken as from April to October, winter as from October to April.

The next table is a summary of averages from the more detailed tables to show, in a general way, the increase in the length and breadth of scales, at various ages of the fish. From these tables it would be an easy matter to calculate the approximate area of scales, as many of the pollack's scales are nearly elliptical in shape.

SUMMARISED TABLE

Showing Average surface size of Scales in the Pollack at various ages.

No. of fish.	Range of length in cm.	Range of weight in grms.	Month of capture.	Average length of scale in mm.	Average length of A.B.[1] and A.B.n in mm.	Average breadth of scales in mm.	Average lines of growth in years. 1	2	3	4	5	6	7	8	9
4	4·4–5·9	·64–1·45	July	·25	·15	·15	3	–	–	–	–	–	–	–	–
3	6·1–7·0	1·67–2·35	,,	·35	·21	·23	4	–	–	–	–	–	–	–	–
6	9·15–9·85	6·60–9·25	Oct.–Dec.	·70	·48	·40	16	–	–	–	–	–	–	–	–
9	10·0–10·80	6·95–9·45	,, ,,	·816	·565	·441	17	–	–	–	–	–	–	–	–
2	11·0–11·75	9·35–12·20	,, ,,	·883	·610	·44	17	–	–	–	–	–	–	–	–
					Length of A.B.n										
1	28·5	not taken	Oct. or Nov.	2·58	1·75	1·37	28	20	–	–	–	–	–	–	–
2	35·5–38·6	530–535	June–July	3·49	2·17	1·51	24	31	7	–	–	–	–	–	–
1	41·40	721·01	April	4·01	2·37	2·16	21	29	18	2	–	–	–	–	–
1	60·0	1922·70	,,	5·55	3·12	3·06	24	25	18	22	3	–	–	–	–
1	83·82	4184·70	June	8·49	5·09	4·35	26	25	12	12	11	9	11	10	3

For purposes of comparison, I annex a short table of ages for the pollack from Cunningham's paper on the "Rate of Growth of some Sea Fishes" (*Journal of Marine Biological Association*, vol. ii., n.s., 1891–2).

GADUS POLLACHIUS, THE POLLACK.

Table from Cunningham's "Rate of Growth of some Sea Fishes" (Journal of Marine Biological Association, 1891–2).

Date of collection.	No. of specimens.	Length in cm.	Length in inches.	Calculated age.
April 3, 1890	22	2–2·4	·8–·95	3 to 6 weeks.
Oct. 2, 1890	10	9·7–11·2	3·8–4·4	7 months.
Dec. 4, 1889	4	9·3–11·8	3·7–4·7	9 ,,

The Poor Cod *(Gadus minutus)*.

Cunningham mentions the occurrence of over two hundred specimens less than three inches long in Whitsand Bay in the middle of June, and that they undoubtedly developed from ova shed the preceding spring. He calculates the age of these at about three months.

Tabular Results of Examination of Scales of Poor Cod, *Gadus minutus*.

FISH.			SCALES.					NOTES.
Length.	Weight in grms.	Date of capture.	Total length in mm.	Maximum breadth in mm.	Length of A B[1] in mm.	No. of excentric lines.	No. of annual rings.	
3·3 cm. = 1·29 in.	·27	June 3, 1889	·23	·13	·12	0	– 1	Locality of capture, Whitsand Bay.
3·9 cm. = 1·53 in.	·48	June 3, 1889	·21	·15	·12	2	0	From Whitsand Bay.
,,	,,	,,	·20	·15	·10	2	0	,,
—	—	—	·21	·15	·11	2	0	Average.
4·3 cm. = 1·69 in.	·55	June 17, 1889	·31	·22	·18	2	0	From Whitsand Bay; also numerous minute scales without any excentric lines.
4·4 cm. = 1·73 in.	·65	June 17, 1889	·50	·40	·28	6	0	From Whitsand Bay.
,,	,,	,,	·30	·27	·19	4	0	,,
,,	,,	,,	·47	·35	·25	5	0	,,
—	—	—	·42	·34	·24	5	0	Average.
4·7 cm. = 1·85 in.	·73	June 3, 1889	·34	·26	·19	3	0	From Whitsand Bay.
,,	,,	,,	·34	·20	·36	3	0	,,
—	—	—	·34	·23	·28	3	0	Average.
4·7 cm. = 1·85 in.	·72	June 3, 1889	·29	·29	·16	3	0	Fish captured 3 miles from Rame Head.
,,	,,	,,	·23	·26	·12	2	0	
—	—	—	·26	·28	·14	3	0	Average.
4·8 cm. = 1·88 in.	1·22	June 17, 1889	·58	·55	·33	7	0	From Whitsand Bay.
,,	,,	,,	·53	·38	·32	6	0	
,,	,,	,,	·55	·55	·35	7	0	
,,	,,	,,	·62	·51	·31	7	0	
—	—	—	·57	·50	·33	7	0	Average.

RESULTS OF EXAMINATION OF SCALES OF POOR COD—*continued.*

FISH.			SCALES.					
Length.	Weight in grms.	Date of capture.	Total length in mm.	Maximum breadth in mm.	Length of AB in mm.	No. of ex-centric lines.	No. of annual rings.	NOTES.
4·8 cm. = 1·88 in.	·8	June 17, 1889	·32	·39	·19	6	0	From Whitsand Bay.
,,	,,	,,	·34	·35	·21	5	0	,,
—	—	—	·33	·37	·20	6	0	Average.
5·0 cm. = 1·96 in.	1·07	June 3, 1889	·55	·50	·33	7	0	From Whitsand Bay.
,,	,,	,,	·45	·49	·27	5	0	,,
—	—	—	·50	·50	·30	6	0	Average.
5·2 cm. = 2·04 in.	1·09	June 17, 1889	·22	·21	·14	4	0	Same lot of fish; few scales remaining on fish.
,,	,,	,,	·37	·29	·19	6	0	
,,	,,	,,	·38	·25	·23	6	0	
—	—	—	·32	·38	.28	8	0	Average.
5·5 cm. = 2·16 in.	1·27	June 17, 1889	·32	·25	·18	3	0	Same lot of fish; from Whitsand Bay.
,,	,,	,,	·33	·29	·21	3	0	
—	—	—	·33	·27	·20	3	0	Average.
5·6 cm. = 2·20 in.	1·32	June 17, 1889	·58	·49	·30	7	0	From Whitsand Bay.
,,	,,	,,	·63	·50	·38	7	0	,,
—	—	—	·61	·50	·34	7	0	Average.
5·6 cm. = 2·20 in.	1·30	June 17, 1889	·67	·68	·35	8	0	From Whitsand Bay.
,,	,,	,,	·71	·65	·41	9	0	,,
—	—	—	·69	·67	·38	9	0	Average.
5·7 cm. = 2·24 in.	1·35	June 17, 1889	·61	·61	·38	7	0	From Whitsand Bay.
,,	,,	,,	·47	·48	·37	6	0	,,
—	—	—	·54	·55	·38	7	0	Average.
5·7 cm. = 2·24 in.	1·32	June 17, 1889	·77	·62	·35	7	0	From Whitsand Bay.
,,	,,	,,	·509	·508	·35	7	0	,,
—	—	—	·640	·564	·35	7	0	Average.
5·8 cm. = 2·28 in.	1·40	June 17, 1889	·75	·65	·36	7	0	From Whitsand Bay, fish labelled being 2–3 months old.
5·8 cm. = 2·28 in.	1·30	June 17, 1889	·59	·42	·30	7	0	From Whitsand Bay.
,,	,,	,,	·63	·45	·32	8	0	,,
—	—	—	·61	·44	·31	8	0	Average.
5·8 cm. = 2·28 in.	1·75	June 17, 1889	·31	·23	·29	3	0	All from same fish; from Whitsand Bay.
,,	,,	,,	·38	29	·22	4	0	
,,	,,	,,	·38	·33	·23	4	0	
,,	,,	,,	·39	·32	·24	5	0	
—	—	—	·37	·29	·25	1	0	Average.

RESULTS OF EXAMINATION OF SCALES OF POOR COD—*continued.*

FISH.			SCALES.					
Length.	Weight in grms.	Date of capture.	Total length in mm.	Maximum breadth in mm.	Length of AB1 in mm.	No. of excentric lines.	No. of annual rings.	NOTES.
5·9 cm. = 2·32 in.	1·55	June 17, 1889	·56	·38	·36	7	0	Same lot of fish; from Whitsand Bay.
,,	,,	,,	·45	·52	·27	7	0	
,,	,,	,,	·65	·50	·35	7	0	
,,	,,	,,	·51	·38	·30	7	0	
—	—	—	·54	·45	·32	7	0	Average for preceding 4 scales, all from same fish.
5·9 cm. = 2·32 in.	1·65	June 17, 1889	·68	·60	·36	9	0	From Whitsand Bay.
,,	,,	,,	·67	·70	·37	9	0	,,
—	—	—	·68	·65	·37	9	0	Average.
6·0 cm. = 2·36 in.	1·59	June 17, 1889	·66	·40	·38	7	0	From Whitsand Bay.
,,	,,	,,	·54	·43	·32	6	0	,,
—	—	—	·60	·42	.35	7	0	Average.
6·0 cm. = 2·36 in.	1·65	June 17, 1889	·50	·39	·32	8	0	From Whitsand Bay.
,,	,,	,,	·55	·44	·29	6	0	,,
—	—	—	·53	·42	·31	7	0	Average.
6·1 cm. = 2·40 in.	1·77	June 17, 1889	·59	·53	·38	6	0	From Whitsand Bay.
,,	,,	,,	·72	·51	·41	9	0	,,
—	—	—	·66	·52	·39	8	0	Average.
6·1 cm. = 2·40 in.	1·92	June 17, 1889	·73	·71	·43	9	0	From Whitsand Bay.
,,	,,	,,	·65	·65	·36	8	0	,,
—	—	—	·69	·68	·40	9	0	Average.
6·3 cm. = 2·48 in.	2·3	June 17, 1889	·72	·72	·38	9	0	From Whitsand Bay.
,,	,,	,,	·74	·79	·43	10	0	,,
—	—	—	·73	·76	·81	10	0	Average.
6·5 cm. = 2·55 in.	2·22	June 17, 1889	·81	·79	·65	9	0	From Whitsand Bay; measurements not very accurate.
,,	,,	,,	·89	·78	·68	10	0	
,,	,,	,,	·98	1·15	·70	10	0	
,,	,,	,,	·92	·78	·70	8	0	
—	—	—	·90	·88	·68	9	0	Average.
6·8 cm. = 2·67 in.	2·57	June 17, 1889	·49	·35	·30	5	0	Same lot of fish.
,,	,,	,,	·75	·59	·40	8	0	
,,	,,	,,	·75	·69	·35	9	0	
,,	,,	,,	·72	·71	·40	10	0	
—	—	—	·68	·59	·36	8	0	Average.
10 cm. = 3·93 in.	8+	Late winter or early spring 1901	1·50	1·25	·90	22	1	N.B.—The weight and date of capture are in this case uncertain.
,,	,,	,,	1·70	1·55	·93	19	1+9 c.l.	
,,	,,	,,	1·67	1·20	·95	22	1	
,,	,,	,,	1·50	1·17	·93	21	1	
,,	,,	,,	1·13	1·16	·85	26	1	
,,	,,	,,	1·30	1·00	·75	23	1	
,,	,,	,,	1·36	1·00	·75	23	1	
—	—	—	1·19	1·19	·86	23	1 + 1-2	Average for above 7 scales, all from same fish.

RESULTS OF EXAMINATION OF

FISH.			SCALES.				
Length.	Weight in grms.	Date of capture.	Total length in mm.	Maximum breadth in mm.	Length of A Ba in mm.	No. of excentric lines.	No. of annual rings.
11·5 cm. = 4·54 in.	14·8	July 9, 1901	1·97	1·68	1·09	40	1 + 10 c.l.
11·70 cm. = 4·60 in.	15·75	July 9, 1901	1·99	1·80	1·00	42	1 + 9 c.l.
,,	,,	,,	1·90	1·68	1·09	33	1 + 6 c.l.
—	—	—	1·95	1·74	1·05	38	1 + 8 c.l.
12·5 cm. = 4·92 in.	16·8	July 9, 1901	1·57	1·40	·94	36	1 + 10 c.l.
,,	,,	,,	1·61	1·38	·85	30	1 + 8 c.l.
,,	,,	,,	1·56	1·17	1·12	27	1 + 8 c.l.
,,	,,	,,	1·74	1·43	1·11	34	1 + 9 c.l.
—	—	—	1·62	1·35	1·01	32	1 + 9 c.l.
13 cm. = 5·11 in.	18·4	July 9, 1901	2·09	1·90	1·19	43	1 + 12 c.l.
,,	,,	,,	2·22	1·88	1·35	38	1 + 10 c.l.
—	—	—	2·16	1·89	1·27	41	1 + 11 c.l.
13 cm. = 5·11 in.	19·5	July 9, 1901	2·18	1·85	1·23	43	1 + 11 c.l.
,,	,,	,,	2·31	1·91	1·18	42	1 + 11 c.l.
,,	,,	,,	2·37	1·90	1·23	42	1 + 10 c.l.
,,	,,	,,	2·03	1·70	1·10	40	1 + 10 c.l.
—	—	—	2·22	1·84	1·19	42	1 + 11 c.l.
13·5 cm. = 5·31 in.	21·5	July 9, 1901	2·22	2·00	1·27	44	1 + 13 c.l.
,,	,,	,,	2·14	2·00	1·19	42	1 + 10 c.l.
,,	,,	,,	1·99	1·87	1·12	45	1 + 13 c.l.
,,	,,	,,	2·21	2·00	1·20	45	1 + 13 c.l.
—	—	—	2·14	1·97	1·20	44	1 + 12 c.l.
14·3 cm. = 5·62 in.	24·9	July 9, 1901	1·57	1·30	·98	32	1 + 10
,,	,,	,,	2·02	1·72	1·22	38	1 + 10
,,	,,	,,	2 00	1·95	1·26	43	1 + 9
,,	,,	,,	2·34	2·00	1·32	47	1 + 11
—	—	—	1·98	1·74	1·20	40	1 + 10

FISH.			SCALES.				
Length.	Weight in grms.	Date of capture.	Total length in mm.	Maximum breadth in mm.	Length of A Ba in mm.	No. of excentric lines.	No. of annual rings.
18·8 cm. = 7·40 in.	53·15	not known	3·00	2·77	1·95	70	2 + c.l.
,,	,,	,,	4·35	1·67	1·73	51	2 + c.l.
—	—	—	3·68	2·22	1·84	61	2 + c l.
19·5 cm. = 7·67 in.	55	not known	2·52	2·30	1·52	52	2 + c.l.
,,	,,	,,	2·45	1·90	1·53	57	2 + c.l.
—	—	—	2·49	2·10	1·53	55	2 + c.l.

SCALES OF POOR COD—*continued.*

YEAR I.			YEAR II.		
Total length year's growth in mm.	Length of AB^1 in mm.	No. of excentric lines.	Length of B^1B^2 in mm.	No. of excentric lines.	REMARKS.
1·35	·80	30	·29	10	Few scales on this fish, and those mostly disintegrated.
1·64	·78	33	·22	9	Several scales disintegrated.
1·54	·89	27	·20	6	
1·59	·84	30	·21	8	Average.
1·20	·72	26	·22	10	
1·18	·77	22	·20	8	
1·20	·87	19	·25	8	
1·30	·90	25	·21	9	
1·22	·82	23	·23	9	Average for preceding 4 scales, all from same fish.
1·40	·85	31	·34	12	
1·50	1·00	28	·35	10	
1·45	·93	30	·35	11	Average.
1·50	·90	32	·33	11	
1·55	·86	31	·32	11	
1·64	·92	31	·31	10	
1·40	·80	30	·30	10	
1·52	·87	31	·32	11	Average for preceding 4 scales, all from same fish.
1·42	·84	32	·43	12	A number of disintegrated scales.
1·40	·85	32	·34	10	,, ,,
1·22	·75	32	·37	13	,, ,,
1·42	·85	32	·35	13	,, ,,
1·37	·82	32	·37	12	Average for preceding 4 scales, all from same fish.
1·05	·70	22	·28	10	
1·43	·90	28	·32	10	
1·41	1·00	34	·26	9	
1·70	·98	36	·34	11	
1·40	·90	30	·30	10	Average for preceding 4 scales, all from same fish.

YEAR I.			YEAR II.		YEAR III.		
Total length year's growth in mm.	Length of AB^1 in mm.	No. of excentric lines.	Length of B^1B^2 in mm.	No. of excentric lines.	Length of B^2B^3 in mm.	No. of excentric lines.	REMARKS.
1·48	·90	28	·78	29	·27	13	Scale from position very slightly posterior to pectoral fin.
1·50	·65	23	·82	20	·26	8	This scale very different from preceding, [and has been taken from [nearer the lateral line.
1·49	·78	26	·80	25	·27	11	Average.
·85	·64	17	·56	19	·32	16	The above statistics are not of much detailed value, as the date of capture of these two fishes is not known.
1·10	·70	20	·52	22	·31	15	
·98	·67	19	·54	21	·32	16	Average.

Summary of Examination of Scales of Poor Cod.

Length of fish. cm.	Length of fish. in.	Weight in grms.	Date of capture.	No. of annual rings.	No. of lines of growth (excentric lines) in years 1	2	3	Approximate age.
3·3	1·29	·27	June	–1	0	—	—	3 months.
3·9	1·53	·18	,,	,,	2	—	—	,,
4·3	1·69	·55	,,	,,	2	—	—	,,
4·4	1·73	·65	,,	,,	5	—	—	,,
4·7	1·85	·73	,,	,,	3	—	—	,,
4·7	1·85	·72	,,	,,	3	—	—	,,
4·8	1·88	1·22	,,	,,	7	—	—	,,
4·8	1·88	·8	,,	,,	6	—	—	,,
5·0	1·96	1·07	,,	,,	6	—	—	,,
5·2	2·04	1·09	,,	,,	8	—	—	,,
5·5	2·16	1·27	,,	,,	3	—	—	,,
5·6	2·20	1·45	,,	,,	6	—	—	,,
5·6	2·20	1·32	,,	,,	7	—	—	,,
5·6	2·20	1·30	,,	,,	9	—	—	,,
5·7	2·24	1·35	,,	,,	7	—	—	,,
5·7	2·24	1·32	,,	,,	7	—	—	,,
5·8	2·28	1·40	,,	,,	7	—	—	,,
5·8	2·28	1·30	,,	,,	8	—	—	,,
5·8	2·28	1·75	,,	,,	4	—	—	,,
5·9	2·32	1·55	,,	,,	7	—	—	,,
5·9	2·32	1·65	,,	,,	9	—	—	,,
6·0	2·36	1·59	,,	,,	7	—	—	,,
6·0	2·36	1·65	,,	,,	7	—	—	,,
6·1	2·40	1·77	,,	,,	8	—	—	,,
6·1	2·40	1·92	,,	,,	9	—	—	,,
6·3	2·48	2·3	,,	,,	10	—	—	,,
6·5	2·55	2·22	,,	,,	9	—	—	,,
6·8	2·67	2·57	,,	,,	8	—	—	,,
10·0	3·93	8·0	late winter or early spring.	1+1...2 l.g.	23	—	—	1 year 1 month (?)
10·16	4·0	4·0	October	–1	not taken			7 months.
11·5	4·54	14·8	July	1+	30	10	—	1 year 3–4 months.
11·70	4·60	15·75	,,	1+	30	8	—	,, ,,
12·38	4·87	not taken	February	–1	not taken			11 months.
12·50	4·92	16·8	July	1+	23	9	—	1 year 3–4 months.
13·0	5·11	18·1	,,	1+	30	11	—	,, ,,
13·0	5·11	19·5	,,	1+	31	11	—	,, ,,
13·0	5·11	not taken	February	–1	not taken			11 months.
13·33	5·25	,,	January	–2	,,			1 year 10 months.
13·50	5·31	21·5	July	1+	32	12	—	1 year 3–4 months
13·65	5·37	not taken	May	1+	—	—	—	1 year 2 months.
14·3	5·62	24·9	July	1+	30	10	—	1 year 3–4 months.
14·3	5·62	not taken	,,	1+	not taken			,, ,,
14·60	5·75	25·0	May	1+	,,			1 year 2 months.
15·55	6·12	not taken	February	–1	,,			11 months.
15·87	6·25	26·0	April	2+	,,			2 years 1 month.
17·14	6·75	35·5	,,	2+	,,			,, ,,
17·78	7·0	not taken	October	–3	,,			2 years 7 months.
18·09	7·12	63·0	May	2+	,,			2 years 2 months.
18·8	7·40	53·15	not known	2+	26	25	11	2 years 3–4 months.
19·05	7·50	not taken	,,	–3	not taken			Under 3 years.
19·36	7·62	48·5	April	3+	,,			3 years 1 month.
19·45	7·66	not taken	not known	–3	,,			Under 3 years.
19·5	7·67	55·0	,,	3	19	21	16	About 3 years.
19·5	7·67	55·0	,,	–3	not taken			Under 3 years.
19·68	7·75	not taken	,,	–3	,,			,, ,,
20·32	8·0	51·5	April	2+	,,			2 years 1 month.
22·22	8·75	110 0	February	–2	—	—	—	1 year 11 months.
23·75	9·35	not taken	,,	–3	—	—	—	2 years 11 months.

SUMMARISED TABLE

Showing Average surface size of Scales in the Poor Cod at various stages.

No. of fish.	Range of length in cm.	Range of weight in grms.	Month of capture.	Average length of scale in mm.	Average length of A B1 or A Bn in mm.	Average breadth of scale in mm.	Average lines of growth in years. 1	2	3
1	3·3	·27	June	·23	·12	·13	0	–	–
7	3·9–4·8	·48–·80	,,	·35	·21	·30	4	–	–
13	5·0–5·9	1·07–1·65	,,	·56	·34	·50	7	–	–
7	6·0–6·8	1·59–2·57	,,	·68	·47	·61	8	–	–
1	10·0	8	uncertain, late winter or early spring.	1·49	·86	1·19	23	–	–
					A Bn				
2	11·5–11·70	14·8–15·75	July	1·92	1·07	1·71	30	9	–
5	12·5–14·3	16·8–24·9	,,	2·02	1·18	1·76	29	11	–
1	18·8	53·15	not known	3·68	1·84	2·22	26	25	11
1	19·5	55	,,	2·49	1·53	2·10	19	21	16

POOR COD.—*Summary of Age.*

Length of fish in cm.	Age of fish.
3–10	First summer.
10·16–15·55	,, winter.
11·50–14·60	Second summer.
13·33–22·22	,, winter.
15·87–20·32	Third summer.
17·78–23·75	,, winter.
19·36–......	Fourth summer.

NOTE.—The detailed table shows more clearly how variable in size fishes of the same age may be.

GADUS MINUTUS, THE POOR COD.

Table from Cunningham's "Rate of Growth of some Sea Fishes" (Journal of Marine Biological Association, 1891–2).

Date of collection.	Number of specimens.	Length in cm.	Length in inches.	Calculated age.
May 28, 1890	12	2·8–4·3	1·1–1·7	8–12 weeks.
June 17, 1889	218	4·2–7·2	1·6–2·9	About 3 months.
July 9, 1891	6	11·5–16·2	4·5–6·4	1 year 3 ,,
April 19, 1891	7	14·3–19·0	5·6–7·5	2 years.
June 17, 1889	2	13·7–15·0	5·4–5·8	1 year 2 months.
,,	1	20·0	7·8	2 ,, 2 ,,

The Whiting *(Gadus merlangus)*.

According to Fulton, "the spawning season of the whiting extends from the beginning of March to the end of June or beginning of July, with its maximum about the end of April, and at the temperature of the water at that time the eggs will take about ten or twelve days to hatch."

"The bulk of the larval whitings may thus be regarded as beginning their independent pelagic life in the early part of May, at a length of about 3·5 mm. ($\frac{1}{7}$ inch)."

By the end of the summer they are, on an average, more than four inches in length. "The growth of the young whiting is very rapid."

According to Cunningham, the whiting at Plymouth spawn in February and March. In the middle of June they are about two inches in length, and he estimates their age at three or four months. In the middle of July they are two to three and a half inches in length, and he estimates their age at about four or five months.

TABULAR RESULTS OF EXAMINATION OF SCALES OF WHITING, *Gadus merlangus*.

FISH.			SCALES.					
Length.	Weight in grms.	Date of capture.	Length in mm.	Maximum breadth in mm.	Length of A B1.	No. of lines of growth.	No of annual rings.	NOTES.
5·4 cm. = 2·12 in.	1·12	June 17, 1889	·29	·23	·17	3	-1	Locality of capture, Whitsand Bay. These scales were taken from a part slightly posterior to the usual area.
,,	,,	,,	·33	·28	·22	4	,,	
,,	,,	,,	·30	·20	·16	3	,,	
,,	,,	,,	·40	·38	·24	4	,,	
,,	,,	,,	·33	·29	·17	3	,,	
—	—	—	·33	·28	·19	3	—	Average.
7·8 cm. = 3·07 in.	2·85	Oct. 25, 1892	·59	·37	·35	11	-1	From Cunningham's Grimsby collection, trawled off the Humber October 25, 1902.
,,	,,	,,	·60	·34	·32	11	,,	
,,	,,	,,	·62	·43	·39	11	,,	
,,	,,	,,	·56	·32	·35	11	,,	
,,	,,	,,	·50	·35	·30	10	,,	
,,	,,	,,	·66	·32	·38	9	,,	
—	—	—	·59	·36	·35	11	,,	Average for preceding ½-dozen scales, all from same fish.
8·2 cm. = 3·22 in.	3·47	Oct. 25, 1892	·69	·52	·38	10	-1	From Cunningham's Grimsby collection, s.s. *Valertia* trawled off Humber, October 25, 1892.
,,	,,	,,	·62	·49	·30	9	,,	
,,	,,	,,	·64	·46	·35	10	,,	
,,	,,	,,	·52	·24	·28	8	,,	
,,	,,	,,	·72	·46	·37	9	,,	
,,	,,	,,	·61	·37	·34	9	,,	
—	—	—	·63	·42	·34	9	,,	Average for preceding ½-dozen scales, all from same fish.
8·4 cm. = 3·30 in.	3·41	Oct. 25, 1892	·56	·41	·30	9	-1	Same locality as last.
,,	,,	,,	·55	·43	·33	10	,,	
,,	,,	,,	·60	·44	·33	10	,,	
,,	,,	,,	·60	·47	·33	11	,,	
—	—	—	·58	·44	·32	10	,,	Average for preceding 4 scales, all from same fish.
9·8 cm = 3·85 in.	3·97	Oct. 25, 1892	·53	·41	·37	9	-1	From Cunningham's Grimsby collection; off the Humber, s.s. *Valertia*.
,,	,,	,,	·56	·55	·39	10	,,	
,,	,,	,,	·70	·37	·40	9	,,	
,,	,,	,,	·60	·49	·33	10	,,	
—	—	—	·60	·46	·37	10	,,	Average.
11 cm. = 4·33 in.	9	Nov. 4–16, 1901	·86	·60	·52	20	-1	From Teignmouth Bay.
,,	,,	,,	·70	·47	·42	16	,,	,,
,,	,,	,,	·76	·55	·49	18	,,	,,
,,	,,	,,	·81	·58	·52	20	,,	,,
—	—	—	·79	·55	·49	19	,,	Average.

TABULAR RESULTS OF EXAMINATION OF SCALES OF WHITING—*continued.*

FISH.			SCALES.					
Length.	Weight in grms.	Date of capture.	Length in mm.	Maximum breadth in mm.	Length of A B[1].	No. of lines of growth.	No. of annual rings.	NOTES.
11·5 cm. = 4·52 in.	9·09	Nov. 4–16, 1901	·64	·39	·40	11	– 1	From Teignmouth Bay.
„	„	„	·74	·46	·46	15	„	„
„	„	„	·66	·39	·41	16	„	„
„	„	„	·75	·42	·42	16	„	„
„	„	„	·74	·43	·47	17	„	„
„	„	„	·67	·39	·41	16	„	„
—	—	—	·70	·41	·43	15	„	Average for preceding ½-dozen scales, all from same fish.
11·90 cm. = 4·68 in.	10·15	Nov. 4–16, 1901	·80	·55	·51	17	– 1	This fish had few scales, some disintegrated, others of very small size, and, indeed, gave some hints of pathological conditions. Fish from same locality.
„	„	„	·67	·40	·41	15	„	
„	„	„	·73	·43	·41	17	„	
„	„	„	·71	·48	·43	16	„	
„	„	„	·70	·49	·42	17	„	
„	„	„	·67	·41	·38	15	„	
—	—	—	·71	·46	·43	16	„	Average for preceding ½-dozen scales, all from same fish.
12·20 cm. = 4·80 in.	12·8	Nov. 4–16, 1901	·90	·69	·54	22	– 1	From same locality.
„	„	„	1·00	·70	·60	22	„	„
„	„	„	·98	·70	·56	21	„	„
„	„	„	1·04	·67	·62	23	„	„
„	„	„	·71	·48	·42	17	„	„
„	„	„	·85	·58	·52	19	„	„
—	—	—	·91	·64	·54	21	„	Average for preceding ½-dozen scales, all from same fish.
12·40 cm. = 4·88 in.	15·40	Nov. 4–16, 1901	·88	·60	·52	21	– 1	From same locality.
„	„	„	·81	·57	·50	19	„	„
„	„	„	·81	·55	·50	20	„	„
„	„	„	·87	·58	·53	20	„	„
„	„	„	·82	·59	·46	19	„	„
„	„	„	·75	·55	·46	19	„	„
—	—	—	·82	·57	·49	20	„	Average for preceding ½-dozen scales, all from same fish.
13 cm. = 5·11 in.	Fish damaged	Sept. 28, 1901	1·10	·73	·67	21	– 1	From Cattewater, Plymouth.
„	„	„	·97	·62	·60	18	„	„
„	„	„	1·00	·58	·60	20	„	„
„	„	„	·92	·58	·54	18	„	„
—	—	—	1·00	·63	·60	19	„	Average for preceding 4 scales, all from same fish.
13·65 cm. = 5·37 in.	17·4	Nov. 4–16, 1901	·81	·55	·50	17	– 1	From Teignmouth. The distinction between summer growth and winter growth is by no means clearly defined in the Whiting scales of this date; there are indications of a much greater winter growth than in the case of Pollack and Poor Cod.
„	„	„	·76	·66	·48	17	„	
„	„	„	1·18	·64	·70	24	„	
„	„	„	1·06	·76	·63	23	„	
—	—	—	·95	·65	·58	20	„	Average for preceding 4 scales, all from same fish.
14·00 cm. = 5·51 in.	18·75	Nov. 4–16, 1901	1·12	·80	·63	24	– 1	From Teignmouth Bay.
„	„	„	1·18	·92	·68	25	„	„
„	„	„	1·07	·79	·59	21	„	„
„	„	„	1·09	1·00	·67	26	„	„
—	—	—	1·12	·88	·64	24	„	Average for preceding 4 scales, all from same fish.

TABULAR RESULTS OF EXAMINATION OF SCALES OF WHITING—*continued.*

FISH.			SCALES.					NOTES.
Length.	Weight in grms.	Date of capture.	Length in mm.	Maximum breadth in mm.	Length of A Bl.	No. of lines of growth.	No. of annual rings.	
14·65 cm. = 5·76 in.	23·15	Sept. 28, 1901	1·27	·90	·80	24	– 1	From Cattewater, Plymouth.
,,	,,	,,	1·20	·78	·73	23	,,	,,
,,	,,	,,	1·10	·75	·70	23	,,	,,
,,	,,	,,	1·20	·77	·70	24	,,	,,
—	—	—	1·19	·80	·73	24	,,	Average for preceding 4 scales, all from same fish.
14·75 cm. = 5·80 in.	26·90	Nov. 4–16, 1901	·94	·60	·59	19	– 1	From Teignmouth Bay.
,,	,,	,,	·93	·55	·95	19	,,	,,
,,	,,	,,	1·30	·69	·73	23	,,	,,
,,	,,	,,	1·18	·77	·70	24	,,	,,
—	—	,,	1·09	·65	·74	21	,,	Average for preceding 4 scales, all from same fish.
14·85 cm. = 5·84 in.	not ascertained	Nov. 2, 1891	1·37	·79	·85	28	– 1	
,,	,,	,,	1·35	·95	·80	27	,,	
,,	,,	,,	1·35	·99	·86	29	,,	
,,	,,	,,	1·32	·98	·76	26	,,	
—	—	—	1·35	·93	·82	28	,,	Average for preceding 4 scales.
15·5 cm. = 6·10 in.	29·25	Sept. 28, 1901	1·28	·83	·70	25	– 1	From Cattewater, Plymouth.
,,	,,	,,	1·32	·90	·72	24	,,	,,
,,	,,	,,	1·22	·80	·72	26	,,	,,
,,	,,	,,	1·36	·90	·67	25	,,	,,
—	—	—	1·30	·86	·70	25	,,	Average for preceding 4 scales, all from same fish.
15·75 cm. = 6·20 in.	28·8	Nov. 4–16, 1901	1·07	·68	·67	23	– 1	From Teignmouth Bay.
,,	,,	,,	1·10	·64	·63	23	,,	,,
,,	,,	,,	·95	·59	·67	20	,,	,,
,,	,,	,,	1·08	·65	·64	22	,,	,,
—	—	—	1·05	·64	·65	22	,,	Average for preceding 4 scales, all from same fish.
15·75 cm. = 6·20 in.	25·62	Nov. 4–16, 1901	1·32	·75	·85	25	– 1	From same locality.
,,	,,	,,	1·28	·80	·85	27	,,	,,
,,	,,	,,	1·05	·65	·70	23	,,	,,
,,	,,	,,	1·20	·80	·70	22	,,	,,
—	—	—	1·21	·75	·78	24	,,	Average for preceding 4 scales, all from same fish.
16·00 cm. = 6·29 in.	29·5	Nov. 4–16, 1901	1·52	1·00	·86	33	– 1	From same locality.
,,	,,	,,	1·29	·85	·75	28	,,	,,
,,	,,	,,	1·48	·97	·80	33	,,	,,
,,	,,	,,	1·48	1·03	·82	31	,,	Average for preceding 4 scales, all from same fish. In the last two specimens the exact length of fish was difficult to determine, on account of broken nature of tail fin.
—	—	—	1·44	·96	·81	31	,,	
16·25 cm. = 6·39 in.	32·9	Nov. 4–16, 1901	1·28	·90	·81	29	– 1	From same locality.
,,	,,	,,	1·30	·81	·70	25	,,	,,
,,	,,	,,	1·23	·80	·74	26	,,	,,
,,	,,	,,	1·35	·88	·82	29	,,	,,
—	—	—	1·29	·85	·77	27	,,	Average for preceding 4 scales, all from same fish.

TABULAR RESULTS OF EXAMINATION OF SCALES OF WHITING—*continued.*

FISH.			SCALES.					
Length.	Weight in grms	Date of capture.	Length in mm.	Maximum breadth in mm.	Length of A B[1].	No. of lines of growth.	No. of annual rings.	NOTES.
16·5 cm. = 6·49 in.	not ascertained.	Nov. 2, 1891	1·51	1·07	·90	30	– 1	
,,	,,	,,	1·40	·94	·95	28	,,	
,,	,,	,,	1·50	1·05	·91	29	,,	
,,	,,	,,	1·55	1·02	1·00	30	,,	
—	—	—	1·49	1·02	·94	29	,,	Average for preceding 4 scales.
17 cm. = 6·69 in.	36·9	Nov. 4–16, 1901	1·35	·95	·66	26	– 1	From same locality; a few small disintegrated scales.
,,	,,	,,	1·18	·80	·73	25	,,	
,,	,,	,,	1·20	·95	·70	27	,,	
,,	,,	,,	1·35	·95	·70	30	,,	
—	—	—	1·27	·91	·70	27	,,	Average for preceding 4 scales, all from same fish.
17·25 cm. = 6·79 in.	42·87	Nov. 4–16, 1901	1·50	1·02	·92	32	– 1	Fish from same locality; some of the scales showed a break in the continuity somewhat resembling in appearance an annual ring, but these were the exception; also a few very small scales observed.
,,	,,	,,	1·49	·85	·89	30	,,	
,,	,,	,,	1·32	·85	·77	29	,,	
,,	,,	,,	1·46	1·02	·82	31	,,	
—	—	—	1·44	·94	·85	31	,,	Average for preceding 4 scales, all from same fish.
17·75 cm. = 6·98 in.	not ascertained.	Nov. 2, 1891	1·55	1·19	·98	31	– 1	
,,	,,	,,	1·72	·92	1·02	33	,,	
,,	,,	,,	1·80	1·26	·97	31	,,	
,,	,,	,,	1·47	1·10	·84	30	,,	
—	—	—	1·64	1·12	·95	31	,,	Average for preceding 4 scales.
17·75 cm. = 6·98 in.	41·6	Nov. 4–16, 1901	1·15	·69	·72	23	– 1	From same locality; a few disintegrated scales observed.
,,	,,	,,	1·25	·76	·80	26	,,	
,,	,,	,,	1·26	·78	·80	26	,,	
,,	,,	,,	1·44	1·07	·93	31	,,	
—	—	—	1·28	·83	·81	27	,,	Average for preceding 4 scales, all from same fish.
18·70 cm. = 7·36 in.	51·7	Nov. 4–16, 1901	1·56	1·03	·99	33	– 1	From same locality; a few disintegrated and small scales observed.
,,	,,	,,	1·57	1·10	·98	34	,,	
,,	,,	,,	1·36	1·02	·77	29	,,	
,,	,,	,,	1·59	1·10	·90	34	,,	
—	—	—	1·52	1·06	·91	32	,,	Average for preceding 4 scales, all from same fish.
18·75 cm. = 7·38 in.	44·7	Nov. 4–16, 1901	1·34	·75	·88	30	– 1	From same locality.
,,	,,	,,	1·22	·80	·79	29	,,	
,,	,,	,,	1·21	·71	·85	27	,,	
,,	,,	,,	1·40	·92	·95	32	,,	
—	—	—	1·29	·80	·87	30	,,	Average for preceding 4 scales, all from same fish.
18·80 cm. = 7·40 in.	56·10	Nov. 4–16, 1901	1·60	1·02	·95	31	– 1	From same locality; a very few disintegrated and small scales.
,,	,,	,,	1·53	1·03	·90	30	,,	
,,	,,	,,	1·55	·87	·95	31	,,	
,,	,,	,,	1·71	1·15	1·00	31	,,	
—	—	—	1·61	1·02	·95	31	,,	Average for preceding 4 scales, all from same fish.

TABULAR RESULTS OF EXAMINATION

FISH.			SCALES.				
Length.	Weight in grms.	Date of capture.	Length in mm.	Maximum breadth in mm.	Length of A Bn in mm.	No. of lines of growth in scale.	No. of annual rings.
26·25 cm. = 10·33 in.	134·30	May 11, 1901	2·76	1·98	1·42	47	1 +
,,	,,	,,	2·73	1·85	1·37	49	,,
,,	,,	,,	2·93	2·05	1·47	48	,,
,,	,,	,,	2·88	2·07	1·35	42	,,
—	—	—	2·83	1·99	1·40	47	,,
28·5 cm. = 11·22 in.	175	July 16, 1901	3·24	1·46	1·44	40	1 +
,,	,,	,,	2·53	1·40	1·27	44	,,
,,	,,	,,	2·37	1·50	1·33	44	,,
,,	,,	,,	2·37	1·52	1·45	44	,,
—	—	—	2·63	1·47	1·37	43	,,
29·5 cm. = 11·61 in.	175	July 16, 1901	2·50	1·45	1·32	41	1 +
,,	,,	,,	2·42	1·40	1·19	39	,,
,,	,,	,,	2·08	1·20	1·33	45	,,
,,	,,	,,	2·12	1·25	1·28	40	,,
—	—	—	2·28	1·33	1·28	41	,,
29·65 cm. = 11·67 in.	205	Dec. 2, 1901	2·06	1·70	1·45	54	− 2
,,	,,	,,	1·55	1·37	1·24	51	,,
,,	,,	,,	1·96	1·25	1·18	48	,,
,,	,,	,,	2·03	1·32	1·21	46	,,
—	—	—	1·90	1·41	1·27	50	,,
30·15 cm. = 11·87 in.	185	Dec. 2, 1901	2·30	1·65	1·28	42	− 2
31·5 cm. = 12·40 in.	215	Dec. 2, 1901	2·49	1·65	1·48	53	− 2
,,	,,	,,	2·73	1·70	1·55	51	,,
—	—	—	2·61	1·68	1·52	52	,,

OF SCALES OF WHITING—*continued.*

YEAR I.			YEAR II.		REMARKS.
Total Length in mm.	Length of A B¹ in mm.	No. of lines of growth.	Length of B¹ B² in mm.	No. of concentric lines.	
2·00	1·08	37	·34	10	
2·03	1·05	38	·32	11	
2·18	1·12	38	·35	10	
2·14	·95	32	·40	10	
2·09	1·05	36	·35	10	Average for preceding 4 scales.
1·52	·97	27 +	·47	13	
1·53	·82	30	·45	14	
1·45	·91	31	·42	13	
1·55	·95	29	·50	15	
1·51	·91	29	·46	14	Average for preceding 4 scales. A number of disintegrated scales.
1·50	·82	27	·50	14	
1·50	·74	25	·45	14	
1·35	·85	31	·48	11	
1·34	·75	25	·48	15	
1·42	·79	27	·48	14	Average for preceding 4 scales, all from same fish.
1·18	·80	30	·65	24	
1·20	·77	30	·47	21	
1·18	·70	29	·48	19	
1·22	·75	26	·46	20	
1·20	·76	29	·52	21	Average.
1·80	·98	32	·30	10	Only scale obtained from this fish (from trawlers).
1·85	1·05	40	·43	13	
1·34	·80	27	·75	24	
1·60	·93	34	·59	19	Only scales obtained from this fish.

TABULAR RESULTS OF EXAMINATION

FISH.			SCALES.				
Length.	Weight in grms.	Date of capture.	Total length in mm.	Maximum breadth in mm.	Length of A B in mm.	No. of lines of growth.	No. of annual rings.
32·3 cm. = 12·71 in.	257	Oct. 8, 1901	2·13	1·65	1·50	55	– 3
,,	,,	,,	1·73	1·80	1·55	58	,,
,,	,,	,,	2·70	1·95	1·80	69	,,
,,	,,	,,	2·89	2·15	1·82	65	,,
,,	,,	,,	2·74	2·00	1·76	72	,,
,,	,,	,,	3·05	2·20	1·80	70	,,
—	—	—	2·54	1·96	1·71	65	,,
33·2 cm. = 13·07 in.	290	Oct. 8, 1901	2·52	1·59	1·46	57	– 3
,,	,,	,,	2·24	1·87	1·42	61	,,
,,	,,	,,	3·03	1·72	2·07	72	,,
,,	,,	,,	2·40	1·60	1·56	55	,,
,,	,,	,,	2·51	1·90	1·72	59	,,
,,	,,	,,	2·55	1·76	1·51	58	,,
—	—	—	2·54	1·74	1·62	60	,,
33·5 cm. = 13·18 in.	245	Dec. 2, 1901	2·39	1·80	1·62	50	– 2
,,	,,	,,	2·42	1·70	1·62	54	,,
—	—	—	2·91	1·75	1·62	52	,,
34 cm. = 13·38 in.	340	Dec. 12, 1901	2·60	1·90	1·80	63	– 3
,,	,,	,,	2·38	1·85	1·70	59	,,
,,	,,	,,	2·65	1·72	1·58	60	,,
,,	,,	,,	2·08	1·45	1·41	57	,,
—	—	—	2·43	1·73	1·62	60	,,
34·2 cm. = 13·46 in.	290	Oct. 8, 1901	2·48	1·60	1·51	56	– 3
,,	,,	,,	2·80	2·50	1·55	58	,,
,,	,,	,,	2·92	2·22	1·78	61	,,
,,	,,	,,	2·24	2·00	1·31	49	,,
,,	,,	,,	2·76	2·01	1·53	60	,,
,,	,,	,,	2·36	1·90	1·38	54	,,
—	—	—	2·59	2·04	1·51	56	,,
34·5 cm. = 13·58 in.	335	Jan. 10, 1902	2·39	2·10	2·40	72	– 3
34·92 cm. 13·75 in. =	255	Dec. 2, 1901	2·96	2·15	1·79	70	3

OF SCALES OF WHITING—*continued.*

YEAR I.			YEAR II.		YEAR III.		REMARKS.
Total length in mm.	Length of A B[1] in mm.	No. of lines of growth.	Length of B[1] B[2] in mm.	No. of lines of growth.	Length of B[2] B[3] in mm.	No. of lines of growth.	
1·20	·87	31	·20	10	·43	14	A few scales showed disintegration; apparently a very small growth in 2nd year, especially winter growth.
1·50	1·00	34	·15	10	·40	14	
1·55	1·00	37	·25	12	·55	20	
1·70	·98	37	·25	10	·59	18	
1·68	1·10	44	·21	10	·45	18	
1·78	1·00	41	·25	10	·55	19	
1·57	·99	37	·22	10	·50	17	Average for preceding 6 scales, all from same fish.
1·70	·90	35	·22	10	·34	12	
1·65	1·07	43	·14	8	·21	10	
2·00	1·36	46	·33	12	·38	14	
1·63	1·00	33	·23	10	·33	12	
1·58	1·07	36	·26	10	·39	13	
1·53	·85	33	·31	13	·35	12	
1·68	1·04	38	·25	10-11	·33	12	Average for preceding ½-dozen scales, all from same fish, Jan. 7, 1902.
1·60	1·05	34	·57	16	—	—	
1·55	1·00	34	·62	20	—	—	Many scales on this fish were in a disintegrated condition.
1·58	1·03	34	·60	18	—	—	Average.
1·70	1·15	40	·40	13	·25	10	
1·30	·95	33	·45	17	·30	9	
1·50	·95	34	·42	16	·21	10	
1·27	·82	32	·42	17	·17	8	
1·44	·97	35	·42	16	·23	9	Average.
·75	·43	16	·55	20	·53	20	
·85	·45	18	·60	19	·50	21	Many disintegrated scales. N.B.—Small growth of first year.
·90	·50	18	·73	23	·55	20	
·65	·35	12	·46	18	·50	19	
·85	·44	18	·57	21	·52	21	
·66	·38	14	·50	18	·50	22	
·78	·43	16	·57	20	·52	20-21	Average.
1·80	1·10	32	·65	20	·65	20	Few scales on this fish, as it came from the trawlers.
1·55	·94	38	·45	18	·40	14	

TABULAR RESULTS OF EXAMINATION

FISH.			SCALES.					YEAR I.		
Length in cm.	Weight in grms.	Date of capture.	Total length in mm.	Maximum breadth in mm.	Length of ABn in mm.	No. of lines of growth.	No. of annual rings.	Total length in mm.	Length of A B1 in mm.	No. of lines of growth.
34·92 = 13·75 in.	320	Dec. 2, 1901	2·76	1·95	1·68	59	– 4 ?	·50	·28	8*
,,	,,	,,	2·52	1·85	1·76	63	– 4	·45	·26	7
—	—	—	2·64	1·90	1·72	61	,,	·48	·27	8
35·56 = 14 in.	395	Dec. 2, 1901	2·55	1·95	1·51	58	– 3	1·35	·76	30
,,	,,	,,	2·56	2·00	1·57	59	,,	1·30	·75	30
—	—	—	2·56	1·98	1·54	59	,,	1·33	·76	30
35·56 = 14 in.	280	Dec. 2, 1901	2·40	1·68	1·42	53	– 3	1·25	.65	20
,,	,,	,,	2·61	2·00	1·57	61	,,	1·75	·96	30
—	—	—	2·51	1·84	1·50	57	,,	1·50	·81	25
36·195 = 14·25 in.	355	Dec. 2, 1901	2·38	2·10	1·47	60	– 3	1·50	·87	36
,,	,,	,,	2·32	1·85	1·52	61	,,	1·45	·92	34
—	—	—	2·35	1·98	1·50	61	,,	1·48	·90	35
36·195 = 14·25 in.	355	Dec. 2, 1901	1·80	1·30	1·42	43	– 3	1·10	·95	24
36·83 = 14·50 in.	332	Dec. 2, 1901	2·76	1·80	1·58	49	– 3	1·55	·83	26
40·005 = 15·75 in.	455	Dec. 2, 1901	2·86	1·90	1·86	72	– 3	1·30	·80	31
,,	,,	,,	3·10	2·00	2·01	71	,,	1·40	·85	31
,,	,,	,,	2·55	1·98	1·68	68	,,	1·25	·78	31
,,	,,	,,	2·66	2·37	1·74	66	,,	1·30	·84	32
—	—	—	2·79	2·06	1·82	69	,,	1·31	·82	31
41·275 = 16·25 in.	500	Dec. 2, 1901	3·41	2·30	2·14	74	– 3	1·66	·92	34
,,	,,	,,	3·10	2·40	2·51	75	,,	1·50	·98	31
,,	,,	,,	3·55	2·36	2·35	75	,,	1·50	·90	30
,,	,,	,,	3·29	1·67	2·27	72	,,	1·26	·97	29
—	—	—	3·35	2·18	2·32	74	,,	1·48	·94	31
46·6 = 18·34 in.	700	Jan. 10, 1902	3·28	2·15	1·65	70	– 4	·70	·40	21
,,	,,	,,	3·07	1·75	1·65	71	,,	·65	·40	20
,,	,,	,,	3·47	2·15	2·00	81	,,	·85	·48	20
,,	,,	,,	3·80	2·10	1·67	71	,,	1·00	·47	26
—	—	—	3·41	2·04	1·74	73	,,	·80	·44	22
49 = 19·29 in.	763·42	May 14, 1901	3·54	2·90	2·15	78	4 +	1·55	·85	27
,,	,,	,,	3·51	2·40	1·94	65	,,	1·53	·93	30
,,	,,	,,	3·52	2·45	2·20	75	,,	1·50	·90	30
,,	,,	,,	3·98	3·10	2·37	76	,,	1·70	·95	29
—	—	—	3·65	2·71	2·17	74	,,	1·57	·91	29

* Some concentration of lines at this point.

OF SCALES OF WHITING—*continued.*

YEAR II.		YEAR III.		YEAR IV.		YEAR V.		REMARKS.
Length of $B^1 B^2$ in mm.	No. of lines of growth	Length of $B^2 B^3$ in mm.	No. of lines of growth.	Length of $B^3 B^4$ in mm.	No. of lines of growth.	Length of $B^4 B^5$ in mm	No. of ex-centric lines.	
·59	21	·35	11	·46	16	—	—	Remarkably small scale growth for first year; also marked disintegration of large number of scales. Yrs. I. and II. should perhaps be Year I.
·63	25	·40	17	·47	14	—	—	
·61	25	·38	14	·47	15	—	—	Average.
·40	16	·35	12	—	—	—	—	
·42	14	·40	15	—	—	—	—	
·41	15	·38	14	—	—	—	—	Average.
·40	17	·37	16	—	—	—	—	
·36	20	·25	11	—	—	—	—	
·38	19	·31	14	—	—	—	—	Average.
·35	14	·25	10	—	—	—	—	
·25	13	·35	14	—	—	—	—	
·30	14	·30	12	—	—	—	—	Average.
·28	13	·19	6	—	—	—	—	
·50	14	·25	9	—	—	—	—	
·63	24	·43	17	—	—	—	—	
·66	24	·48	16	—	—	—	—	
·50	25	·40	13	—	—	—	—	
·55	22	·35	12	—	—	—	—	
·59	24	·42	15	—	—	—	—	Average.
·74	18	·48	22	—	—	—	—	Many of the scales from the last fish were in a disintegrated condition.
·95	23	·58	21	—	—	—	—	
·80	25	·65	20	—	—	—	—	
·80	24	·50	19	—	—	—	—	
·82	23	·55	21	—	—	—	—	Average.
·55	22	·35	13	·35	14	—	—	This is a corrected observation: in my previous observation I had evidently put Years III. and IV. together as one year.
·65	25	·35	14	·25	12	—	—	
·80	30	·40	16	·32	15	—	—	
·60	23	·30	11	·30	11	—	—	
·65	25	·35	14	·31	13	—	—	Average.
·50	19	·40	14	·30	14	·10	4	
·40	13	·29	12	·20	7	·12	3	
·47	16	·35	12	·35	11	·13	3	
·57	18	·38	13	·35	13	·12	3	
·49	17	·38	13	·30	12	·12	3	Average.

Examination of Scales of Whiting—*Summary.*

Length of fish. cm.	Length of fish. inches.	Weight in grms.	Month of capture.	Annual rings.	Lines of growth. I.	II.	III.	IV.	V.	Locality.	Approximate age.
5·4	2·12	1·12	June	– 1	3	–	–	–	–	From English Channel	3–4 months.
7·8	3·07	2·85	Oct.	,,	11	–	–	–	–	From North Sea	
8·2	3·22	3·47	,,	,,	9	–	–	–	–	,,	
8·4	3·30	3·14	,,	,,	10	–	–	–	–	,,	
9·8	3·85	3·97	,,	,,	10	–	–	–	–	,,	
11·0	4·33	9·0	Nov.	,,	19	–	–	–	–	From English Channel	8 months.
11·5	4·52	9·09	,,	,,	15	–	–	–	–	,,	,,
11·90	4·68	10·15	,,	,,	16	–	–	–	–	,,	,,
12·20	4·80	12·8	,,	,,	21	–	–	–	–	,,	,,
12·40	4·88	15·40	,,	,,	20	–	–	–	–	,,	,,
13·0	5·11	fish damaged	Sept.	,,	19	–	–	–	–	,,	6–7 months.
13·65	5·37	17·4	Nov.	,,	20	–	–	–	–	,,	8 months.
14·0	5·51	18·75	,,	,,	24	–	–	–	–	,,	,,
14·65	5·76	23·15	Sept.	,,	24	–	–	–	–	,,	6–7 months.
14·75	5·80	26·90	Nov.	,,	21	–	–	–	–	,,	8 months.
14·85	5·84	not taken	,,	,,	28	–	–	–	–	,,	,,
15·5	6·10	29·25	Sept.	,,	25	–	–	–	–	,,	6–7 months.
15·75	6·20	28·8	Nov.	,,	22	–	–	–	–	,,	8 months.
15·75	6·20	25·62	,,	,,	24	–	–	–	–	,,	,,
16·0	6·29	29·5	,,	,,	31	–	–	–	–	,,	,,
16·25	6·39	32·9	,,	,,	27	–	–	–	–	,,	,,
16·50	6·49	not taken	,,	,,	29	–	–	–	–	,,	,,
17·0	6·69	36·9	,,	,,	27	–	–	–	–	,,	,,
17·25	6·79	42·87	,,	,,	31	–	–	–	–	,,	,,
17·75	6·98	not taken	,,	,,	31	–	–	–	–	,,	,,
17·75	6·98	41·6	,,	,,	27	–	–	–	–	,,	,,
18·70	7·36	51·7	,,	,,	32	–	–	–	–	,,	,,
18·75	7·38	44·7	,,	,,	30	–	–	–	–	,,	,,
18·80	7·40	56·10	,,	,,	31	–	–	–	–	,,	,,
26·25	10·33	134·30	May	1 +	36	10	–	–	–	,,	1 yr. 2–3 mths.
*28·50	11·22	175	July	,,	29	14	–	–	–	,,	1 yr. 4–5 mths.
29·50	11·61	175	,,	,,	27	11	–	–	–	,,	,,
29·65	11·67	205	Dec.	– 2	29	21	–	–	–	,,	1 yr. 9 mths.
30·15	11·87	185	,,	,,	32	10	–	–	–	,,	,,
31·50	12·40	215	,,	,,	34	19	–	–	–	,,	,,
32·30	12·71	257	Oct.	– 3	37	10	17	–	–	,,	2 yrs. 7 mths.
33·2	13·07	290	,,	,,	38	10–11	12	–	–	,,	,,
33·5	13·18	245	Dec.	– 2	34	18	–	–	–	,,	1 yr. 9 mths.
†34·0	13·38	340	Jan.	– 4	31	21	10	9	–	,,	3 yrs. 10 mths.
34·2	13·46	290	Oct.	– 3	16	20	20 or 21	–	–	,,	2 yrs. 7 mths.
34·5	13·58	335	Jan.	,,	32	20	20	–	–	,,	2 yrs. 10 mths.
34·92	13·75	255	Dec.	– 3?	33	14	15	–	–	,,	
34·92	13·75	320	,,	– 3	38	18	14	–	–	,,	2 yrs. 9 mths.
35·56	14·0	395	,,	,,	30	15	14	–	–	,,	,,
35·56	14·0	280	,,	,,	25	19	14	–	–	,,	,,
36·19	14·25	355	,,	,,	35	14	12	–	–	,,	,,
36·19	14·25	355	,,	,,	24	13	6	–	–	,,	,,
36·83	14·50	332	,,	,,	26	14	9	–	–	,,	,,
40·0	15·75	455	,,	,,	31	24	15	–	–	,,	,,
41·27	16·25	500	,,	,,	31	23	21	–	–	,,	,,
46·6	18·34	700	Jan.	– 4	22	25	14	13	–	,,	3 yrs. 10 mths.
‡49·0	19·29	763·42	May	4 +	29	17	13	12	3	,,	4 yrs. 2 mths.

* See Pl. VI., Fig. 1. † See Pl. VI., Fig. 2. ‡ See Pl. VII., Fig. 1.

GADUS MERLANGUS.

Summarised Table of Annual Rings.

No. of fish.	Length of fish. in cm.	Length of fish. in inches.	Month of capture.	No. of annual rings.	No. of lines of growth (excentric lines) in years. 1	2	3	4	5	Remarks.
1	5·4	2·12	June	– 1	3	–	–	–	–	From North Sea.
1	7·8	3·07	October	,,	11	–	–	–	–	
2	8·0	*S. 3·22 L. 3·30	,,	,,	9–10	–	–	–	–	
1	9·8	3·85	,,	,,	10	–	–	–	–	
4	11–12	S. 4·33 L. 4·80	November	,,	15–21	–	–	–	–	
3	12–13	S. 4·88 L. 5·37	,,	,,	19–20	–	–	–	–	
5	14·	S. 5·51 L. 5·84	Oct. to middle November	,,	21–28	–	–	–	–	
6	15–16	S. 6·10 L. 6·49	,,	,,	22–31	–	–	–	–	
4	17·0	S. 6·69 L. 6·98	November	,,	27–31	–	–	–	–	
3	18·0	S. 7.36 L. 7·40	,,	,,	30–32	–	–	–	–	
1	26·25	10·33	May	1 +	36	10	–	–	–	
3	28–29	S. 11·22 L. 11·67	July to Dec.	1 + to – 2	27–29	14–21	–	–	–	
2	30–31	S. 11·87 L. 12·40	Dec.	– 2	32–34	10–19	–	–	–	
1	32·3	12·7	October	– 3	37	10	17	–	–	
1	33·2	13·07	,,	,,	38	10	12	–	–	
1	33·5	13·18	December	– 2	34	18	–	–	–	
4	33–34	S. 13·3 L. 13·97	Oct. to Jan.	– 3	16–38	16–20	9–21	–	–	
1	34·92	13·75	December	– 3 ?	34	14	15	–	–	
5	35–36	S. 14·0 L. 14·50	,,	– 3	24–35	13–19	6–14	–	–	
2	40–41	S. 15·75 L. 16·25	,,	,,	31	23–24	15–21	–	–	
1	46·6	18·34	January	,,	23	31	24	–	–	
1	46·6	18·34	,,	– 4	22	25	14	13	–	
1	49·0	19·29	May	4 +	29	17	13	12	3	

* Have here taken the smallest (S.) and largest (L.) fish.

SUMMARISED TABLE SHOWING AVERAGE SURFACE SIZE OF SCALES IN WHITING AT VARIOUS STAGES.

No. of fish.	Range of length in cm.	Range of weight in grms.	Month of capture.	Average length of scale in mm.	Average length of A B[1] or A B[1] in mm.	Average breadth of scale in mm.	Average lines of growth (excentric lines) in years I.	II.	III.	IV.	V.	Notes.
1	5·4	1·12	June	·33	·19	·28	3	–	–	–	–	
4	7·8–9·8	2·85–3·97	Oct.	·60	·35	·42	10	–	–	–	–	From North Sea
25	11·0–18·80	9·0–56·10	Oct. to Nov.	1·16	·70	·77	24	–	–	–	–	
					A B[11]							
1	26·25	134·30	May	2·83	1·40	1·99	36	10	–	–	–	
2	28·5–29·5	175	July	2·45	1·32	1·40	28	14	–	–	–	
3	29·65–31·5	205–215	Dec.	2·27	1·35	1·58	32	13	–	–	–	
2	32·3–33·2	257–290	Oct.	2·54	1·66	1·85	38	10	15	–	–	
7	35·56–41·27	280–500	Dec.	2·59	1·67	1·88	29	17	13	–	–	
1	46·6	700	Jan.	3·41	1·74	2·04	22	25	14	13	–	
1	49·0	763·42	May	3·65	2·17	2·71	29	17	13	12	3	

GADUS MERLANGUS (WHITING).

Length of fish in cm.	Age of fish.
5·4	First summer.
7–18	,, winter.
26–29	Second summer.
29–31	,, winter.
32–42	Third ,,
(33·5	Second ,,)
(34·0	Fourth ,,)
46·6	,, ,,
49·0	Fifth spring.

For purposes of comparison I submit two tables of ages for the Whiting, the first table from Fulton's paper on "The Rate of Growth of the Cod, Haddock, Whiting, and Norway Pout" (*Fishery Board for Scotland*, 1900); the second table from Cunningham's paper on "The Rate of Growth of some Sea Fishes and their Distribution at Different Ages" (*Journal Marine Biological Association*, vol. ii., n.s., 1891–2).

Table showing the Rate of Growth of the Whiting (*Gadus merlangus*), after Fulton.

		Size.		Approximate age.		Apparent growth in a year from previous series.	
		mm.	inches.	yrs.	mths.	mm.	inches.
A Series (6,203 fish).	Smallest	69	$2\frac{11}{16}$	–	2	–	–
	Average	124·4	$4\frac{7}{8}$	–	$5\frac{1}{2}$	–	–
	Largest	196	$7\frac{11}{16}$	–	7	126	$4\frac{11}{16}$
B Series (1,168 fish).	Smallest	183	$7\frac{1}{4}$	1	2	111·0	$4\frac{1}{2}$
	Average	237·9	$9\frac{3}{8}$	1	$5\frac{1}{2}$	113·5	$4\frac{1}{2}$
	Largest	297	$11\frac{11}{16}$	1	7	101	4
*C Series (1,110 fish).	Smallest	257	$10\frac{1}{8}$	2	2	74	$2\frac{15}{16}$
	Average	313·5	$12\frac{5}{16}$	2	$5\frac{1}{2}$	75·6	3
	Largest	404	$15\frac{7}{8}$	2	7	107	$4\frac{3}{16}$
*D Series (30 fish).	Smallest	410	$16\frac{1}{8}$	3	2	[153	6
	Average	469·4	$18\frac{1}{2}$	3	$5\frac{1}{2}$	[155·9	$6\frac{1}{8}$]
	Largest	491	$19\frac{5}{16}$	3	7	[87	$3\frac{3}{8}$]
*E Series (5 fish).	Smallest	526	$20\frac{11}{16}$	[4	2]	[116	$4\frac{9}{16}$]
	Average	534·2	21	[4	$5\frac{1}{2}$]	[64·8	$2\frac{9}{16}$]
	Largest	541	$21\frac{5}{16}$	[4	7]	[50	

* Deep water hauls.

Table showing the Rate of Growth of the Whiting (*Gadus merlangus*), after Cunningham.

Date of collection.	No. of specimens	Length in cm.	Length in in.	Calculated age.
June 13, 1889	2	5·7	2·2	3 or 4 months old.
July 16, 1891	13	5·4–9·0	2·1–3·5	4 or 5 months old.

I must notice here the case of a whiting which I kept living under observation in one of the small tanks of the laboratory, from a month or so after hatching until it was one year and four or five months old. When first placed in the tank, in early May, 1902, this whiting measured 10–20 mm. in length (according to Cunningham the larval whiting when first hatched is 3·6 mm. in length). The whiting in question was fed regularly from the hand until July 4th, 1903, when it leapt from the tank. At the latter date it measured $8\frac{1}{2}$ inches in length, and was $3\frac{1}{8}$ oz. in weight. On examining its scales I found them much more regular in their arrangement than the scales of whiting captured at sea. The lines of growth appeared almost uniformly separated from one another, and because of this I could not observe any distinction into summer and winter areas such as are marked out in my plates.

Another noteworthy point about the lines of growth in the scales of this whiting was that they appeared throughout to be closer to one another than is the case in captured fish. This would probably indicate a uniformly slower growth of the scale.

The temperature of the water in the Plymouth tanks remains fairly constant; but there is naturally a distinct difference between the summer and winter temperature, and the whiting in question may be taken as having been fairly regularly supplied with food. From these facts, and also from the fact that fish from deep water, where the temperature of the sea does not show marked variation in summer and winter, show annual rings as clearly as those from shallow water where there is a marked difference between the summer and winter temperature, inclines me to believe that it is a question of variation in the food-supply rather than variation in temperature which influences the metabolism of the fish, and indirectly brings about the formation of annual rings in scales.

The scales of this aquarium whiting showed, however, some interesting points, firstly as to the number of lines of growth: the total number of these lines was on an average 50, and whiting from the sea which I determined to be of about the same age, though of a larger size (see tables), showed on an average 43 lines of growth. It appears to me, if I had not already known the real age of this captive whiting, that from my tables of calculated ages for captured whiting I would at least have arrived at the approximate age by counting the number of lines of growth in the scales.

In regard to the sizes of scales in this captive whiting, they were on an average the following: Total length of scale, 2·00 mm.; maximum breadth of scale, 1·50 mm.; long axis AB^n, 1·10 mm. On comparing the figures above with those given in my tables, it seems that the size of the scale is small for the number of growth lines present, and this one might expect from my previous observation that the growth lines are all uniformly closely adjacent to one another.

The Haddock *(Gadus aeglefinus)*.

Tabular Results of Examination of Scales of Haddock.

FISH.			SCALES.				
Length in cm.	Weight.	Date of capture.	Total length in mm.	Maximum breadth in mm.	Length of A B^n in mm.	No. of excentric lines in A B^n	No. of annual rings.
26·25 = 10·33 in.	6½ oz.	May 15, 1901	2·83	1·50	1·65	38	2
,,	,,	,,	2·72	1·38	1·85	42	2
,,	,,	,,	2·71	1·76	1·56	39	2
,,	,,	,,	3·04	1·65	1·62	41	2
—	—	—	2·83	1·57	1·67	40	2
29 = 11·41 in.	9¼ oz.	May 15, 1901	2·81	1·67	1·63	39	2 +
,,	,,	,,	2·84	1·70	1·65	38	2 +
,,	,,	,,	2·79	1·56	1·55	40	2 +
,,	,,	,,	2·67	1·43	1·49	42	2 +
—	—	—	2·78	1·59	1·58	40	2 +
35 = 13·77 in.	14¼ oz.	May 15, 1901	3·13	1·55	1·71	47	2 +
,,	,,	,,	2·93	1·90	1·63	43	2 +
,,	,,	,,	3·30	1·80	1·83	45	2 +
,,	,,	,,	2·93	1·82	1·75	42	2 +
—	—	—	3·07	1·77	1·73	44	2 +

Length in cm.	YEAR I.			YEAR II.		YEAR III.		REMARKS.
	Total length of year's growth in mm.	Length of A B^1 in mm.	No. of excentric lines.	Length of B^1 B^2 in mm.	No. of excentric lines.	Length of B^2 B^3 in mm.	No. of excentric lines.	
26·25 = 10·33 in.	1·44	·83	20	·82	18	—	—	
,,	1·55	·89	21	·96	21	—	—	
,,	1·45	·80	20	·76	19	—	—	
,,	1·64	·82	21	·80	20	—	—	
—	1·52	·84	21	·84	20	—	—	Average for preceding 4 scales, all from same fish.
29 = 11·41 in.	1·43	·87	19	·68	16	·08	4	
,,	1·37	·77	17	·78	17	·10	4	
,,	1·29	·70	19	·78	20	·07	1	
,,	1·25	·65	18	·74	20	·10	4	
—	1·34	·75	18	·75	18	·09	3	Average for preceding scales, all from same fish.
35 = 13·77 in.	1·70	·90	21	·74	19	·07	1	
,,	1·68	·93	23	·60	16	·10	4	
,,	1·80	1·00	24	·67	16	·16	5	
,,	1·58	·90	22	·63	15	·22	5	
—	1·69	·93	23	·66	17	·14	5	Average for preceding scales, all from same fish.

HADDOCK, *from the North Sea.*

Length of fish. in.	Length of fish. cm.	Weight.	No. of annual rings in scale.	Date of capture.	Approximate age.	Notes.
$10\frac{1}{2}$	26·67	$6\frac{1}{2}$ oz.	2	May 15, 1901	2 years.	No clearly marked growth for spring of 1901.
$11\frac{5}{8}$	29·52	$9\frac{1}{4}$ oz.	2+	,,	2 years 1 month	Clearly marked growth for spring of 1901.
$12\frac{3}{4}$	32·38	12 oz.	,,	,,	,,	Ditto.
$13\frac{1}{8}$	33·33	12 oz.	,,	,,	2 yrs. 1–2 mths.	1st year's growth small; 2nd year normal; much growth for spring of 1901.
$13\frac{1}{8}$	33·33	$12\frac{1}{4}$ oz.	,,	,,	2 years 1 month	Spring growth of 1901 apparent.
14	35·56	$14\frac{1}{4}$ oz.	,,	,,	,,	,, ,,
$14\frac{1}{4}$	36·19	$15\frac{3}{4}$ oz.	,,	,,	,,	,, ,,
$15\frac{1}{2}$	39·37	1 lb. $5\frac{3}{4}$ oz.	3	,,	3 years	Very little, if any growth for spring of 1901.
$16\frac{1}{4}$	41·27	1 lb. $12\frac{1}{4}$ oz.	3+	,,	3 years 1 month	Spring growth of 1901 more clearly marked than in last.
$20\frac{1}{4}$	51·43	2 lbs. $9\frac{1}{2}$ oz.	4+	,,	4 years 1 month	Spring growth of 1901 apparent.
$21\frac{1}{2}$	54·61	4 lbs.	,,	,,	,,	,, ,,

N. B.—These haddocks were probably hatched in May. According to Fulton the majority of larval haddocks are probably hatched in early April, and it may be later, as spawning fish can be obtained as far on as the beginning of May.

AGE OF HADDOCK AS DETERMINED BY FULTON.

Length.		Age.
Series A. Range from $4\frac{5}{8}$ to $8\frac{3}{4}$ in.	Average length, $6\frac{5}{16}$ inches	7 to 8 months in October.
Series B. Range up to $13\frac{3}{4}$ inches	Average length, $11\frac{1}{2}$ inches	1 year 7 months ,,
Series C. Range up to $17\frac{1}{2}$ inches	Average length, $13\frac{1}{2}$ to 14 in.	2 years 7 months ,,

The Cod *(Gadus callarias, L.)*.

Length of fish.	Date of capture.	No. of annual rings in scale.	No. of lines of growth. Year 1.	Year 2.	Approximate age.
9·87 in. = 25·08 cm.	August 26, 1902	1 +	19	9	1 year 4–5 months.
,,	,,	,,	19	10	,,
,,	,,	,,	20	9	,,
,,	,,	,,	17	10	,,
,,	,,	,,	20	10	,,
,,	,,	,,	20	10	,,
—	—	—	19	10	Average of scales, all from [same fish.
8·25 in. = 20·95 cm.	August 26, 1902	1 +	15	8	1 year 4–5 months.
,,	,,	,,	13	8	,,
,,	,,	,,	14	8	,,
,,	,,	,,	12	9	,,
,,	,,	,,	15	8	,,
,,	,,	,,	13	8	,,
—	—	—	14	8	Average of scales, all from [same fish.

NOTE.—The ages thus determined agree with Fulton's results. According to Fulton, the majority of Cod probably hatch about the end of March and early part of April, and this may be taken as the period from which to date the average age of the season's brood, and Haddock $8\frac{1}{4}$ to $11\frac{1}{4}$ inches long are 1 year and 5 months in September.

The Scales of Eels.

This paper commenced with the scales of the eel, and towards my conclusion I must again refer to them.

I have recently obtained eels from the Isle of May, Firth of Forth, in order to examine their scales to see if by this means I could throw any light on their interesting life-history. I endeavoured to obtain eels from the lighthouse-keeper of the isle during the past winter (1902–1903), but was informed by him that they were never seen there during winter. He thought they must bury themselves in the mud at the bottom of the loch during winter-time, and it seems probable that at this season they indulge in a winter sleep. In the following August, however, the lighthouse-keeper was kind enough to send me three eels, measuring 28, 33, and 35 inches respectively. The eels of the Isle of May have previously attracted the attention of the biologist on account of their supposed history. They were supposed to have been introduced there by the monks some centuries ago, and to have lived in the land-locked loch on the isle since that time. It had been held for sometime that eels could only breed in salt water, and that those eels prevented from reaching salt water by their land-locked habitat were the identical eels brought over by the monks, being therefore of great age. Sandeman has contributed a paper to the Linnean Society showing that the eyes and other organs show symptoms of senile decay.

Lately, in the *Field*, it has been held that eels can breed in fresh water. The lighthouse-keeper on the isle tells me that the eels found by him are much smaller than those found formerly, that instead of being five feet or so, they are only three feet or so in length.

The scales of eels are well buried in the skin, and from this position one would naturally suppose that they could not easily be shed or rubbed off. The scales show rings very clearly; but whether these are annual or not I would not at present certainly determine, as I have not a complete series of the fish. If the rings are annual, and from the fact that these animals seem to have a winter sleep, it would be natural to suppose that such is the case, then the eels on the Isle of May are of no great age, and the largest of the specimens (35 inches in length) examined by me, may not be more than fourteen years old, but on this determination I do not place any exact reliance.

The scales were thick, well preserved, and showed no signs of disintegration such as are found in scales from aged pollack. This may be partly accounted for by the fact that scales in the eel do not overlap one another.

IV. Conclusion.

My present paper, firstly, rests on the foundation of Dr. Hoffbauer's work for fresh-water fish, which no authority has as yet proved false. Dr. Hoffbauer showed that scales gave a direct index of age in carp, etc., for all of which he had exact and direct knowledge as to their age and history. It is surely opposed to the principle of the unity of science to believe that a law which holds true for some fresh-water fish would not also be found applicable to some marine fish.

After reading the preceding statistics, I think that it must be granted that, even after allowing for variation, they afford strong cumulative proof that in these species of Gadidæ the growth of scales is cyclical or periodic, and that the rings formed thereby are annual. To believe that these are not annual rings, but are rings formed in some more irregular manner, seems quite opposed to the facts in regard to the growth of the scale, and the arrangement of the lines which mark that growth, as brought out by my statistics and plates.

That scales of those Gadidæ show a larger surface growth, and a wider separation of the lines of growth in summer as contrasted with winter, appears to me to be indisputable. This divergence in the growth of scales during summer and winter is probably due to changes in the general metabolism of the body, which are in their turn, in all probability, the result of seasonal variation in the temperature and food-supply. Of these two causes I am more inclined to give preponderance to the latter.

After an examination of thousands of scales from these Gadidae I hold that in ninety-eight cases out of a hundred one would arrive at a very closely approximate idea of the age of the fish from an examination of three or four well-developed scales taken from the median region of the flanks near the lateral line. Other areas of the body show annual rings in the scales, but in the area mentioned they are more easily determined than elsewhere. The percentage given would be less in the case of fish more than four or five years of age, for reasons already stated in a previous part of this paper. In this connection, however, it has to be remembered that the determination of age for younger is of more practical importance than for older fish.

Corroboration of the truth of this hypothesis, that the ages of certain marine fishes may be determined by means of annual rings on the scales is afforded by the fact that the ages ascertained by my method agree in the main with the results calculated out by other workers who have worked at the subject of the age of fish from a different standpoint. In this connection I have quoted repeatedly from Cunningham and Fulton, the latter of whom has worked out the subject in a very complete manner after Petersen's method (*Scottish Fishery Board*, 1900 and 1901).

Allowing for difference of locality of capture, my results agree in the main with those of Fulton, and they also afford many points of agreement with Cunningham's results for fish of the English Channel. As I have already stated, I had little previous knowledge of Mr. Cunningham's and Dr. Fulton's results on the probable ages of fish, and it was only after I compiled my own statistics on age-determination that I compared them with those of other workers.

It is almost impossible to acquire direct proof of this hypothesis, the conditions of life in tank and aquarium being so unlike the natural haunts, yet even with this, I have already mentioned that in the case of a whiting which lived from shortly after hatching for thirteen and a quarter months in a tank, the number of growth-lines formed on the scale during that period roughly agreed (after allowing for a slower scale growth under captive conditions) with the number of growth-lines in the scales from sea whiting calculated to be about the same age.

The labelling of Gadidae as adopted for other fish by the International Sea Fisheries Scheme along with an examination of their scales would, I believe, furnish a direct proof of this hypothesis.

LITERATURE.

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EXPLANATION OF PLATES.

Plates I. to IV., Photo-micrographs of Scales of Pollack.
Plate V., Scales of Poor Cod.
Plate VI., Scales of Whiting.
Plate VII., Fig. 1, Scale of Whiting; Fig. 2, Scale of Coal Fish (*Gadus virens*).
Plate VIII., Fig. 1, Scale of Haddock; Fig. 2, Scale of Norwegian Whiting Pollack (*Gadus Esmarkii*).

The lettering is taken in each case from the posterior area of the scale.

C = Centre of growth.
C – W 1 = Growth of first year.
C – S 1 = Growth of first summer.
S 1 – W 1 = Growth of first winter.
W 1 – S 2 = Growth of second summer.
W 1 – W 2 = Growth of second year.
W 2 – W 3 = Growth of third year.
L.G. = Lines of growth.
S.L.G. = Summer lines of growth.
W.L.G. = Winter lines of growth.

PLATE I.

Fig. 1.—Scale of young Pollack, 3 to 4 months old, magnified about 140 diameters. Length of fish, 5·4 cm. (2·12 in.); date of capture, July, 1901. Scale shows three lines of growth. The figure was drawn with the aid of the camera.

Fig. 2.—Scale of Pollack, 7 to 8 months old, magnified about 45 diameters. Length of fish, 10·15 cm. (3·99 in.); date of capture, December 4th, 1889; number of lines of growth, 18. The later lines are closer to one another than the earlier, indicating winter growth as distinguished from summer growth. The distance between two consecutive summer lines of growth is seen, from the Figures 2, 3, and 4, to be in some cases half as much again as the distance between two consecutive lines of winter growth; in other cases it may be twice as great.

Fig. 3.—Scale of pollack, 7 to 8 months old, magnified 45 diameters. Length of fish, 10·0 cm. (3·93 in.); date of capture, December, 1889. Shows 20 lines of growth.

Fig. 4.—Scale of Pollack, 7 to 8 months old, magnified 45 diameters. Length of fish, 11·75 cm. (4·62 in.); date of capture, December 4th, 1889; number of lines of growth, 20. The later lines are closer to one another than the earlier lines, indicating winter growth as distinguished from summer growth.

Fig. 5.—Scale of Pollack, 1 year 2 to 3 months old, magnified 37½ diameters. Length of fish, 24·76 cm. (9·75 in.); date of capture, May, 1902; number of lines of growth first year, 26, 8 lines the early growth of the second year.

PLATE II.

Fig. 1.—Pollack scale at end of second summer, magnified 45 diameters. Length of fish, 28·5 cm. (11·22 in.); date of capture, October, 1900; age determined, 1 year 6 to 7 months.

Fig. 2.—Pollack scale at end of second year. Length of fish, 33·65 cm. (13·25 in.); date of capture, May, 1902. This photo-micrograph has, owing to the larger size of the scale, been magnified much less than preceding scale.

PLATE III.

Fig. 1.—Scale of Pollack at end of second year. Length of fish, 33·65 cm. (13·25 in.); date of capture, May, 1902. This scale has been photographed because it shows extremely little growth for first year, namely, only 18 lines of growth, while that of the preceding scale, for example, shows 28 during this period.

Fig. 2.—Scale of Pollack at commencement of fourth summer, magnified 28 diameters. Length of fish, 44·40 cm. (17·50 in.); date of capture, April 30th, 1901; age determined, 3 years 6 weeks.

PLATE IV.

Scale of Pollack at commencement of ninth year. Length of fish, 78·74 cm. (31 in.); date of capture, April or May, 1902. This photo-micrograph shows, firstly, how it becomes a much harder task to distinguish the annual rings in the scales of older and larger fish, and, secondly, that the scales of such tend naturally to become broken and disintegrated. Age determined, 8 years 6 weeks.

PLATE V.

Fig. 1.—Scale of *Gadus minutus* in its second summer. Length of fish, 14·30 cm. (5·62 in.); date of capture, July 9th, 1901. This scale shows very clearly the earlier growth of second summer. First year, 37 lines of growth; second year (early summer), 9 lines of growth. Age determined, 1 year 3 to 4 months.

Fig. 2.—Scale of *Gadus minutus* at end of third winter. Length of fish, 19·05 cm. (7·50 in.) age determined, about 3 years.

PLATE VI.

Fig. 1.—Scale of Whiting in its second summer. Length of fish, 28·50 cm. (11·22 in.); date of capture, July 16th, 1901. This scale shows 29 lines of growth for the first year, and 14 lines of growth for the second summer up to July 16th. Age determined, 1 year 4 to 5 months.

Fig. 2.—Scale of Whiting towards end of the fourth year. Length of fish, 34·0 cm. (13·38 in.); date of capture, January 10th, 1902. This scale shows the following lines of growth: first year, 31; second year, 21; third year, 10; fourth year, 9. Age determined, 3 years 10 months.

PLATE VII.

Fig. 1.—Scale of Whiting at commencement of fifth summer. Length of fish, 49 cm. (19·29 in.); date of capture, May 14th, 1901. Age determined, 4 years 2 months.

Fig. 2.—Scale of Coal Fish (*Gadus virens*) in the early summer of second year. Length of fish, 20·22 cm. (8 inches). This scale shows very clearly the early growth of second summer.

PLATE VIII.

Fig. 1.—Scale of Haddock at commencement of third summer. Length of fish, 26·25 cm. (10·33 in.); date of capture, May 10th to 15th, 1901. This scale shows 21 lines of growth for the first year, and 20 lines of growth for the second year. Age determined, 2 years.

Fig. 2.—Scale of Norwegian Whiting Pollack (*Gadus Esmarkii*) in its third summer. Length of fish, 19·05 cm. (7·50 in.); date of capture, August 27th, 1900. Age determined, 2 years 3 to 4 months.

As to the photo-micrographs, Figures 2, 3 and 4, Plate I., were taken by myself; the remainder are the work of Mr. L. E. Sexton, Plymouth, and Mr. A. Flatters, Manchester.

Notes on the Copepoda of the North Atlantic Sea and the Faröe Channel.

By

R. Norris Wolfenden, M.D., F.Z.S.

(With Plate IX., and one Figure in the text.)

In a previous notice in this Journal, vol. vi., p. 344, January, 1902, a brief description of the plan of work undertaken by the writer was given. This comprised cruises across the cold-water area of the Faröe Channel during 1900, 1901, and 1902, during the course of which tow-nettings were made at each station with Garstang's net, or Fowler's net, down to 500 to 600 fathoms, simultaneously with hydrographical observations (temperature, collection of water, etc.), which have already been partly reported upon by Mr. H. N. Dickson (*Geographical Journal*, April, 1903).

The exploration of the Faröe Channel being now, under the International Investigation Scheme, handed over to the Scottish Fishery Board, I have, during 1903, endeavoured to supplement this work by a cruise from Valentia, in Ireland, to the Faröe Banks, crossing in the route the deep Atlantic trough, and keeping almost entirely within the "warm area" of the Atlantic. The first station was located at lat. 51° 66′ N., long. 11° 21′ W., 120 fathoms, and successive stations at:—

Lat. 51° 46′ N., long. 12° 15′ W., 560 fms.	Lat. 55° 47′ N., long. 12° 28′ W., 1,561 fms.
,, 51° 34′ N. ,, 12° 30′ W., 725 ,,	,, 55° 47′ N. ,, 10° 12′ W., 1,325 ,,
,, 51° 0′ N. ,, 11° 32′ W., 375 ,,	,, 56° 11′ N. ,, 9° 50′ W., 875 ,,
,, 51° 0′ N. ,, 12° 0′ W., 980 ,,	,, 56° 37′ N. ,, 9° 48′ W., 912 ,,
,, 50° 56′ N. ,, 12° 6′ W., 1,000 ,,	,, 58° 24′ N. ,, 8° 30′ W., 110 ,,
,, 51° 30′ N. ,, 12° 0′ W., 600 ,,	,, 58° 45′ N. ,, 8° 35′ W., 342 ,,
,, 52° 0′ N. ,, 12° 0′ W., 255 ,,	,, 59° 18′ N. ,, 8° 30′ W., 841 ,,
,, 52° 30′ N. ,, 12° 0′ W., 130 ,,	,, 59° 54′ N. ,, 8° 42′ W., 720 ,,
,, 53° 0′ N. ,, 11° 56′ W., 100 ,,	,, 60° 29′ N. ,, 8° 30′ W., 194 ,,
,, 53° 30′ N. ,, 12° 0′ W., 150 ,,	,, 60° 41′ N. ,, 8° 50′ W., 75 ,,
,, 54° 0′ N. ,, 12° 0′ W., 205 ,,	,, 61° 1′ N. ,, 7° 42′ W., 475 ,,
,, 54° 30′ N. ,, 12° 0′ W., 1,608 ,,	,, 60° 0′ N. ,, 7° 47′ W., 547 ,,
,, 55° 0′ N. ,, 12° 0′ W., 1,577 ,,	,, 60° 1′ N. ,, 6° 4′ W., 580 ,,

During this cruise was used a new tow-net, devised by the writer and his skipper, Buchan Henry, which has already been exhibited by the writer at the "Challenger" Society, and which has been found to work with much greater certainty than either Garstang's net or Fowler's net. The former is too light for very deep-water work, and the latter has frequently been a source of annoyance, but the new net, partly owing to its superior weight and to the extreme neatness and accuracy of the workmanship (manufacturers, Messrs. Bullivant and Co.), was found to work with absolute certainty in the deepest water explored, viz. 1,200 fathoms, until one of the side springs gave way towards the end of the cruise. This was, however, soon replaced.

Altogether on these cruises 216 hauls have been made with closing nets from 0–1,200 fathoms, 125 vertical hauls, and 89 surface hauls, a total number of 430 hauls. The hydrographical observations made during 1903 have been entrusted to Mr. H. N. Dickson, and will be reported on in due course.

The Pelagic Copepoda collected between lat. 51° N. and 60° N. and long. 6° 4′ and 12° 30′, *i.e.* west of Valentia and the Faröe Banks, comprise 70 species; those collected in the Faröe Channel, *i.e.* the cold area, number about 50 species. These therefore give a very fairly complete list of the Copepoda which inhabit the area lying between 51° N. and 60° N., lat.

1. *Species occurring in the warm area of the Atlantic* (51°–60° N.).

Calanus finmarchicus (Gunner.).
„ tenuicornis (Dana).
Megacalanus (*nov. gen.*).
Eucalanus elongatus (Dana).
„ atlanticus (*nov. sp.*).
„ crassus (Giesb.).
Rhincalanus nasutus (Giesb.).
Paracalanus parvus (Claus).
Pseudocalanus elongatus (Boeck).
Spinocalanus abyssalis (Giesb.).
„ magnus (*nov. sp.*).
Calocalanus pavo (Dana).
Ctenocalanus vanus (Giesb.).
Ætideus tenuirostris (*nov. sp.*).
Bradyidius armatus (Giesb.).
Gaidius pungens (Giesb.).
„ major (*nov. sp.*).
Gaetanus armiger (Giesb.).
„ caudani (Canu).
„ major (*nov. sp.*).
Undeuchæta major (Giesb.).
„ minor (Giesb.).
Euchirella carinata (*nov. sp.*).
„ curticauda, var. Atlantica.
Euchæta norvegica (Boeck).
„ glacialis (Hansen).
Euchæta acuta (Giesb.).
Scolecithrix minor (Brady).
„ similis (*nov. sp.*).
„ atlanticus (*nov. sp.*).
Amallophora magna (Scott).
Lophothrix frontalis (Giesb.).
„ securifrons (*nov. sp.*).
Phaenna spinifera (Claus).
Xanthocalanus subagilis (*nov. sp.*).
„ atlanticus (*nov. sp.*).
„ cristatus (*nov. sp.*).
Pseudætideus armatus (*nov. sp.*).
Faroella multiserrata (*nov. gen. et sp.*).
Metridia lucens (Boeck).
„ Normani (Giesb.).
„ brevicauda (Giesb.).
Pleuromamma robusta (Dahl).
„ abdominalis (Lubbock).
Lucicutia grandis (*nov. sp.*).
„ flavicornis (Claus).
„ atlantica (*nov. sp.*).
Phyllopus bidentatus (Brady).
Haloptilus acutifrons (Giesb.).
„ longicornis (Claus).
Augaptilus magnus (*nov. sp.*).
„ gibbus (*nov. sp.*).

Augaptilus longicaudatus (Claus).
Heterorhabdus norvegicus (Boeck).
" longicornis (Giesb.).
" vipera (Giesb.).
" grandis (*nov. sp.*).
" abyssalis.
Anomalocera Patersoni (Templeton).
Ægisthus atlanticus (*nov. sp.*).
Ectinosoma atlantica (Brady and Robertson).
Acartia Clausii (Giesb.).
Candace norvegica (Boeck).
" rotunda (*nov. sp.*).
Oncea sp.
Oithona sp.
Longipedia coronata (Claus).
Paraugaptilus Buchani (*nov. gen. et sp.*).

2. *Species occurring in the Faröe Channel, cold area.*

Calanus finmarchicus.
" hyperboreus.
Eucalanus elongatus.
" atlanticus.
" crassus.
Paracalanus parvus.
Ctenocalanus vanus.
Rhincalanus nasutus.
Bradyidius armatus.
Bryaxis brevicornis.
Gaidius pungens.
" major.
Gaetanus major.
Chiridius obtusifrons.
" Vanhöffeni.
Pseudætideus armatus.
Faroella multiserrata.
Ætideus tenuirostris.
Scolecithrix minor.
" similis.
Heterorhabdus norvegicus.
" longicornis.
Augaptilus zetesios.
Euchæta norvegica.
" glacialis.
Euchæta barbata.
Pleuromamma robusta.
" abdominalis.
" abyssalis.
Lucicutia flavicornis.
" magna.
Phaenna spinifera.
Haloptilus longicornis.
Euchirella carinata.
" rostrata.
Metridia lucens.
" longa.
Ægisthus atlanticus.
Candace pectinata.
Temora longicornis.
Centropages hamatus.
" typicus.
Acartia Clausii.
" longiremis.
" discaudata.
Anomalocera Patersoni.
Oncea sp.
Oithona sp.
Tetragoniceps sp.

A BRIEF DESCRIPTION OF THE NEW GENERA AND SPECIES.*

1. *Megacalanus princeps* (*nov. gen. et sp.*). A huge Copepod was twice taken in the deep water of the Atlantic area, measuring 10 mm. in length, and externally much resembling a *Calanus*, but differing absolutely in the fact of the last segment of the exopodite of the second, third, and fourth pairs of feet having three marginal spines as well as the terminal saw. The inner margins of the fifth pair have neither denticulations nor hairs. The head is separate from the first segment, and the last two thoracic segments are also separate, the posterior one produced laterally into wing-like ex-

* A full description, with figures of the Copepoda mentioned here, is reserved for a larger work which the writer has had in preparation for the past two years.

pansions like *C. hyperboreus*. The anterior antennæ of twenty-five joints are much longer than the whole body. The first pair of feet have an extraordinary double-hooked process on the dorsal surface of the second basal joint, an upper and lower hook placed vertically, the latter very strong and prominent. (Pl. IX., figs. 1 and 2.) The structure of the mouth organs is very similar to *Calanus*. In both cases it was an adult female, with well-developed symmetrical genital segment. The only described Copepod at all resembling it is the *C. princeps* of Brady (*Challenger Report*, "Copepoda"), in which the feet are very similar, but there are no such setæ on the anterior foot-jaws as Brady figures, the maxilla is totally different as regards its bristles, and the segmentation of the anterior antennæ and abdomen is also different. It is therefore certainly not Brady's species. The latter cannot be a *Calanus*, as is evident from the presence of three external spines on the last segment of the exopodite of the swimming feet.

2. *Eucalanus atlanticus* (*nov. sp.*). In the course of dissecting many examples of the well-known *E. elongatus* ♂, I have come across a good many specimens which to all outward appearance resemble *E. elongatus*, except that the larger furcal segment, and longest tail seta, are on the left side instead of the right side (Giesbrecht had already noted the irregularity in this respect of the females). But together with this condition *the oral organs are not retrograded*, as in the ♂ *elongatus*, and resemble entirely those of the female. The exopodite of the posterior antenna is longer; the first joint of the endopodite is not twice as long as the second joint, and is only two and a half times as long as broad; the mandible palp is longer (three times as long as broad), and divided by the origin of the exopodite into two nearly equal parts, and a normal masticatory plate is retained with the usual teeth. (Plate IX., fig. 4.) In the maxilla all the inner lobes are retained as in the ♀, while in *E. elongatus* ♂ they have disappeared. The anterior and posterior foot-jaws are also normal as in the ♀. The left fifth foot is only a little longer than the right, the first segment of the exopodite of each foot has a short marginal bristle, the last joint of the left side two distal bristles, the right foot three distal bristles. (Pl. IX., fig. 3.) In size (4·45 mm. to 4·50 mm.) the animal is equal to the adult ♂ of *E. elongatus*.

In various species of *Ætidiinæ*, while in the last adult stage many males possess fully developed fifth feet together with retrograded oral organs, the stage antecedent to the last is one in which the fifth feet are imperfectly developed, while the oral organs are retained as in the female. This I have proved to be the case in many instances, and the fact accounts for many discrepancies of authors in the description of males with immature fifth feet. I do not know, however, if the peculiarity exists outside of the family *Ætidiinæ* and extends to the *Eucalanidæ*. Meanwhile, until this is proved to be the case, in which instance the ♂ described above would be only the ♂ of *E. elongatus* in the last stage but one, I prefer to regard it as a new species.

3. *Gaetanus major* (*sp. nov.*). This has been referred to by the writer in *Proc. Zool. Soc.*, February 3rd, 1903.* It has much resemblance to *G. armiger* (Gbt.), but is much larger, reaching a size of over 5 mm.; the anterior antennæ are as long, or longer than the body; the lamellar appendage of the posterior foot-jaw is absent, and the exopodites of the first pair of feet are distinctly three-segmented.

The ♂ 4·65 mm. long; cephalic spine short; spines of last thoracic segment short; abdomen of five segments; anterior antennæ twenty-two-jointed (24–25, 8–9, 1–2), nineteenth joint long; oral organs much retrograded; fifth feet very like those of *Gaidius major* ♂. The dorsal spine of the head at once distinguishes it as a *Gaetanus*. (Pl. IX., figs. 7 and 8.)

4. *Gaetanus caudani* (Canu,? *vel nov.*). A *Gaetanus* somewhat resembling *G. miles* (Gbt.), but the anterior antenna only one and a half times as long as the body; the lamella of the posterior foot-jaw, as in *G. miles*, not different, as stated by Canu, and the exopodites of the first feet distinctly two-jointed (not three, as in Canu's species); the basal of the fourth feet, like *G. armiger*, *i.e.* with tubal bristles, and not with spines, as in *G. miles* (Gbt.). (Pl. IX., figs. 20, 21, and 22).

This may be identical with Canu's *sp. G. caudani* (*Ann. Univ. Lyon*, v. 26), but if so, the species is subject to variation. His description referred only to a young ♂. My specimens, of which there are several, are adult females of a size of 5 mm. and over.

5. *Gaidius major*† (Wolfenden). A large *Gaidius*, 4·65 mm. long (and over), more robust than *G. pungens* (Gbt.), with longer anterior antennæ, shorter spines of the last thoracic segment, three-jointed exopodites of the first feet, and endopodites of the second feet clearly of two joints. It is identical probably with the *Chiridius brevispinus* of Sars, and his *Ch. tenuispinus* is almost identical with Giesbrecht's species *G. pungens*, with which the writer carefully compared it at Naples in April, 1902.‡ Neither of Sars' species is a *Chiridius*.

The ♂ averages 3·1 mm. long; the head is united with the first segment, there is a one-pointed rostrum; the spines of the last segment are slender; the abdomen, of five segments, only little more than a third of the length of the cephalothorax; anterior antennæ shorter than the thorax, and of twenty-two segments, with long nineteenth

* "The Plankton of the Faröe Channel," No. VIII., G. Herbert Fowler. (*Proceed. Zool. Soc.*, 1903.) † *Ibid.* ‡ Subsequently referred to.

joint; the oral parts are retrograded; the first to fourth feet as in the female, the fifth pair rather like *Pseudætideus armatus* ♂, each of two basal joints, and a two-jointed exopodite, right foot the largest, with last segment a curved thin joint ending in recurved spiny process, last joint of the left exopodite spatulate; rudimentary endopodites on each side, the left simple, long, thin, the right short and club-shaped. (Pl. IX., figs. 7 and 8.)

6. *Pseudætideus armatus* * (*nov. gen. et sp.*). Resembling *Ætideus* in many features. Strongly bifurcate rostrum in both sexes, last thoracic segments united and produced into short spines. Cephalothorax three times as long as the abdomen; second basal of the posterior foot-jaw three times as long as the endopodite; endopodite of second feet two-jointed; simple hairs on the margins of the basals of the fourth feet; anterior antennæ in the ♀ twenty-three-jointed (8–9, 24–25); mandibles with exopodite twice as long as endopodite; posterior antennæ with both rami nearly equal. ♂ with rostrum; anterior antennæ twenty-two-jointed; oral parts retrograded; a pair of fifth feet, the right foot ending in a curved, spine-like process, the left foot shorter, with broad-haired terminal segment; rudimentary endopodite on each side. Size, ♀ 3·68 mm.; ♂ a little less. (Pl. IX., figs. 29, 30, and 31.)

This Copepod is identical with Sars' *Chiridius armatus* † and Boeck's *Euchæta armata*. It is, however, neither a *Chiridius* nor a *Euchæta*, and from its general resemblance to *Ætideus* I have named the genus *Pseudætideus* and the species *armatus*.

7. *Euchirella carinata* (Wolfenden). I have previously referred to the ♂ of this species found by me in the Faröe Channel (this Journal, vol. vi., p. 366, January, 1902). I have since found adult females in the Atlantic, which confirm the correctness of the previous diagnosis. The female is distinguished by the presence of a median cephalic crest and helmet, a short, strong, one-pointed rostrum, in the proportions of the posterior antennæ (endopodite about half as long as the exopodite and with 8 + 6 bristles on the second joint), and the absence of any spinulation of the basals of the fourth feet. In size, 5 mm. (cephalothorax nearly five times as long as the abdomen), this is one of the largest *Euchirellas*. The bristles of the maxilla are, second basal = 5, endopodite = 15.

* Subsequently referred to.

† The genus *Chiridius*, described by Sars (*Crustacea of Norway*), contains only one true Chiridius, viz. *Ch. obtusifrons*. His *Ch. tenuispinus* and *brevispinus* are true *Gaidius* (Giesbrecht), and his *Ch. armatus* a new genus *Pseudætideus*. The modified bristles, large and almost like tubal processes, of the fourth pair of feet, so characteristic of the genus *Gaidius*, are found in the *G. major* and *pungens* (*Ch. brevispinus* and *tenuispinus*, Sars) in all my examples and in those kindly sent to me in April, 1902, by Professor Sars, to whom I then pointed out the nature of his species.

The endopodite of the posterior foot-jaw is only one-third as long as the second basal, which again is very much longer than the first basal (proportions 11 : 19 : 6). The anterior antennæ are a little longer than the thorax, with the twenty-fifth joint partially divided from the twenty-fourth (eighth coalesced with ninth), and the head is separated by a dorsal line from the first thoracic segment. This Copepod is entirely different from *E. pulchra*, *galatea*, or *curticauda*, especially in the proportions and number of bristles of the posterior antennæ, and the absence of any spines on the first basal of the fourth feet. It occurred at a depth of 400 fathoms, lat. 55° 47′ N., and also in the Faröe Channel.

7*a*. *Euchirella curticauda*, *var. Atlantica*. Head with strong crest and helmet, but no rostrum; genital segment very protuberant, and abdomen very short (about one-sixth the length of the cephalothorax); endopodite of posterior foot-jaw only one-half the length of the second basal, the three joints proportionate respectively 10 : 13 : 6; posterior antennæ with very slender endopodite, only one-quarter the length of the exopodite, and end joint of the former with only 3 + 2 bristles; head separate from the first thoracic segment; maxilla with bristles of second basal and endopodite much reduced (= 6). The basals of the fourth feet have only six rather broad-based and long spines, instead of twelve to thirteen, as in *E. curticauda* (Gbt.), and also they differ in some minor particulars. The latter is also a Pacific Ocean species, the Atlantic variety being a little larger (3·80 mm.) than the Pacific. The Atlantic form is a distinct variety if not a true species, and the widely different habitats suggest specific differences. In the warm area of the Atlantic, lat. 54° 30′ N., it occurred at 300 fathoms. Probably the *E. curticauda* of the "Oceana" collections (nine stations from 809–1,710 fathoms) is this, or the previous species.

8. *Ætideus tenuirostris* (*nov. sp.*). It is certain that the *Ætideus armatus* of the Faröe Channel and North Atlantic is not identical with that described by Giesbrecht from the Mediterranean, with which I have compared it at Naples. The former has a much less pronounced dorsal cephalic curve; the rostrum is not nearly so strong or so greatly produced, nor does it possess (as Sars has pointed out already) any secondary knobs of chitin at the base of the rostral processes as in the Mediterranean species. In addition the spines of the last thoracic segment are not so long or strong, and the endopodite of the second pair of feet is biarticulate. It therefore seems desirable to distinguish it as a distinct species. Brady's Indian Ocean species (*Chall. Report*) has not again been met with. I do not find any *Ætideus* in Mr.

Gardiner's Maldive collection, nor does Scott mention its occurrence in Professor Herdman's collection of Ceylon Copepoda.

9. *Faroella multiserrata* (*nov. gen. et sp.*).* Slender two-pointed rostrum; head fused with first segment, but last two segments of the thorax more or less completely divided, the posterior segment with long lateral spines. Anterior antennæ with eighth and ninth joints fused, but the twenty-fourth distinctly separate from the twenty-fifth. Mandibles with exopodite shorter than the endopodite; posterior foot-jaws with endopodites not more than half the length of the exopodites; first feet with one-jointed endopodites, second pair two-jointed, the terminal saws of the feet distinguished by an extraordinary number of fine and closely-set teeth (69–70). Size of the ♀ 3·54 mm. and over, the ♂ about the same. (Pl. IX., figs. 26, 27, 28.)

It is not uncommon in the deep water of the Faröe Channel, and has been traced by the writer as far south as Valentia in Ireland.

10. *Chiridius Vanhöffeni* (*nov. sp.*). One example only of a ♂, which I think to be identical with the *Pseudocalanus armatus* described by Vanhöffen (*Grönland Exped.*, 1891, II. Bd., Berlin, 1897), was taken in the Faröe Channel. Length 3·1 mm.; head without rostrum, and last thoracic segment produced into short spines; anterior antennæ of twenty-three joints; posterior antennæ with the outer ramus twice as long as the inner; mandibles with endopodite only half the length of the exopodite, the masticatory plate wanting; anterior foot-jaw almost obsolete, the posterior foot-jaw with the endopodite more than half the length of the second basal; maxilla retrograded, inner lobes nearly obsolete, exopodite large and with ten bristles; first pair of feet with one-jointed endopodite, second pair with two-jointed endopodite; fifth pair of one ramus on each side, each of five segments, the right foot the longest; two short basal and three slender terminal joints, the last ending in a delicate curved stylet process; the left foot with larger basal joints, of the three distal the proximal the largest, the distal short, spatulate, and haired on the inner margin. (Pl. IX., fig. 3.)

In the different segmentation of the feet and in other particulars this Copepod differs from *Ch. obtusifrons*, of which it might be the hitherto unknown ♂. It is certainly not a *Pseudocalanus*, and though there must always be hesitation about giving an unknown ♂ specific rank, it does not agree with any genus except *Chiridius*, and provisionally, at any rate, must be distinguished from other species.

* This is probably identical with the species described by Sars as *Ætidiopsis*. His description is, however, rather meagre, and as the writer's descriptions and lithographed plates were prepared for publication two years ago, but have been held over for completion of his monograph, he retains the name originally given to this genus and species.

11. *Candacia rotunda* (*nov. sp.*). This is distinguished from all other *Candace* species by the fact that the last thoracic segment is rounded on each side instead of being produced into points; the proximal part of the anterior antennæ is of seven joints, the last joint (twenty-fourth) nearly as long as the two preceding joints; the two middle hooks of the anterior foot-jaw of the same length, but shorter than the two end claw bristles. The maxilla, with the second inner lobe, second basal, and endopodite, of about equal length; the third feet with the last exopodite segment denticulated and short end spine slightly bent; fifth feet of three joints, terminal the longest, with three outer short marginal spines, and one inner apical spine long. (Pl. IX., figs. 10, 11.) Size of female, 3·2 mm. This is a deep-water species, taken in 300 fathoms in the North Atlantic.

12. *Spinocalanus magnus* (*nov. sp.*). Head partially separate from the first segment; genital segment as large as the next two; furcal segments a little longer than the anal; last thoracic segment produced on each side; exopodite of first feet with four inner marginal bristles on the last segment; exopodites of second to fourth pairs with five bristles on the last segment; no fifth feet; joints of the feet very spinulose; anterior antennæ of twenty-four segments, the eighth and ninth fused, the twenty-fourth separate from the twenty-fifth. The characters of the feet clearly distinguish this species as a *Spinocalanus*, of which it is the largest known species, attaining a size of 2·75 mm. in the ♀. It was very common in deep water in the Atlantic off the west coast of Ireland.

13. *Xanthocalanus subagilis* (*nov. sp.*). Several examples of a Xanthocalanus, taken off the Mull of Galloway by scraping the sandy bottom, resembled *X. agilis* very closely, but the fifth feet of the ♀ differed in length and proportions of the segments and of the three terminal spines from Giesbrecht's species, and the ♂ possessed a pair of fifth feet instead of only one as in the Mediterranean species. The right foot of four segments is only a little longer than the left of five segments and a terminal stylet process. The exopodite of the female maxilla has only nine bristles; the endopodite of the anterior foot-jaw has six or seven brush sensory processes and two vermiform processes. A brush process also exists on the first basal of the posterior foot-jaw. The fifth foot of the female has the basal joint the longest and broadest, the margin beset with strong teeth, the second joint with a bunch of hairs at the distal margin, the last joint spinulose on the surface, longer than broad, and the inner marginal spine the largest of the three. ♀ 2·6 mm., ♂ 2·3 mm. The abdomen is not at all setose, as in Giesbrecht's species. (Pl. IX., figs. 17, 32.)

14. *Xanthocalanus atlanticus* (*nov. sp.*). Differs from *X. agilis* and *borealis* in the characters of the anterior antennæ: very thick basally, tapered distally, and much shorter than the cephalothorax. The first joint of the fifth feet in the ♀ broader than long, with the inner margin armed with closely set spines, the second joint short, the third joint twice as long as broad, with short strong spines marginally, and distally with four broad-based long spines, the inner the longest, the surfaces of all three segments covered with short spines. Size 2·50 mm Taken on a sandy bottom, at 375 fathoms west of Valentia. Distinguished from *X. agilis* and *borealis* by the very short anterior antennæ, the fifth feet, and other minor characters. The swimming feet have the segments densely covered with short spines. (Pl. IX., figs. 24, 25, 33.)

15. *Xanthocalanus cristatus* (*nov. sp.*). ♀ very large, 5·0 mm.; head triangular and with prominent crest; anterior antennæ extending to the end of the furca; anterior foot-jaw with very strong curved hook on the fifth lobe, endopodite of the same with seven short thick brush processes and a long thin curved vermiform process; posterior foot-jaw with brush sensory process on first basal. Feet as in *Xanthocalanus*, but fifth pair each of three joints, the first as broad as long, the second longer than broad, the third two and a half times as long as broad, all densely spinulose, with long and short spines intermixed on the surfaces, the last segment with a row of long stout spines on the external surface, and ending distally in two short, rather stout, spiny processes (not articulating spines, as in other species), the innermost a little longer than the outer, and a third similarly formed outer spiny process. (Pl. IX., figs. 18, 19.)

No other *Xanthocalanus* has a crest. Sheaf-like sensory processes as in *Amallophora* are absent; the segmentation of the feet and of the anterior antennæ, the spinulation of the feet, the separation of the head from the first segment indicate it clearly to be a *Xanthocalanus*. Taken off the west of Ireland at a depth of 300 fathoms.

16. *Scolecithrix similis* (*nov. sp.*). Much resembling *S. minor*, but the head rounded and oval, the last thoracic segment rounded with rounded flap-like projections; fifth feet one-jointed, twice as long as broad, with very short inner marginal spine inside the apex, and longer spine arising from just below the middle of the inner margin, not as long as the distance between its origin and the apex of the segment. The different shape of the head and corners of the last thoracic segment, and the fifth feet, at once distinguish it from *S. minor*. (Pl. IX., fig. 5, 6.) Size 1·50 mm. Several examples have been taken in the Faröe Channel and the Atlantic.

17. *Scolecithrix atlanticus* (*nov. sp.*). ♀ very large, 3·95 mm. long. Anterior antennæ twenty-three-jointed and longer than the whole body; rami of posterior antennæ nearly equal; sensory processes of the anterior foot-jaw both brush and vermiform, a brush process on the posterior foot-jaw; fifth pair of feet of two segments, distal the longest, with rounded extremity, and one short stout bristle at the apex, and a thick bristle twice as long arising from the inner margin. Feet like *Scolecithrix*. There may be doubt whether this species should be considered a *Scolecithrix* or a *Xanthocalanus;* the twenty-three-jointed antennæ and coalesced head and first segment are more characteristic of the former genus. It is a very large species, and was taken in 300 fathoms depth off the west coast of Ireland.

18. *Lophothrix securifrons* (*nov. sp.*). Head with a strong crest, and strongly pointed wing-like expansions of the last thoracic segment; very short abdomen, with large genital segment, with a downward projecting process in front and strong bunches of lateral hairs. Helmet-shaped appendage of head produced anteriorly into a thick rostrum, each ramus ending in a short point. Amalliform (sheaf-like) sensory processes on the anterior foot-jaw, and a similar process on the posterior foot-jaw. Anterior antennæ of twenty-four segments reaching the end of the furca. (Pl. IX., figs. 12, 13, 14, 15.) The animal closely resembles the *Scolecithrix securifrons* described by Scott (*Trans. Linn. Soc.*), but differs in the segmentation of the anterior antennæ and in the possession of amalliform sensory processes apparently absent in Scott's species. Size of ♀ 4·2 mm. Occurred in the warm area of the north Atlantic.

NOTE.—The sub-family *Scolecithrichina* is conveniently subdivided into the genera *Scolecithrix*, *Amallophora*, and *Lophothrix*. The characters distinguishing each are as follows:—

1. *Scolecithrix*. Head usually without crest (only in *S. securifrons*, Scott); anterior antennæ nineteen to twenty-four jointed; sensory processes of anterior and posterior foot-jaws of one kind only (vermiform); fifth feet generally present in the ♀ but always small and of one to three segments; type species *S. minor* (Brady) and *S. danae* (Brady).

2. *Amallophora* (Scott). Head with crest and helmet-shaped projection; no epistome; anterior antennæ of twenty-two joints; foot-jaws with three kinds of sensory appendages, amallæ, brush processes, and vermiform; maxilla with seven bristles on the exopodite, nine on the endopodite, second basal with four only; fifth feet of two or three segments, with very long inner bristle; type species *Amallophora magna* (Scott).

3. *Lophothrix* (Giesb.). Head with a crest and helmet appendage, produced into rostrum ending in short spines and not filaments; anterior antennæ twenty-four-jointed; maxilla with five bristles on the second basal, eight on the endopodite, nine on the exopodite; sensory processss of the foot-jaws amallæ and vermiform; fifth feet of two or three segments with one to three terminal spines apical and inner, usually strong epistomal projection; type species *L. frontalis* (Giesb.). (Pl. IX., figs. 41, 42.)

19. *Heterorhabdus grandis* (*nov. sp.*) (?). The largest known species of *Heterorhabdus*, attaining a size of 6·60 mm. in length; the anterior

antennæ longer than the whole body; the mandibles without long curved teeth; posterior foot-jaw without the long spine; the fifth feet of the ♀ with two stout spines on the surface of the second joint of the exopodite, in the same position as the spines of the same segment in *H. longicornis* (Gbt.). (Pl. IX., fig. 36.) This may possibly be the same species as the *H. major* of Dahl, of which, however, no description has been published. Only two specimens were captured in deep water in the Atlantic off the west coast of Ireland.

20. *Lucicutia grandis* (*nov. sp.*) (?). A ♀ 6·5 mm. long, the largest known species of *Lucicutia* from the deep water of the Atlantic; the anterior antennæ about four joints longer than the whole body; the genital segment asymmetrical; the first pair of feet with tubular process on the first basal; all the swimming feet, including the fifth pair, with three-jointed exopodites and endopodites. (Pl. IX., figs. 37, 38.) Very pigmented, with deep orange pigment about the mouth, and all organs of the mouth and the feet coloured a shade of burnt sienna. This may be the ♀ of the species described by Giesbrecht from the Pacific, *L. grandis*, of which, however, he only knew the ♂ (6 mm. long).

21. *Lucicutia magna* (Wolfenden). A single specimen, a ♂ 3·54 mm. long, was found by me in Fowler's Collection from the Faröe Channel. Anterior antennæ longer by one and a half joints than the whole body; the endopodites of the first feet two-jointed; the right fifth foot with a strong spiny process on the inner side of the second basal, and an exopodite of two segments; the rami of the left foot each of three segments. (Pl. IX., fig. 35, 35*a*.)

21*a*. *Lucicutia atlantica* (*nov. sp.*). ♀ 3·5 mm. long (cephalothorax 2·1, abdomen 1·4 mm.). Head separate from first segment, last two segments fused, and as long as the two preceding. Furcal segments nearly five times as long as broad and as long as the two last abdominal segments. Anterior antennæ longer than the whole body by four segments; rami of the posterior antennæ about equal; the basals and endopodite of the posterior foot-jaws about equal lengths; maxilla resembling *L. flavicornis*, but exopodite larger. First feet with endopodite clearly only two-jointed, the second basal with a marginal tubular process. Second feet with the end saw only one-third of the length of the exopodite last joint. Fifth feet with the end spine only one-half the length of the last exopodite segment, the margin not crenated as in *L. flavicornis*, the inner marginal thick bristle rather long (nearly two-thirds as long as the last joint of the exopodite) slightly serrated at the distal end. The only *Lucicutias* with a two-jointed endopodite of the first foot are *L. Clausi* and *longiserrata*. The shape of the head alone distinguishes this species from the former, the size and proportions of the saws of the feet from the latter. One example only occurred at a depth of 400 fathoms at station 55° 47′ N. It may perhaps be the ♀ of *L. magna*, but is better described, provisionally at least, as a new species.

22. *Augaptilus zetesios*, Wolfenden. A ♀ which has already been described in this Journal (January, 1902).

23. *Augaptilus magnus* (*nov. sp.*). ♀ 7 mm. long and over. Anterior antennæ reaching to the end of furca; genital segment larger than the rest of the abdomen; second abdominal segment as long, or a little longer, than the anal segment; furcal segments very short; mandible two-branched; maxilla with seven strong hooks, outer lobe with five, exopodite with only two, second inner lobe with one long hook bristle; both basal joints of the posterior foot-jaw of similar length; endopodite much shorter. Branches of the posterior antenna subequal. Rami of the fifth feet three-segmented.

It has most general resemblance to *A. megalurus* (Gbt.), a Pacific Ocean form, while the furcal segments and shape of the abdomen somewhat resemble *A. filigerus*, but it is nearly twice the size of the latter, and differs in the anatomy of the anterior and posterior antennæ, maxilla, etc. It is a purely deep-water form, found only in the warm area of the Atlantic.

24. *Augaptilus gibbus* (*nov. sp.*). The back of the head has a remarkably gibbous swelling. The anterior antennæ are not quite as long as the whole animal. The exopodite of the posterior antenna is not half the length of the endopodite; mandible with two-branched palp; basals and endopodite of posterior foot-jaw equal in length; genital segment longer than the rest of the abdomen; anal longer than the second, and furcal longer than the anal segment; maxilla with outer lobe with three, inner first lobe with six hooks; exopodite with four bristles. Size, 2·75 mm.

25. *Pseudocyclopia Giesbrechti*, Wolfenden. This was described in this Journal (January, 1902).

26. *Ægisthus atlanticus*, Wolfenden. Mentioned in this Journal (January, 1902).

This striking and beautiful little Copepod bears a very close resemblance to *Ægisthus mucronatus* (Gbt.), but differs in the following points: there is no spine on the third segment of the anterior antennæ; there is a long sensory process on the last joint resembling the sensory process on the third segment (this is the only one present in *Ægisth. mucron.*); the first feet are clearly three-segmented (two-segmented in *Ægisth. muc.*); the terminal lance bristle of the fifth foot is only about half the length of the foot, and this foot is very clearly three-segmented (in *Æg. mucron.* one-segmented).

On these grounds I hesitate to regard it as identical with Giesbrecht's species. One specimen was taken in the Faröe Channel (Fowler's Collection), and a second was captured in lat. 50° 56′ at 300 fathoms in June, 1903. Giesbrecht's species was a Pacific Ocean one. The *Æg. mucronatus* recorded from eight stations of the *Oceana* given by J. C. Thompson is probably identical with my species.

26*a*. *Paraugaptilus Buchani* (*nov. gen. et sp.*). ♀ 3·25 mm. long (cephalothorax 2·55, abdomen 0·7). The head very much narrowed in front and general shape like an *Augaptilus;* two slender rostral filaments very divergent; the abdomen of four distinct segments, the genital very protuberant ventrally and twice as long as the next, which with the middle and anal segment are each of the same size (Pl. IX., fig. 44); the furcal segments not quite twice as long as broad, each with four tail setæ (the longest about as long as the abdomen) and a short dorsal accessory bristle; the last thoracic segment on each side dorsally ends in a short stumpy spine; anterior antennæ of twenty-one joints, the first and second comparatively long, the next nine very short and compressed, the eleventh partly divided from the twelfth, the twentieth from the twenty-first; the left antenna is a little longer than the right, neither of them as long as the whole body; the posterior antenna has the endopodite about twice as long as the exopodite; the mandible is one-branched only, the masticatory plate like *Arietellus;* the maxilla has the inner lobes much reduced, the second basal and endopodite fused with only three distal bristles, the first inner lobes with five, and exopodite short with two bristles; the anterior foot-jaw is very like that of *Arietellus* divided into three segments, the first two with small lobes and short bristles, the endopodite short and with very long bristles (eight) provided with augaptiloid cups; posterior foot-jaws with the endopodite as long as the second basal, its segments, five in number, progressively diminishing in size, the first two large; many of its bristles have the augaptiloid cups; the first four pairs of feet have endopodites and exopodites of three segments each; the fifth feet are peculiar, consisting only of a foliaceous plate on each side, imperfectly segmented into two, and carrying each one long marginal and a longer apical bristle. (Pl. IX., fig. 45.)

The animal is an adult with well-formed genital segment; the four-jointed abdomen removes it from the genus *Augaptilus;* the shape is augaptiloid and not like *Arietellus,* and the fifth feet are quite peculiar. It seems to partake of some of the characters of each of these genera, but cannot, I think, be referred to either; I attach to it the name of my sailing master, to whose constant labour in the management of instruments I owe a great deal.

In addition to the before described new species the following are new:—

27. *Heterorhabdus longicornis* (Giesb.) ♂. This was described by me in this Journal (vol. vi., 1902) under the name of *H. zetesios*. Since that time I have taken many specimens in the Faröe Channel and the Atlantic, and have come to the conclusion that it is the ♂ of *H. longicornis*, the ♀ of which is of common occurrence in the north Atlantic, and occurs not infrequently in the Faröe Channel. The anterior antennæ are longer than the whole body by four joints, the left a clasping organ of six segments beyond the geniculation; the left furcal segment is much longer and broader than the right. The anterior foot-jaw has one thick hooked bristle on the fifth lobe, but no toothcomb bristles, and the fifth feet have on the right side an upright and stiff process of the second basal armed with stiff bristles on the inner margin, and the proximal inner margin of the first joint of the exopodite with a protuberance armed with four teeth, and a second smaller protuberance above with a bunch of short hairs. The second basal joint of the foot of the opposite side is armed with short, stiff bristles, the end joint of the exopodite produced into a long curved spine with a shorter marginal spine on the inner side. (Pl. IX., fig. 34.) The mandibles with three teeth on the left side, four teeth on the right masticatory plate.

In the report by I. C. Thompson upon the "Oceana" Copepoda * is figured on Plate VI. a pair of fifth feet of *Metridia venusta*, which are unlike any known *Metridia* feet, and resemble those of *Heterorhabdus longicornis* ♂. The general appearance of the whole animal and the description in the letterpress probably refer to a *Heterorhabdus*, which the writer had wrongly thought to be a *Metridia*.

28. *Phyllopus bidentatus* (Brady). The female of this species is of not uncommon occurrence in the Atlantic west of Ireland. It has been fully described by Giesbrecht. But much uncertainty has existed about the ♂. Brady's example was undoubtedly a male. The ♂ is 2·25 mm. in length, and closely resembles the ♀ except in the structure of the anterior antennæ and fifth pair of feet. The margins of the last thoracic segment are not in any specimens produced like the figures of Brady (*Chall. Rep.*, "Copepoda"). The abdomen is of five segments, which, with the furcal segments, are of about equal length. The left anterior antenna is of twenty joints, and between the seventeenth and eighteenth is a geniculating joint. Æsthetasks are numerous,

* *Ann. and Mag. Nat. Hist.*, vol. xii. Pl. VI.

and paired at the basal joints. The fifth feet have each a two-jointed basopodite and three-jointed exopodite; the foot of the right side has a rudimentary endopodite, broad and without spines. The second exopodite segment carries two distal hooks; the foot of the other side has a much simpler exopodite, the last joint long and broad distally, without spines. The second basopodite of each side has a long, thin, feathered bristle. (Pl. IX., fig. 16.) The *Phyllopus bidentatus*, figured by I. C. Thompson,* is certainly not identical with my species, if the former is correctly drawn. My Atlantic specimens are, I think, without a doubt the ♂ of the species described by Giesbrecht; and the females captured at the same time by me agree entirely with the description and figures of the last-named authority, and not with Brady's. The "bidentate process" does not exist in the Atlantic specimens, and as I have minutely examined quite a dozen, it is not likely that it has been broken off in all of them.

29. *Ctenocalanus vanus* ♂ (*nov.*). On two occasions, once in the Faröe Channel and once in the Atlantic, off the west coast of Ireland, this Copepod has been taken, the ♀ only (described by Giesbrecht) of which is known.

The ♂ is 1·25 mm. long; the anterior antennæ of twenty-one joints, the posterior antennæ, with the exopodite, nearly twice as long as the endopodite; the exopodite of the mandible longer than the endopodite, a chitinous remnant of a masticatory plate remaining, but without teeth; anterior foot-jaws retrograded, posterior foot-jaws with the two basal joints of about the same length, the endopodite longer than either; first feet with a one-jointed endopodite, second pair with a two-jointed endopodite, the marginal spines especially of the fourth pair modified, as Giesbrecht has described as characteristic of the species, having peculiarly crenated edges; fifth feet, one long (left) foot of five segments, basal two joints largest and broadest, the distal three joints small, the end one spatulate with bundles of short, stiff bristles on the inner margin; the right side carries a very short stump only, representing the foot. (Pl. IX., fig. 9.)

30. *Metridia Normani* ♀ (*nov.*). The ♂ only of this species has been described by Giesbrecht; the ♀ has hitherto remained unknown. It is of common occurrence in the Atlantic, west of Ireland.

Length of the ♀ 2·5 mm.; anterior antennæ of twenty-five joints, a little longer than the whole body, the first, second, and third with prominent but not recurved spines on the upper margin, that of the third segment the longest, the fifth and sixth segments with shorter spines; both second feet with the usual notch and hook; fifth pair

* *Ann. and Mag. Nat. Hist.*, vol. xii. Pl. III.

of feet, the left longer than the right, of three segments, with three apical bristles, of which the middle is the longest, and a long outer marginal bristle on the second segment; right foot smaller, indistinctly three-segmented, with only two apical bristles of similar length. (Pl. IX., figs. 39, 40.)

The genital segment is not so long as the next two; the furca is longer than the anal, nearly four times as long as broad, and asymmetrical, that of the right side shorter than the left. This Copepod was frequently found in company with undoubted ♂ examples of *Met. Normani.*

Dichotomous branching of tail setæ. A curious condition was first observed by me in many instances amongst the Copepoda (referred to me by my friend Mr. Stanley Gardiner) from the Maldive Islands of the Indian Ocean. This consisted of a branching and sub-branching of the setæ of the tail, an attempt at dichotomous division, so that in many instances the whole of the tail setæ were converted into a sort of brush. I had never observed this in any Copepoda from our more northern regions, and looked upon it as a condition probably peculiar to the Copepoda of the Maldive region; but I have lately observed exactly the same in two examples from the Atlantic taken west of Valentia, in Ireland, viz. once in *Undeuchæta major* and once in *Euchæta norvegica.* In the Maldive seas it has occurred with great frequency in *Calanus vulgaris,* and also in *Calocalanus, Paracalanus aculeatus, Scolecithrix Danæ, Euchirella bella.* It will be observed that it is always in the *Amphaskandria* that this condition occurs. In the Maldive Collection it is of such frequent occurrence that it suggests a special variety in each instance. What the precise significance may be I do not know, possibly a device to assist flotation, but it is curious that it should occur also in examples from the North Atlantic. The dichotomous branching is very irregular, sometimes of one seta only, or two, or all the setæ of one side only, or of both sides.

Remarks on the Horizontal Distribution of the Copepoda.

Calanus finmarchicus. Sars (*Crustacea of Norway*) has recently endeavoured to distinguish the Northern and Polar form under the name of *C. finmarchicus* from a southern form *C. helgolandicus,* basing his opinion upon the size, length of the antennæ, shape of the head, and structure of the fifth feet. I have very carefully compared examples from Thorshaven, the cold area of the Faröe Channel, the warm area of the Atlantic, and the English Channel, and I am of opinion that the factors upon which Sars bases this distinction are too inconstant to admit such a separation into specific forms. Examples from the southern waters are met with in which the shape of the head and the size of the animal, length of antennæ, etc., are in no wise different from the northern species. The structure of the fifth feet of the ♂ is known to vary very considerably, as Giesbrecht long ago pointed out for examples from Hong Kong. Even in Faröe examples (and those from more southerly latitudes) this is also the case, and the fact is that the species is very variable. Being also the most prolific Copepod known, at any rate in northern waters, and constantly present in various stages of development, is it not more natural to regard these variations as only different stages of growth? At any rate, the very careful measurements and study which I have made of this Copepod between the lat. 51°–62° N. convince me that the points stated by Sars are not sufficiently reliable to justify such a differentiation of the species. The horizontal distribution of this Copepod is known to be very wide. In the Faröe Channel it is extraordinarily abundant, but south of the Wyville-Thompson ridge it appears to get less frequent the further south we go, and though taken throughout the Atlantic traverse, it does not occur in great numbers at about lat. 51° (at any rate in 1903). It is, however, known to reach the deep water under the Sargasso Sea (Dahl).

Eucalanus. In a former list (this Journal, January, 1902) I included *Euc. attenuatus* in the list of Copepoda found in the Faröe Channel. It is true that I found it once in a sample from Station A 1 in the Faröe Channel, but I am of opinion now that this sample had become contaminated with some material from the Indian Ocean, and as I have never found it in any other samples from the Faröe Channel, including those collected by Fowler, which were afterwards referred to me, I must conclude that it does not occur in the Faröe Channel. In a subsequent paper by Dr. Fowler in *Proc. Zool. Soc.*, February 3rd, 1903, it is spoken of as forming 22 per cent. of the Epiplankton and 41 per cent. of the Mesoplankton of this region. This, however, is an error, and it should be eliminated from the list. The species referred to is undoubtedly *E. elongatus.* This species is very abundant in the Faröe Channel, not uncommon in the fiords of Shetland, and occurs throughout the Atlantic stations as far south as 51°, but less abundantly than in the Faröe Channel, where it is apparently indifferent to temperature, occurring at all depths. It is, however, curious that it does not extend further north to the Norwegian Sea, and is not mentioned by Sars as having been seen off the Norwegian coast. Its northern limitation appears to be very well defined.

Euc. crassus is frequently met with in the Faröe Channel, and has occurred in great abundance in some hauls with the "midwater open net" at 45 to 50 fathoms. It is also met with throughout the Atlantic stations, and is very common in Mr. Gardiner's Maldive Collections, thus appearing to thrive under widely differing conditions as to temperature, etc. Its northward and eastern extension appears to be as well defined as that of the previous species, as it is not mentioned by Sars.

Rhincalanus. The *Rhincalanus cornutus*, also included in the list before mentioned, must be removed for the same reasons as *E. attenuatus*. It never occurs in the Faröe Channel, and I have never yet found it in the Atlantic north of 51°. lat. In Fowler's list (*P.Z.S.*, June 21st, 1898) it is recorded as frequent, especially in the Mesoplankton. In Fowler's collection it was certainly absent, but *Rhinc. nasutus* was common, and, in fact, is scarcely ever absent from the Epi- or Meso- plankton of this region, and it is evident that the two species have been confused. *R. cornutus* is distinctly a southern ocean form, and all records of its occurrence beyond 30° N. must be looked upon with suspicion. *Rhinc. nasutus* occurs often in great abundance in the Faröe Channel, and frequently throughout the Atlantic traverse. I have found it in the Maldive Collection, but very sparingly, and Scott mentions it among the Ceylon Copepods. Like *Eucalanus*, its northern distribution is apparently well defined, having occurred only at two stations of the cruise of the *Michael Sars*, in deep water off the coast of Iceland, and once in the North Sea between Scotland and Norway.

Pleuromamma. Pl. abdominalis is not common in the Faröe Channel, while *Pl. robusta* (Dahl) occurs with great frequency. Consequently the records of *Pl. abdominalis* in Fowler's list (*loc. cit.*), and the figures (5 per cent. Epiplankton and 58 per cent. Mesoplankton) in his second paper (February 3rd, 1903) must be doubted. *Pleur. robusta* occurred abundantly in Fowler's collection, and in my own Faröe collections it is the common *Pleuromamma* of the Faröe Channel and North Atlantic (51° to 62° N.). Though *Pl. abdominalis* does occur in the North Atlantic, it is comparatively rare in my collections.

The distribution of this Copepod (*Pl. robusta*) is not unlike that of *Eucalanus* and *Rhincalanus.* Sars mentions the occurrence of a few specimens "somewhat north of the Faröe Islands," and two specimens only from Norway. It occurred throughout my Atlantic traverse in 1903, and for four years successively has been always abundant in the Faröe Channel, but north and east of Shetland it appears to have a fairly well defined limit, though apparently reaching, in small numbers, the coast of Norway. *Pl. abdominalis* was not common in the Atlantic traverse. *Pl. abyssalis* has occurred in my experience only once in the Faröe Channel.

Euchirella. Only two species of *Euchirella* occur in the Faröe Channel, viz. *E. rostrata* and *E. carinata*. The former is of frequent occurrence. What was meant by *E. pulchra* (frequent at 450 to 320 fathoms) in Fowler's list (*P.Z.S.*, June 21st, 1898) I do not know, but I am pretty confident that it was not *E. pulchra*, and probably was *E. rostrata*. I found the latter species in Fowler's collection, and I have taken it several times since, but it has not occurred in my collections in the Atlantic south of the Wyville-Thompson ridge, being there replaced by a variety of *E. curticauda*. *E. rostrata* does not apparently occur in the Norwegian Sea, but it is recorded by Scott in the Ceylon Copepoda. In the neighbouring Maldive Islands, however, I have not met with it, but only *E. bella*. That it should occur at such widely different localities is not a little curious. The limitation previously given by Giesbrecht (*F. u. Fl. N.*) was 44° N. to 41° S.

Paracalanus parvus. Found plentifully in Christiana Fjord by Sars, and South Norway, though not apparently further north, none having been observed at Bergen by Nordgaard, nor in the Plankton samples from the Northern Ocean examined by G. O. Sars (Sars' *Crust. Norway*, p. 18), and common round the British coasts. It occurs in the Faröe Channel, and as far south, at any rate, as lat. 51° (Valentia in Ireland); occasional in deep-water samples, it is not common in the open ocean. It has probably not such a wide southern distribution as has been imagined. Met with in the Indian Ocean and Mediterranean, I think there is reason to differentiate the two forms, boreal and Mediterranean (and Indian Ocean), as at least distinct varieties. A careful examination of the figures of this species given by Sars (*Crust. Norway*) and Giesbrecht (*F. u. Fl. Golfes Neapel*) discloses differences, and I have made a detailed examination of examples from the Faröe Channel and from the Indian Ocean (Maldives) for the purpose of comparison.

The Southern Ocean examples are found constantly to be rather smaller than the northern, the basal joints of the feet are more densely armed with short spines (in the northern variety these are almost entirely absent, especially on the fourth pair), the basal joints and the last segment of the exopodites (fourth pair) are broader in proportion to the length (exopodite 3 is five times as long as broad in the boreal variety, only four as long as broad in the Indian variety), and the anterior antennæ are rather longer in proportion to the body in the southern variety. On the whole the southern variety may be said to be constantly smaller, more spiny, and with less attenuated segments of the feet (in which the marginal teeth are also stronger and coarser) than the northern. This difference is also noted in comparing the figures of Giesbrecht's *P. parvus* from the Mediterranean with those of Sars' *P. parvus* from Norway. They are not distinct species, but undoubted varieties, and the northern form, though extending as far south as lat. 51° (Valentia), does not probably reach the Mediterranean, from which point southwards the southern variety extends. The species described by Scott as *P. parvus* from the Gulf of Guinea must, I think, be designated *P. aculeatus* (Gbt.).

Calocalanus pavo. The occurrence of this species north of 50° N. is unusual, its previous limitation being 30° N. Two undoubted examples occurred in hauls made west of Valentia, but in this case it was probably an accidental wandering beyond its proper limitations.

Ctenocalanus vanus and *Calanus tenuicornis* must probably be regarded as having wandered far out of their usual habitat when found, the former in the Faröe Channel, the latter off the west coast of Ireland. The former is recorded, however, by Giesbrecht as rather common in the Antarctic Ocean (*Voy. du Belgica*).

Heterorhabdus. The species which I had previously named *H. Clausii* (this Journal, January, 1902) should be *H. norvegicus.* Until the publication of Sars' recent work (*Crust. of Norway*) no full account, and no figures of the original species of Boeck were available. I am now convinced that the Faröe examples are really Boeck's species, *H. norvegicus,* which extends southwards at any rate to 52° N.

The *H. zetesios* recorded in that list I now think to be the male of *H. longicornis*, previously unknown, and I have taken it on many occasions since that date, both in the Faröe Channel and the Atlantic.

H. norvegicus is distinctly a boreal species, while *H. longicornis* (vel *zetesios*) belongs just as certainly to the warm area, occurring with considerable frequency in the warm Atlantic area. The ♂ is of such frequent occurrence in this region that it is curious that it should have been overlooked in previous records. *H. vipera* and *H. abyssalis* occurred only in the warm area, and have never been seen north of the Wyville-Thompson ridge. *H. grandis* is certainly only a very deep water species.

The *Heterorhabidæ* are species which seek deep water and do not approach the coasts, at any rate in the North Atlantic. *H. norvegicus* is capable of existence within a very extreme range of temperature, from the polar water of the Faröe Channel to the warm Atlantic. *H. longicornis* can apparently endure greater extremes than *H. vipera*, but is not so robust as the first-named species. Amongst Epiplankton I have found only quite young and undeveloped examples of *Heterorhabdus.*

Candace. What is meant by *Candace truncata* in Fowler's list (*P.Z.S.*, June, 1898) it is impossible to say. It is a Pacific Ocean species. Probably Thompson meant *C. norvegica* (Boeck), which has received a full description from Sars (in *Crustacea of Norway*) and extends southwards, at any rate as far as 51° N., where I took it at a depth of 300 fathoms.

Chiridius. In 1892 Giesbrecht established this genus for a Copepod (*Ch. poppei*) of small size (1·8 mm.), which was characterised by the absence of rostrum and the very short endopodites of posterior antennæ and mandible.

Sars has extended the genus by the inclusion of four species—*Ch. armata, Ch. brevispinus, Ch. tenuispinus,* and *Ch. obtusifrons.* There can, however, be no doubt that *brevispinus* and *tenuispinus* are really examples of Giesbrecht's genus *Gaidius.* In both occur the modified tubal bristles of the basal joint of the fourth feet, which Giesbrecht remarked long ago to be midway between the ordinary bristles of *Ætideus* and the spines and teeth of *Euchirella. Chiridius tenuispinus* (Sars) is identical with *Gaidius borealis* (described by me in this Journal, January, 1902), and *Chiridius brevispinus* (Sars) is identical with the species which I had previously named *Gaidius major.*

Chiridius armatus (Sars), owing to its possession of a two-pointed rostrum, is clearly not a *Chiridius,* and from its close resemblance to *Ætideus* was, two years ago, placed by me in another genus to which I gave the name *Pseudætideus.* (See *Report of the Brit. Assoc.*, the Zoological Station at Naples, 1902.)

Consequently only one of Sars' species, viz. *Chiridius obtusifrons* remains to be included in the genus *Chiridius,* which now includes only *Ch. poppei* (Gbt.) and *Ch. obtusifrons* (Sars). The latter form, which appears to have been abundant in the Polar basin in Nansen's Expedition (Sars, *loc. cit.*), occurs also, though not commonly, in the Faröe Channel, and my examples agree entirely with the description given by Sars.

It may be doubted if the *Gaidius pungens* of Giesbrecht is really identical with the Faröe Channel and North Atlantic forms, for in the former the second pair of feet have a one-jointed endopodite, while in the latter it is distinctly two-jointed, added to which must be considered the widely different localities of habitat, which would at once lead to a supposition of non-identity. (Pl. IX., fig. 43.)

G. pungens (Giesbrecht).

Exopodite of first foot two segments.
Endopodite of second foot one segment.
Spiny prolongation of last segment shorter than in *borealis.*
Size, ♀ 3·2 mm. (Pacific Ocean).

G. borealis (Wolfenden), *Ch. tenuispinus* and *G. tenuispinus* (Sars).

Exopodite of first foot indistinctly three segments.
Endopodite of second foot two segments.
Spiny prolongation of last segment longer than *pungens.*
Size, ♀ 3·8 mm. (North Atlantic).

In addition there are minor differences in the relative proportions of the segments of the feet, number of teeth on the terminal saws, hooked bristles of the anterior foot-jaws, proportions and length of the segments of the posterior foot-jaws (first and second basals shorter and broader).

The differences, though small, along with the widely different habitats, cause me to hesitate before regarding them as identical, and probably they are varieties.

Gaetanus. Of the two species of *Gaetanus* (*armiger* and *major*) which I find common in the Atlantic, and somewhat more uncommon in the Faröe Channel, the doubt may be expressed (as in the case of *Gaidius*) whether the species *G. armiger* is really identical with Giesbrecht's Pacific Ocean examples. Specimens from the Atlantic clearly have the modified tubal bristles on the basal of the fourth feet (apparently absent in Giesbrecht's species), and are larger than Giesbrecht's species (viz. 4·4 mm., as compared with 3·2 mm.), but otherwise the resemblance is very great. However, combined with such widely different habitat, it might be considered advisable to regard them as different species, in which case our northern species might be distinguished as *G. atlanticus*. No doubt can be entertained in the case of *Gaetanus caudani* that it is not identical with *G. miles* (Gbt.), though doubt may be felt whether the specimen described by Canu (*Ann. Univ. Lyon*, vol. xxvi.) is identical with the North Atlantic examples; but as this appears to have been an immature male, a proper comparison can scarcely be made.

With regard to the horizontal distribution of the genera *Gaidius* and *Gaetanus*, *Gaidius* is of constant occurrence in the deep water only of the Faröe Channel, and though it wanders south into the warm Atlantic, it is by no means of such frequent occurrence as further north. *Gaidius major*, and to a less degree *G. pungens*, are in the North Atlantic distinctly boreal species, occurring with frequency in the Polar seas (Sars). *Chiridius obtusifrons* seems at present to be still more markedly a Polar species, occurring sparingly in the cold under-water of the Faröe Channel, and *Pseudætideus armatus* has the same distribution as *Gaidius*. Both can be traced down as far as lat. 51° N., possibly further south.

Gaetanus species, on the contrary, appear to be of more a warm Atlantic area habitat. Their frequency diminishes going northwards, and *Gaetanus* is not mentioned in Sars' lists. *G. major* alone passes into the Faröe Channel, *G. armiger* and *caudani* not appearing north of the Wyville-Thompson ridge, though on one occasion I took an undeveloped example (? *G. miles* vel *caudani*) just south of this locality.

Euchæta. *E. marina*, described in Fowler's paper as common at various depths, is erroneous.* It does not occur in the Faröe Channel, nor have I found it in the North Atlantic, at any rate as far south as

* Its inclusion in my list (this Journal, January, 1902) was also an error.

51° N. Two species, *E. norvegica* and *barbata*, are common; the third, *E. glacialis*, is rather rare. The first species occurs in so many stages of development that Thompson, who reported upon Fowler's Copepoda, was probably misled. Though doubt has been expressed upon the accuracy of the diagnosis of *E. barbata*, there is no doubt that this is a good species. Each of the three differs, especially in the form of the genital segment of the female, the length of the appendicular tail setæ, the structure of the first and second feet, and the anatomy of the last segment of the fifth foot of the ♂, especially in its "scissors" arrangement. What is meant in Thompson's list by *E. hessii* and *E. gigas* (Brady) it is difficult to say. At any rate only the three *Euchætas* mentioned are as yet known to occur in the Faröe Channel.

E. norvegica extends southwards into the warm Atlantic area, at any rate, as far south as 51° N. It is fairly common in the warm area, but not so much so as in the deep water of the Faröe Channel, where it is seldom absent from deep hauls; it is thus capable of ranging through wide differences of temperature. Though, as I am informed by Sir J. Murray, it is of common occurrence in the surface waters of some of the Western Scotch lochs, I have never seen an adult in the surface area of the Faröe Channel or Atlantic. Young and undeveloped specimens are not uncommon near the surface, but the adult animal appears to prefer the deep water down to 500 to 600 fathoms, and to extend northwards to the Polar basin.

E. glacialis, observed abundantly in the Polar basin (Hansen), but seldom in the Norwegian Sea, is of rare occurrence in the Faröe Channel, and once only it occurred in the warm Atlantic area.

E. acuta, of which a few undoubted examples were met with in lat. 50° 56′ and 12° 6′ W. long. at 300 fathoms depth, has hitherto had a northern limit of only 41° N. It has lately been recorded by Scott from the Indian Ocean.

E. barbata, first described by Brady from the South Atlantic (Rio Janeiro), and lately by Scott from Ceylon, occurring with frequency in the Faröe Channel, has thus a very wide range. In the Atlantic it is purely a deep-water species, occurring once at 500 fathoms in lat. 55° 47′ N.

These three species (*E. norvegica, glacialis, barbata*) may be distinguished from each other by the following points (cf. Fig. 1 in text):—

E. norvegica, ♀. The last thoracic segment on each side ending in a blunt spine. The genital segment with genital swelling occupying the lower part of the segment, the opening nearly round, guarded on each side by a prominent blunt tubercle. Second foot: the external spine of exopodite 2 does not reach the end of the first marginal spine of exopodite 3, the second spine of exopodite 3 does not nearly reach the end of the segment. First foot: exopodite 1, with partial division into two segments, margin very concave above and convex below, with a marginal bristle not reaching the end of the segment. Appendicular bristle of the tail very long. Colour greenish yellow; about 8 mm. long.

E. glacialis. The last thoracic segment rounded and without tip. Genital segment very prominent with conical swelling; genital orifice guarded on each side by an upper and lower tubercle, and opening oval

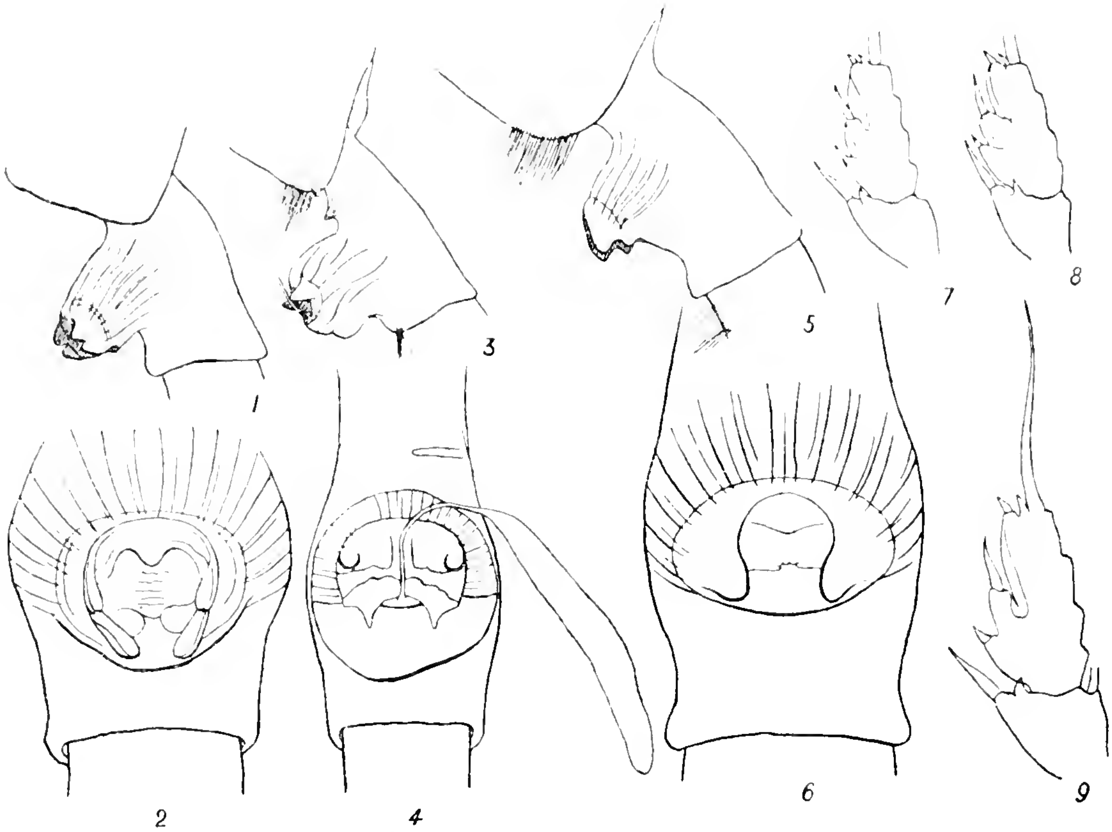

Fig. 1. Comparison of three species of Euchæta.

1. *Euchæta glacialis.*
2. ,, ,, Genital segment, ventral surface.
3. ,, *norvegica.*
4. ,, ,, Genital segment, ventral surface.
5. ,, *barbata.*
6. ,, ,, Genital segment, ventral surface.
7. Last two segments of exopodite of second feet of *Euch. glacialis.*
8. ,, ,, ,, ,, *Euch. norvegica.*
9. ,, ,, ,, ,, *Euch. barbata.*

(broader than long); the genital swelling occupies more the middle of the segment, which is much swollen laterally. Second foot, with the marginal spine of exopodite 1 very large, reaching the tip of the first spine of exopodite 2; the second marginal spine of exopodite 3 larger than in *E. norvegica* and reaching the end of the segment. First foot without trace of segmentation in the exopodite 1 and its marginal seta very small. Appendicular bristle very short. Colour greenish yellow, with a quantity of red pigment diffused, especially about the mouth organs; size, about 10 mm.

E. barbata. Last thoracic segment rounded on each side. Genital segment not so swollen as the other two species, swelling occupying the middle of the segment, more protuberant above than below; genital orifice oval, broader than long, guarded by lateral lamellar swelling on each side. Second foot, with marginal spine of exopodite 1 stout and reaching the end of the first spine of exopodite 3; second spine of exopodite 3 not reaching the end of the segment. First foot, with exopodite distinctly segmented into 3. Appendicular bristle long. Colour always bright red, feet and mouth organs coloured red; size, 10–11 mm.; very hirsute.

Haloptilus. H. acutifrons (Gbt.), recorded by Sars once from the Polar Sea and once from the Norwegian Sea, occurred twice only in the Atlantic townettings. *H. longicornis,* recorded by Sars once only from a station between Finmark and Bear Island, was captured several times in the North Atlantic, and once only in the Faröe Channel cold area.

Neither of these species can be regarded as indigenous to the north cold ocean. Their distribution is pronouncedly southern, and *H. longicornis* extends from the Mediterranean to the Indian Ocean, where it is very common round the Maldive Islands.

Augaptilus. The occurrence of several members of this genus in the North Atlantic is interesting. Only one of them am I able to thoroughly identify with any species described in the list of Giesbrecht and Schmeil (*Das Tierreich*, "Copepoda"), only three of which, by the way, are European, four being Pacific Ocean species, and one recorded only from the Gulf of Guinea.

The description of *Augaptilus glacialis* (Sars), said by this authority to be a Polar species, is not at the moment of writing available to me. The ♂ briefly described by I. C. Thompson is in all probability not this species at all, the size given by Thompson,* 4 mm., being greatly in excess of that of *A. palumboi* (Gbt.), viz. 2·25 mm. ♀, and no truly Pacific Ocean† forms have yet been recorded from the North Atlantic. While the three species taken by Scott in the Gulf of Guinea appear to be as much epiplanktonic as mesoplanktonic (25–360 fathoms), in the "Oceana" report the *Augaptilus* species appear to be only mesoplanktonic, all being captured at 1,000 fathoms or under. In the North Atlantic none of my species appeared above 300 fathoms. Two of them are new, and only one, *A. longicaudatus* (Claus) has a wide range (Mediterranean, Gulf of Guinea, and Pacific Ocean).

* "'Oceana' Copepoda," *Ann. and Mag. Nat. Hist.*, vol. xii.

† *Augap. palumboi, bullifer, megalurus.*

Lucicutia species show a distribution similar to other warm-water species, and may be regarded as wandering into the Faröe Channel by accident. *L. flavicornis* is not often found there, but increases in frequency further south of the Wyville-Thompson ridge. It has a very extensive range, occurring with frequency about the Maldive Islands of the Indian Ocean.

Metridia species. *M. longa* is clearly a distinctly northern form, occurring with great frequency in the deep water of the Faröe Channel, and at very low temperatures, and is traced down the North Atlantic, where it occurs with much less frequency and in deep water. *M. lucens*, on the contrary, is apparently very common in the warm area of the Atlantic; equally with the cold area of the Faröe Channel, at any rate as far south as lat. 50° N., south of which, however, it appears only doubtfully to reach.

M. Normani, which was described by Giesbrecht from the Faröe Channel, has not occurred in any of my collections in that region for the last four years, but was common in the North Atlantic during the summer of 1903, especially between lat. 50° and 55°; its presence in the Faröe Channel at any time is therefore probably accidental.

M. brevicauda, of which several examples occurred off the Irish coast in 1903, has hitherto been regarded entirely as a Pacific Ocean species (Giesbrecht). *M. longa*, and especially *M. lucens*, may be regarded as typical northern cold-area forms.

Oncea species (especially *O. conifera*) are rarely absent from any tow-netting in the Faröe Channel or North Atlantic in deep water; they are very rarely, however, found at the surface. The genus is cosmopolitan and has representatives in the Indian Ocean nearly as abundantly as the northern seas. The same may be said of *Oithona*, especially *O. plumifera* and *similis*, and both *Oncea conifera* and *Oithona similis* are recorded by Giesbrecht from the Antarctic Ocean (*Voyage du S.Y. Belgica*, 1902). The same may be said of *Microsetella atlantica*, common throughout the Faröe Channel, the North Atlantic, less common in the Indian Ocean (Maldives, Wolfenden), Ceylon (Scott), and in the Antarctic Ocean (Giesbrecht *loc. cit.*). *Bradyidius armatus* is similarly cosmopolitan, frequent in the Faröe Channel, round the British Isles, occurring also in the Mediterranean, and round the Maldive Islands of the Indian Ocean. *Acartia Clausii* is similarly cosmopolitan, and along with *Oncea conifera*, *Oithona plumifera* and *similis*, and *Ectinosoma* (*Microsetella*) *atlantica*, indifferent to depth and temperature. *Scolecithrix minor* is also widely distributed, very common in the Faröe Channel, but less common in the North Atlantic.

Amallophora magna occurred with frequency in the warm Atlantic area, especially about lat. 51° to 52° N., in the summer of 1903. Scott has described it from the Gulf of Guinea, and Sars states that it was abundant in the Polar basin crossed by Nansen; it is recorded by Giesbrecht from the Pacific, near Bergen (Nordgaard), and "at some distance north of the Shetland Isles" (Sars). I have never once found it in the Faröe Channel. Considering its widely differing habitats, it is not easy to see why it should be described by Sars (*Crust. Norway*, p. 53) as of "undoubtedly Arctic origin." An allied species, *A. brevicornis*, is recorded by Scott once from a locality east of the Shetland Isles. The same Copepod occurred in the cold area in July, 1902, but differs from Sars' description in the entire absence of amalliforus sensory processes, which are replaced by strong brush processes on both maxillipedes. The head is broad and entirely without crest, and in every other respect it agrees with Sars' *A. brevicornis*, but cannot be an *Amallophora*.

In considering the horizontal distribution of the Copepoda of this region, the following occur with frequency, and may be said to be indigenous to the Faröe Channel:—

Calanus finmarchicus, Eucalanus elongatus and crassus, Rhincalanus nasutus, Paracalanus parvus, Pseudocalanus elongatus, Ætideus tenuirostris, Gaidius pungens and major, Gaetanus major, Euchæta norvegica, barbata, and glacialis, Pseudætideus armatus, Faroella multiserrata, Metridia lucens and longa, Pleuromamma robusta, Heterorhabdus norvegicus, Ectinosoma atlantica, Acartia Clausii, Candace pectinata, Oncea conifera, Oithona similis, Centropages typicus and hamatus, Euchirella rostrata, Bryaxis brevicornis, Scolecithrix minor and similis, Bradyidius armatus.

Others in the foregoing list, which occur only occasionally, are visitors brought from the Norwegian Sea or from the Atlantic south of the Wyville-Thompson ridge, such as Phaenna, Haloptilus, Chiridius obtusifrons, Ctenocalanus, Augaptilus, Pleuromamma abdominalis, Lucicutia, Anomalocera, Ægisthus.

I have not been able to state any essential differences as to abundance of these individual species during the years 1899–1903, though the hydrographical conditions of the Channel have been widely different.* Thus in 1900 the whole Channel was occupied by water coming from the south, strong earlier in the season, but in July with little movement, but indications of intrusion of northern water at a depth of 300 fathoms on the east side. In 1901 most of the Channel was occupied by water from the south, with feeble southward movement in the depth. In 1902, at all depths below 150 fathoms, the Channel was filled with unusually cold fresher water, the southward movement increasing both

* See Mr. H. N. Dickson's report ("Hydrography of the Faröe-Shetland Channel," *Geographical Journal*, April, 1903) upon the hydrographical results of the author's cruises in this region.

at the surface and deep as the season progressed, driving out the waters of southern origin. This was an exceptional year.

The physical conditions in the Faröe Channel are, as is well known, widely different from those existing in the neighbouring Atlantic, and in this area we have a very mixed fauna, but it is not difficult to determine which species of Copepoda are, so to say, indigenous to this area. In the tables appended the species captured at each station in the 1903 cruise are tabulated. I purposely leave out the consideration of the observations made exclusively in the Faröe Channel in the three preceding years for future consideration. Only three stations in the "cold-water area" (F. VII., VIII., IX.) were visited in 1903, but they serve for comparison with those on the southern side of the Wyville-Thompson ridge.

Throughout the cruise there was a remarkable paucity of Copepoda at the surface as far as species are concerned, and the well-known fact is again established that the nearer the cold ocean is approached the smaller the number of species, but the greater the abundance of individuals of the same species. Thus between 51° and 52° N., thirteen species occurred at the surface; at no station north of this were there more than six species found.

Between lat. 51° and 52° N. there occurred at

0 fathoms,	13 species.	500 fathoms,	18 species.
100 ,,	14 ,,	600 ,,	13 ,,
200 ,,	22 ,,	700 ,,	10 ,,
300 ,,	28 ,,	800 ,,	15 ,,
400 ,,	24 ,,	1,000 ,,	5 ,,

Between 52° and 54° N. there occurred at

0 fathoms,	8 species.	150 fathoms,	12 species.
100 ,,	15 ,,	250 ,,	6 ,,

Between 54° and 55° N. there occurred at

0 fathoms	1 species.	600 fathoms,	12 species.
100 ,,	13 ,,	700 ,,	9 ,,
200 ,,	14 ,,	800 ,,	10 ,,
300 ,,	20 ,,	1,000 ,,	9 ,,
400 ,,	22 ,,	1,200 ,,	9 ,,
500 ,,	7 ,,		

Between 55° and 56° N. there occurred at

0 fathoms,	4 species.	600 fathoms,	8 species.
100 ,,	6 ,,	700 ,,	8 ,,
200 ,,	10 ,,	800 ,,	6 ,,
400 ,,	12 ,,	1,000 ,,	8 ,,
500 ,,	18 ,,		

Between 56° and 57° N. there occurred at

0 fathoms,	4 species.	500 fathoms,	11 species.
100 ,,	10 ,,	600 ,,	4 ,,
200 ,,	5 ,,	700 ,,	5 ,,
400 ,,	6 ,,	800 ,,	6 ,,

Between 58° and 59° N. there occurred at

0 fathoms,	2 species.	200 fathoms,	8 species.
100 ,,	11 ,,	300 ,,	8 ,,

Between 59° and 60° N. there occurred at

0 fathoms,	3 species.	400 fathoms,	5 species.
100 ,,	8 ,,	500 ,,	4 ,,
200 ,,	5 ,,	600 ,,	5 ,,
300 ,,	15 ,,	800 ,,	4 ,,

Between 60° and 61° N. there occurred in the warm area (F. V., F. VI.) at

0 fathoms,	2 species.	200 fathoms,	8 species.
100 ,,	4 ,,		

Between 60° and 61° N. there occurred in the cold area (F. VII., F. VIII., F. IX.) at

0 fathoms,	6 species.	300 fathoms,	11 species.
100 ,,	9 ,,	400 ,,	6 ,,
200 ,,	11 ,,	500 ,,	14 ,,

It is not unfair to conclude from these data that the greater number of species of Copepoda in the North Atlantic prefer a mesoplanktonic existence between 200–500 or 600 fathoms depth; and that this is also the case in the "cold area" of the Faröe Channel.

At Station A 2, June, 1901, there were taken at

0 fathoms,	6 species.	400 fathoms,	14 species.
100 ,,	5 ,,	500 ,,	9 ,,
300 ,,	11 ,,		

At Station A 2, July, 1901, there were taken at

0 fathoms,	3 species.	200 fathoms,	9 species.
100 ,,	6 ,,	400 ,,	7 ,,

At 400 and 500 fathoms there was an abundance of Copepoda, much more than from 200 fathoms to the surface.

At Station A 2, June, 1902, there were taken at

100 fathoms,	11 species.	400–200 fathoms,	13 species.
200 ,,	8 ,,		

When the Copepod species of the warm area of the North Atlantic are examined it is seen that there is not a single species which is purely epiplanktonic. For long it has been considered that *Anomalocera Patersoni* was a purely surface species, but the capture of an adult male example in a bottom scraping at 400 fathoms, in perfect condition, shows that it can sometimes descend to considerable depths.

Longipedia coronata, an Harpacticid of supposed purely littoral habit, is shown also to exist at great depths, having been taken in scrapings of the bottom at 400 and 500 fathoms respectively.

*The Vertical Range of Species in the North Atlantic (excluding the Faröe Channel cold area).**

	Fathoms.		Fathoms.
Calanus finmarchicus	0–1,200	Oithona species	0–1,200
,, tenuicornis	500	Gaetanus sp. †	200– 400
Eucalanus elongatus	0– 500	Gaidius sp.	300– 400
,, crassus	100– 500	Spinocalanus sp.	300–1,000
Rhincalanus nasutus	0–1,000	Pseudætideus armatus	200– 600
Paracalanus parvus	0–1,000	Phyllopus bidentatus	200– 700
Pseudocalanus elongatus	0– 100	Ægisthus	300
Acartia Clausii	0–1,000	Bradyidus armatus	400– 500
Oncea sp.	0–1,200	Scolecithrix minor	100– 300
Ectinosoma atlantica	0–1,200	,, similis	100– 200
Metridia lucens	0–1,200	,, atlanticus	300
,, Normani	300– 800	Amallophora magna	300
,, longa	300– 400	Lophothrix securifrons	300
Euchæta norvegica	100–1,000	,, frontalis	
,, acuta	300	Faroella multiserrata †	200–1,000
Ætideus armatus	100– 700	Undeuchæta major and minor	300
Pleuromamma robusta	200–1,200	Augaptilus sp.	300– 500
,, abdominale	200	Candace norvegica	300– 500
Heterochæta vipera	200	,, rotunda	300
,, longicornis	300	Megacalanus	600
,, norvegica	100–1,200	Xantholcalanus sp.	300– 400
,, hibernica	400	Euchirella carinata ‡	100– 400
,, grandis	700	,, curticauda	300
Haloptilus longicornis	100– 200	Paraugaptilus	300
,, acutifrons	200– 300	Longipedia coronata	300– 500
Lucicutia flavicornis	200– 500	Anomalocera Patersoni	0– 375
,, grandis	700		
Phaenna spinifera	100– 400		

* The depth in fathoms here given is only the extreme range above and below at which the species were taken.

† Young examples only at 200 fathoms.

‡ Young examples only at 100 fathoms.

Tables showing the depths at which the different species of Copepoda were taken in the Closing Net.

In the following tables j signifies young specimen. The temperatures at each of these stations will be published subsequently along with the salinities.

TABLE I.

FARÖE CHANNEL COLD AREA.

Station F VII. 61° 1′ N., 7° 42′ W.—460 f. ; August 13, 1903.
,, F VIII. 60° 30′ N., 7° 47′ W.—547 f. ; ,, 14 ,,
,, F IX. 60° 1′ N., 6° 4′ W.—580 f. ; ,, 17 ,,

Depth in fathoms. Closing net.	0	100	200	300	400	500
Calanus finmarchicus	×	×	×	×	–	–
,, hyperboreus	–	–	×	×	×	–
Eucalanus elongatus	–	–	–	–	–	×
Pseudocalanus elongatus	–	×	×	–	–	×
Paracalanus parvus	–	–	×	–	×	×
Rhincalanus nasutus	–	×	×	–	–	×
Metridia lucens	×	×	×	–	–	×
,, longa	–	–	×	–	×	–
Ætideus armatus	–	×	×	×	–	×
Euchæta norvegica	–	–	–	×	×	×
Gaidius pungens	–	–	–	×	–	×
Temora longicornis	×	–	–	–	–	×
Pleuromamma robusta	–	–	×	×	–	×
Acartia Clausii	×	×	×	–	×	×
Gaetanus caudani	–	–	–	×	–	–
Lophothrix securifrons	–	–	–	×	–	–
Heterorhabdus norvegicus	–	–	–	×	–	–
Scolecithrix minor	–	×	–	–	–	–
Ectinosoma atlantica	×	×	–	–	–	–
Oithona sp.	×	–	×	×	–	×
Oncea sp.	–	×	–	×	×	×

TABLE II.

Between 60°–61° N. Stations F v. and F VI.

F v. 60° 29′ N., 9° 30′ W.—194 f. ; August 8, 1903.
F VI. 60° 41′ N., 8° 50′ W.— 75 f. ; ,, 9 ,, (Faröe Bank).

Depth in fathoms. Closing net.	0	100	200
Calanus finmarchicus	–	×	×
,, hyperboreus	–	–	×
Metridia lucens	–	×	×
,, longa	–	–	×
Euchæta norvegica	–	–	× j
Acartia Clausii	×	×	×
Candace norvegica	–	–	×
Oithona sp.	×	×	×

TABLE III.

Between 59°–60° N. Stations F III. and F IV.

F III. 59° 18′ N., 8° 30′ W.—840 f.; August 6, 1903.
F IV. 59° 54′ N., 8° 42′ W.—720 f.; ,, 7 ,,

Depth in fathoms. Closing net.	0	100	200	300	400	500	600	800
Calanus finmarchicus	–	×	–	–	×	×	×	×
Rhincalanus nasutus	–	–	–	–	–	–	–	×
Megacalanus princeps	–	–	–	–	–	×	–	–
Paracalanus parvus	–	×	×	–	–	–	–	–
Acartia Clausii	×	×	×	–	–	–	–	×
Ectinosoma atlantica	–	–	×	–	–	–	–	–
Pseudætidius armatus	–	–	–	×	–	–	–	–
Faroella multiserrata	–	–	–	×	–	–	×	–
Metridia lucens	×	×	–	–	–	–	–	–
,, longa	–	×	–	–	–	–	–	–
,, Normani	–	–	–	×	–	–	–	–
,, brevicauda	–	–	–	×	–	×	–	–
Heterorhabdus norvegicus	–	–	–	–	–	–	×	×
,, longicornis	–	–	–	×	×	–	–	–
Pleuromamma robusta	–	–	–	×	–	–	×	–
Lucicutia flavicornis	–	–	–	×	–	–	–	–
Euchæta norvegica	–	–	–	×	×	–	–	–
Gaetanus armiger	–	–	–	×	–	–	–	–
Candace norvegica	–	×	–	×	–	–	–	–
Amallophora magna	–	–	–	×	–	–	–	–
Augaptilus longicaudatus	–	–	–	×	–	–	–	–
,, magnus	–	–	–	×	–	–	–	–
Paraugaptilus	–	–	–	×	–	–	–	–
Spinocalanus magnus	–	–	–	×	–	–	–	–
Oithona sp.	×	×	×	–	×	–	–	–
Oncea sp.	–	×	×	–	×	×	×	–

TABLE IV.

Between 58° and 59°—Stations F I. and F II.

F I. 58° 24′ N., 8° 30′ W.—110 f.; Aug. 4, 1903.
F II. 58° 45′ N., 8° 35′ W.—340 f.; ,, 5 ,,

Depth in fathoms. Closing net.	0	100	200	300
Calanus finmarchicus	–	×	×	×
Eucalanus elongatus	–	×	–	–
Rhincalanus nasutus	–	×	–	–
Paracalanus parvus	–	×	–	–
Ætideus armatus	–	×	×	–
Acartia Clausii	×	×	–	×
Scolecithrix minor	–	×	–	–
Euchæta norvegica	–	×	×	×
Pleuromamma robusta	–	–	×	×
Metridia lucens	–	×	×	–
,, brevicauda	–	–	×	×
Augaptilus magnus	–	–	–	×
Oithona sp.	×	×	×	×
Oncea sp.	–	×	×	×

TABLE V.

Between 56°–57°. Stations E 17 and E 18.

E 17. 56° 11′ N., 9° 50′ W.—875 f.; July 15, 1903.
E 18. 56° 37′ N., 9° 48′ W.—912 f. ,, 21 ,,

Depth in fathoms.	Closing net.	0	100	200	400	500	600	700	800
Calanus finmarchicus	. .	–	×	×	×	×	–	×	×
Eucalanus elongatus	. .	–	–	–	–	×	–	–	–
,, crassus	. .	–	–	×	–	–	–	–	–
Rhincalanus nasutus	. .	–	×	–	–	–	–	–	×
Paracalanus parvus	. .	×	–	–	–	×	–	–	–
Pseudocalanus elongatus	. .	×	×	–	–	–	–	–	–
Acartia Clausii	. .	×	×	–	–	×	×	–	×
Ætideus armatus	. .	–	×	–	–	–	–	–	–
Scolecithrix minor	. .	–	×	–	–	–	–	–	–
Spinocalanus magnus	. .	–	–	–	×	×	–	–	–
Metridia lucens	. .	×	×	×	×	×	×	×	×
,, Normani	. .	–	–	–	×	–	–	–	–
Pseudætideus armatus	. .	–	–	–	×	×	–	–	–
Euchæta norvegica	. .	–	×	–	–	×	–	×	–
Heterorhabdus grandis	. .	–	–	–	–	–	–	×	–
Ectinosoma atlantica	. .	–	–	–	–	–	–	–	×
Candace norvegica	. .	–	–	–	–	×	–	–	–
Lucicutia flavicornis	. .	–	–	–	–	×	–	–	–
Oithona sp.	. .	–	×	×	×	–	×	–	–
Oncea sp.	. .	–	×	×	–	×	×	×	×

TABLE VI.

Between 55° and 56°—Stations E 14, E 15, E 16.

E 14. 55° 00′ N., 12° 00′ W.—1,577 f.; July 12, 1903.
E 15. 55° 47′ N., 12° 28′ W.—1,561 f.; ,, 16 ,,
E 16. 55° 47′ N., 10° 12′ W.—1,325 f.; ,, 19 ,,

Depth in fathoms.	Closing net.	0	100	200	400	500	600	700	800	1,000
Calanus finmarchicus	. .	–	×	–	×	×	–	–	×	×
,, tenuicornis	. .	–	–	–	–	×	–	–	–	–
Rhincalanus nasutus	. .	–	–	–	–	×	–	×	–	×
Eucalanus elongatus	. .	–	–	–	×	×	–	–	–	–
,, crassus	. .	–	–	× j	×	×	–	–	–	–
Metridia lucens	. .	×	×	×	×	×	–	×	×	×
,, Normani	. .	–	–	–	–	×	×	–	–	–
,, longa	. .	–	–	×	–	×	–	–	–	–
Ætideus armatus	. .	–	×	×	–	–	–	×	–	–
Acartia Clausii	. .	×	×	–	×	×	×	×	×	×
Ectinosoma atlantica	. .	–	–	–	×	×	–	×	–	–
Gaetanus armiger	. .	–	–	× j	–	×	–	–	–	–
,, major	. .	–	–	–	×	–	–	–	–	–
,, caudani	. .	–	–	×	–	–	–	–	–	–
Gaidius pungens	. .	–	–	–	–	×	–	–	–	–
Euchæta norvegica	. .	–	× j	–	–	–	×	–	–	–
,, barbata	. .	–	–	–	–	×	–	–	–	–
Heterorhabdus norvegicus	.	–	–	×	–	–	×	–	–	–
,, grandis	.	–	–	–	×	–	–	–	–	–
Pseudætideus armatus	. .	–	–	–	–	–	×	–	–	–
Lucicutia flavicornis	. .	–	–	–	–	–	×	–	–	–
Euchirella carinata	. .	–	–	–	–	×	–	–	–	–
Faroella multiserrata	. .	–	–	–	–	–	–	–	–	×
Pleuromamma robusta	. .	×	–	×	–	×	–	–	–	×
Scolecithrix minor	. .	–	–	–	–	×	–	–	–	–
Xanthocalanus atlanticus	.	–	–	–	×	–	–	–	–	–
Candace norvegica	. .	–	–	–	–	×	–	–	–	–
Spinocalanus magnus	. .	–	–	–	×	–	×	×	×	–
Oncea sp.	. .	–	–	×	–	×	×	×	×	×
Oithona sp.	. .	×	×	×	×	×	–	×	×	×

TABLE VII.

Between 54°–55′ N. Stations E 12 and 13. E 12. 54° 00′ N., 12° 0′ W.—205 f.; July 9, 1903. E 13. 54° 30′ N., 12° 0′ W.—1,608 f.; ,, 11 ,,												Between 53°–54°. Stations E 10 and 11. E 10. 53° 00′ N., 11° 56′ W.—100 f.; July 8, 1903. E 11. 53° 30′ N., 12° 00′ W.—150 f.; July 9, 1903.		Between 52°–53°. Stations E 8 and 9. E 8. 52° 00′ N., 12° 00′ W.—255 f.; July 8, 1903. E 9. 52° 30′ N., 12° 00′ W.—130 f.; July 8, 1903.		
Depth in fathoms. Closing net.	0	100	200	300	400	500	600	700	800	1000	1200	0	150	0	100	250
Calanus finmarchicus	—	×	—	×	×	×	×	×	×	×	—	×	×	—	×	—
,, tenuicornis	—	—	—	—	—	—	×	—	—	—	—	—	—	—	—	—
Eucalanus elongatus	—	×	—	×	×	—	—	—	—	—	—	—	—	—	×	—
,, crassus	—	×	—	×	×	—	—	—	—	—	—	—	—	—	—	—
Rhincalanus nasutus	—	—	×	×	×	—	—	×	×	×	×	—	×	—	×	×
Paracalanus parvus	—	×	—	—	—	—	—	—	—	—	—	×	×	×	×	×
Metridia lucens	—	×	×	×	×	—	×	×	—	×	×	×	×	—	×	×
,, brevicauda	—	—	×	×	—	—	—	—	—	—	—	—	×	—	—	—
,, Normani	—	—	—	×	—	×	—	—	×	—	—	×	—	—	—	—
Scolecithrix minor	—	×	×	—	—	—	—	—	—	—	—	—	—	—	—	—
Acartia Clausii	×	×	×	—	×	—	—	×	×	×	×	×	×	×	×	×
Ectinosoma atlantica	—	—	—	—	×	—	×	×	—	×	×	—	—	—	—	—
Ætideus armatus	—	×	×	—	—	—	—	×	—	—	—	—	×	—	×	—
Euchæta norvegica	—	× j	×	×	×	—	×	—	×	—	—	—	×	—	×	—
Heterorhabdus norvegicus	—	×	×	—	×	—	×	—	—	—	× !	—	—	—	—	—
,, longicornis	—	—	—	×	×	—	—	—	—	—	—	—	—	—	—	—
Gaidius pungens	—	—	—	—	×	—	×	—	—	—	—	—	—	—	—	—
,, major	—	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—
Gaetanus armiger	—	—	×	—	×	×	×	—	—	—	—	—	—	—	—	—
,, major	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—	—
,, caudani	—	—	×	—	—	—	×	—	—	—	—	—	—	—	—	—
Euchirella carinata	—	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—
Lucicutia flavicornis	—	—	—	×	×	—	—	—	—	—	—	—	—	—	—	—
Phyllopus bidentatus	—	—	—	—	—	—	—	—	×	—	—	—	—	—	—	—
Pleuromamma abdominalis	—	—	×	—	—	—	—	—	×	—	—	—	—	—	—	—
,, robusta	—	—	×	×	×	—	×	—	×	×	×	×	×	—	×	—
Haloptilus longicornis	—	×	—	—	×	—	—	—	—	—	—	—	—	—	—	—
Undeuchæta major	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—	—
,, minor	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—	—
Amallophora magna	—	—	—	×	—	—	—	—	—	—	×	—	—	—	—	—
Candace norvegica	—	—	—	×	×	—	—	—	—	—	—	—	—	—	—	—
,, robusta	—	—	—	×	—	×	—	—	—	—	—	—	—	—	—	
Pseudætideus armatus	—	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—
Augaptilus longicaudatus	—	—	—	×	×	—	—	—	—	—	—	—	—	—	—	—
Spinocalanus magnus	—	—	—	×	×	—	×	×	—	×	—	—	—	—	—	—
Oithona sp.	—	×	×	—	—	×	×	×	×	×	×	—	×	×	×	×
Oncæa sp.	—	×	×	×	×	×	×	×	×	×	×	—	×	—	×	—
Pseudocalanus elongatus	—	—	—	—	—	—	—	—	—	—	—	×	×	—	×	—
Euchirella curticauda		—			—	—	—	—	—	—	—	—	—	—	×	—
Ctenocalanus vanus		—	—		—	—	—	—	—	—	—	—	—	—	×	—
Calocalanus pavo		—	—	—	—	—	—	—	—	—	—	—	—	—	×	—
Longipedia coronata		—	—	—	—	—	—	—	—	—	—	—	—	—	—	×

TABLE VIII.

Between 51° and 52°—Stations E 1, E 2, E 3, E 4, E 5, E 6, E 7.

E 1. 51 56′ N., 11 21′ W.—120 f. ; June 10, 1903.
E 2. 51° 46′ N., 12 15′ W.—560 f. ; ,, 12 ,,
E 3. 51 34′ N., 12 30′ W.—720 f. ; ,, 22 ,,
E 4. 51 00′ N., 11° 32′ W.—375 f. ; ,, 24 ,,
E 5. 51 00′ N., 12 00′ W.—980 f. ; June 25, 1903.
E 6. 50 56′ N., 12 6′ W.—1,000 f. ; July 6 ,,
E 7. 51 30′ N., 12 00′ W.—600 f. ; ,, 7 ,,

Depth in fathoms.	Closing net.	0	100	200	300	400	500	600	700	800	1,000
Calanus finmarchicus		×	×	–	×	×	×	×	×	×	–
Eucalanus elongatus		×	×	×	×	×	×	×	×	×	–
,, crassus		× j	–	×	–	–	–	–	–	–	–
Rhincalanus nasutus		–	×	×	×	×	×	×	×	×	×
Acartia Clausii		×	×	×	×	×	×	–	×	×	–
Ectinosoma atlantica		×	×	×	×	×	–	×	–	×	–
Metridia lucens		×	×	×	×	×	×	×	×	×	×
,, brevicauda		–	–	–	–	–	×	×	–	×	–
,, Normani		–	–	–	–	×	–	×	–	–	–
Heterorhabdus vipera		–	–	×	×	–	–	–	–	–	–
,, longicornis		–	–	–	×	×	–	–	–	–	–
,, norvegicus		–	–	–	–	×	×	–	–	–	×
,, abyssalis		–	–	–	×	–	–	–	–	×	–
Lucicutia flavicornis		–	–	×	–	×	–	–	–	–	–
Bradyidius armatus		–	–	–	–	×	×	–	–	–	–
Phyllopus bidentatus		–	–	×	×	–	–	–	–	–	–
Paracalanus parvus		×	–	×	–	×	×	×	–	–	–
Lucicutia grandis		–	–	–	–	–	–	–	×	–	–
Anomalocera Patersoni		×	–	–	–	×	–	–	–	–	–
Ætideus armatus		–	×	×	–	–	–	–	–	×	–
Pseudætidius armatus		–	–	×	–	–	–	–	–	×	–
Faroella		–	–	–	×	×	–	–	–	–	–
Euchæta norvegica		–	× j	× j	×	–	×	–	–	×	×
,, acuta		×	–	–	×	–	–	–	–	–	–
Phaenna spinifera		–	×	×	–	×	–	–	–	–	–
Haloptilus longicornis		×	–	–	–	×	–	–	–	–	–
,, acutifrons		–	×	×	–	–	–	–	–	–	–
Pseudocalanus elongatus		×	×	–	×	×	–	–	–	×	–
Lophothrix frontalis		–	–	–	–	–	×	–	–	–	–
Spinocalanus magnus		–	–	–	–	×	×	×	×	×	–
,, abyssalis		–	–	–	×	–	–	–	–	–	–
Augaptilus gibbus		–	–	–	–	×	–	–	–	–	–
,, longicaudata		–	–	×	×	×	–	–	–	–	–
,, magnus		–	–	–	–	–	×	–	–	–	–
Scolecithrix minor		–	×	×	×	–	–	–	–	–	–
Undeuchæta major		–	–	–	×	–	–	–	–	–	–
,, minor		–	–	–	×	–	–	–	–	–	–
Gaetanus armiger		–	–	×	–	×	–	–	–	–	–
,, caudani		–	–	–	×	–	–	–	–	–	–
Amallophora magna		–	–	–	×	–	–	–	–	–	–
Xanthocalanus		–	–	–	×	–	–	–	–	–	–
,, atlanticus		–	–	–	×	–	–	–	–	–	–
Ægisthus atlanticus		–	–	–	×	–	–	–	–	–	–
Candace norvegica		–	–	×	×	–	–	–	–	–	–
Amallophora securifrons		–	–	×	–	–	–	–	–	–	–
Pleuromamma robusta		×	–	×	×	×	×	×	×	×	–
Xanthocalanus cristatus		–	–	–	×	–	–	–	×	–	–
Megacalanus		–	–	–	–	–	×	–	–	–	–
Oncea sp.		–	×	×	–	×	×	×	×	×	×
Oithona sp.		×	×	–	×	×	×	×	–	–	–
Longipedia coronata		–	–	–	–	–	×	×	–	–	–

EXPLANATION OF PLATE IX.

1. Megacalanus, first foot, basal joints.
2. ,, third foot.
3. Eucalanus atlanticus, ♂, fifth feet.
4. ,, ,, ♂, mandible.
5. Scolecithrix similis, ♀, fifth foot.
6. ,, ,, ♀, side view.
7. Gaetanus major, ♀, abdomen and last thoracic segment.
8. ,, ,, ♀, first foot.
9. Ctenocalanus vanus, ♂, fifth feet.
10. Candace rotunda, ♀, dorsal view.
11. ,, ,, ♀, fifth foot.
12. Lophothrix securifrons, ♀, dorsal view.
13. ,, ,, ♀, fifth feet.
14. ,, ,, ♀, distal portion of anterior foot-jaw.
15. ,, ,, ♀, head.
16. Phyllopus bidentatus, ♂, fifth feet.
17. Xanthocalanus subagilis, ♀, fifth foot.
18. ,, cristatus, ♀, fifth foot.
19. ,, ,, ♀, head, dorsal view.
20. Gaetanus caudani, ♀, dorsal view.
21. ,, ,, ♀, basal of fourth foot.
22. ,, ,, ♀, first foot.
23. Chiridius Vanhöffeni, ♂, lateral view.
24. Xanthocalanus atlanticus, ♀, fifth foot.
25. ,, ,, ♀, second foot.
26. Faroella multiserrata, ♀, dorsal view.
27. ,, ,, ♀, posterior foot-jaw.
28. ,, ,, ♀, terminal view of one of the feet.
29. Pseudætideus armatus, ♀, dorsal view.
30. ,, ,, ♀, first foot.
31. ,, ,, ♂, fifth feet.
32. Xanthocalanus subagilis, ♂, fifth feet. 32*a*. Terminal segment.
33. ,, atlanticus, ♀, lateral view.
34. Heterorhabdus longicornis, ♂, fifth feet.

35 and 35*a*. Lucicutia magna, ♂, fifth feet.

36. Heterorhabdus grandis, ♀, fifth foot.
37. Lucicutia grandis, ♀, first foot.
38. ,, ,, ♀, fifth foot.
39. Metridia Normani, ♀, fifth feet.
40. ,, ,, ♀, portion of anterior antenna.
41. Lophothrix frontalis, ♀, head.
42. ,, ,, ♀, fifth foot.
43. Gaidius pungens, ♂, fifth feet.
44. Paraugaptilus Buchani, ♀, abdomen.
45. ,, ,, ♀, fifth feet.

Marine Biological Association of the United Kingdom.

LIST

OF

Governors, Founders, and Members.

1st MARCH, 1904.

I.—Governors.

The British Association for the Advancement of Science, *Burlington House, W.* £500
The University of Cambridge £500
The Worshipful Company of Clothworkers, 41, *Mincing Lane, E.C.* £500
The Worshipful Company of Fishmongers, *London Bridge* £6905
The University of Oxford £500
Bayly, Robert (the late) £1000
Bayly, John (the late) £600
Thomasson, J. P., *Woodside, near Bolton* £970

II.—Founders.

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

1884 The Corporation of the City of London £210
1884 The Worshipful Company of Mercers, *Mercers' Hall, Cheapside* .... £341 5*s.*
1884 The Worshipful Company of Goldsmiths, *Goldsmiths' Hall, E.C.* £100
1884 The Royal Microscopical Society, 20, *Hanover Square, W.* £100
1884 The Royal Society, *Burlington House, Piccadilly, W.* £350
1884 The Zoological Society, 3, *Hanover Square, W.* £100
1884 Bulteel, Thos., *Radford, Plymouth* £100
1884 Burdett-Coutts, W. L. A. Bartlett, 1, *Stratton Street, Piccadilly, W.* £100
1884 Crisp, Frank, LL.B., B.A., Treas. Linn. Soc., 17, *Throgmorton Avenue, E.C.* £100
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1884 Eddy, J. Ray, *The Grange, Carleton, Skipton* £100
1884 Gassiott, John P. (the late) £100
‡1884 Lankester, Prof. E. Ray, F.R.S., *British Museum (Natural History), South Kensington, S.W.* £100
1884 The Rt. Hon. Lord Masham, *Swinton Park, Masham, Yorkshire* £100
1884 Moseley, Prof. H. N., F.R.S. (the late) £100

†1884 The Rt. Hon. Lord Avebury, F.R.S., *High Elms, Bromley, Kent* £100
1884 Poulton, Prof. Edward B., M.A., F.R.S., *Wykeham House, Oxford* ... £100
1884 Romanes, G. J., LL.D., F.R.S. (the late) £100
1884 Worthington, James (the late) £100
1885 Derby, the late Earl of £100
*1887 Weldon, Prof. W. F. R., F.R.S., *Merton Lea, Oxford* £100
1888 Bury, Henry, M.A., *Mayfield House, Farnham, Surrey* £100
1888 The Worshipful Company of Drapers, *Drapers' Hall, E.C.* £315
1889 The Worshipful Company of Grocers, *Poultry, E.C.* £120
†1889 Thompson, Sir Henry, Bart., 35, *Wimpole Street, W.* £110
1889 Revelstoke, The late Lord £100
1890 Riches, T. H., B.A., *Kitwells, Shenley, Herts* £230
*1900 Bidder, G. P., *Cavendish Corner, Hills Road, Cambridge* £300
1902 Gurney, R., *Longmoor Point, Catfield, Great Yarmouth* £100

III.—Members.

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

1897 Adams, W. R., 57, *Wood Vale, Lordship Lane, London, S.E.* .... Ann.
1900 Aders, W. M., 28, *St. John's Wood Road, London, N.W.* .... Ann.
1884 Alger, W. H., 8, *The Esplanade, Plymouth* .... *C.*
*1895 Allen, E. J., D.Sc., *The Laboratory, Plymouth* .... Ann.
*1889 Alward, G. L., *Enfield Villa, Humberstone Avenue, Waltham, Grimsby* Ann.
1892 Assheton, R., M.A., *Riversdale, Grantchester, Cambridge* £20
1899 Auckland, The Rt. Hon. Lord, *Kitley, Plymouth* .... Ann.

1884 Bailey, Charles, F.L.S., *Atherstone House, North Drive, St. Anne's-on-the-Sea* .... Ann.
1893 Bailey, W. E., *Porth Enys Museum, Penzance* .... *C.*
1902 Baker, R. J., 5, *Restormel Terrace, Plymouth* .... Ann.
1884 Balfour, Prof. Bayley, F.R.S., *Royal Botanic Gardens, Edinburgh* ...... *C.*
1897 Baxter, G. H., *Hutton Road, Brentwood, Essex* .... Ann.
1884 Bayliss, W. Maddock, D.Sc., *St. Cuthberts, West Heath Road, Hampstead* Ann.
1884 Bayly, Miss, *Seven Trees, Plymouth* £50
1884 Bayly, Miss Anna, *Seven Trees, Plymouth* £50
1884 Beaumont, W. I., B.A., *The Laboratory, Plymouth* .... Ann.
1885 Beck, Conrad, 68, *Cornhill, E.C.* .... *C.*
*1889 Beckwith, E. L., *The Knoll, Eastbourne* .... Ann.
1887 Beddard, F. E., F.R.S., *Zoological Society's Gardens, Regent's Park, N.W.* Ann.
1884 Beddington, Alfred H., 8, *Cornwall Terrace, Regent's Park, N.W.* ...... *C.*
1897 Bedford, Mrs., 326, *Camden Road, London, N.* .... Ann.
1903 Bidder, H. F., 10, *Queen's Gate Gardens, London, S.W.* .... Ann.
1893 Bles, A. J. S., *Palm House, Higher Broughton, Manchester* .... Ann.
1884 Bompas, G. C., 121, *Westbourne Terrace, Hyde Park, London, W.* ...... Ann.
1884 Bostock, E., *Stone, Staffordshire* .... Ann.
1890 Bourne, Prof. A. G., F.R.S., *The Presidency College, Madras* .... Ann.
*1884 Bourne, Gilbert C., M.A., *Savile House, Mansfield Road, Oxford* .... Ann.

1898 Bowles, Col. Henry, M.P., *Forty Hall, Enfield* .... Ann.
1895 Bridge, Prof. T. W., D.Sc., *University of Birmingham* .... Ann.
1902 Brighton Corporation, Town Clerk, *Town Hall, Brighton* .... Ann.
1890 Brindley, H. H., M.A., 4, *Devana Terrace, Huntingdon Road, Cambridge* Ann.
1886 Brooksbank, Mrs. M., *Leigh Place, Godstone, Surrey* .... C.
1884 Brown, Arthur W. W., 62, *Carlisle Mansions, Carlisle Place, London, S.W.* C.
1893 Browne, Edward T., B.A., 141, *Uxbridge Road, W.* .... Ann.
1884 Buckton, G. B., *Weycombe, Haslemere* .... Ann.
1896 Bulstrode, H. T., M.D., 4, *The Mansions, Earl's Court, S.W.* .... Ann.
1889 Burnard, Robert, 3, *Hillsborough, Plymouth* .... Ann.
1897 Byrne, L. W., B.A., 33, *Lancaster Gate, London, W.* .... Ann.

1887 Caldwell, W. H. .... C.
†1884 Chamberlain, Rt. Hon. J., M.P., 40, *Prince's Gardens, S.W.* .... Ann.
1887 Clarke, Rt. Hon. Sir E., K.C., 5, *Essex Court, Temple, E.C.* £25
1884 Clay, Dr. R. H., *Windsor Villas, Plymouth* .... Ann.
1885 Clerk, Major-General H., F.R.S., "*Mountfield*," 5, *Upper Maze Hill, St. Leonards-on-Sea, Sussex* £21
1886 Coates and Co., *Southside Street, Plymouth* .... C.
1885 Collier Bros., *Old Town Street, Plymouth* .... C.
1900 Cooper, W. F., B.A., *Ashlyns Hall, Berkhamsted* .... Ann.

*1885 Darwin, Francis, F.R.S., *Wychfield, Cambridge* .... C.
1885 Darwin, W. E., *Ridgemount, Bassett, Southampton* £20
1889 Davies, H. R., *Treborth, Bangor* .... Ann.
1884 Dewick, Rev. E. S., M.A., F.G.S., 26, *Oxford Square, Hyde Park, W.* ... C.
1885 Dixey, F. A., M.A. Oxon., *Wadham College, Oxford* ....£26 5*s.* *and* Ann.
1890 Driesch, Hans, Ph.D., *Philosophenweg* 5, *Heidelberg, Germany* .... C.
†1889 Ducie, The Rt. Hon. the Earl of, F.R.S., *Tortworth Court, Falfield, R.S.O.* £50 15*s.*
1884 Dunning, J. W., 4, *Talbot Square, W.* ....£26 5*s.*
1884 Dyer, Sir W. T. Thiselton, M.A., K.C.M.G., F.R.S., *Director of the Royal Gardens, Kew* .... C.

1898 Eliot, Sir C. N. E., K.C.M.G., C.B., *British Agency, Zanzibar* .... Ann.
1891 Ellis, Hon. Evelyn, *Rosenais, Datchet, Windsor* .... C.
1893 Enys, John Davies, *Enys, Penryn, Cornwall* .... Ann.
1884 Evans, Sir John, D.C.L., F.R.S., *Nash Mills, Hemel Hempstead* £20
1885 Ewart, Prof. J. Cossar, M.D., *University, Edinburgh* £25

1902 Farmer, Prof. J. B., F.R.S., *Claremont House, Wimbledon Common, London* .... Ann.
1894 Ferrier, David, M.A., M.D., F.R.S., 34, *Cavendish Square, W.* .... Ann.
1884 Fison, Frederick W., M.P., 64, *Pont Street, London, S.W.* .... C.
1897 Foster, Richard, *Windsworth, Looe, R.S.O.* .... Ann.
*1885 Fowler, G. Herbert, B.A., Ph.D., 58, *Bedford Gardens, London, W.* ... Ann.
1884 Fox, George H., *Wodehouse Place, Falmouth* .... Ann.
1886 Freeman, F. F., *Abbotsfield, Tavistock, S. Devon* .... C.
1884 Fry, George, F.L.S., *Carlin Brae, Berwick-on-Tweed* £21
1884 Fryer, Charles E., *Board of Trade, S.W.* .... Ann.

1898 Ganz, C., *Aldeburgh, Suffolk* .... Ann.
1892 Galton, F., F.R.S., 42, *Rutland Gate, S.W.* .... Ann.

1885 Gaskell, W. H., F.R.S., *The Uplands, Shelford, Cambridge* .... C.
1899 Gardiner, Dr. Edw. G., *Woods Hole, Mass., U.S.A.* .... C.
1897 Gibbs, Hon. Henry, 10, *Lennox Gardens, S.W.* .... Ann.
1901 Giles, Col. G. M., *Byfield, Mannamead, Plymouth* .... C.
1885 Gordon, Rev. J. M., *St. John's Vicarage, Redhill, Surrey* .... Ann
1902 Gresson, Lieut.-Col. W., *The Barracks, Naas, Co. Kildare, Ireland* ...... Ann.
1884 Grove, E., *Norlington, Preston, Brighton* .... Ann.
1899 Guinness, Hon. Rupert, *Elveden, Thetford* ....£35 15s.
†1884 Günther, Dr. Albert, F.R.S., 2, *Lichfield Road, Kew Gardens* .... Ann.
1900 Gurney, E., *Sprowston Hall, Norwich* .... Ann.

1884 Halliburton, Prof. W. D., M.D., F.R.S., *Church Cottage*, 17, *Marylebone Road, London, W.* .... Ann.
1884 Hannah, Robert, 82, *Addison Road, Kensington, W.* .... C.
*1885 Harmer, S. F., D.Sc., F.R.S., *King's College, Cambridge* .... C.
1889 Harvey, T. H., *Cattedown, Plymouth* .... Ann.
1888 Haselwood, J. E., 3, *Lennox Place, Brighton* .... C.
1884 Haslam, Miss E. Rosa, *Ravenswood, Bolton* £20
1884 Head, J. Merrick, F.R.G.S., J.P., *Pennsylvania Castle, Isle of Portland, Dorset* .... Ann.
1884 Heape, Walter, *Heyroun, Chaucer Road, Cambridge* .... C.
*1884 Herdman, Prof. W. A., F.R.S., *University College, Liverpool*.............. Ann.
1884 Herschel, Col. J., R.E., F.R.S., *Observatory House, Slough, Berks.* ...... C.
1889 Heywood, Mrs. E. S., *Light Oaks, Manchester* .... C.
1884 Hickson, Prof. Sydney J., M.A., D.Sc., F.R.S., *Ellesmere House, Wilenslow Road, Withington, Manchester* .... Ann.
1902 Hill, M. D., M.A., *Eton College, Windsor*.. Ann.
1897 Hodgson, T. V., c/o L. E. Sexton, Esq., 17, *Collings Park, Higher Compton, Plymouth* .... Ann.
1884 Holdsworth, E. W. H., F.L.S., F.Z.S., *Lucerne House, Dartmouth* . .... Ann.
*1887 Howes, Prof. G. Bond, F.R.S., F.L.S., *Royal College of Science, South Kensington* .... Ann.
1884 Hudleston, W. H., M.A., F.R.S., 8, *Stanhope Gardens, South Kensington, S.W.* .... Ann.

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

1885 Jackson, W. Hatchett, M.A., D.Sc., F.L.S., *Pen Wartha, Weston-super-Mare* .... Ann.
1893 Jago, Edward, *Coldrenick, Liskeard, Cornwall* .... Ann.
1887 Jago-Trelawny, Major-Gen., F.R.G.S., *Coldrenick, Liskeard* .... C.
1900 Johnsen, Hans, Norwegian Fisheries Commissioner, *Hull* .... Ann.
1894 Justen, F. W., F.G.S., F.Z.S., 120, *Alexandra Road, South Hampstead, London, N.W.* .... Ann.

1884 Kellock, W. B., F.L.S., F.R.C.S., 94, *Stamford Hill, N.* .... Ann.
1899 Kent, W. Saville, F.L.S., *Belsito, Milford-on-Sea, Hants* .... Ann.

1897 Lanchester, W. F., B.A., *The Knott, Lady Margaret Road, Cambridge*... C.
1885 Langley, Prof. J. N., F.R.S., *Trinity College, Cambridge* .... C.

*1895 Lister, J. J., M.A., F.R.S., *St. John's College, Cambridge* .... Ann.
1888 Lopes, The Rt. Hon. Sir Massey, Bart., *Maristow, Roborough, South Devon* .... Ann.

1885 Macalister, Prof. A., F.R.S., *St. John's College, Cambridge* .... Ann.
1884 MacAndrew, James J., *Lukesland, Ivybridge, South Devon* .... Ann.
1900 Macfie, J. W. Scott, *Rowton Hall, Chester* .... C.
1884 Mackrell, John, *High Trees, Clapham Common, S.W.* .... C.
1886 MacMunn, Charles A., M.D., *Oak Leigh, Wolverhampton* .... Ann.
1902 Major, Surgeon H. G. T., 24, *Beech House Road, Croydon* .... C.
1889 Makovski, Stanislaus, *Fairlawn, Redhill* .... Ann.
1885 Marr, J. E., M.A., F.R.S., *St. John's College, Cambridge* .... C.
1902 Martin, C. H., *Magdalen College, Oxford* .... Ann.
1884 McIntosh, Prof. W. C., F.R.S., 2, *Abbotsford Crescent, St. Andrews, N.B.* C.
1884 Michael, Albert D., *Cadogan Mansions, Sloane Square, S.W.* .... C.
*1903 Mill, H. R., D.Sc., 62, *Camden Square, London, N.W.* .... Ann.
*1899 Minchin, Prof. E. A., *University College, London* .... Ann.
1885 Mocatta, F. H., 9, *Connaught Place, W.* .... C.
1886 Mond, Ludwig, F.R.S., 20, *Avenue Road, Regent's Park, N.W.* .... C.
1884 Morgan, Prof. C. Lloyd, F.R.S., *University College, Bristol* .... Ann.
†1889 Morley, The Rt. Hon. the Earl of, 31, *Prince's Gardens, S.W.* .... Ann.
†1896 Murray, Sir John, K.C.B., F.R.S., *Challenger Lodge, Wardie, Edinburgh* Ann.

†1884 Newton, Prof. Alfred, M.A., F.R.S., *Magdalen College, Cambridge* £20
†1884 Norman, Rev. A. M., M.A., D.C.L., F.R.S., *The Red House, Berkhamsted, Herts* .... Ann.

1885 Phillips, Chas. D. F., M.D., 10, *Henrietta Street, Cavendish Square, W.* C.
1887 Phipson, Mrs., *Dasak Bungalow, Nasik Road, Deccan, India* .... Ann.
1886 Power, Henry, C.B., F.R.C.S., 37A, *Great Cumberland Place, W.* ...... Ann.
1885 Pritchard, Prof. Urban, 26, *Wimpole Street, W.* .... Ann.
1884 Pye-Smith, P. H., M.D., 48, *Brook Street, W.* .... C.

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

1884 Ralli, Mrs. Stephen £30
1885 Ransom, W. B., *The Pavement, Nottingham* .... C.
1888 Rawlings, Edward, *Richmond House, Wimbledon Common* .... Ann.
1892 Robinson, Miss M., *University College, London, W.C.* .... Ann.
1892 Rüffer, M. A., M.D., *Conseil Sanitaire, Maritime et Quarantenaire, Alexandria, Egypt* .... Ann.

1897 Sandeman, H. D., 4, *Elliot Terrace, Plymouth* .... Ann.
1888 Scharff, Robert F., Ph.D., *Science and Art Museum, Dublin* .... Ann.
1901 Schiller, F. W., *Burnham, Westcombe Hill, Blackheath, London, S.E.* ... Ann.
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Published on behalf of the International Council

BY

ANDR. FRED. HÖST ET FILS,

COPENHAGEN.

OBJECTS

OF THE

Marine Biological Association of the United Kingdom.

THE ASSOCIATION was founded at a Meeting called for the purpose in March, 1884, and held in the Rooms of the Royal Society of London.

The late Professor HUXLEY, at that time President of the Royal Society, took the chair, and amongst the speakers in support of the project were the late Duke of ARGYLL, the late Sir LYON PLAYFAIR, Lord AVEBURY, Sir JOHN HOOKER, the late Dr. CARPENTER, Dr. GÜNTHER, the late Lord DALHOUSIE, the late Professor MOSELEY, the late Mr. ROMANES, and Professor LANKESTER.

The Association owes its existence and its present satisfactory condition to a combination of scientific naturalists, and of gentlemen who, from philanthropic or practical reasons, are specially interested in the great sea fisheries of the United Kingdom. It is universally admitted that our knowledge of the habits and conditions of life of sea fishes is very small, and insufficient to enable either the practical fisherman or the Legislature to take measures calculated to ensure to the country the greatest return from the "harvest of the sea." Naturalists are, on the other hand, anxious to push further our knowledge of marine life and its conditions. Hence the Association has erected at Plymouth a thoroughly efficient Laboratory, where naturalists may study the history of marine animals and plants in general, and where, in particular, researches on food-fishes and molluscs may be carried out with the best appliances.

The Laboratory and its fittings were completed in June, 1888, at a cost of some £12,000. Since that time investigations, practical and scientific, have been constantly pursued at Plymouth. Practical investigations upon matters connected with sea-fishing are carried on under the direction of the Council; in addition, naturalists from England and from abroad have come to the Laboratory, to carry on their own independent researches, and have made valuable additions to zoological and botanical science, at the expense of a small rent for the use of a working table in the Laboratory and other appliances. The number of naturalists who can be employed by the Association in special investigations on fishery questions, and definitely retained for the purpose of carrying on those researches throughout the year, must depend on the funds subscribed by private individuals and public bodies for the purpose. The first charges on the revenue of the Association are the working of the sea-water circulation in the tanks, stocking the tanks with fish and feeding the latter, the payment of servants and fishermen, the hire and maintenance of fishing-boats, and the salary of the Resident Director and Staff. At the commencement of this number will be found the names of the gentlemen on the staff.

In the summer of 1902 the Association was commissioned by His Majesty's Government to carry out in the southern British area the scheme of International Fishery Investigations adopted by the Conference of European Powers which met at Christiania in 1901. In connection with this work a laboratory has been opened at Lowestoft.

The purpose of the Association is to aid at the same time both science and industry. It is national in character and constitution, and its affairs are conducted by a representative Council, by an Honorary Secretary and an Honorary Treasurer, without any charge upon its funds, so that the whole of the subscriptions and donations received are devoted absolutely to the support of the Laboratory and the prosecution of researches by aid of its appliances. The reader is referred to page 4 of the Cover for information as to membership of the Association.

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All correspondence should be addressed to the Director, The Laboratory, Plymouth.

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Journal

OF THE

MARINE BIOLOGICAL ASSOCIATION

OF

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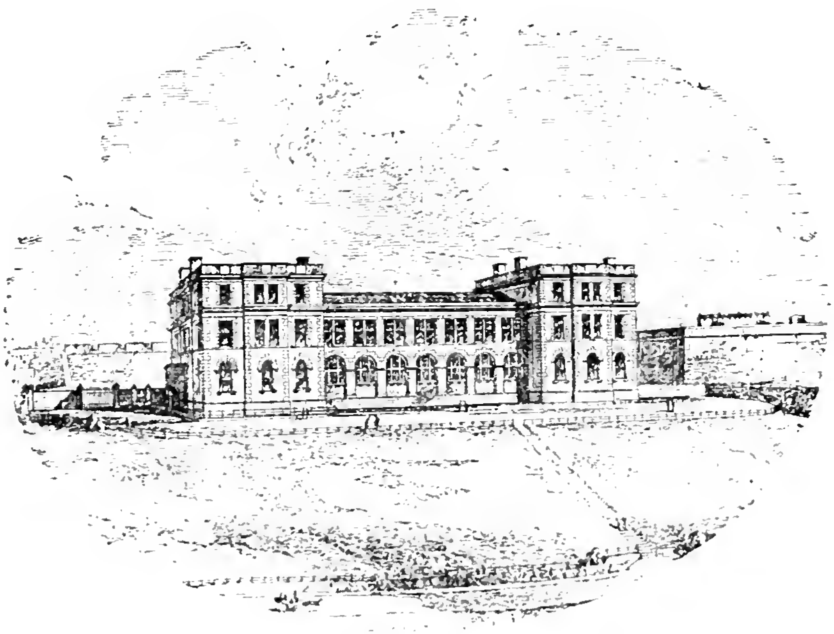

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SCALE OF 1 SEA MILE
SALTASH
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RAT ISLAND
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DEVONPORT
PLYMOUTH
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ST JOHNS LAKE
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FISHERS NOSE
LAIRA BR
CATTEDOWN
CATTEWATER
ORESTON
DEVILS PT
CREMYLL
BARN POOL
DRAKES ISLAND
ASIA SH
WINTER SH
MALLARD
RUM BAY
MT BATTEN
TURNCHAPEL
MILLBROOK LAKE
MOUNT EDGCUMBE
THE BRIDGE
MILLBROOK
MAKER CH
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STADDON PT
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LIGHTHOUSE
BREAKWATER
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BOVISAND BAY
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THE SOUND
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SHAGSTONE
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RIVER YEALM
RAME HEAD
MEWSTONE
MAGNETIC
TO EDDYSTONE 7 MILES
20 FATHOMS
BLACKSTONE PT
STOKE POINT

Plymouth Marine Invertebrate Fauna

Being Notes of the Local Distribution of Species occurring in the Neighbourhood.

COMPILED FROM THE RECORDS OF THE LABORATORY OF THE

Marine Biological Association.*

(With one Chart.)

TABLE OF CONTENTS.

INTRODUCTION.

AFTER the publication in this Journal in 1899 of the paper "On the Fauna and Bottom-Deposits near the Thirty-Fathom Line from the Eddystone Grounds to Start Point" (*Journ. Mar. Biol. Assoc.*, vol. v. pp. 365–542), observations were undertaken for the purpose of pre-

* It is hoped that main references to this paper may be made under "Marine Biological Association," and not under an author's name.—ED.

paring a similar account of the fauna of the inshore grounds in the neighbourhood of Plymouth. As the work proceeded, however, it was realised that, owing to the great damage which has been caused to the grounds within easy reach of the harbour by the constant discharge of mud and refuse from barges working in connection with the new dock-yard extension at Devonport and other harbour works, any attempt to prepare a consecutive account of the fauna and bottom-deposits over the whole area, such as was given for the grounds from Eddystone to Start, would be a matter of extreme difficulty and of little use.

The present report has therefore been arranged in a somewhat different way. A general account is first given of certain typical areas, their physical conditions are briefly described, and a short list is added of the more common and characteristic species which are found in them. This description of the grounds is followed by a general list of the species which have been recorded in the whole area investigated, and the local distribution of each, so far as it is shown from the Laboratory records, is given. The information supplied in the two sections of the report when combined furnishes for each species a general idea of the conditions under which it lives.

Some explanation is necessary as to the scope of the general list. It is not intended to be a complete list of all species which have been recorded from the Plymouth district,* but only of such as have been found in recent years as a result of the work carried on at the Plymouth Laboratory and for which the exact locality of capture is known. All records which appeared to be in any way questionable have been deliberately omitted. Omissions, which in some groups especially are known to be exceedingly numerous, are easily made good at a later date, whilst false records are less readily corrected.

In all cases the initials of the person or persons responsible for a record have been given, but it must not be supposed that the persons so indicated were the first or only ones to find the species in the locality indicated. During the course of preparing this paper for the press it has been frequently necessary, especially in the case of the common and widely distributed species, to frame a general note expressing facts which have for long been well known in the Laboratory, but in order to fix responsibility such notes have been followed by the initials of the person by whom they were framed. In editing the notes, care has been taken that the collection of records for each species shall, as far as possible, give a not incorrect indication of the abundance and distribution of the species in the Plymouth district.

* Records for Plymouth previous to 1888 are summarised by Heape, "Preliminary Report upon the Fauna and Flora of Plymouth Sound," *Journ. Mar. Biol. Assoc.*, Old Series, ii.

Many of the records have already been printed in the Journal of the Association and elsewhere. It has not, however, been thought necessary in such cases to give detailed references, as a classified list of papers dealing with work done in the Laboratory has already been published (*Journ. Mar. Biol. Assoc.*, vol. vi. p. 115).

As regards the question of nomenclature, whilst the names used are in general those which it is thought will be finally adopted by zoologists, we have not attached undue importance to this aspect of the matter, but by supplying in each case one reference to a good description (preference being given to one accompanied by a figure or to one in a recognised monograph of the group), we have endeavoured to leave no room for doubt as to the precise species which the name is intended to indicate.

The vast amount of detailed work which the preparation of this paper has entailed has been carried out chiefly by Mr. R. A. Todd and by Mr. S. Pace. A large amount of preliminary work in bringing the records together was carried out by Mr. Todd. The whole, excepting Foraminifera and Worms, has been critically reviewed, extended, and prepared for the press by Mr. Pace, who has also paid special attention to the nomenclature and references employed.

Each group when completed has been submitted for critical examination to one or more specialists, to whom, as well as to the authors of the records, the best thanks of the Association are due for the help given.

Taking the groups in the order in which they are printed, the following notes as to the relative completeness of the lists, and as to those who have chiefly assisted in their preparation, may be of service.

FORAMINIFERA. Our records for this group are almost all due to Mr. R. H. Worth, who has also arranged the list for publication. It has been submitted to Mr. J. J. Lister, who has made some valuable additions.

PORIFERA. The list is a very imperfect one, many common species not having been identified and recorded. The records that we have are chiefly due to Prof. E. A. Minchin and Mr. G. P. Bidder, both of whom have assisted in the revision.

HYDROZOA. Most of the species which occur at all frequently are believed to have been included. The lists have all been revised by Mr. E. T. Browne, to whom we are indebted for many additions and suggestions.

ALCYONARIA. Probably gives all the local species.

ZOANTHARIA. An incomplete list, no specialist on the group having worked at Plymouth.

CTENOPHORA. The only frequent species are included, but the number of records is not large.

ECHINODERMA. Mr. Pace has devoted particular attention to this group, and the list given is an almost complete one, except for the Holothuria.

TURBELLARIA. The records are almost all derived from Dr. F. W. Gamble's list published in this Journal (vol. iii. p. 30), and has been submitted to Dr. Gamble and Dr. E. G. Gardiner.

NEMERTINI. The list is based on that published in this Journal (vol. iii. p. 1) by Mr. T. H. Riches. It has been revised and added to by Mr. Riches, Mr. R. C. Punnett, and Mr. W. I. Beaumont.

POLYCHÆTA, ARCHIANNELIDA. The majority of the records are by Dr. E. J. Allen, by whom the list has been prepared. It is believed to be fairly complete for species which occur at all frequently, excepting in the families *Syllidæ* and *Maldanidæ*.

The list of *Polynoidæ* is based on that published by Mr. T. V. Hodgson in this Journal (vol. vi. p. 218).

MYZOSTOMARIA, GEPHYREA, HIRUDINEA, OLIGOCHÆTA, CHÆTOGNATHA. The lists of these groups are known to be incomplete.

CRUSTACEA. The list of BRANCHIOPODA is probably complete, that of the OSTRACODA contains only a few records kindly supplied by the Rev. Dr. A. M. Norman, of which no account of the local distribution can be given, whilst that of the COPEPODA is confined to species for which Plymouth records have already been published by Mr. G. C. Bourne (*Journ. Mar. Biol. Assoc.*, N.S., i. p. 144) and by Prof. P. T. Cleve (*Svenska. Akad. Handl.*, vol. xxxiv., No. 2; Stockholm, 1900, etc.). The parasitic Copepoda recorded by Dr. Bassett-Smith as occurring at Plymouth have been omitted, as they were probably not found upon fish caught within the area dealt with in this paper. The list of CIRRIPEDIA is fairly complete.

The AMPHIPODA and ISOPODA are incomplete as regards the smaller forms, and do not contain records by anyone who has worked exhaustively at the groups in this district. CUMACEA are also incomplete. The SCHIZOPODA, the account of which has been prepared by Mr. W. I. Beaumont, probably includes all the species which occur in any abundance.

The MACRURA and BRACHYURA are fairly complete.

PYCNOGONIDA have not been revised by a specialist, and the list is imperfect.

BRYOZOA. The list has been submitted to Dr. S. F. Harmer, who has added many records.

MOLLUSCA. The lists, which are chiefly based on the work of Mr. Todd and Mr. Pace, include all the more prominent forms, but are incomplete as regards the smaller and more critical species. The TECTIBRANCHIATA have been revised by Mr. W. I. Beaumont.

TUNICATA. The account is chiefly based upon the work of Mr. W. Garstang, but is by no means complete, as many of his records could not be made available in time for publication.

The description of the grounds has been prepared by Dr. E. J. Allen, with the assistance of Mr. S. Pace.

An alphabetical index of the grounds will be found below, and a list of all those zoologists by whom records have been made on p. 172.

E. J. A.

DESCRIPTION OF GROUNDS.

ALPHABETICAL INDEX.

The area dealt with in this report extends from the shore to a depth of from 30 to 35 fathoms and may be considered as limited on the seaward side by a line running westwards from Bolt Head, passing a little outside the Eddystone Rocks and Hand Deeps, and then drawing northwards and meeting the coast at Looe. The length of such a line is about 35 miles, and the greatest breadth of the sea area included within it (from Plymouth to beyond the Eddystone) is from 14 to 15 miles. Roughly speaking, this area may be said to lie within a radius of 15 miles from the Laboratory. The area contains a number of typical tidal rivers (Hamoaze, Cattewater, Yealm R.), the large sheets of enclosed and sheltered sea represented by Plymouth Sound and the mouth of the Yealm, and a considerable stretch of coastal water exposed to the full force of the waves of the English Channel.

Before giving the detailed list of the fauna inhabiting the area, it will be convenient to review the general conditions prevailing in its different parts. In this way it is hoped that some conception, even if it be an imperfect one, of the nature of the influences which limit the distribution of the different species may be formed by those having no personal knowledge of the neighbourhood.

PLYMOUTH SOUND AND THE ADJACENT TIDAL RIVERS.

Plymouth Sound must be regarded as an enclosed and sheltered arm of the sea, into which the two tidal rivers, the Tamar (with its estuary the Hamoaze) on the west, and the Plym (with its estuary the Cattewater) on the east, discharge their waters. The fauna and the flora of the Sound, in their general nature, are marine rather than estuarine. The typical estuarine species of the Hamoaze and Cattewater occupy no predominant place in their composition, and the effect of the fresh water entering the area does not appear to be great. On the other hand the conditions in the Sound differ from those obtaining on the open coast, chiefly in respect to the force of the action of the waves, and possibly also to the degree of circulation of the waters, both being greatly modified by the presence of the Breakwater.

The fauna and the flora of the Sound are comparable to those found near the mouths of the different estuaries along the south coasts of Cornwall and Devon: *e.g.* Salcombe Estuary below the Salstone (*cf.* this Journal, vol. vi. p. 151), Yealm Estuary below the junction of Newton Creek with Yealm River.

Shores of the Sound.

No attempt will be made to give a detailed account of the whole coast-line, but typical portions, which offer the best opportunities for collecting, will be described.

The shores of the Sound are for the most part rocky, with gravel and stones between the rocks. Fine sand in small patches is exposed here and there at extreme low water, but there are no stretches of sandy shore.

Rum Bay. This term is used as a general name for the shore from Batten Breakwater to Jennycliff Bay.* It is a moderately sheltered stretch of coast, with low rocks of a very friable shale, which dip seawards and form ridges parallel to the line of coast. Near low-water mark the ground between the rocks is for the most part very stony, but fine sand and gravel are found at intervals. The low shale **rocks** are covered, between tide-marks, with *Fucus*, *Pelvetia*, *Ascophyllum*, and other brown weeds, occurring in definite zones, whilst at dead low water *Laminaria* is plentiful. The weeds and rocks are the home of the usual shore Gastropods of the district (*Purpura lapillus*, *Patella vulgata*, *Littorina neritoides*, *L. rudis*, *L. littoralis*, *Gibbula cineraria*, *G. umbilicata*, *Calliostoma zizyphinus*, *Ocinebra erinacea*), occurring each at its proper tidal level, as well as of the Polychaetes *Nereis pelagica*

* The term Rum Bay, as here used, includes both Batten Bay and Rum Bay of the Admiralty charts.

and *Eulalia viridis*. The **overhanging ledges of rock** give shelter to colonies of encrusting sponges (*Hymeniacidon sanguineum*, *Halichondria panicea*, and *Sycon compressum*), compound Ascidians (*Botryllus violaceus*, *Botrylloides rubrum*), and Polyzoa (*Umbonula verrucosa*, *Crisia*), upon, which Nudibranchs (*Archidoris tuberculata*, *Æolidia papillosa*) feed.

On the *Fucus* the Hydroid *Sertularia pumila*, the Polyzoa *Flustrella hispida* and *Membranipora pilosa*, and *Spirorbis borealis* occur in quantity, and, on the *Laminaria*, *Membranipora membranacea* in large patches. *Clava squamata* and *Coryne vaginata* are also often plentiful.

The cracks and **crevices between the layers of shale** shelter a characteristic and typical fauna, of which *Terebella lapidaria*, *Amphitrite gracilis*, *Polydora flava*, *Potamilla reniformis*, and *Petalostoma minutum* are representative species of the higher and intermediate tidal zones, whilst *Marphysa sanguinea* and *Polymnia nebulosa* occupy a similar situation near low-water mark.

The patches of **gravel and coarse sand** contain at the higher tidal levels *Audouinia tentaculata* in large numbers, and the intermediate and lower zones are characterised by the presence of large *Nephthys cæca*, *Sthenelais boa*, *Nereis cultrifera*, and *Glycera convoluta*.

Patches of **fine sand**, the most productive of which lies immediately south of Batten Castle, are found to contain *Arenicola marina*, *Lanice conchilega* (in sheltered situations near rocks), *Nephthys cæca* and *N. Hombergi*, *Pectinaria Koreni*, *Scoloplos armiger*, *Magelona papillicornis*, *Pœcilochætus serpens*, *Scolelepis vulgaris* (in black muddy sand), and a number of other sand-burrowing Polychætes, the burrowing brittle star *Ophiocnida brachiata*, and the Lamellibranchs *Cultellus pellucidus* and *Tapes pullastra*.

On **stony ground** the following species are met with in considerable abundance beneath the stones: *Gammarus marinus*, *Porcellana platycheles*, *Cancer pagurus*, *Carcinus mænas*, *Portunus puber*, *Nebalia bipes*, *Galathea squamifera*, *Lepidonotus clava* and *L. squamata*, *Amphiura elegans*, *Asterina gibbosa*, *Ophiothrix fragilis*, *Leptoplana tremellaris*, *Botryllus violaceus*, *Actinia equina*, and during the winter months *Goniodoris nodosa*.

At the western end of Rum Bay, under Batten Castle, the shale joins the Plymouth **limestone**, and there is a mass of high rocks of the latter kind, with a fauna similar to that described in a subsequent paragraph.

Drake's Island and Mount Edgcumbe. From their position off the mouth of the Hamoaze Estuary, the shores of Drake's Island and Mount Edgcumbe are under the influence of tidal streams of considerable force, whilst at the same time they are sheltered from the south-west, and hence not exposed to the most violent wave action. The shores of Drake's Island are for the most part rocky, the rocks, composed of a hard grit, being generally steep and high. Between the rocks are small patches of stony ground, and of sand and gravels of various textures. The shores of Mount Edgcumbe resemble the stony patches on Drake's Island, and may be treated with them.

The fauna on the rock faces resembles that at Rum Bay, and needs no further detailed description beyond a notice of the fact that owing to the steeper character of the shore and the height of the rocks, the extent of surface exposed at each of the tidal levels becomes very much reduced, so that those animals which are restricted to a particular zone are represented by a relatively smaller number of individuals.

The overhanging ledges of rock are larger and more profusely covered than those at Rum Bay, but the same species are plentiful. Perhaps the most important addition to be made to the list given for Rum Bay is the Ascidian *Clavelina lepadiformis*, which during some summers has been very abundant beneath these ledges.

The characteristic fauna in the crevices of the soft shale at Rum Bay is not so marked at Drake's Island, though *Marphysa sanguinea* and *Polymnia nebulosa* are plentiful in crevices at dead low water.

On stony ground between the rocks at Drake's Island and along the Mount Edgcumbe shore, in addition to the species found under similar circumstances at Rum Bay, there may be found beneath the stones, more plentifully than at the latter locality, specimens of *Cucumaria saxicola*, *Cucumaria Normani*, and *Echinus miliaris*, whilst *Myriothela phrygia* is very frequent attached to the under surface of the stones.

On the south side of Drake's Island a patch of clean shell gravel is exposed, which is probably continuous with the shell gravel of Queen's Ground (cf. p. 165). In addition to numerous specimens of *Carcinus mænas*, which are often of variegated colours matching the colour of the shell gravel, the crab *Pirimela* is found, whilst in the gravel *Glycera gigantea* occurs.

On the north-east side is a patch of sand, which is the most characteristic bit of clean, even-grained sand in the district. Its fauna includes *Ammodytes*, *Natica Alderi*, and *Spisula* (*Mactra*) *solida*.

A *Zostera*-bed exposed on the north side of the Island contains numerous *Solen*, occasional specimens of *Echinocardium*, whilst a patch of a few square yards of harder sand is crowded with *Lutraria elliptica*.

Limestone Shores (Rocks below Laboratory and under West Hoe; Rocks at Batten). The rocks on the limestone shores differ from the shale rocks which have been described at Rum Bay, in being much higher, in forming a large number of rock pools at the higher tidal levels, and in being of a much harder and closer texture, with few cracks and crevices. The rock fauna at the higher tidal levels, therefore, shows special features on the limestone shores, whilst the fauna characteristic of the cracks and crevices between the layers of the shale is not represented. The upper portions of the rocks are densely covered with barnacles, amongst which the molluscs *Otina otis* and *Leuconia bidentata* are plentiful. The sides of the rock pools are covered by growths of Coralline, red and green seaweeds, Hydroids such as *Syncoryne gravata*, *Clava squamata*, small *Tubularia*, and the sponges *Leucosolenia botryoides*, *L. complicata*, *L. variabilis*, and *Clathrina coriacea*. In certain of these pools the Archiannelid *Dinophilus tæniatus* is found in great numbers. *Saxicava rugosa* and *Cliona celata* are abundant, boring in the limestone.

In other respects the fauna on the limestone rocks does not greatly differ from that on the shale, the free-living animals being almost exactly the same. Some of the overhanging ledges are densely covered with the Ascidian, *Styelopsis grossularia* and *Potamilla reniformis* is very abundant.

The Breakwater. The most interesting feature of the fauna of the Breakwater is the collection of animals which are found boring in the limestone of which it is built. To such an extent is the stone eaten into by various animals that considerable damage is done to the structure, and constant repairs are called for. In a stone which has been injured through this cause the outer surface, to the depth of about a quarter of an inch, is converted into a honey-combed, friable mass through the ravages of the boring sponge *Cliona celata*, whilst at frequent intervals larger holes, each of which may have a diameter of a quarter of an inch, and may pierce the stone to the depth of one inch, are formed by the boring mollusc, *Saxicava rugosa*. To these two animals most of the damage is due, but in addition there are found a few holes formed by the mollusc *Gastrochæna dubia*, and many by the Polychætes *Dodecaceria concharum*, *Polydora ciliata*, *Polydora hoplura*, and *Potamilla reniformis* (the *Sabella saxicava* of Quatrefages). *Dodecaceria* forms holes of oval or figure of eight section, which may penetrate for a depth of several inches into the heart of the stone; *Polydora ciliata* forms small U-shaped burrows, open at each end, whilst *P. hoplura* makes similar burrows of larger size.*

Other features of the fauna of the Breakwater are the abundance of the anemone *Corynactis viridis*, and of a small salmon-red anemone at present undescribed, of *Caryophyllia Smithi* and of *Galathea strigosa*. Large nests of *Lima hians* have also been found there.

* The facts here recorded were investigated at the request of the Government engineers responsible for the repair of the Breakwater, and a report was furnished on the subject.—E. J. A.

Dredging and Trawling Grounds of the Sound.

The greater part of Plymouth Sound consists of comparatively shallow water (4-6 fms.) with a bottom-deposit of fine muddy sand. Winding through this is a channel of much deeper water, which represents the old river-bed of the Tamar. After leaving the Hamoaze (the estuary of the Tamar) this deep channel turns northwards until it strikes the northern shores of the Sound close to Millbay, where, bending sharply to the eastward, it attains a depth of 23 fathoms. The channel continues to run eastwards, keeping within a short distance of the shore but gradually diminishing in depth until it reaches the Mallard Shoal, where, after passing southward between this and the Winter Shoal, it becomes lost in the shallow water forming the central part of the Sound (4-6 fms.). It is in this channel, and in the two channels at the eastern and western ends of the Breakwater, that stony ground suitable for dredging occurs. The greater part of the rest of the Sound, having a bottom of fine sand and mud, is better worked with trawls. The principal grounds referred to in the records are the following:—

Millbay Channel (14–23 fms.). The deep channel off Millbay is one of the most productive dredging grounds in the Sound. The dredge brings up masses of stones of varying size (chiefly limestone), with a few shells, all free from any growth of red or brown seaweeds. The stones are generally covered with a good deal of brownish mud, and are much honeycombed by the boring sponge *Cliona celata*, and by *Saxicava rugosa*, *Polydora ciliata*, and *Dodecaceria concharum*. Sponges, compound Ascidians, *Antennularia antennina*, and small Hydroids and Polyzoa are numerous; a great variety of small Polychætes, more especially Phyllodocids and Syllids, are hidden amongst the cavities on the surface of the stones, and masses of tubes of *Filograna implexa* are frequent.

The deepest part of the channel, which forms a deep pit or hole, is remarkable for the abundance of *Antedon bifida*, the dredge often coming up half full of these Echinoderms. From the sides of the pit *Tubularia indivisa* is often obtained in quantity.

Asia Shoal. Another productive dredging ground lies along the northern edge of the Asia Shoal, which is really the southern margin of the deep channel. The water is here shallower (5–7 fms.) than in the Millbay Channel, the stones are chiefly the shales and grits of Drake's Island, instead of the honeycombed limestones found at Millbay, and they are generally covered with more or less mud. Red seaweeds grow on them in small quantities, and large Hydroids, especially *Antennularia antennina* and *Tubularia indivisa*, are often abundant.

Alcyonidium gelatinosum is sometimes present in large quantities, as well as *Bowerbankia*. Sponges also are numerous, and large numbers of the smaller Polychaetes (*Phyllodoce maculata*, especially, may occur in great quantity) take refuge amongst the fixed organisms. *Calyptraea chinensis* is frequently found.

Queen's Ground. This term is used in the records to indicate the area extending from the Queen's Ground Buoy to the New Ground's Buoy and the ground around the latter. It is really the inner margin of the channel at the western entrance of the Sound. The depth is 5–6 fms. The soil is mainly a coarse shell gravel, amongst which are a number of large shells and rather small flat stones. The ground is very clean, there being little mud covering the stones and shells, and the water is clearer and purer than the estuarine waters from the Hamoaze which run through Millbay Channel. The stones and shells afford attachment to occasional pieces of red seaweed (the rare *Stenogramma* may be especially noted) and to many of the larger Calyptoblastic Hydroids and branching Polyzoa (especially *Bowerbankia*). Lamellibranchs (especially *Spisula*) live amongst the shell gravel, whilst *Portunus depurator* is abundant on it. The Polychaete fauna differs considerably from that found on the edge of the Asia Shoal and in Millbay Channel.

Duke Rock. Depth 4–5 fms. The grounds around the Duke Rock form the western border of the channel at the eastern entrance of the Sound. In recent years the Admiralty have carried out extensive dredging operations in this neighbourhood, and have to a large extent diminished its value as a dredging ground for scientific purposes. The stones and shells which are taken here carry a similar collection of animals to that found at Queen's Ground, but the shell gravel, with the animals which inhabit it on the latter ground, is replaced by finer muddy sand.

Trawling Grounds of the Sound. The fine sand and mud grounds of the centre of the Sound and of Jennycliff Bay are best worked with small trawls of either shrimp mesh or mosquito mesh. Shrimps, prawns, and small crustacea, small flat-fishes, pipe-fishes, *Sepiola atlantica*, and *Philine aperta*, are the characteristic species taken. The dog-whelk (*Nassa reticulata*) and shore crab (*Carcinus maenas*) are abundant species on these grounds, but are best taken in traps.

The Cattewater. The soil in the Cattewater (estuary of the Plym) below Turnchapel is all soft mud, which can be worked with a shrimp trawl. The characteristic local forms are almost exclusively shrimps, prawns (especially *Palaemonetes*), *Mysis flexuosa*, and *Carcinus maenas*. The Cattewater is chiefly useful, however, as a collecting ground, from the fact that the Plymouth trawlers often throw a good deal of their refuse overboard there, and many of the species from outside amongst this refuse are capable of surviving for a time.

THE YEALM ESTUARY.

In the Yealm Estuary is a large body of enclosed and sheltered water, with a fauna which is essentially marine for a considerable distance above the mouth. The mouth is almost closed by a bar of sand, a deep channel being left only on the southern side. At a distance of about a mile from the mouth, the estuary divides into two branches, the Yealm River proper and Newton Creek. The Yealm possesses a number of rich collecting grounds, which would well repay a more careful and detailed study than they have yet received.

Shores.

Yealm Sand-bank. This name has been used in the records to indicate a bank of fine to medium sand on the left bank of the Yealm River above the junction with Newton Creek, which is uncovered at low spring tides. The fauna is characterised by the presence in the sand of large numbers of *Ensis ensis.* By digging may also be obtained in more or less considerable numbers *Synapta inhærens*, *Tapes pullastra* and *T. decussatus*, *Spisula solida*, *Gari depressa*, *Sigalion boa*, *Amphitrite gracilis*, and large specimens of *Nephthys cæca.* On the surface of the bank are found *Calliostoma zizyphinus*, and, during the summer months, *Aplysia punctata*, both in considerable quantities.

Eastern Shore below junction of Yealm River and Newton Creek. Along this shore the soil is composed of a coarse, muddy gravel, the most striking feature of the fauna of which is the abundance of the large Terebellid *Amphitrite Johnstoni*, with its commensal Polynoid, *Gattyana cirrosa.* *Scalibregma inflatum* is also found here.

Zostera Bed near the Mouth of the Yealm. Along the southern shore a *Zostera* bed is just exposed close to the mouth of the estuary. The muddy sand in which the *Zostera* is rooted contains an abundant Polychæte fauna, of which the two most numerous species are *Aonides oxycephala* and *Marphysa Belli*, whilst *Notomastus rubicundus* and *N. latericeus* are also found.

Dredging and Trawling Grounds.

The channel of the river just below the junction of the Yealm and Newton Creek is the best dredging ground in the estuary. The bottom is covered with stones and shells (chiefly oyster-shells), to which red and brown seaweeds are attached in considerable quantities. *Echinus* *miliaris* is often abundant, and both *Asterias rubens* and *A. glacialis* are generally taken as well as *Ophiothrix fragilis.* In addition to the ordinary shallow-water crabs, *Pilumnus hirtellus, Portunus arcuatus, Macropodia rostratus, Inachus dorynchus,* and *Hyas araneus* are usually found. Large specimens of *Archidoris tuberculata* are met with, and *Acmæa virginea, Calyptræa chinensis,* and *Acanthochites fascicularis,* each in considerable numbers, are characteristic. Of Hydroids, large colonies of *Plumularia pinnata* are the most abundant, whilst *Hydractinia echinata* is plentiful on shells inhabited by *Eupagurus Bernhardus.* Large specimens of *Phallusia mamillata* are frequent, as well as specimens of *Ascidiella aspersa. Polycirrus aurantiacus* is very plentiful, whilst numbers of Phyllodocids and Syllids, as well as other small Polychætes, hide amongst the stones and shells. *Eurylepta cornuta, Lineus marinus,* and *Prostheceræus vittatus* are also generally to be found.

In the Yealm River itself, above the junction with Newton Creek, there is a large oyster bed.

Zostera Bed along the Southern Shore.—A *Zostera* bed lies close to the southern shore at the mouth of the harbour, which can be most usefully worked with a shrimp trawl. Its fauna resembles that of the *Zostera* bed in Cawsand Bay, to be mentioned later. In addition to pipe-fishes, wrasse, and other small fishes, *Macromysis flexuosa* is abundant, as well as *Hippolyte varians, Calliostoma striatum, Lacuna divaricata,* and *Haliclystus auricula,* whilst small *Anemonia sulcata* are abundant attached to the *Zostera.*

OUTSIDE GROUNDS.

Shores.

Wembury Bay. The shores of this bay form one of the best collecting grounds on the open coast in the neighbourhood of Plymouth. A reef of high rocks (Church Reef and Blackstone Rocks) runs seawards in a south-westerly direction from in front of Wembury Church, forming deep overhanging ledges on the landward side, and leaving at low water many tide-pools both large and small. To the westward of this reef the shore is formed of stretches of low, weed-covered rocks alternating with patches of gravel and sand of different textures. The whole shore is exposed to almost the full force of the Channel waves, and the greater part of the fauna is found beneath the overhanging ledges and in other sheltered situations amongst the rocks and seaweeds, The fauna of the sand and gravel is not very extensive.

The general character of the fauna of the rock ledges and of the rock pools is similar to that found in corresponding situations within the Sound (*e.g* Rum Bay, Drake's Island), but there is greater profusion both of individuals and of species. The same shore Gastropoda are found in their respective tidal zones, and the ledges of rocks and under sides of stones are covered with the same species of sponges, ascidians, polyzoa, anemones, and hydroids. Of echinoderms the representative species, as on the shores of the Sound, are *Amphiura elegans*, *Ophiothrix fragilis Echinus miliaris*, and *Cucumaria saxicola*, all of which are found under stones, the two latter only at extreme low water.

Reny Rocks. A reef of exposed, weed-covered, low rocks running from the Shagstone to the mainland. The fauna resembles that of the rocks in Wembury Bay.

Whitsand Bay. An exposed shore which consists chiefly of fine shifting sand of a not very productive character. At intervals small reefs of low rocks run out amongst the sand, which form the home of a few ordinary rock-haunting species, and are specially characterised in places by the great abundance of the reef-building polychæte, *Sabellaria alveolata*. The rocky foundation in close proximity to an abundant supply of sand evidently furnishes to these worms the special conditions necessary for the formation of their masses of sand-built tubes.

Dredging and Trawling Grounds.

Cawsand Bay. Depth 3–5 fms. A characteristic inshore shallow bay with a bottom of fine sand. Being sheltered from the south-west, it is protected from the most violent and frequent gales, which in this district come from that direction, and is only visited by heavy seas during gales from the east. In the shallowest parts of the bay is an extensive bed of *Zostera*, with a characteristic fauna, this being one of the chief features which distinguishes the trawling grounds of Cawsand Bay, from those of the more exposed Whitsand Bay, to be presently mentioned.

The smaller Crustacea (*Hippolyte varians*, *Macromysis flexuosa*, Cumacea, etc.) are abundant, and specimens of *Maia squinado*, the common edible crab (*Cancer pagurus*), and the shrimp (*Crangon vulgaris*) are generally obtained. *Sepiola atlantica* is always present and often numerous, and in the summer months *Sepia officinalis* is often abundant. On the *Zostera*, small specimens of *Anemonia sulcata* are frequent, and Foraminifera, especially *Polystomella crispa* and *Discorbina rosacea*, are generally abundant. *Nassa reticulata* occurs in quantity, often covered with Hydroids. *Spisula elliptica* and *Ensis ensis* are common buried in the sand.

The most characteristic feature of the fauna of this bay is, however, the fishes, which are not dealt with in the present report. These consist of flat-fishes (Soles, Plaice, Dabs, etc.), Skates and Rays, and several species of pipe-fish.

Whitsand Bay. Depth 4–8 fms. Another example of a shallow sandy bay, but being open to the south and west, it is subject to much more disturbance from the waves than Cawsand Bay. There is here also a great variety of the smaller Crustacea and *Sepiola atlantica* is abundant. *Corystes cassivelaunus* and *Astropecten irregularis*, characteristic sand-dwelling species, are often taken in this bay, though much less frequently than in deeper water.

Mewstone Ledge. Depth 10–15 fms. A ridge of soft, red conglomerate rock runs seawards in a southerly direction from the Mewstone. Over this ridge at a depth of 10 to 12 fms. it is possible to work a dredge, the dredge often breaking away and bringing to the surface pieces of the rock of considerable size. The rock is free from the growth of any seaweeds, but is well covered with Hydroids, Polyzoa, and sponges. The following species are common and typical of the fauna associated with this red rock: *Eunicella verrucosa* with *Gephyra Dohrni* and *Tritonia plebeia* living upon it; *Alcyonium digitatum* with *Ovula patula; Caryophyllia Smithi* with its associated barnacle *Pyrgoma anglicum; Antennularia antennina* and *A. ramosa* with *Scalpellum vulgare;* small colonies of *Sertularella Gayi* and *S. polyzonias; Plumularia pinnata* and *P. Catharina; Lafoea dumosa* with occasional specimens of *Myzomenia banyulensis* attached: *Cucumaria brunnea* on the rock itself and on the attached Hydroids; occasional specimens of *Antedon rosacea, Ophiothrix fragilis, Henricia sanguinolenta*, and of the large Holothurian, *Holothuria nigra; Ophiopsila aranea* concealed in holes and crevices of the rock; *Phallusia mamillata, Ascidiella scabra*, and *Ciona intestinalis* (small specimens); the Polyzoa *Crisia cornuta* and *Bugula flabellata* in abundance, *Alcyonidium gelatinosum, Bicellaria ciliata*, small colonies of *Cellaria fistulosa* and *C. sinuosa*, and occasional large masses of *Lepralia foliacea*, amongst which a number of small Crustacea, especially large numbers of *Porcellana longicornis*, are to be found. The large *Phyllodoce Paretti* is also often found here. The red rock itself is bored by numbers of *Pholadidea loscombiana*.

Mewstone Shell Gravel. On either side of the Mewstone ledge, and probably in patches between the rocks and the ledge, the bottom soil is composed of a coarse shell gravel. In working a dredge over the ledge a mixed fauna, comprising the animals from the rocks and from the gravel, is generally obtained. The gravel itself may also be worked with a small trawl, the Agassiz trawl having been generally used in our work.

Species characteristic of this shell gravel are *Holothuria nigra* (often in considerable numbers), *Cardium norvegicum, Spatangus purpureus, Glycimeris glycimeris, Lumbriconereis impatiens, Glycera gigantea, Aglaophenia myriophyllum*, and *Eurynome aspera*.

Mewstone 'Amphioxus' Ground. Depth 10–12 fms. About 1½ miles to the southward of the Mewstone (off Yealm Head) is a patch of shell gravel of finer texture than that last described, which is one of the few localities in the Plymouth district where *Amphioxus lanceolatus* has been found in numbers. The fauna of this shell gravel is limited, but very characteristic. In addition to *Amphioxus*, the following are typical species: *Anapagurus lævis* and *Eupagurus cuanensis*, inhabiting chiefly the shells of *Turritella communis* and *Aporrhais pes-pelecani*, associated with which *Epizoanthus incrustatus* is very frequent and the Hydroid *Merona cornucopiæ* is often found, especially on the *Aporrhais* shells; *Phascolion strombi*, not uncommon living in empty *Aporrhais* shells; *Ebalia tumefacta* and *E. tuberosa*, *Glycera lapidum*, and *Onuphis conchilega*.

Mewstone 'Echinoderm' Ground. 2–4 miles south of Mewstone. Depth 23–24 fms. A few years ago this was one of the most profitable grounds in the neighbourhood on which to shoot a trawl when it was desired to obtain a good collection of invertebrates. Recently it has been almost entirely ruined owing to the amount of mud and refuse tipped upon it by barges from Plymouth and Devonport. The bottom soil consists of a coarse muddy gravel. The trawl, after a successful haul, will contain large numbers of *Echinus esculentus*, together with a few *E. acutus;* numbers of *Solaster papposus*, *Buccinum undatum*, *Eupagurus Bernhardus* in *Buccinum* shells, some carrying *Adamsia polypus*, others *Hydractinia echinata*, *Eupagurus Prideauxi*, with *Adamsia palliata ; Pecten opercularis* often in quantity, *P. tigerinus* not uncommon, and an occasional specimen of *P. maximus; Galathea dispersa*, *Inachus dorsettensis*, *Macropodia longirostris*, *Ascidiella scabra*, a few *Asterias glacialis* and *A. rubens*, and varying quantities of *Sertularella Gayi* and *Cellaria sinuosa* and *C. fistulosa*, according to the exact position of the haul.

Inside the 'Echinoderm' ground, between that ground and Yealm Head, in rather shallower water, there is a stretch of coarse, muddy, gravel ground, which is covered almost exclusively with the brittle-star *Ophiothrix fragilis*. A dredge hauled on this ground comes up full of these Echinoderms, a few specimens of large *Ophiocoma nigra* being mixed with them.

Fine Sand south of Mewstone. Depths 27–30 fms. From 5 to 7 miles south of the Mewstone is a frequently worked trawling ground with a bottom of fine clean sand. The fauna here closely resembles that found on the Inner Eddystone Trawling Ground (*cf.* this Journal, vol. v. p. 389). Characteristic and typical species are: *Astropecten irregularis*, *Aphrodite aculeata*, *Corystes cassivelaunus*, *Ophiura ciliaris*, *Dentalium entalis*, *Alcyonium digitatum* attached to shells, *Pecten opercularis* (abundant in patches), *Sertularella Gayi* and *S. polyzonias*, *Aglaophenia myriophyllum*, *Cellaria sinuosa* and *C. fistulosa*, *Ascidiella scabra*, and *Macropodia longirostris*.

Stoke Point Grounds. Western boundary, Blackstone Point; eastern boundary, Revelstoke Church Cove; seaward extension, about 1½ miles. The ground shelves very regularly outside the 10-fm. line; inside this line it is very uneven; maximum depth, 22 fms.

In their general features these grounds present much similarity to the 'Mewstone grounds,' but they offer rather greater diversity of type within a given area; and perhaps partly as the result of this and also of the fact that they are exposed to the full sweep of the Channel tide, the fauna is considerably richer than it is on the Mewstone grounds.

The friable red rock characteristic of the Mewstone Ledge is met with again, and forms numerous more or less detached reefs, off Stoke Point. It is abundantly perforated by *Pholadidea*, and in the disused crypt of this mollusc, the remarkable Ophiurid *Ophiopsila aranea* is plentiful. As at the Mewstone, the surface of the rock is very clean, and it affords attachment to *Eunicella*, *Antennularia*, *Aglaophenia*, *Alcyonium digitatum*, *Caryophyllia*, *Tethya*, etc.

Between the reefs of red rock are patches of very rich shell sand and gravel.

The grounds include an eastward extension of the Mewstone 'Echinoderm' ground, together with patches where *Ophiothrix* and *Ophiocoma* are abundant. In deeper water this gives place to typical '*Chætopterus*' ground.

The Rame-Eddystone Grounds. This name has been used to indicate the grounds lying for 3 to 4 miles on either side of the line from Rame to Eddystone and at depths of from 25 to 30 fms. Two typical classes of grounds can be recognised in this area: (1) coarse grounds with a bottom soil of muddy gravel, on which *Chætopterus* is one of the most striking forms, and the chief Hydroids are *Halecium halecinum* and *H. Beani*; and (2) fine grounds with a bottom soil of fine sand, characterised by the abundance of *Cellaria sinuosa* and *C. fistulosa* and by the Hydroid *Sertularella Gayi*. The grounds are very patchy, and the two typical faunas are much intermingled, so that it is only occasionally and after a short haul that a fair representation of either of the two types of fauna is obtained.

Both classes of ground can be profitably worked with both the dredge and trawl. On both, *Echinus esculentus* and *Pecten opercularis* may be met with in large numbers in particular spots, and *Asterias rubens* and *A. glacialis* are generally distributed over the area.

The following are typical species occurring on the two classes of grounds:—

COARSE GROUNDS. *Chætopterus variopedatus*, *Hyalinœcia tubicola*, *Halecium halecinum* and *H. Beani*, *Atelecyclus septemdentatus*, *Ophiura albida*, *Ophiactis Balli*, *Venus fasciata*, *Tapes virgineus*, and *Ebalia tuberosa* and *E. tumefacta*.

FINE GROUNDS. *Cellaria sinuosa* and *C. fistulosa*, *Ophiura ciliaris*, *Sertularella Gayi* and *S. polyzonias*, *Echinocardium cordatum*, *Corystes cassivelaunus*.

From the above description it will be seen that the fauna of the Rame-Eddystone grounds resembles very closely that of the grounds in the neighbourhood of the Eddystone, already described in this Journal (vol. v. p. 365 *et seq.*).

The Looe-Eddystone Grounds. This name has been applied to an extension westwards of the Rame-Eddystone Grounds. Depths 25–30 fms. The fauna is of a similar general character to that of the latter grounds, but is particularly rich, as the result probably of the presence of much rough and rocky ground intermingled with trawling ground.

The Eddystone Grounds. For a detailed description of these grounds see this Journal (vol v. p. 365).

LIST OF THE SPECIES.

Explanation of Abbreviations.

The authorities for the various records are indicated by their initials, of which the following is a complete list; those of members, or late members, of the staff are marked with an asterisk :—

*A.J.S.—A. J. Smith, Assistant at the Laboratory since 1895.

A.M.N.—The Rev. A. M. Norman, LL.D., F.R.S.

A.O.W.—A. O. Walker.

C.C.N.—Professor C. C. Nutting, University of Iowa.

C.S.—Professor Charles Stewart, LL.D., F.R.S., Conservator of the Royal College of Surgeons.

E.A.M.—Professor E. A. Minchin, M.A., Professor of Zoology, University College, London.

E.B.—Émile Brumpt, Lic. ès Sci., Paris.

E.G.G.—Dr. E. G. Gardiner, Woods Holl, Mass.

*E.J.A.—E. J. Allen, D.Sc., Director of the Plymouth Laboratory since 1895.

*E.J.B.—E. J. Bles, B.Sc., Director of the Plymouth Laboratory 1893-1894.

E.T.B.—E. T. Browne, B.A., University College, London.

*E.W.L.H.—E. W. L. Holt, Naturalist in Charge of North Sea Investigations 1892-1894; Hon. Naturalist at the Plymouth Laboratory 1897-1898; Scientific adviser to the Fisheries Branch of the Board of Agriculture for Ireland.

F.E.B.—F. E. Beddard, F.R.S., Prosector of the Zoological Society of London.

F.J.B.—Professor F. Jeffrey Bell, M.A., Assistant Keeper British Museum Natural History.

F.W.G.—F. W. Gamble, D.Sc., Lecturer in Zoology, Owen's College, Manchester.

*G.C.B.—G. C. Bourne, M.A., Director of the Plymouth Laboratory, 1888-1890.

G.P.B.—G. P. Bidder, M.A., Cambridge.

J.C.S.—J. C. Sumner, A.R.C.S.

J.J.L.—J. J. Lister, M.A., F.R.S., Fellow of St. John's College, Cambridge.

*J.T.C.—J. T. Cunningham, M.A., Naturalist in Charge of Fishery Investigations at the Plymouth Laboratory 1887-1894; ditto in charge of North Sea Investigations 1895-1896.

*L.H.G.—L. H. Gough, PH.D., Assistant Naturalist in charge of Plankton Observations since November, 1902.

M.F.W.—The late Martin F. Woodward, A.R.C.S., Demonstrator in Zoology, Royal College of Science, London.

P.T.C.—Professor P. T. Cleve, University of Upsala.

R.C.P.—R. C. Punnett, M.A., Cambridge.

*R.A.T.—R. A. Todd, B.Sc., Director's Assistant 1898-1902; Assistant Naturalist since 1902.

R.G.—Robert Gurney, M.A.

R.H.W.—R. Hansford Worth, Plymouth.

R.M.P.—Mrs. S. Pace (Miss R. M. Clark).

S.F.H.—S. F. Harmer, D.Sc., F.R.S., Curator of the Museum of Zoology, Cambridge University.

*S.P.—S. Pace, Assistant Naturalist at the Plymouth Laboratory since Nov. 1902.

T.H.R.—T. H. Riches, M.A.

T.H.T.—T. H. Taylor, M.A., Lecturer in Zoology at the Yorkshire College, Leeds.

*T.V.H.—T. V. Hodgson, Director's Assistant at the Plymouth Laboratory 1895-1897.

W.B.B.—Professor W. B. Benham, D.Sc., University of Otago, New Zealand.

W.E.H.—W. E. Hoyle, M.A., F.R.S., Curator of the Manchester Museum.

W.F.R.W.—Professor W. F. R. Weldon, F.R.S., Professor of Comparative Anatomy in the University of Oxford.

*W.G.—W. Garstang, M.A., Director's Assistant 1888-1890; Naturalist 1892-1894; ditto in charge of Fishery Investigations since 1897.

*W.H.—W. Heape, M.A., Superintendent of the Marine Biological Association, 1886-1888.

W.I.B.—W. I. Beaumont, B.A.

W.P.M.—W. P. Marshall.

In some cases where there is only a single record, this has been indicated by a superior numeral, *e.g.* (J.T.C.[1]), or Queen's Gd.[1]

In the notes on *Breeding Periods* only those months are named for which definite records exist at the Laboratory.

FORAMINIFERA.

BY

R. H. WORTH.

Miliolinæ.

BILOCULINA RINGENS (Lamarck): *Williamson*, 1858, Rec. For. Gt. Br., p. 79, pl. vi, figs. 169, 170, pl. vii, fig. 171.

BILOCULINA RINGENS, var. *patagonica*, Williamson, 1858, Rec. For. Gt. Br., p. 80, pl. vii, figs. 175, 176. See also *Biloculina elongata*.

Cawsand B.; Drake's I.: Rame-Eddystone, generally distributed, but with unexplained preferences for certain localities, only occasionally plentiful; Eddystone-Looe, same remarks as last; Bolt, the species seems to be poorly represented.

BILOCULINA DEPRESSA, d'Orbigny: *Williamson*, 1858, Rec. For. Gt. Br., p. 79, pl. vii, figs. 172–174 (as *Biloculina ringens*, var. *carinata*).

Rame-Eddystone, distribution similar to that of *Biloculina ringens*, but decidedly less numerous; Eddystone-Looe, same remarks as last; the species also occurs around the Bolt; [Drake's I. (J.J.L.)].

BILOCULINA ELONGATA, d'Orbigny: *Williamson*, 1858, Rec. For. Gt. Br., p. 80, pl. vii, figs. 175, 176 (as *Biloculina ringens*, var. *patagonica*).

Five miles W. ¼ S. from Rame, characteristics exceptionally marked.

BILOCULINA TUBULOSA, Costa: *Brady*, 1884, "Challenger" Report, p. 147, pl. iii, fig. 6.

A few individuals have been somewhat doubtfully attributed to this species.

SPIROLOCULINA PLANULATA (Lamarck): *Williamson*, 1858, Rec. For. Gt. Br., p. 82, pl. vii, fig. 178 (as *Spiroloculina depressa*, var. *rotundata*).

Rame-Eddystone, generally distributed and fairly plentiful in places; Eddystone-Looe, same remarks as last; Bolt, an occasional spec.

SPIROLOCULINA LIMBATA, d'Orbigny: *Williamson*, 1858, Rec. For. Gt. Br., p. 82, pl. vii, fig. 177 (as *Spiroloculina depressa*).

Rame-Eddystone, follows distribution of last, but is less numerous; Eddystone-Looe, here the conditions seem somewhat changed, and this form is more numerous than *planulata*; [Drake's I. (J.J.L.)].

SPIROLOCULINA TENUISEPTATA, Brady: *Brady*, 1884, "Challenger" Report, p. 153, pl. x, figs. 5, 6.

Rame-Eddystone, an occasional spec. only; Eddystone-Looe, an occasional spec. only.

SPIROLOCULINA EXCAVATA, d'Orbigny: *Brady*, 1884, "Challenger" Report, p. 151, pl. ix, figs. 5, 6.

Rame-Eddystone, generally distributed, but rare; Eddystone-Looe, as above.

SPIROLOCULINA FRAGILISSIMA, Brady: *Brady*, 1884, "Challenger" Report, p. 149, pl. ix, figs. 12–14.

Found on the eastern slope of the Hand Deeps.

[**Foraminifera**—*contd.*]

Miliolina trigonula (Lamarck): *Williamson*, 1858, Rec. For. Gt. Br., p. 84, pl. vii, figs. 180–182.

Drake's I.; Rame-Eddystone, generally distributed, but not numerous; Eddystone-Looe, scarce in the dredgings examined; Bolt, an occasional spec.

Miliolina tricarinata (d'Orbigny): *Brady*, 1884, "Challenger" Report, p. 165, pl. iii, fig. 17.

Rame-Eddystone, an uncommon form; Eddystone-Looe, none found as yet.

Miliolina oblonga (Montagu): *Williamson*, 1858, Rec. For. Gt. Br., p. 86, pl. vii, 186, 187, as *M. seminulum*, var. *oblonga*.

Rame-Eddystone, generally distributed, numerous everywhere, sometimes the dominant species in a dredging, one of the commonest Foraminifera: Eddystone-Looe, much as above, but the species is a little less frequent; Bolt, the species is less common in the dredgings examined; [Drake's I. (J.J.L.)].

Miliolina seminulum (Linné): *Williamson*, 1858, Rec. For. Gt. Br., p. 85, pl. vii, figs. 183–185.

Cawsand B.; Drake's I.; Rame-Eddystone, universally present, common everywhere, but numbers fluctuate considerably from point to point, not unusually one of the dominant species in a dredging; Eddystone-Looe, much as last, but never the dominant species so far as dredgings have been examined; Bolt, extremely common, the dominant species of the ground.

Miliolina subrotunda (Montagu): *Brady*, 1884, "Challenger" Report, p. 168, pl. v, figs. 10, 11.

Drake's I.; Rame-Eddystone, common and almost universally distributed, but more plentiful in shallower water. These remarks apply to whole district.

Miliolina circularis (Bornem): *Brady*, 1884, "Challenger" Report, p. 169, pl. v, figs. 13, 14.

Drake's I.; Rame-Eddystone, as last species, but less common: Bolt, occasional specimens.

Miliolina secans (d'Orbigny): *Williamson*, 1858, Rec. For. Gt. Br., p. 86, pl. vii, figs. 188, 189 (as *M. seminulum*, var. *disciformis*).

From the shallower dredgings throughout the district, seems to prefer clean sands, and is often common on beaches.

Miliolina bicornis (Walker & Jacob): *Williamson*, 1858, Rec. For. Gt. Br., p. 87, pl. vii, figs. 190–192.

Miliolina bicornis, var. *elegans*: *Williamson*, 1858, Rec. For. Gt. Br., p. 88, pl. vii, fig. 195.

Cawsand B.; Drake's I.; Rame-Eddystone, generally distributed, always present, sometimes plentiful. The same remarks may safely be applied to the whole district.

Miliolina boueana (d'Orbigny): *Brady*, 1884, "Challenger" Report, p. 173, pl. vii, fig. 173.

As last species, but a trifle less common.

MILIOLINA AGGLUTINANS (d'Orbigny): *Brady*, 1884, "Challenger" Report, p. 180, pl. viii, figs. 6, 7.

Drake's I.; Rame-Eddystone, but commoner in shallow water; by no means an infrequent species anywhere in the district; occurs on Eddystone-Looe Gds., Bolt Gds., and all areas examined.

Peneroplidinæ.

CORNUSPIRA FOLIACEA (Philippi): *Williamson*, 1858, Rec. For. Gt. Br., p. 91, pl. vii, fig. 199 (as *Spirillina*).

Rame-Eddystone, generally distributed, some localities yield more specs. than others, but the form is very sparingly represented anywhere; Eddystone-Looe, rare.

CORNUSPIRA INVOLVENS (Reuss): *Brady*, 1884, "Challenger" Report, p. 200, pl. xi, figs. 1–3.

Drake's I.; Rame-Eddystone, generally distributed, in some dredgings numbers were found adherent to Hydroids; Eddystone-Looe, same remarks as last.

Astrorhizidæ.

HALIPHYSEMA TUMANOWICZII, Bowerbank: *Brady*, 1884, "Challenger" Report, p. 281, pl, xxvii A, figs. 4, 5.

Occurs but sparingly in the deeper dredgings everywhere in the district, is probably much commoner near the shore: [Queen's Gd., abundant at times (S.P.): Duke Rk. (E.J.A.)]

Lituolinæ.

HAPLOPHRAGMIUM CANARIENSE (d'Orbigny): *Williamson*, 1858, Rec. For. Gt. Br., p. 34, pl. iii, figs. 72, 73 (as *Nonionina jeffreysii*).

Drake's I.; Rame-Eddystone and all grounds, not uncommon anywhere, but shows a preference for more silty areas, at times quite plentiful.

HAPLOPHRAGMIUM FONTINENSE, Terquem: *Brady*, 1884, "Challenger" Report, p. 305, pl. xxxiv, figs. 1–4.

Occurs near the Eddystone, and possibly elsewhere on the outer grounds, but is nowhere common.

HAPLOPHRAGMIUM GLOBIGERINIFORME (Parker & Jones): *Brady*, 1884, "Challenger" Report, p. 312, pl. xxxv, figs. 10, 11.

Found in small numbers on the Rame-Eddystone Gd.

Trochammininæ.

AMMODISCUS INCERTUS (d'Orbigny): *Williamson*, 1858, Rec. For. Gt. Br., p. 93, pl. vii, fig. 203 (as *Spirillina arenacea*).

Rame-Eddystone, uncommon.

AMMODISCUS GORDIALIS (Jones & Parker): *Brady*, 1884, "Challenger" Report, p. 333, pl. xxxviii, 7–9.

Rame-Eddystone, rare.

TROCHAMMINA OCHRACEA: *Williamson*, 1858, Rec. For. Gt. Br., p. 55, pl. iv, fig. 112, pl. v, fig. 113 (as *Rotalina*).

Found over the whole area, but is not plentiful anywhere.

[**Foraminifera**—*contd.*]

TROCHAMMINA INFLATA (Montagu): *Williamson*, Rec. For. Gt. Br., p. 50, pl. iv, figs. 93, 94 (as *Rotalina*).

Distributed much like *Haplophragmium canariense*, which in some estuarine waters it largely replaces; it also occurs, however, well outside the 30-fathom line.

Textularinæ.

TEXTULARIA SAGITTULA, Defrance: *Brady*, 1884, "Challenger" Report, p. 361, pl. xlii, figs. 17, 18.

The difficulty of precisely defining the limits of each species of the arenaceous textularia on these grounds is almost insuperable. *Textularia sagittula* is one of the less frequent forms, but it may occur anywhere where either *gramen* or *agglutinans* is found. The most typical specimens are found in estuarine waters.

TEXTULARIA TROCHUS, d'Orbigny: *Williamson*, 1858, Rec. For. Gt. Br., p. 75, pl. vi, figs. 160, 161 (as *T. cuneiformis*, var. *conica*).

This form, like the last, is infrequent, but while some specimens of *sagittula* may be divided from *agglutinans* by fairly marked features, *trochus*, if it really occurs on these grounds, is always most suspiciously like a somewhat unorthodox *gramen*.

TEXTULARIA AGGLUTINANS, d'Orbigny: *Brady*, 1884, "Challenger" Report, p. 363, pl. xliii, figs. 1–3.

Even between *Textularia agglutinans* and *Textularia gramen* there may arise difficulties of discrimination. *Textularia agglutinans* is everywhere the less common, but is generally distributed, and follows *gramen* in its preference of localities.

TEXTULARIA AGGLUTINANS, var. *porrecta*, Brady: *Brady*, 1884, "Challenger" Report, p. 364, pl. xliii, fig. 4.

This variety is occasionally found in all parts of the district.

TEXTULARIA GRAMEN, d'Orbigny: *Brady*, 1884, "Challenger" Report, p. 365, pl. xliii, figs. 9, 10.

Cawsand B.; Drake's I.; and the district generally.

Textularia gramen is much the most common of the Textularia; it frequently rises to from third to fifth in numerical order of the foraminifera taken in a dredging, and on the eastern slope of the Hand Deeps at one station it is only excelled by *Miliolina seminulum*.

VERNEUILINA POLYSTROPHA (Reuss): *Williamson*, 1858, Rec. For. Gt. Br., p. 65, pl. v, figs. 136, 137 [as *Bulimina scabra* (arenacea)].

Drake's I.; also sparingly present throughout the district, but this species shows a preference for shallow water. In estuaries it sometimes practically replaces the *Textularia*.

Buliminінæ.

BULIMINA PUPOIDES, d'Orbigny: *Williamson*, 1858, Rec. For. Gt. Br., p. 62, pl. v, figs. 124, 125.

Drake's I. A common species throughout the district, a little more plentiful within than without the 25-fathom line.

BULIMINA MARGINATA, d'Orbigny: *Williamson*, 1858, Rec. For. Gt. Br., p. 62, pl. v, figs. 10–12 (as *B. pupoides*, var. *marginata*).

Drake's I. Distribution precisely similar to that of *Bulimina pupoides*, but individuals of the latter species average twice as numerous.

BULIMINA ACULEATA, d'Orbigny: *Williamson*, 1858, Rec. For. Gt. Br., p. 62, pl. v, fig. 128 (as *B. pupoides*, var. *spinulosa*).

Common throughout the district, follows closely the distribution of *Bulimina pupoides*, on the average one specimen of *aculeata* occurs to every twenty of *pupoides*. Williamson is probably right in making *Bulimina marginata* and *Bulimina aculeata* mere varieties of *Bulimina pupoides*, all intermediate forms occur.

BULIMINA ELEGANS, d'Orbigny: *Brady*, 1884, "Challenger" Report, p. 398, pl. l, figs. 1–4.

Drake's I. Occurs sparingly wherever *Bulimina pupoides* is found, probably it should be regarded as a variety only.

BULIMINA ELEGANS, var. *exilis*, Brady: *Brady*, 1884, "Challenger" Report, p. 399, pl. l, figs. 5, 6.

5 miles W. ¼ S. from Rame; 4¼ miles W. ¼ S. from Rame.

BULIMINA ELEGANTISSIMA, d'Orbigny: *Williamson*, 1858, Rec. For. Gt. Br., p. 64, pl. v, figs. 134, 135.

A minute form which is easily overlooked. On floating the silts, however, it is found in practically all dredgings; never numerically strong, it is none the less generally distributed.

VIRGULINA SCHREIBERSIANA, Czjzek: *Goës*, 1894, Syn. Arctic and Scandinavian For., p. 48, pl. ix, fig. 459: *Williamson*, 1858, Rec. For. Gt. Br., p. 63, pl. v, fig. 131 (as *Bulimina pupoides*, var. *compressa*).

Generally distributed throughout the district. A small species liable to be underestimated as to numerical prevalence, unless the sands are floated; it is really present in considerable numbers almost everywhere.

BOLIVINA PUNCTATA, d'Orbigny: *Brady*, 1884, "Challenger" Report, p. 417, pl. lii, figs. 18, 19.

Drake's I., and generally distributed throughout the district. See also note to *Bolivina dilatata*.

BOLIVINA TEXTILAROIDES, Reuss: *Williamson*, 1858, Rec. For. Gt. Br., p. 77, pl. vi, fig. 168 (as *Textularia variabilis*, var. *lævigata*).

Drake's I., and generally distributed throughout the district, nowhere very numerous, nowhere rare.

I regard this and Williamson's *Textularia variabilis*, *typica*, as one species.

BOLIVINA DIFFORMIS (Williamson): *Williamson*, 1858, Rec. For. Gt. Br., p. 77, pl. vi, figs. 166, 167 (as *Textularia variabilis*, var. *difformis*).

A small form, easily overlooked, but well defined. It is generally distributed, but nowhere numerous. The prevalence of this species in surface townettings from the mouth of the Channel is a feature which must influence its apparent distribution on the sea-bottom.

[**Foraminifera**—*contd.*]

BOLIVINA DILATATA, Reuss: *Williamson*, 1858, Rec. For. Gt. Br., p. 76, pl. vi, figs. 164, 165 (as *Textularia variabilis*, var. *spathulata*).

Drake's I., and generally distributed over the district.

This species and *Bolivina punctata* both flourish on almost any bottom soil and are both happier on genuine muddy silts than most foraminifera. The relative prevalence of the two species obeys some so far undiscoverable law and is subject to wide variations.

BOLIVINA ÆNARIENSIS (Costa): *Brady*, 1884, "Challenger" Report, p. 423, pl. liii, figs. 10, 11.

Drake's I., and generally distributed throughout the district.

This is a species which will most probably be overlooked unless the silts are floated. Although common, it is not numerically well represented.

Cassidulininæ.

CASSIDULINA CRASSA, d'Orbigny: *Williamson*, 1858, Rec. For. Gt. Br., p. 69, pl. vi, figs. 143, 144 (as *C. obtusa*).

Drake's I. Universally distributed and fairly numerous everywhere.

CASSIDULINA BRADYI, Norman: *Brady*, 1884, "Challenger" Report, p. 431, pl. liv, figs. 6–10.

Distributed over whole district, but distinctly in less numbers than *Cassidulina crassa*.

Lageninæ.

LAGENA GLOBOSA (Montagu): *Williamson*, 1858, Rec. For. Gt. Br., p. 8, pl. i, figs. 15, 16 (as *Entosolenia*).

A common form of universal occurrence.

LAGENA APICULATA, Reuss: *Brady*, 1884, "Challenger" Report, p. 453, pl. lvi, figs. 15–18.

Somewhat rare.

LAGENA BOTELLIFORMIS, Brady: *Brady*, 1884, "Challenger" Report, p. 454, pl. lvi, fig. 6.

Not uncommon.

LAGENA LÆVIS (Montagu): *Williamson*, 1858, Rec. For. Gt. Br., p. 4, pl. i, figs. 5, 5*a* (as *L. vulgaris*).

Present everywhere, but in less numbers than either *Lagena orbignyana*, *globosa*, *marginata*, or probably *sulcata*. Small specs. with either two or three chambers arranged in nodosarian form are not rare; some large individuals are entosolenian at one extremity and ectosolenian at the other.

LAGENA CLAVATA (d'Orbigny): *Williamson*, 1858, Rec. For. Gt. Br., p. 5, pl. i, fig. 6 (as *L. vulgaris*, var. *clavata*).

Generally distributed, but in considerably less number than *Lagena lævis*.

LAGENA GRACILLIMA (Seguenza): *Brady*, 1884, "Challenger" Report, p. 456, pl. lvi, figs. 19–28.

A not unusual form, has not been found in all dredgings, but probably is very generally distributed.

LAGENA ASPERA, Reuss: *Brady*, 1884, "Challenger" Report, p. 457, pl. lvii, figs. 7–12.

Rare, but seems to exhibit a preference for the shallower waters.

LAGENA HISPIDA, Reuss: *Brady*, 1884, "Challenger" Report, p. 459, pl. lix, figs. 2–5.

Somewhat rare in the district.

LAGENA LINEATA (Williamson): *Williamson*, 1858, Rec. For. Gt. Br., p. 9, pl. i, fig. 17 (as *Entsolenia globosa*, var. *lineata*).

Rame-Eddystone and Eddystone-Looe Gds., not a common form.

LAGENA DISTOMA, Parker & Jones: *Brady*, 1884, "Challenger" Report, p. 461, pl. lviii, figs. 11–15.

Generally distributed, but in small numbers.

LAGENA SULCATA (Walker & Jacobs): *Brady*, 1884, "Challenger" Report, p. 462, pl. lvii, figs. 23, 26, 34.

Drake's I., and throughout the district, a common species, occurring in moderate numbers.

LAGENA SULCATA, var. *interrupta*, Williamson.

[Drake's I. (J.J.L.).]

LAGENA STRIATA (d'Orbigny): *Williamson*, 1858, Rec. For. Gt. Br., p. 7, pl. i, fig. 14 (as *L. vulgaris*, var. *substriata*).

Drake's I., and throughout the district; a common species, and sometimes numerically strong.

LAGENA SEMISTRIATA, Williamson: *Williamson*, 1858, Rec. For. Gt. Br., p. 6, pl. i, fig. 9 (as *L. vulgaris*, var. *semistriata*).

Drake's I., and throughout the district; common.

LAGENA GRACILIS, Williamson: *Williamson*, 1858, Rec. For. Gt. Br., p. 7, pl. i, figs. 12, 13 (as *L. vulgaris*, var. *gracilis*).

Generally distributed.

LAGENA SQUAMOSA (Montagu): *Williamson*, 1858, Rec. For. Gt. Br., p. 12, pl. i, fig. 29.

Drake's I., and throughout the district. Common and sometimes prominent in point of numbers.

LAGENA HEXAGONA (Williamson): *Williamson*, 1858, Rec. For. Gt. Br., p. 13, pl. i, fig. 32 (as *Entosolenia squamosa*, var. *hexagona*).

Drake's I., and throughout the district. Common, perhaps not quite so plentiful as *Lagena squamosa*.

LAGENA MARGINATA, Walker & Boys: *Brady*, 1884, "Challenger" Report, p. 476, pl. lix, figs. 21, 23.

Generally distributed and in considerable numbers; small forms are sometimes difficult to discriminate from *Lagena orbignyana*.

LAGENA MARGINATA, var. *ornata* (Williamson): *Williamson*, 1858, Rec. For. Gt. Br., p. 11, pl. i, fig. 24 (as *Entosolenia*).

Rare, but possibly many specs. have been overlooked.

LAGENA TRIGONO-MARGINATA, Parker & Jones: *Brady*, 1884, "Challenger" Report, p. 482, pl. lxi, figs. 12, 13.

Rame-Eddystone, not infrequent, but represented by single specs. in the quantities of sand examined from the different dredgings.

[**Foraminifera**—*contd.*]

LAGENA QUADRATA (Williamson): *Williamson*, 1858, Rec. For. Gt. Br., p. 11, pl. i, figs. 27, 28 (as *Entosolenia marginata*, var. *quadrata*).

Present everywhere, but in small numbers. A mere variety of *Lagena marginata*.

LAGENA ORBIGNYANA (Seguenza): *Brady*, 1884, "Challenger" Report, p. 484, pl. lix, figs. 24–26, etc.

Cawsand B.: Drake's I., and generally distributed over the whole district. This is distinctly the most common of the Lagenæ, and is well represented everywhere. The larger specimens are well characterised, but the smaller forms are sometimes extremely difficult to discriminate from *Lagena marginata*.

LAGENA LAGENOIDES (Williamson): *Williamson*, 1858, Rec. For. Gt. Br., p. 11, pl. i, figs. 25, 26 (as *Entosolenia marginata*, var. *lagenoides*).

Generally distributed and present everywhere, but not numerically strong in any dredging.

Nodosariinæ.

NODOSARIA PYRULA, d'Orbigny: *Williamson*, 1858, Rec. For. Gt. Br., p. 17, pl. ii, fig. 39.

Generally distributed, but somewhat scarce, and rarely represented by more than a few chambers of the shell

NODOSARIA COMMUNIS, d'Orbigny: *Williamson*, 1858, Rec. For. Gt. Br., p. 18, pl. ii, figs. 40, 41 (as *Dentalina subarcuata*).

Generally distributed, in moderate numbers. The larger specs. are the largest foraminifera of the district; one in especial, from one mile S.E. of Eddystone, measures 4 mm. in length.

NODOSARIA SCALARIS (Batsch): *Williamson*, 1858, Rec. For. Gt. Br., p. 15, pl. ii, figs. 36–38 (as *N. radicula*).

Drake's I., and generally distributed. Somewhat scarce at places.

NODOSARIA CALOMORPHA, Reuss: *Brady*, 1884, "Challenger" Report, p. 497, pl. lxi, figs. 23–27.

A small species, and very easily overlooked. Brady does not include it in his Synopsis of recent British Species. It is by no means uncommon in this district.

CRISTELLARIA CREPIDULA (Fichtel & Moll): *Williamson*, 1858, Rec. For. Gt. Br., p. 29, pl. ii, figs. 56, 57 (as *C. subarcuatula*).

Drake's I., and generally distributed in the district: a common form, but not numerically strong.

CRISTELLARIA ROTULATA (Lamarck): *Williamson*, 1858, Rec. For. Gt. Br., p. 27, pl. ii, figs. 52, 53 [as *C. calcar* (*typica*)].

Generally distributed, and somewhat more plentiful than *Cristellaria crepidula*.

CRISTELLARIA VORTEX (Fichtel & Moll): *Brady*, 1884, "Challenger" Report, p. 548, pl. lxix, figs. 14–16.

Brady's only British locality is off the west coast of Scotland, and he states that the specs. are doubtfully referrible to this species. Occasional specs., the characteristics of which are well marked, are found in this district.

CRISTELLARIA ITALICA (Defrance): *Brady*, 1884, "Challenger" Report, p. 544, pl. lxviii, figs. 17, 18, 20–23.
Generally distributed, but scarce.

AMPHICORYNE FALX (Jones & Parker): *Brady*, 1884, "Challenger" Report, p. 556, pl. lxv, figs. 7–9.
Rare.

Polymorphininæ.

POLYMORPHINA LACTEA (Walker & Jacob): *Brady*, 1884, "Challenger" Report, p. 559, pl. lxxi, figs. 11, 14.
Drake's I., and generally distributed throughout district. Not a prominent species.

POLYMORPHINA GIBBA, d'Orbigny.
Included for present purposes in last-named species.

POLYMORPHINA OBLONGA, Williamson: *Williamson*, 1858, Rec. For. Gt. Br., p. 71, pl. vi, figs. 149, 149*a* (as *P. lactea*, var. *oblonga*).
An occasional spec. from Rame-Eddystone Gds.
According to Spence Bate, this species was abundant near the Eddystone in or before 1858. I should not call it other than somewhat scarce now; [on *Zostera*, Drake's I. (J.J.L.)].

POLYMORPHINA COMPRESSA, d'Orbigny: *Brady*, 1884, "Challenger" Report, p. 565, pl. lxxii, figs. 9–11.
Occasionally found; [Drake's I. (J.J.L.)].

UVIGERINA ANGULOSA, Williamson: *Williamson*, 1858, Rec. For. Gt. Br., p. 67, pl. v, fig. 140.
Generally distributed and not uncommon, but never abundant.

Globigerinidæ.

GLOBIGERINA BULLOIDES, d'Orbigny: *Williamson*, 1858, Rec. For. Gt. Br., p. 56, pl. v, figs. 116–118.
Drake's I., and generally distributed throughout the district. Universally present, and if never abundant at least never scarce.

GLOBIGERINA INFLATA, d'Orbigny: *Brady*, 1884, "Challenger" Report, p. 601, pl. lxxix, figs. 8–10.
An occasional spec. only.

ORBULINA UNIVERSA, d'Orbigny: *Williamson*, 1858, Rec. For. Gt. Br., p. 2, pl. i, fig. 4.
An occasional spec. only.

SPHÆROIDINA DEHISCENS, Parker & Jones: *Brady*, 1884, "Challenger" Report, p. 621, pl. lxxxiv, figs. 8–11.
Rare.

Spirillininæ.

SPIRILLINA VIVIPARA, Ehrenberg: *Williamson*, 1858, Rec. For. Gt. Br., p. 92, pl. vii, fig. 202 (as *S. perforata*).
Drake's I.; Rame-Eddystone, everywhere, but not plentiful.

SPIRILLINA MARGARITIFERA, Williamson: *Williamson*, 1858, Rec. For. Gt. Br., p. 93, pl. vii, fig. 204.
Rame-Eddystone, an occasional spec.

[**Foraminifera**—*contd.*]

Rotalinæ.

PATELLINA CORRUGATA, Williamson: *Williamson*, 1858, Rec. For. Gt. Br., p. 46, pl. iii, figs. 86–89.

Generally distributed, but in small numbers.

DISCORBINA GLOBULARIS (d'Orbigny): *Williamson*, 1858, Rec. For. Gt. Br., p. 53, pl. iv, figs. 104, 105 [as *Rotalina concamerata* (young)].

Cawsand B., at times abundant on the *Zostera*; [Drake's I. (J.J.L.)]. Generally distributed throughout the district, and in places common.

DISCORBINA ROSACEA (d'Orbigny): *Williamson*, 1858, Rec. For. Gt. Br., p. 54, pl. iv, figs. 109–111 (as *Rotalina mamilla*).

Cawsand B., very plentiful; Drake's I., and generally distributed. A common species, universally present, and frequently from fifth to sixth of all species in abundance. But both *Discorbina globularis* and *Discorbina orbicularis* appear to merge in this species, and few specimens are so well characterised as Williamson's figure.

DISCORBINA ORBICULARIS (Terquem): *Brady*, 1884, "Challenger" Report, p. 647, pl. lxxxviii, figs. 4–8.

Common, and of universal distribution, but less abundant than either of the preceding Discorbinæ.

DISCORBINA PARISIENSIS (d'Orbigny): *Brady*, 1884, "Challenger" Report, p. 648, pl. xc, figs. 5, 6, 9–12.

Cawsand B., and sparingly represented in most dredgings, but at places apparently scarce.

DISCORBINA BERTHELOTI (d'Orbigny): *Brady*, 1884, "Challenger" Report, p. 650, pl. lxxxix, figs. 10–12.

Much as *Discorbina parisiensis*.

PLANORBULINA MEDITERRANENSIS, d'Orbigny: *Williamson*, 1858, Rec. For. Gt. Br., p. 57, pl. v, figs. 119, 120 (as *P. vulgaris*).

Cawsand B.; Drake's I., and generally distributed through the district, but in very varying abundance. Sometimes third or fourth in numerical precedence, and sometimes very low indeed. There is no present key to its preferences of locality.

TRUNCATULINA LOBATULA (Walker & Jacob): *Williamson*, 1858, Rec. For. Gt. Br., p. 59, pl. v, figs. 121–123.

Cawsand B.; Drake's I., generally distributed throughout the district. Present practically everywhere, but in very varying abundance. Long ago Montagu noted it adherent to Hydroids, and this is the clue to its distribution; wherever Hydroids are present, this is one of the commonest foraminifera. It also exhibits an apparent preference for *Sertularella gayi* as a host.

PULVINULINA REPANDA (Fichtel & Moll): *Williamson*, 1858, Rec. For. Gt. Br., p. 52, pl. iv, figs. 101–103 [as *Rotalina concamerata* (mature)].

Cawsand B., and generally distributed, but not a species which occurs in abundance.

PULVINULINA MENARDII (d'Orbigny): *Brady*, 1884, "Challenger" Report, p. 690, pl. ciii, figs. 1, 2.

Somewhat uncommon, and doubtfully an inhabitant of the district, but rather a casual visitor.

ROTALIA BECCARII (Linné): *Williamson*, 1858, Rec. For. Gt. Br., p. 48, pl. iv, figs. 90–92.

Cawsand B.; Drake's I.; everywhere throughout the district competes with *Miliolina seminulum* and, at places, *Truncatulina lobatula* for first place in abundance. On fine sands it seems best at home, and one dredging, about 4 m. W. of Rame, in 20 fms., yielded close on 12,000 individuals of this species to each 10 grms. of bottom deposit, while *Miliolina seminulum* was present in equal numbers.

ROTALIA NITIDA, Williamson: *Williamson*, 1858, Rec. For. Gt. Br., p. 54, pl. iv, figs. 106–108.

A common form of general distribution; never attaining the occasional extreme abundance of *Rotalia beccarii*, it none the less runs that species very nearly at places.

Polystommellinæ.

NONIONINA DEPRESSULA (Walker & Jacob): *Brady*, 1884, "Challenger" Report, p. 725, pl. cix, figs. 6, 7.

Cawsand B.; Drake's I., and generally distributed. A common species, present everywhere, and frequently in some abundance.

NONIONINA UMBILICATULA (Montagu): *Williamson*, 1858, Rec. For. Gt. Br., p. 32, pl. iii, figs. 68, 69 (as *N. barleeana*).

Apparently prefers the deeper waters of the area examined; is nowhere a prominent species. Since, however, it also occurs in estuaries, it evidently is not restricted to deeper waters only.

NONIONINA TURGIDA (Williamson): *Williamson*, 1858, Rec. For. Gt. Br., p. 50, pl. iv, figs. 95–97 (as *Rotalina*).

Cawsand B., and generally distributed. A small form probably present everywhere, but not abundant.

NONIONINA SCAPHA (Fichtel & Moll): *Brady*, 1884, "Challenger" Report, p. 730, pl. cix, figs. 14–16.

Occurrence similar to that of *Nonionina turgida*.

NONIONINA STELLIGERA, d'Orbigny: *Brady*, 1884, "Challenger" Report, p. 728, pl. cix, figs. 3–5.

Cawsand B.; Drake's I., generally distributed, with an apparent preference for the shallower waters. Nowhere present in such numbers as *Nonionina depressula*.

POLYSTOMELLA CRISPA (Linné): *Williamson*, 1858, Rec. For. Gt. Br., p. 40, pl. iii, figs. 78–80.

Cawsand B.; Drake's I., and generally distributed within the 15 fm. line; outside the 20 fm. line this form is practically unknown; never abundant outside 10 fms., but within that limit sometimes the dominant species. The *Zostera* of Cawsand B. is at times crowded with this species.

POLYSTOMELLA SUBNUDOSA (Münster): *Brady*, 1884, "Challenger" Report, p. 734, pl. cx, fig. 1.

Not infrequent outside 28 fms.

POLYSTOMELLA MACELLA (Fichtel & Moll): *Brady*, 1884, "Challenger" Report, p. 737, pl. cx, figs. 8, 9, 11.

Drake's I., and probably wherever *Polystomella crispa* flourishes.

POLYSTOMELLA STRIATOPUNCTATA (Fichtel & Moll): *Williamson*, 1858, Rec. For. Gt. Br., p. 42, pl. iii, figs. 81, 82 (as *P. umbilicatula*).
Cawsand B.; Drake's I., and generally distributed, by no means uncommon at the 30-fm. line and outside.

POLYSTOMELLA ARCTICA, Parker & Jones: *Brady*, 1884, "Challenger" Report, p. 735, pl. cx, figs. 2–5.
Drake's I.: Cawsand B., and throughout the district, but much less abundant than either *Polystomella crispa* or *Polystomella striato-punctata*; a complete series of intermediate forms connects these three species.

PORIFERA.

Leucosoleniidæ.

LEUCOSOLENIA BOTRYOIDES (Ellis & Solander): *J. S. Bowerbank*, Monogr. Brit. Spongiadæ, vol. iii, pp. 7, etc., fig.
On the shore between tide-marks, not abundant except in certain localities (E.A.M.): rocks under the Hoe, in abundance (G.P.B.): Wembury B., very abundant, on seaweeds, together with *Sycon compressum* (E.A.M.).

LEUCOSOLENIA COMPLICATA (Montagu).
Fairly common in rock-pools between tide-marks; also in deeper water off the Mewstone and elsewhere (E.A.M.).

LEUCOSOLENIA VARIABILIS, Haeckel.
Common everywhere in rock-pools between tide-marks (E.A.M.).

Clathrinidæ.

CLATHRINA CORIACEA (Fleming): *J. S. Bowerbank*, Monogr. Brit. Spongiadæ, vol. iii, pp. 8, etc., fig. (as *Leucosolenia*).
Found in small quantities nearly everywhere on rocks between tide-marks; near ladies' bathing-place; on rocks under the pier, etc. (E.A.M.): rocks under the Hoe, in abundance (G.P.B.): Reny Rks. (W.G. & R.A.T.).

CLATHRINA LACUNOSA (Johnston): *J. S. Bowerbank*, Monogr. Brit. Spongiadæ, vol. iii, p. 9, fig. (as *Leucosolenia*).
Occasionally (W.G.): Rame-Eddystone Gds., not uncommon (S.P.): only below tide-marks and in deep water (E.A.M.).

Syconidæ.

SYCON COMPRESSUM (Fleming): *J. S. Bowerbank*, Monogr. Brit. Spongiadæ, vol. iii, p. 1, fig. (as *Grantia*).
Common at low water on most rocky stations (S.P.): Millbay Docks, large specs. (E.J.A., R.A.T., S.P.).
This form appears to be an annual. The ova develope in Feb., free larvæ occur in July, and sponges 3 mm. long in Sept. (G.P.B.).

SYCON CORONATUM, Ellis & Solander: *J. S. Bowerbank*, Monogr. Brit. Spongiadæ, vol. iii, pp. 3, etc., fig. (as *Grantia ciliata*).
Common at most rocky stations at low water (S.P., E.A.M.): occurs in less exposed situations than *S. compressum*; common under the Hoe except in autumn (G.P.B.).

Halisarcidæ.

HALISARCA DUJARDINI, Johnston: *F. E. Schulze*, Zeitschr. wiss Zool., vol. xxviii, p. 36, fig.

Millbay Ch. (G.P.B.).

Haploscleridæ.

CHALINA OCULATA (Pallas): *J. S. Bowerbank*, Monogr. Brit. Spongiadæ, vol. iii, pp. 169, etc., fig.

Millbay Pit; Wembury B. (T.V.H.).

HALICHONDRIA PANICEA (Pallas): *J. S. Bowerbank*, Monogr. Brit. Spongiadæ, vol. iii, pp. 97, etc., fig.

Common; Rum B.; Drake's I. (R.A.T.).

Apparently an annual (G.P.B.).

Pœcilosceridæ.

LEPTOLABIS LUCIENSIS, Topsent: *E. Topsent*, Result. Sci. Monaco, pt. xxv, p. 185, fig.

Plymouth (E.A.M.).

Axinellidæ.

HYMENIACIDON SANGUINEUM (Grant): *J. S. Bowerbank*, Monogr. Brit. Spongiadæ, vol. iii, pp. 81, etc., fig.

Rocks under the Hoe, in abundance (G.P.B.).

Apparently an annual (G.P.B.).

TRAGOSIA INFUNDIBULIFORMIS (Johnston): *J. S. Bowerbank*, Monogr. Brit. Spongiadæ, vol. iii, pp. 137, etc., fig. (as *Isodictya*).

Looe-Eddystone Gds. (S.P.).

TRAGOSIA POLYPOIDES, O. Schmidt: *J. S. Bowerbank*, Monogr. Brit. Spongiadæ, vol. iii, pp. 137, etc., fig. (as *Isodictya dissimilis*).

Mewstone Ledge (G.P.B.).

Suberitidæ.

SUBERITES DOMUNCULA, Olivi: *J. S. Bowerbank*, Monogr. Brit. Spongiadæ, vol. iii, pp. 91, etc., fig. (as *Hymeniacedon suberea*).

Millbay Ch. (T.V.H., R.A.T., G.P.B.): Cattewater (T.V.H.): Mewstone Gds. (T.V.H., R.A.T., G.P.B.): Eddystone Gds., Rame-Eddystone Gds. (E.J.A.): Yealm R. (E.J.A., T.V.H.).

Polymastiidæ.

POLYMASTIA MAMILLARIS (O. F. Müller): *G. C. J. Vosmaer*, Bijdr. Dierk., vol. xii, pt. v, p. 14.

Millbay Ch.; Mewstone Ledge; Yealm R. (T.V.H.): 4½ m. S.E. of the Mewstone (G.P.B.).

Clionidæ.

CLIONA CELATA, Grant: *J. S. Bowerbank*, Monogr. Brit. Spongiadæ, vol. iii, pp. 95, etc., fig.

Millbay Ch.; Queen's Gd. (T.V.H.): Millbay Dock, common on piles (R.A.T.): Mewstone Gds. (T.V.H., R.A.T.): Eddystone Gds. (E.J.A.): Rame-Eddystone Gds. (E.J.A.).

Tethyidæ.

TETHYA LYNCURIUM (Linnæus): *J. S. Bowerbank*, Monogr. Brit. Spongiadæ, vol. iii, pp. 38, etc., fig.

Mewstone Ledge (T.V.H., S.P.).

ANTHOMEDUSÆ.

(HYDROID STAGE.)

Clavidæ.

CLAVA (sp.?) LEPTOSTYLA, Agassiz: *W. Garstang*, Journ. Mar. Biol. Assoc., ser. 2, vol. iii, p. 212.

Under the Hoe (W.G.).

Bearing gonophores in March (W.G.).

CLAVA MULTICORNIS (Forskål): *G. J. Allman*, Monogr. Gymnobl. Hydr., p. 246, fig.

Common in tide-pools under the Hoe (G.C.B., W.G.): common Wembury B., and inside Penlee (G.C.B.): Millbrook (T.V.H.).

Bearing gonophores: Feb. (R.A.T.): Mar.–Apr. (W.G.): Nov. (T.V.H.).

CLAVA SQUAMATA (O. F. Müller): *G. J. Allman*, Monogr. Gymnobl. Hydr., p. 243, fig.

Fairly common between tide-marks; under the Hoe; Drake's I.; Rum B.; etc. (E.J.A., R.A.T.): Jennycliff B. (A.J.S.): Barn Pool (E.T.B.): St. Germans R., abundant on *Fucus* (W.G.).

Breeding: Feb., May (W.G.): Sept. (E.T.B.).

MERONA CORNUCOPIÆ, Norman: *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 11, fig. (as *Tubiclava*).

Not uncommon on shells of *Aporrhais*, *Dentalium*, and *Turritella*, tenanted by *Phascolion strombi* (R.A.T., S.P.): Mewstone Gds. (W.G., R.A.T., S.P.): Stoke Pt. Gds. (R.A.T., S.P.): on the fine sand S. of the Eddystone (E.J.A.): Rame-Eddystone Gds. (R.A.T., S.P.).

Breeding: May (W.G., R.A.T.): June (W.G.).

TUBICLAVA LUCERNA, Allman: *G. J. Allman*, Monogr. Gymnobl. Hydr., p. 256, fig.

Millbay Ch., on stones (E.J.A.).

Hydractiniidæ.

HYDRACTINIA ECHINATA, Fleming: *G. J. Allman*, Monogr. Gymnobl. Hydr., p. 345, fig.

Moderately common, on *Buccinum* and other shells inhabited by *Eupagurus Bernhardus* (R.A.T., S.P.): occasionally taken on living *Buccinum* (R.A.T.): Cattewater (R.A.T., S.P.): Asia Sh., Jennycliff B. (R.A.T.): Cawsand B. (G.C.B., R.A.T., S.P.): Yealm R. (T.V.H., R.A.T.): Eddystone Gds. (E.J.A., S.P.): Mewstone Gds., Rame-Eddystone Gds. (R.A.T., S.P.).

Breeding: Aug. (W.G.): Nov. (S.P.).

Podocorinidæ.

PODOCORYNE CARNEA, M. Sars: *G. J. Allman*, Monogr. Gymnobl. Hydr., p. 349, fig.

Occasionally on old shells, 10–20 fms. (G.C.B.): Cawsand B., small colonies common on living *Nassa reticulata* (R.A.T.).

Medusæ liberated in May, 1896 (E.T.B.).

Laridæ.

LAR SABELLARUM, Gosse [Medusa = *Willia stellata*]: *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 36, fig.

Millbay Ch., on Sabellid tubes (A.J.S.): on *Potamilla Torelli* (E.T.B.). Attached medusæ, Feb. (E.T.B., A.J.S.).

Corynidæ.

CORYNE VAGINATA, Hincks: *G. J. Allman*, Monogr. Gymnobl. Hydr. p. 268, fig.

Under the Hoe, fairly abundant (E.J.A.): common in tide-pools; Rum B.; Cawsand B. (R.A.T.): Drake's I. (G.C.B., T.V.H.): inside Bovisand Pier (W.G.): Bovisand B. (G.C.B.): Wembury B. (G.C.B., E.J.A.).

Breeding: Apr. (R.A.T.): May-Aug. (G.C.B.).

SYNCORYNE EXIMIA, Allman: *G. J. Allman*, Monogr. Gymnobl. Hydr. p. 282, fig.

Single colony on piece of old rope, 1 m. S. of the Mewstone, May, 1889 (G.C.B.): Penlee Pt., Sept., 1897 (E.T.B.).

Medusa buds in September (E.T.B.).

SYNCORYNE (sp.?) GRAVATA (T. S. Wright): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 53, fig.

Rocks under the Hoe, occasionally; Mt. Edgeumbe (W.G., R.A.T.): Drake's I.; Devil's Pt.; Garden Battery (E.J.A.).

With attached medusæ: Mar. (W.G., R.A.T.): Apr. (E.J.A.).

ZANCLEA IMPLEXA (Alder): *G. J. Allman*, Monogr. Gymnobl. Hydr., p. 290, fig. (as *Gemmaria*).

A single colony on an encrusting Polyzoan dredged from rocky ground between Penlee Pt. and Rame Hd., Aug. 1899 (E.T.B.).

Medusæ liberated: Aug. (E.T.B.).

Stauridiidæ.

STAURIDIUM PRODUCTUM, Wright: *G. J. Allman*, Monogr. Gymnobl. Hydr., p. 371, fig.

A small colony in a Laboratory tank, June, 1899 (E.T.B.).

Myriothelidæ.

MYRIOTHELA PHRYGIA, Fabricius: *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 77, fig.

Common, under stones, at low tide (G.C.B.): Drake's I. (G.C.B., R.A.T., S.P.): Millbay Ch. (E.J.A., A.J.S., T.V.H., R.A.T., S.P.): shore below the Lab., Mt. Edgcumbe (E.J.A.): Rame Hd. (T.V.H.): Asia Sh., Reny Rks. (R.A.T.): Picklecombe, Bovisand B., Mewstone (G.C.B.): Rum B. (A.J.S.): Wembury B. (G.C.B., T.V.H., A.J.S., R.A.T.).

Gonophores ripe: Jan., Mar., Apr. (R.A.T.): May–Aug. (G.C.B.).

Eudendriidæ.

EUDENDRIUM ALBUM, Nutting: *C. C. Nutting*, Ann. Mag. Nat. Hist., ser. 7, vol. i, p. 362, fig.

One of the most abundant Hydroids at Plymouth during the spring: on stones from Millbay Ch., often covering the stones

[**Anthomedusæ**—*contd.*]

with a dense growth of white cottony tufts (C.C.N.): Millbay Ch. (E.J.A., T.V.H., A.J.S., R.A.T., S.P.): Asia Sh., Duke Rk. (R.A.T.).

Bearing gonophores: Jan., Feb. (A.J.S.): Mar. (T.V.H.): Apr. (C.C.N.): May (R.A.T.).

EUDENDRIUM CAPILLARE, Alder: *G. J. Allman*, Monogr. Gymnobl. Hydr., p. 335, fig.

Off Stoke Pt. on worm tubes, and on *Antennularia antennina* (G.C.B.): Eddystone Gds. (E.J.A.).

EUDENDRIUM RAMEUM (Pallas): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 80, fig.

Eddystone, 30 fms., not common (G.C.B.).

EUDENDRIUM RAMOSUM (Linnæus): *G. J. Allman*, Monogr. Gymnobl. Hydr., p. 232, fig.

Not uncommon in dredgings from the Sound (R.A.T.): Reny Rks., at low tide (T.V.H.): off the Mewstone, very common (G.C.B.): Rame-Eddystone Gds. (R.A.T.): Eddystone Gds., generally growing on shells or on other Hydroids, most frequent on sandy grounds (E.J.A.).

Breeding: Feb. (W.G.): Mar. (W.G., R.A.T., A.J.S.): Apr., May, Nov. (R.A.T.).

Bougainvilliidæ.

BOUGAINVILLIA RAMOSA (van Beneden): *G. J. Allman*, Monogr. Gymnobl. Hydr., p. 311, fig.

Drake's I., at low tide (G.C.B., R.A.T.): Millbay Pit; Millbay Dock, on piles; Asia Sh. (R.A.T.): Cawsand B., on old tin can (E.T.B.): Eddystone Gds., practically confined to the fine sand ground, where it is frequently met with, generally on Polychæte tubes or on other hydroids (E.J.A.).

Medusæ: Apr. (W.F.R.W.): May (E.J.A.).

PERIGONIMUS REPENS (T. S. Wright): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 90, fig.

Drake's I., on living *Nassa reticulata* (T.V.H.): Cawsand B., on *Nassa*; Cattewater, large colony on abdomen of *Carcinus* (R.A.T.): Mewstone 'Echinoderm' Gd., inside *Buccinum* shell (E.T.B., R.A.T.): Rame-Eddystone Gds. on *Turritella* shells (G.C.B.): Eddystone Gds., on claw of *Eupagurus Bernhardus* (E.J.A.).

Breeding: Aug. (W.G.): medusæ in April (R.A.T.).

PERIGONIMUS SERPENS, Allman: *G. J. Allman*, Monogr. Gymnobl. Hydr., p. 327, fig.

3 m. S. of the Mewstone, on an old rope, Oct. 1897; Eddystone Buoy, Apr. 1898 (E.T.B.).

Medusa-buds present: Oct. (E.T.B.).

Bimeriidæ.

GARVEIA NUTANS, T. S. Wright: *G. J. Allman*, Monogr. Gymnobl. Hydr., p. 295, fig.

Rocks under the Hoe (E.J.A., T.V.H., R.A.T.): on the piles of the Promenade Pier, occasionally (R.A.T.): Millbay Ch. and Pit (W.G., E.J.A., T.V.H., R.A.T.): Asia Sh. (R.A.T.).

Bearing gonophores: Feb.–Apr. (R.A.T.).

HETEROCORDYLE CONYBEAREI, Allman: *G. J. Allman*, Monogr. Gymnobl. Hydr., p. 307, fig.

Abundant in the Sound on living *Nassa reticulata* (E.T.B., R.A.T.): Drake's I., on *Nassa* (T.V.H.): Cawsand B., on *Nassa* (R.A.T., S.P.): Eddystone Gds., with *Eupagurus* (E.J.A.): near the East Rutts, on *Buccinum* shells containing *Eupagurus Bernhardus* (E.T.B.).

With gonophores: Aug., Oct. (E.T.B.).

Tubulariidæ.

TUBULARIA INDIVISA, Linnæus: *G. J. Allman*, Monogr. Gymnobl. Hydr., p. 400, fig.

Rocks under the Hoe (E.J.A.): Drake's I., in low tide rock-pools (G.C.B.): Millbay Ch. and Pit, moderately common (W.G., E.J.A., R.A.T., S.P.): Asia Sh. (E.J.A., R.A.T.): Mt. Edgcumbe (E.J.A.): Duke Rk. (R.A.T.): Eddystone Rk. (E.J.A.).

Breeding: Feb.–Apr. (W.G., R.A.T.): May (R.A.T.).

TUBULARIA (THAMNOCNIDIA) HUMILIS, Allman: *W. Garstang*, Journ. Mar. Biol. Assoc., ser. 2, vol. iii, p. 212.

Tide-pools below the Hoe (W.G., T.V.H.): Barn Pool (W.G.).

Breeding in March (W.G.).

TUBULARIA (THAMNOCNIDIA) LARYNX, Ellis & Solander: *G. J. Allman*, Monogr. Gymnobl. Hydr., p. 406, fig.

Growing profusely on the Duke Rk. Buoy, and on other buoys in the East Ch., 1889 (G.C.B.): Millbay Ch. (W.G., R.A.T.): not taken in 1895 (E.J.A.).

Breeding: Apr.–May (W.G., R.A.T.): Dec. (S.P.).

Corymorphidæ.

CORYMORPHA NUTANS, M. Sars [Medusa = *Steenstrupia rubra*, Forbes]: *G. J. Allman*, Monogr. Gymnobl. Hydr., p. 388, fig.

The hydroid generation has only been taken very occasionally, although its medusa is common (E.J.A.): off Ft. Tregantle, 5 specs. in about 3 fm., May 1887 (W.H.), 3 specs., May 1895 (E.J.A.): sought for unsuccessfully, 1889–90 (G.C.B.): two specs. on patch of sand in East Ch., May 1895 (E.J.A.): Queen's Gd., single spec., June 1904 (S.P.): Cawsand B., single spec., June 1904 (S.P.).

Attached medusæ in May.

(*MEDUSA STAGE.*)

Codonidæ.

SARSIA EXIMIA, Allman [Hydroid *Syncoryne*]: *G. J. Allman*, Monogr. Gymnobl. Hydr., p. 282, fig.

Plymouth, some specimens in July (W.G.).

SARSIA GEMMIFERA: *E. Forbes*, Monogr. Brit. Naked-eyed Med., p. 57, fig.

Plymouth; Sept., 1897; May, 1898; 1899, fairly common in June, few in July: Cawsand B., a young stage with medusa-buds, Sept. 1897 (E.T.B.).

[**Anthomedusæ**—*contd.*]

SARSIA PROLIFERA: *E. Forbes*, Monogr. Brit. Naked-eyed Med., p. 59, fig.
Plymouth (W.G.): single spec. Aug., 1895; Whitsand B., about 100 specs., May 1896; May 1898, few; July 1899, very abundant off Rame Hd. (E.T.B.).

SARSIA TUBULOSA (Sars): *E. Forbes*, Monogr. Brit. Naked-eyed Med., p. 55, fig.
Plymouth, rare (W.G.): very abundant about Saltash Bridge, Apr. 1898; occasionally taken in the Sound during May (E.T.B.).
Medusæ appeared in a Laboratory tank April 1898, and were reared to the adult stage (E.T.B.).

ECTOPLEURA DUMORTIERI, L. Agassiz: *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 124, fig.
The Sound, a single spec. of an early stage (E.T.B.).

DIPURENA HALTERATA: *E. Forbes*, Monogr. Brit. Naked-eyed Med., p. 53, fig. (as *Slabberia*).
Plymouth, Sept. 1893; July 1899, two early stages (E.T.B.).

DIPURENA OPHIOGASTER, Haeckel: *G. J. Allman*, Monogr. Gymnobl. Hydr., p. 45, fig. (as *Sarsia strangulata*).
Single spec., July 1897 (E.T.B.).

PERIGONIMUS REPENS (T. S. Wright): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 90, fig.
Plymouth (E.T.B.).
Medusæ budded off in tank in March (E.T.B.).

STEENSTRUPIA RUBRA, Forbes [Hydroid = *Corymorpha nutans*, M. Sars]: *E. T. Browne*, Proc. Zool. Soc., vol. 1896, p. 463, fig.
Abundant in spring and early summer (E.J.A.).

HYBOCODON PROLIFER, Agassiz: *E. T. Browne*, Proc. Zool. Soc., vol. 1896, p. 466.
Not uncommon Apr. 1898 (E.T.B.): few specs. with numerous buds, Apr. 1894 (W.G.).

EUPHYSA AURATA: *E. Forbes*, Monogr. Brit Naked-eyed Med., p. 71, fig.
Single spec. 4 m. S. of Breakwater, Sept. 1897; Apr.–June 1898, few specs. (E.T.B.).

Tiaridæ.

AMPHINEMA DINEMA (Péron & Lesueur): *E. Haeckel*, Syst. Medus., Denkschr. med.-naturw. Ges. Jena, vol. i, p. 50, fig. (as *A. Titania*).
Plymouth (W.G., E.T.B.): Sept. 1893, fairly common; Sept. 1895, scarce; Sept. 1897, several specs. from the Sound and outside grounds; May 1898, two specs. near the Eddystone; June 1898, single spec. near the Mewstone; July 1899, common (E.T.B.).

TIARA PILEATA, A. Agassiz: *E. Haeckel*, Syst. Medus., Denkschr. med.-naturw. Ges. Jena, vol. i, p. 58, fig.
Plymouth (W.G.): Sept. 1897, 2 specs. 4 m. S. of the Breakwater and 2 specs. 5 m. E. of the Eddystone, all young stages; May–June 1898; June 1899, one or two specs. occasionally (E.T.B.).

[**Anthomedusæ**—*contd.*]

Margellidæ.

LIZZIA BLONDINA: *E. Forbes*, Monogr. Brit. Naked-eyed Med., p. 67, fig.
Plymouth, Sept. 1897, of varying frequency in the Sound and outside grounds, a large shoal off the Eddystone on Sept. 15th; May 1898, a large shoal in the Sound on May 2nd, it disappeared from the Sound on the 12th, and was off the Eddystone from the 16th to the 26th, but no specimens were then seen in the Sound or near the Mewstone; 1899, June–Aug., very scarce (E.T.B.).

PODOCORYNE CARNEA, M. Sars: *G. J. Allman*, Monogr. Gymnobl. Hydr., p. 349, fig.
Free-swimming medusæ in March (W.F.R.W.); July–Aug. (W.G.).

CYTÆANDRA AREOLATA, Haeckel: *E. T. Browne*, Proc. Zool. Soc., vol. 1897, p. 817, fig.
Sept. 1897, intermediate stages occasionally met with in the Sound and outside; June 1898, single spec. 10 m. S. of the Mewstone (E.T.B.).

MARGELIS AUTUMNALIS: *C. Hartlaub*, Wiss. Meeresunters., ser. 2, vol. ii, p. 465, fig. (as *Bougainvillia*).
Sept. 1897, very scarce; Sept. 1898, scarce (E.T.B.).

MARGELIS BELLA: *C. Hartlaub*, Wiss. Meeresunters., ser. 2, vol. ii, p. 470, fig. (as *Bougainvillia*).
1898, a young stage in May, 4 specs. in June (E.T.B.).

MARGELIS BRITANNICA (Forbes): *E. T. Browne*, Proc. Liverp. Biol. Soc., vol. ix, p. 267.
Plymouth, end of April (E.T.B.).

MARGELIS PRINCIPIS, Steenstrup: *E. Haeckel*, Syst. Medus., Denkschr. med.-naturw. Ges. Jena, vol. i, p. 88, fig.
Plymouth, end of April (W.G.).

MARGELLIUM OCTOPUNCTATUM (M. Sars): *E. Forbes*, Monogr. Brit. Naked-eyed Med., p. 64, fig. (as *Lizzia*).
Numerous specs. during latter half of Feb. and March, 1893; less abundant in 1894 (W.G.): 1898, few specs. in Apr. and May (E.T.B.).

Cladonemidæ.

GEMMARIA IMPLEXA (Alder): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 59, fig. (as *Zanclea*).
Plymouth, 2 specs., Aug. 1895; Cawsand B., single spec. of an early stage, Sept. 1897 (E.T.B.).

WILLIA STELLATA [Hydroid = *Lar Sabellarum*, Gosse]: *E. Forbes*, Monogr. Brit. Naked-eyed Med., p. 19, fig.
Single spec., May 1896; Sept. 1897, earlier and intermediate stages frequently taken, adult very scarce; June–Aug. 1899, very scarce, only 2 specs. taken (E.T.B.).

LEPTOMEDUSÆ.

(*HYDROID STAGE.*)

Campanulariidæ.

CLYTIA JOHNSTONI (Alder): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 143, fig.

Ubiquitous on Algæ and on other Hydroids (G.C.B.): L.W.–35 fms. (R.A.T., S.P.).

Breeding: Mar. (R.A.T.): Apr. (A.J.S.): July (E.T.B.). Medusæ produced in Laboratory tanks, May 1895 (C.C.N.). Medusæ bearing gonothecæ, July (E.T.B.).

AGASTRA CALICULATA (Hincks) [Medusa = *A. mira* (Hartlaub)]: *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 164, fig. (as *Campanularia*).

The Hydroid form has not yet been recorded (S.P.).

OBELIA DICHOTOMA (Linnæus): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 156, fig.

Rame Hd. (W.H.): Rame-Eddystone Gds., on *Antennularia antennina* and *Sertularella Gayi* (R.A.T.): Whitsand B., on worm-tubes (G.C.B.): Eddystone Gds., on the fine sand area, growing on *Pecten opercularis* shells, *Hydrallmania*, *Bougainvillia*, *Sertularia argentea*, and *Cellaria* (E.J.A.).

OBELIA GENICULATA (Linnæus): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 149, fig.

Very common, generally on *Laminaria* (G.C.B., W.H., R.A.T., S.P.): Millbay Dock, on the piles (R.A.T.): Rame-Eddystone Gds., on *Lepralia* (R.A.T.).

Bearing gonophores: Mar.–Sept. (W.G.).

OBELIA LONGISSIMA (Pallas): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 154, fig.

From trawl refuse from outside the Eddystone (G.C.B.): S. of Eddystone (E.J.A.).

OBELARIA GELATINOSA (Pallas): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 151, fig. (as *Obelia*).

Lynher R., large colonies, up to 13 inches, in deep water under Sheviock Wood, July 1898 (E.W.L.H., W.I.B., E.T.B.): Bovisand B. (T.V.H.).

CAMPANULARIA ANGULATA, Hincks: *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 170, fig.

Bovisand B., at low tide (G.C.B.).

CAMPANULARIA FLEXUOSA (Hincks): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 168, fig.

Very common on weeds and in rock-pools below the Hoe (G.C.B.): common on the shore between tide-marks; on hulks and buoys in the Sound and Cattewater; Phœnix Wharf and Millbay Dock, on piles: Millbay Pit (R.A.T.): Mt. Edgcumbe (E.J.A.): Saltash Pier, very abundant Oct. 1897 (E.T.B.).

Gonosomes well developed in May (C.C.N.).

[**Leptomedusæ**—*contd.*]

CAMPANULARIA HINCKSI, Alder: *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 162, fig.

Common in 10–30 fms. on shells, Hydroids, *Cellaria*, etc.; Rame-Eddystone Gds.; Mewstone Gds. (R.A.T.): Eddystone Gds. (E.J.A.).

CAMPANULARIA NEGLECTA (Alder): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 171, fig.

On stems of *Tubularia indivisa*; Millbay (C.C.N.).

CAMPANULARIA VERTICILLATA (Linnæus): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 167, fig.

Mewstone Gds.; Eddystone Gds., occasionally on the fine sand areas (E.J.A.).

CAMPANULARIA VOLUBILIS (Linnæus): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 160, fig.

Duke Rk., on shells (G.C.B.): N. of Breakwater, 5½ fms., plentiful (W.H.).

GONOTHYRÆA LOVÉNI, Allman: *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 181, fig.

Millbay Ch.; Hamoaze (E.J.A.): Millbay Dock, on piles; on hulks in Cattewater; between tide-marks Turnchapel, Rum B., and Yealm R.; Asia Sh. (R.A.T.): Mt. Edgcumbe, at low tide (C.C.N., E.J.A.): Barn Pool on *Fucus*; Saltash Pier (E.T.B.).

Breeding: Mar. (R.A.T.): Apr. (W.G., R.A.T.): Sept. (E.T.B.): Oct. (W.G., E.T.B.): Nov. (W.G.).

Sometimes grows in great profusion in the Laboratory tanks (E.J.A.).

Campanulinidæ.

CAMPANULINA REPENS, Allman: *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 189, fig.

Winter Sh.,[1] abundant on *Delesseria*; between Penlee Pt. and Rame Hd., on Algæ and stems of *Tubularia*; Mewstone Gds.,[1] many colonies on a piece of rope (E.T.B.).

Gonophores: July (E.T.B.).

OPERCULARELLA HISPIDA: *C. C. Nutting*, Ann. Mag. Nat. Hist., ser. 7, vol. i, p. 363, fig.

The type specimen from Plymouth, on a stone associated with *Clava multicornis* (C.C.N.).

OPERCULARELLA LACERATA (Johnston): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 194, fig.

Millbay Dock, on young stems of *Tubularia indivisa* and on *Eudendrium* (C.C.N.).

Lafoëidæ.

LAFOËA DUMOSA (Fleming) [cf. *Coppinia arcta* (Dalyell)]: *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 200, fig.

Common in 15–35 fms., on shells, worm-tubes, other Hydroids, etc. (R.A.T., S.P.): Eddystone Gds., both the creeping and branched varieties, the latter especially upon the fine sand areas where it is attached to shells or Polychæte tubes (E.J.A.).

The Neomenian *Myzomenia* (= *Dondersia*) *banyulensis* is frequently associated with the erect form of *L. dumosa* (E.J.A., S.P.).

[**Leptomedusæ** —*contd.*]

LAFOËA FRUTICOSA, M. Sars: *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 202, fig.

Not uncommon, 15–30 fms. (R.A.T., S.P.): Rame-Eddystone Gds. (E.T.B. & R.A.T., S.P.): Eddystone Gds. (E.J.A.): Stoke Pt. Gds. (G.C.B., S.P.).

CALYCELLA SYRINGA (Linnæus): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 206, fig.

Abundant on roots of *Laminaria* (G.C.B.): abundant on young stems of *Tubularia indivisa* (C.C.N.): Penlee Pt.; Rame Hd. (G.C.B.): Saltash Pier, on *Sertularia* (E.T.B.).

CALYCELLA FASTIGIATA (Alder): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 208, fig.

Eddystone Gds. (E.J.A.).

CUSPIDELLA COSTATA: *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 210, fig.

Inner Eddystone trawling grounds (E.J.A.): growing on weed, trawl refuse (G.C.B.).

CUSPIDELLA GRANDIS: *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 210, fig.

On stems of *Halecium tenellum* (C.C.N.).

Trichydridæ.

TRICHYDRA PUDICA, T. S. Wright: *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 216, fig.

Eddystone Gds., fine gravel (E.T.B. & E.J.A.): Eddystone Buoy (E.T.B.).

Coppiniidæ.

COPPINIA ARCTA (Dalyell) [? = gonosome of *Lafoëa dumosa* (Fleming)]: *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 219, fig.

Eddystone Gds., abundant on the fine sand grounds; growing on Hydroids, especially *Lafoëa dumosa* var. *robusta* and *Sertularia abietina* (E.J.A.): Mewstone Gds. (A.J.S.): Rame-Eddystone Gds.: Mewstone Ledge, very occasionally (R.A.T.).

Haleciidæ.

HALECIUM BEANI (Johnston): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 224, fig.

Not uncommon in the Sound, on stones and shells, and outside, in 15–30 fms., on shells, other Hydroids, and on *Chætopterus* tubes. Not so abundant as *H. halecinum* (R.A.T., S.P.): Eddystone Gds. (E.J.A.).

With gonophores: Jan. (W.G.): Mar., Apr. (R.A.T.): May (S.P.): July (W.G.): Oct. (R.A.T.).

HALECIUM HALECINUM (Linnæus): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 221, fig.

Not uncommon in the Sound, on stones and shells. Common outside, 15–30 fms., on *Chætopterus* tubes, stones, and shells (R.A.T., S.P.): Eddystone Gds., abundant on certain grounds, and generally on *Chætopterus* tubes (E.J.A., S.P.): Rame-Eddystone Gds.; Mewstone Gds. (R.A.T., S.P.); Stoke Pt. Gds.; Looe-Eddystone Gds. (S.P.).

Breeding: Jan. (W.G.): Feb.–June (R.A.T.): July (W.G.).

HALECIUM LABROSUM, Alder: *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 225, fig.

Eddystone Gds. (E.T.B.).

HALECIUM TENELLUM, Hincks: *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 226, fig.

Plymouth, 18 fms. (C.C.N.).

Breeding: Apr. (C.C.N.).

HALOIKEMA LANKESTERI: *G. C. Bourne*, Jour. Mar. Biol. Assoc., ser. 2, vol. i, p. 395, fig.

Duke Rk., on flat stones (G.C.B., E.T.B.): S. end of Jennycliff B. (G.C.B., W.G.).

Sertulariidæ.

SERTULARELLA GAYI (Lamouroux): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 237, fig.

Not uncommon in the Sound (R.A.T., S.P.): Eddystone Gds., one of the most characteristic features of the fauna of the fine sand grounds (E.J.A., S.P.): Rame-Eddystone Gds.; Mewstone Gds. (R.A.T., S.P.): Stoke Pt. Gds.; Looe-Eddystone Gds. (S.P.).

Breeding: Feb. (W.G.): Mar. (R.A.T.): Aug.–Oct. (W.G.).

SERTULARELLA POLYZONIAS (Linnæus): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 235, fig.

Occasionally in the Sound (R.A.T., S.P.): Eddystone Gds., with *S. Gayi*, but much less common (E.J.A., S.P.): Mewstone Gds.: Rame-Eddystone Gds. (R.A.T., S.P.): Stoke Pt. Gds. (S.P.).

Breeding: Aug. (S.P.): Sept. (R.A.T.)

DIPHASIA ATTENUATA (Hincks): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 247, fig.

On the fine sand of the 'Outer' Trawling Gds. (E.J.A.).

DIPHASIA PINASTER (Ellis & Solander): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 252, fig.

Very common in trawl refuse: S. of Eddystone (G.C.B.).

DIPHASIA PINNATA (Pallas): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 255, fig.

5 m. S. of Eddystone (G.C.B.).

Breeding: Apr. (W.G.): gonophores in May (G.C.B.).

DIPHASIA ROSACEA (Linnæus): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 245, fig.

Millbay Ch., common on stones (W.G.): Millbay Dock, on the piles (W.G., R.A.T.): 2 m. S. of the Mewstone, small colony on piece of rope (E.T.B.): Eddystone Gds., occasionally met with (E.J.A.).

Breeding: Mar. (W.G., R.A.T.): Apr. (W.G.).

DIPHASIA TAMARISCA (Linnæus): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 254, fig.

Eddystone Gds. (E.J.A.).

SERTULARIA ABIETINA, Linnæus: *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 266, fig.

Common in trawl refuse (G.C.B.): abundant in depths below 30 fms. on the 'Outer' Trawling Gds. (E.J.A.): Millbay Ch., occasionally (R.A.T., S.P.).

[**Leptomedusæ**—*contd.*]

SERTULARIA ARGENTEA, Ellis & Solander: *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 268, fig.

Queen's Gd.: Asia Sh.: Millbay Ch. and Pit (R.A.T., S.P.): Eddystone Gds., not infrequent on *Pecten opercularis* shells, and on other Hydroids (E.J.A.): Yealm R. (R.A.T.): Stoke Pt. Gds. (R.A.T., S.P.): Saltash Pier (E.T.B.).

Breeding: Feb. (W.G.): Mar., Apr. (R.A.T.).

SERTULARIA CUPRESSINA, Linnæus: *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 270, fig.

Common in trawl refuse from the Eddystone (G.C.B.): Queen's Gd. (R.A.T., S.P.).

Gonophores ripe: March (R.A.T.).

SERTULARIA OPERCULATA, Linnæus: *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 263, fig.

Wembury B.; Eddystone Rk., abundant Apr. 1898; Eddystone Buoy (E.T.B.).

SERTULARIA PUMILA, Linnæus: *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 260, fig.

Abundant on rocks and weeds, especially *Fucus*, between tide-marks (G.C.B., R.A.T., S.P.): buoy near Breakwater (R.A.T.).

Breeding: Mar.–July (W.G.).

HYDRALLMANIA FALCATA (Linnæus): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 273, fig.

Not uncommon in the Sound; common, 15–30 fms., on stony ground, and on sand with stones and shells: always attached to stones or shells (R.A.T.): abundant in the Hamoaze (E.J.A.): Millbay Pit; Duke Rk.; Mewstone Gds.: Cawsand B.; Rame-Eddystone Gds. (R.A.T.): Eddystone Gds., occasional specs. (E.J.A.).

Breeding: Jan. (W.G.): Feb.–Apr. (R.A.T.).

THUIARIA ARTICULATA (Pallas): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 277, fig.

Wembury B.; stones and shells off Mewstone (G.C.B.): Mewstone Ledge (R.A.T.).

Plumulariidæ.

ANTENNULARIA ANTENNINA (Linnæus): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 280, fig.

Not uncommon in the Sound; common outside, 15–30 fms., especially on medium gravel and muddy sand (R.A.T., S.P.): Eddystone Gds. (E.J.A., S.P.): Cawsand B: Rame-Eddystone Gds.; Mewstone Gds. (R.A.T., S.P.): Stoke Pt. Gds.: Looe-Eddystone Gds. (S.P.).

Breeding: Apr. (R.A.T.): May (W.G., R.A.T., S.P.): June–July (W.G.).

ANTENNULARIA RAMOSA (Lamouroux): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 282, fig.

With *A. antennina*, but less abundant (E.J.A., R.A.T., S.P.).

Breeding: Apr. (R.A.T.): May (W.G., R.A.T., S.P.).

AGLAOPHENIA HELLERI, Marktanner-Turneretscher: *C. C. Nutting*, Journ. Mar. Biol. Assoc., ser. 2, vol. iv, p. 153.

Eddystone Rk. (C.C.N., E.T.B.).

AGLAOPHENIA MYRIOPHYLLUM (Linnaeus): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 290, fig.

Moderately common, 15–30 fms., on fine sand and sand with gravel (R.A.T., S.P.): Eddystone Gds. (E.J.A., R.A.T., G.C.B., S.P.): Rame-Eddystone Gds. (R.A.T., S.P.): Stoke Pt. Gds. (S.P.).

Breeding: Apr.–June (R.A.T.): Aug. (W.G.).

The Aplacophoran *Rhopalomenia Aglaopheniae* is very commonly met with twined round the base of the stem of this form (E.J.A., R.A.T., S.P.).

AGLAOPHENIA PLUMA (Linnaeus): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 286, fig.

Common on the fronds of *Halidrys siliquosa*; Bovisand B.; off Mewstone (G.C.B.): Rame-Eddystone Gds. (R.A.T.): Yealm R. (T.V.H., A.J.S.): Penlee-Rame Gds.: N. of Mewstone (E.J.A.): Millbay Ch.; Queen's Gd.: Wembury B.; occasional specs. (E.J.A., R.A.T.).

Breeding: May (E.J.A., R.A.T.): Aug. (W.G.).

AGLAOPHENIA TUBULIFERA (Hincks): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 288, fig.

Not uncommon, Aug.–Oct.; Wembury B.; off the Mewstone (G.C.B.): Eddystone Gds. (E.J.A., E.T.B.): Rame-Eddystone Gds.; Mewstone Ledge (R.A.T.): Bovisand B. (G.C.B.).

Breeding: Sept. (R.A.T.): Oct. (W.G.).

PLUMULARIA ALLENI, Nutting: *C. C. Nutting*, Ann. Mag. Nat. Hist., ser. 7, vol. i, p. 364, fig.

Growing on *Antennularia ramosa* (C.C.N.).

Bearing gonophores: Apr. or May (C.C.N.).

PLUMULARIA CATHARINA, Johnston: *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 299, fig.

Not uncommon; Duke Rk.; Winter Sh.; off Stoke Pt. (G.C.B.): Queen's Gd., occasionally (T.V.H., R.A.T., S.P.): Eddystone Gds., the most abundant species on both the fine sands on other Hydroids, and on the gravels, where Hincks' green variety is often very abundant on *Chaetopterus* tubes (E.J.A.): Rame-Eddystone Gds., on *Chaetopterus* and Terebellid tubes, *Cellaria*, *Antennularia*, *Ascidiella scabra*, etc. (R.A.T.).

With gonophores: Apr.–May (R.A.T.): Aug. (E.J.A.).

PLUMULARIA ECHINULATA, Lamarck: *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 302, fig.

On weed, not very common (G.C.B.): Winter Sh., on *Delesseria*; Millbay Dock, on the piles; Yealm Est., on *Laminaria* (E.T.B.).

PLUMULARIA FRUTESCENS (Ellis & Solander): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 307, fig.

Eddystone Gds., single colony on shell of *Pecten maximus* (E.J.A.): Wembury B. (G.C.B.): Stoke Pt. Gds. (S.P.).

PLUMULARIA HALECIOIDES, Alder: *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 306, fig.

Parasitic on *P. setacea* and on *Antennularia* (C.C.N.).

[**Leptomedusæ**—*contd.*]

PLUMULARIA PINNATA (Linnæus): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 295, fig.

By far the most abundant Plumularian at Plymouth (C.C.N.): Millbay Ch. (E.J.A., R.A.T., S.P.): Millbay Dock, on piles: Asia Sh.: Rum B., occasionally (R.A.T.): common; Duke Rk.; Barn Pool: off Mewstone (G.C.B.): Rame-Eddystone Gds. (E.T.B. & R.A.T., S.P.): Eddystone Gds., generally distributed, particularly on the gravel W. of the Eddystone, where it is usually attached to *Chætopterus* tubes or to other Hydroids (E.J.A.): Yealm R. (E.J.A., R.A.T.).

Asexual 'stoloniferous' reproduction has been observed in Apr. (C.C.N.). Gonophores in Apr. (W.G., R.A.T.): May (E.J.A., R.A T.): June (E.J.A.).

PLUMULARIA SETACEA (Ellis): *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 296, fig.

Common in the Sound: Hincks' branched variety is very common, generally on *Halichondria panicea* (G.C.B.): Millbay Ch. and Pit, not uncommon: Millbay Dock, on piles: Tinside, occasionally: Asia Sh., occasionally: Rame-Eddystone Gds., on *Chætopterus* tubes (R.A.T.): Eddystone Gds., generally on other Hydroids or on Polychæte tubes (E.J.A.).

Breeding: Feb.–June (W.G.).

PLUMULARIA SIMILIS, Hincks: *T. Hincks*, Hist. Brit. Hydr. Zooph., p. 303, fig.

Common; rocks below Lab.; Jennycliff B. (G.C.B.): under the Hoe: Bovisand B.: Yealm R. (T.V.H.): Church Reef, Wembury B., very occasional: Millbay Ch., occasional specimens (R.A.T.).

(*MEDUSA STAGE.*)

Eucopidæ.

AGASTRA MIRA (Hartlaub) [Hydroid = *A. caliculata* (Hincks)]: *E. T. Browne*, Proc. Zool. Soc., vol. 1897, p. 832., fig.

A single spec., in the Sound, Aug. 1897 (E.T.B.).

OBELIA LUCIFERA: *E. Forbes*, Monogr. Brit. Naked-eyed Med., p. 52, fig. (as *Thaumantias*).

Very plentiful, June 1892 (E.J.B.): by far the most abundant Leptomedusan in the Sound and outside, Sept. 1897 (E.T.B.).

OBELIA NIGRA: *E. T. Browne*, Proc. Irish Acad., ser. 3, vol. v, p. 721.

Common; 1898, very abundant Apr.–May; 1899, abundant in June (E.T.B.).

TIAROPSIS MULTICIRRATA (Sars); *E. Haeckel*, Syst. Medus., Denkschr. med.-naturw. Ges. Jena., vol. i, p. 179.

Apr. 1895 (E.J.A.).

EUCHILOTA PILOSELLA (Forbes): *E. T. Browne*, Proc. Zool. Soc., vol. 1896, p. 484, fig.

Plymouth (E.T.B., E.J.A.); common every summer (W.G.).

MITROCOMELLA FULVA: *E. T. Browne*, Bergens Mus. Aarb., vol. 1903, No. 4, p. 17, fig.

Single spec., off the Eddystone, May 1898 (E.T.B.).

PHIALIDIUM BUSKIANUM (Gosse): *E. T. Browne*, Proc. Zool. Soc., vol. 1896, p. 488, fig.

Sept. 1893; Sept. 1895; Sept. 1897, few specs. nearly always present in townettings; June 1898, only once taken (E.T.B.).

PHIALIDIUM CYMBALOIDEUM (van Beneden) [Hydroid ?=*Campanulina repens*]: *E. T. Browne*, Proc. Zool. Soc., vol. 1896, p. 491, fig.

Sept. 1893: Sept. 1897: Apr.–May 1898: June–July 1899: never very abundant, but a few specimens generally taken (E.T.B.).

PHIALIDIUM TEMPORARIUM: *E. T. Browne*, Proc. Zool. Soc., vol. 1896, p. 489.

Nearly always present from the spring until autumn (E.T.B.).

EUTIMA INSIGNIS (Keferstein): *E. T. Browne*, Proc. Zool. Soc., vol. 1896, p. 492.

Oct. 1893 (W.G., E.T.B.[1]): Sept. 1895, single adult; June 1898, S. of the Mewstone, two specs.; Aug. 1899, single spec. (E.T.B.).

SAPHENIA MIRABILIS (Wright): *E. T. Browne*, Proc. Zool. Soc., vol. 1896, p. 493, fig.

Near the Eddystone, July 1891, some hundreds (J.T.C.[1]): off Penlee, at bottom in 9 fms., July 1892 (E.J.B.[1]): 1897, single specs. in Aug. and Sept.; Apr.–June 1898, few specs.; June–July 1899, few (E.T.B.).

OCTORCHIS GEGENBAURI, Haeckel: *E. Haeckel*, Syst. Medus., Denkschr. med.-naturw. Ges. Jena, vol. i, p. 197, fig.

Sept. 1895, single spec.; 1899, four specs. in July, one in Aug. (E.T.B.).

IRENE PELLUCIDA (Will): *E. Haeckel*, Syst. Medus., Denkschr. med.-naturw. Ges. Jena, vol. i, p. 201, fig.

Oct. 1892, several specs. (W.G.); Sept. 1897, single spec. from the Sound, two specs. 3 m. S.W. of the Mewstone, all young stages (E.T.B.).

TRACHYMEDUSÆ.

Geryonidæ.

LIRIANTHA APPENDICULATA: *E. Forbes*, Monogr. Brit. Naked-eyed Med., p. 36, fig. (as *Geryonia*).

Exceedingly abundant Sept.–Oct., 1893: absent Sept. 1895; scarce and only early stages in the Sound and outside grounds, Sept. 1897 (E.T.B.): Jan. 1896 (E.J.A.).

Solmaridæ.

SOLMARIS CORONANTHE, Haeckel: *E. Haeckel*, Syst. Medus., Denkschr. med.-naturw. Ges. Jena, vol. i, p. 359, fig.

Plymouth, Sept., 1895 (E.T.B.).

SIPHONOPHORA.

Monophyidæ.

MUGGLÆA ATLANTICA: *J. T. Cunningham*, Journ. Mar. Biol. Assoc., ser. 2, vol. ii, p. 212, fig.

First met with 5 m. S. of the Eddystone, afterwards in great abundance close to the Breakwater, and even inside the Sound, Sept. 1891 (J.T.C.): 1892, appeared near end of Aug. (E.J.B.): Sept. 1893, fairly abundant early part of month: Sept. 1895, exceedingly abundant (E.T.B.): 1895, middle Aug.–mid. Dec. (T.V.H.): 1903, occasionally met with in Feb. (W.G.).

Agalmidæ.

AGALMOPSIS SARSI, Haeckel: *E. T. Browne*, Proc. Irish Acad., ser. 3, vol. v, p. 678.

Mar., 1902, single specimen from ½ m. S.W. of the Mewstone and from West Channel (R.A.T.).

STAUROMEDUSÆ.

Lucernariidæ.

LUCERNARIA CAMPANULATA, Lamouroux: *E. Haeckel*, Syst. Medus., Denkschr. med.-naturw. Ges. Jena, vol. i, p. 392.

Reny Rks., several small specs. with *Haliclystus*; single specs. from Cawsand B. and Whitsand B. (W.I.B.).

HALICLYSTUS AURICULA (Fabricius): *W. I. Beaumont*, Proc. Irish Acad., ser. 3, vol. v, p. 806.

Yealm Est., on *Zostera*, fairly common (S.P.): Reny Rks., on *Enteromorpha*, in high tide rock-pools (A.J.S.): Cawsand B., on *Zostera*, occasionally (S.P.).

DEPASTRUM CYATHIFORME: *M. Sars*, Fauna Litt. Norvegiæ, pt. i, p. 26, fig. (as *Lucernaria*).

Mount Edgcumbe; Batten (E.J.A.): Drake's I.; Rame Hd. (W.G.).

DISCOMEDUSÆ.

Pelagiidæ.

CHRYSAORA ISOSCELES (Linnæus): *E. Haeckel*, Syst. Medus., Denkschr. med.-naturw. Ges. Jena, vol. i, p. 513.

Occasionally during the summer months (S.P.).

Planulæ liberated in Aug. and reared to Scyphistoma stage (E.T.B.).

Cyaneidæ.

CYANEA CAPILLATA (Linnæus): *E. Haeckel*, Syst. Medus., Denkschr. med.-naturw. Ges. Jena, vol. i, p. 529.

Plymouth (E.T.B.).

CYANEA LAMARCKI, Péron & Lesueur: *E. Haeckel*, Syst. Medus., Denkschr. med.-naturw. Ges. Jena, vol. i, p. 530.

Occasionally, every summer (A.J.S.).

Ulmaridæ.

AURELIA AURITA, Lamarck: *E. Haeckel*, Syst. Medus., Denkschr. med.-naturw. Ges. Jena, vol. i, p. 552.

Most abundant in the estuaries in spring and summer; R. Tamar; Hamoaze; Yealm R.; carried out into the Channel towards the end of the summer (E.J.A.): Saltash (E.T.B.).

The ephyræ appear in February and may be taken in shoals during the first fortnight of March, they metamorphose towards the end of the month and begin to disappear. The young medusæ reappear towards the end of May and reach their maximum abundance during June (W.G.).

Pilemidæ.

RHIZOSTOMA OCTOPUS (Linnæus): *E. Haeckel*, Syst. Medus., Denkschr. med.-naturw. Ges. Jena, vol. i, p. 593 (as *Pilema*).

Occasionally (S.P.).

ALCYONARIA.

Cornulariidæ.

SARCODICTYON CATENATA, Forbes: *W. A. Herdman*, Proc. Liverp. Biol. Soc., vol. IX, p. 163, fig.

Eddystone Gds.; the red form is found, often in abundance, on old shells, and is generally most plentiful on clean shell-gravel (E.J.A., S.P.): Stoke Pt. Gds.: Rame-Eddystone Gds.; etc. (S.P.).

Alcyonidæ.

ALCYONIUM DIGITATUM, Linnæus: *S. J. Hickson*, Quart. Journ. Micr. Sci., ser. 2, vol. xxxvii, p. 349, fig.

Generally present in dredgings from the Sound and outside grounds, but the colonies are usually small (R.A.T., S.P.): Promenade Pier, large colonies are occasionally common, at extreme low water (E.J.A., R.A.T., S.P.): Eddystone Gds., large colonies abundant on the fine sand of the 'Outer' Trawling Gds. and S. of the Eddystone, attached to valves of *Cardium echinatum*, etc. (E.J.A.).

Breeding: Oct.; Jan. (R.A.T.): Nov.–Feb. (W.G.).

ALCYONIUM GLOMERATUM (Hassall): *S. J. Hickson*, Quart. Journ. Micr. Sci., ser. 2, vol. xxxvii, p. 353, fig.

Mewstone Ledge (R.A.T.).

ALCYONIUM PALMATUM, Pallas: *G. v. Koch*, Mitth. Stat. Neapel, vol. ix, p. 663, fig.

Mewstone Ledge (S.P.): 3 m. S.E. of the Mewstone (E.J.A.).

Plexauridæ.

EUNICELLA CAVOLINI: *G. v. Koch*, Fauna Flora Neapel, vol. xv, p. 58, fig.

More or less common everywhere on rocky ground, 10–25 fms. (S.P.): Mewstone Ledge, very common (E.J.A., R.A.T., S.P.): Queen's Gd., rare (R.A.T., S.P.): Rame-Eddystone Gds.; Stoke Pt. Gds. (S.P.).

Virgulariidæ.

VIRGULARIA MIRABILIS, O. F. Müller: *A. M. Marshall & W. P. Marshall*, Rept. Pennatulida Oban, p. 51, fig.

Single spec., Nr. Eddystone (W.P.M.): 6 m. W.S.W. of Penlee Pt. (R.A.T.[1]): Stoke Pt. Gds. (S.P.).

ZOANTHARIA.

Cerianthidæ.

CERIANTHUS LLOYDI, Gosse: *P. H. Gosse*, Hist. Brit. Sea-Anem., p. 268, fig.
The adult form has only once been taken, in muddy sand on the N. side of Drake's I., but the free-swimming larva (*Arachnactis albida*) is common during April (R.A.T.).

Zoanthidæ.

EPIZOANTHUS COUCHI (Johnston): *A. C. Haddon & Shackleton*, Trans. Dublin Soc., ser. 2, vol. iv, p. 644, fig.
Duke Rk., common (W.G.): Millbay Ch., not uncommon (W.G., R.A.T.).

EPIZOANTHUS INCRUSTATUS, Düben & Koren: *A. C. Haddon & Shackleton*, Trans. Dublin Soc., ser. 2, vol. iv, p. 636, fig.
Mewstone Gds., common on shells inhabited by *Anapagurus lævis* (R.A.T.): Eddystone Gds., a characteristic species of, and confined to, the 'Outer' Trawling Gds. (E.J.A.).

Edwardsiidæ.

EDWARDSIA BEAUTEMPSI, Quatrefages: *A. C. Haddon*, Trans. Dublin Soc., ser. 2, vol. iv, p. 327, fig.
Yealm Sand-bank, single spec. (R.A.T.).

EDWARDSIA CARNEA, Gosse: *P. H. Gosse*, Hist. Brit. Sea-Anem., p. 259, fig.
Millbay Ch. (S.P.): Church Reef, Wembury B. (R.A.T.).

Ilyanthidæ.

HALCAMPA CHRYSANTHELLUM (Peach): *A. C. Haddon*, Proc. Dublin Soc., ser. 2, vol. v, p. 1, fig.
Yealm Sand-bank, common (A.J.S., R.A.T.).
The larvæ parasitic on Medusæ (*Irene*, *Phialidium*, etc.), are common in May (W.G., E.J.A., R.A.T.).

ELOACTIS MAZELI (Jourdan): *W. Garstang*, Trans. Devon. Assoc., vol. xxiv, p. 380.
Single spec., few miles off the Mewstone, 20 fms. (W.G.).

Actiniidæ.

ACTINIA EQUINA, Linnaeus: *P. H. Gosse*, Hist. Brit. Sea-Anem., p. 175, fig. (as *A. mesembryanthemum*).
Common on rocks between tide-marks (R.A.T., S.P.).
Breeding: Jan.–Aug. (R.A.T.).

ANEMONIA SULCATA (Pennant): *P. H. Gosse*, Hist. Brit. Sea-Anem., p. 160, fig. (as *Anthea cereus*).
More or less common everywhere on rocks between tide-marks and on the *Zostera* beds. The slate-coloured variety is more abundant than the typical form with violet-tipped, green tentacles, and on the *Zostera* it is alone present. A flesh-coloured variety is occasionally met with. Yealm Sand-bank, brownish var. only (S.P.).

METRIDIUM SENILIS (Linnaeus): *P. H. Gosse*, Hist. Brit. Sea-Anem., p. 12, fig. (as *Actinoloba dianthus*).

Promenade Pier, very common on the piles at extreme low water (R.A.T., S.P.): Millbay Ch., occasional specimens (R.A.T.): Yealm Sand-bank, occasionally (R.A.T.): Yealm Estuary, young specs. common on the rocks between tide-marks (S.P.).

Breeding, in tanks, Aug.–Sept. (S.P.).

SAGARTIA MINIATA (Gosse): *P. H. Gosse*, Hist. Brit. Sea-Anem., p. 41, fig.

Asia Sh. (A.J.S., R.A.T.): Millbay Ch. (R.A.T.).

SAGARTIA NIVEA (Gosse): *P. H. Gosse*, Hist. Brit. Sea-Anem., p. 67, fig.

Rocks below the Laboratory (G.C.B.[1]).

CEREUS PEDUNCULATUS (Pennant): *P. H. Gosse*, Hist. Brit. Sea-Anem., p. 27, fig. (as *Sagartia bellis*).

Common on the shore where the ground is suitable, this form seeming to prefer muddy sand with stone. Not uncommon in dredgings from Millbay Ch., Mallard Sh., etc. (R.A.T.). Especially common in the estuaries of the Yealm, Tamar, and Plym (E.J.A.).

Breeding: Jan.–Feb.; Dec. (W.G.).

CHONDRACTINIA DIGITATA (O. F. Müller): *A. C. Haddon*, Trans. Dublin Soc., ser. 2, vol. iv, p. 306, fig.

Eddystone Gds., few specimens on the 'outer' trawling grounds, and on the fine sand S. of the Eddystone, inside valves of *Cardium echinatum* (E.J.A.).

CHITONACTIS CORONATA (Gosse): *P. H. Gosse*, Hist. Brit. Sea-Anem., p. 202, fig. (as *Bunodes*).

Occasionally in the deeper water outside the Breakwater, and in Millbay Ch. (W.G.): Rame-Eddystone Gds., single spec. on Hydroid stem (R.A.T.).

Breeding: Jan.–Apr. (W.G.).

PARAPHELLIA EXPANSA (Haddon): *A. C. Haddon*, Trans. Dublin Soc., ser. 2, vol. iv, p. 321, fig.

Eddystone Gds., few specimens, apparently living buried in the sand (E.J.A.): Rame-Eddystone Gds. (R.A.T.).

CYLISTA UNDATA (O. F. Müller): *P. H. Gosse*, Hist. Brit. Sea-Anem., p. 88, fig. (as *Sagartia troglodytes*).

Common at Plymouth (W.G.).

CYLISTA VIDUATA (O. F. Müller): *P. H. Gosse*, Hist. Brit. Sea-Anem., p. 105, fig. (as *Sagartia*).

Rare within the Sound, but common in the neighbourhood (W.G.): Promenade Pier, not uncommon on the piles at extreme low tide (R.A.T., A.J.S.): Millbay Ch., not uncommon (R.A.T.).

ADAMSIA PALLIATA (Bohadsch): *P. H. Gosse*, Hist. Brit. Sea-Anem., p. 125, fig.

Generally distributed and common, 10–30 fms., associated with *Eupagurus Prideauxi*. Eddystone Gds., Rame-Eddystone Gds., Mewstone Gds., Cawsand B., Yealm R., etc. (S.P.).

[**Zoantharia**—*contd.*]

ADAMSIA POLYPUS (Forskål): *P. H. Gosse*, Hist. Brit. Sea-Anem., p. 112, fig. (as *Sagartia parasitica*).

More or less common everywhere 15-30 fms., associated with *Eupagurus Bernhardus* (S.P.).

AIPTASIA COUCHII (Cocks): *P. H. Gosse*, Hist. Brit. Sea-Anem., p. 152, fig.

Rocks below the Lab., occasionally (G.C.B., R.A.T.): Reny Rks., not uncommon (R.A.T.).

THOE SPHYRODETA (Gosse): *P. H. Gosse*, Hist. Brit. Sea-Anem., p. 73, fig. (as *Sagartia*).

Drake's I., at low tide (W.H.): Mallard Sh. (J.C.S.): Millbay Ch., occasionally (R.A.T., E.J.A.).

BUNODES BALLI (Cocks): *P. H. Gosse*, Hist. Brit. Sea-Anem., p. 198, fig.

The Breakwater; the typical form is rare, being replaced by Gosse's varieties "*dealbata*" and "*livida*" (W.G.).

BUNODES GEMMACEA, Ellis: *P. H. Gosse*, Hist. Brit. Sea-Anem., p. 190, fig.

Caves under the Lab. (G.C.B.): Drake's I., common on rocks (E.J.A., R.A.T., S.P.): Mt. Edgcumbe (E.J.A.): Rum B., not uncommon between tide-marks (R.A.T., E.J.A.): Jennycliff B., between tide-marks, rare (R.A.T.): Bovisand Cove (R.A.T.): Whitsand B., common between tide-marks (R.A.T.).

Breeding: Mar. (R.A.T.): Apr.; Sept. (W.G.).

Corallimorphidæ.

CORYNACTIS VIRIDIS, Allman: *P. H. Gosse*, Hist. Brit. Sea-Anem., p. 289, fig.

More or less common in crevices and under stones on all rocky stations, L.W.-15 fms. (S.P.): The Breakwater (E.J.A., R.A.T., S.P.): Millbay Ch. (R.A.T., S.P.).

Amphianthidæ.

GEPHYRA DOHRNI, v. Koch: *A. C. Haddon*, Trans. Dublin Soc., ser. 2, vol. iv, p. 325, fig.

Mewstone Ledge, on *Eunicella*, not uncommon (T.V.H., A.J.S., R.A.T., S.P.).

Urticinidæ.

URTICINA FELINA (Linnæus): *P. H. Gosse*, Hist. Brit. Sea-Anem., p. 209, fig. (as *Tealia crassicornis*).

Not uncommon on rocks between tide-marks and occasionally in 10–20 fms. in the Sound. The specimens are not usually of great size, but large ones are occasionally trawled in 20–40 fms. (R.A.T.).

Breeding: May (W.G.).

Turbinolidæ.

CARYOPHYLLIA SMITHII, Stokes: *P. H. Gosse*, Hist. Brit. Sea-Anem., p. 310, fig.

More or less abundant on all rocky stations, L.W.-30 fms., under boulders and in rock-crevices (S.P.): The Breakwater; Mewstone Ledge, etc. (E.J.A., S.P.).

The Cirripede *Pyrgoma anglicum* is commonly found attached to the margin of the cup of this species; and frequently several occur upon a single coral (S.P.).

CTENOPHORA.

BOLINA INFUNDIBULUM (Fabricius): *E. Vanhöffen*, Nordisches Plankt., pt. xi, p. 5, fig.

Abundant in May of particular years (W.G.): Sept., 1900 (A.J.S.).

BEROE CUCUMIS, Fabricius: *E. Vanhöffen*, Nordisches Plankt., pt. xi, p. 7, fig.

Plymouth, few small specs. (E.T.B.).

PLEUROBRACHIA PILEUS (Fabricius): *E. Vanhöffen*, Nordisches Plankt., pt. xi, p. 3, fig.

Always abundant towards the end of May (W.G.). Adults not seen after June; minute specs. appeared in Sept. (E.J.B.): Aug. (T.V.H.).

ECHINODERMA.

Synaptidæ.

SYNAPTA DIGITATA (Montagu): *F. J. Bell*, Catal. Brit. Echinod. Brit. Mus., p. 34, fig.

Rame-Eddystone Gds., occasional specs. (R.A.T.).

SYNAPTA INHÆRENS (O. F. Müller): *F. J. Bell*, Catal. Brit. Echinod. Brit. Mus., p. 33, fig.

Drake's I., occasional specs.; Yealm R., not uncommon between tide-marks in coarse, loose sand (R.A.T.).

Cucumariidæ.

CUCUMARIA BRUNNEA (Thompson): *E. Forbes*, Hist. Brit. Starf., p. 229, fig. (as *Ocnus*).

Frequently in some numbers on Hydroids, Algæ, etc., from rocky ground and from the trawling grounds; below tide-marks to 25 fms. (S.P.): often abundant on rocky ground off the Mewstone (E.J.A.): Yealm R., not uncommon (R.A.T.).

CUCUMARIA HYNDMANI (Thompson): This species may be readily recognised by the silvery appearance of its test.

Occasional specs. not uncommon on coarse ground; Stoke Pt. Gds.; Rame-Eddystone Gds.: Looe-Eddystone Gds. (S.P.).

CUCUMARIA NORMANI*: *S. Pace*, see p. 309.

Not uncommon on rocky ground in crevices and under stones, L.W.–10 fms. (S.P.).

CUCUMARIA SAXICOLA†, Brady & Robertson: *S. Pace*, see p. 306.

Not uncommon on rocky ground, in crevices and under stones, L.W.–10 fms. (S.P.).

THYONE FUSUS (O. F. Müller): *F. J. Bell*, Catal. Brit. Echinod. Brit. Mus., p. 42, fig.

Occasional specs. from Millbay Ch., Cattewater, Cawsand B.: not uncommon on the Mewstone Gds., and occasionally met with in 15–35 fms. on other grounds (R.A.T.).

* Previously recorded as *C. Planci*.
† Previously recorded as *C. pentactes*.

[**Echinoderma**—*contd.*]

Holothuriidæ.

Holothuria nigra, Gray: *F. J. Bell*, Catal. Brit. Echinod. Brit. Mus., p. 49, fig.

Common on the Mewstone Gds. on clean gravel (E.J.A., R.A.T., S.P.): occasional specs. have been taken in Whitsand B., off Penlee, Melampus Sh. (R.A.T.): Stoke Pt. Gds., not uncommon (S.P.): Eddystone Gds., on the clean shell gravel immediately adjacent to the rocks (E.J.A.): Queen's Gd. (S.P.).

Gonads ripe: Apr. (S.P.): July, Dec. (R.A.T.).

Antedonidæ.

Antedon bifida (Pennant) [=*A. rosacea*, auctt.]: *F. J. Bell*, Catal. Brit. Echinod. Brit. Mus., p. 54, fig.

Extremely abundant at certain small areas, but practically restricted to these (S.P.): Millbay Pit (R.A.T., S.P.): Asia Sh., occasionally (R.A.T., S.P.): Mallard Sh. (G.C.B., J.T.C., S.P.): inside the Bridge (S.P.): the Cattewater, several specs. on bottom of coal hulk off Turnchapel (A.J.S., S.P.): Mewstone Ledge (S.P., R.A.T.).

The marsupia containing ova: Oct. (T.V.H.). Pentacrinoid larvæ in Feb. (A.J.S.): July (R.A.T., S.P.): Aug., abundant at all stages, chiefly on *Cellaria* (E.W.L.H.): Sept.–Oct. (W.G.).

The parasitic Polychæte *Myzostoma cirriferum* is common on the arms of this species (E.J.A.).

Astropectinidæ.

Astropecten irregularis (Pennant): *E. Forbes*, Hist. Brit. Starf., p. 130, fig. (as *Asterias aurantiacus*).

Common on fine, clean sand and moderately so on clean gravel and shell, 15–35 fms. (R.A.T., S.P.): Eddystone Gds. (E.J.A., S.P.): Mewstone Gds. (R.A.T., S.P.): Stoke Pt. Gds.: Rame-Eddystone Gds.; Looe-Eddystone Gds. (S.P.).

Luidia Sarsi, Düben & Koren: *F. J. Bell*, Catal. Brit. Echinod. Brit. Mus., p. 72.

Eddystone Gds. (E.J.A., J.T.C., R.A.T.).

Gymnasteriidæ.

Porania pulvillus (O. F. Müller): *F. J. Bell*, Catal. Brit. Echinod. Brit. Mus., p. 79, fig.

Occasionally at about 3 m. S. of the Breakwater (E.J.A., S.P.): Eddystone Gds. (E.J.A., R.A.T.).

Breeding: Feb.–Apr. (R.A.T.).

Asterinidæ.

Asterina gibbosa (Pennant): *F. J. Bell*, Catal. Brit. Echinod. Brit. Mus., p. 82, fig.

Common under stones at all rocky shore stations (S.P.): single spec. ½ m. S. of the Breakwater in 7 fms. (R.A.T.).

Breeding: May–June (W.G.).

Palmipes placenta (Pennant): *E. Forbes*, Hist. Brit. Starf., p. 116, fig. (as *P. membranaceus*).

Eddystone Gds., moderately common (E.J.A., S.P.): Rame-Eddystone Gds. (R.A.T., S.P.): Stoke Pt. Gds., not uncommon; about 3 m. S. of Breakwater, fairly common (S.P.).

Solasteridæ.

SOLASTER PAPPOSUS (Fabricius): *E. Forbes*, Hist. Brit. Starf., p. 112, fig.

Fairly common on coarse sand and gravel, 15–35 fms. (S.P.): the most plentiful starfish in 1892 (W.G.): Mewstone Gds., Rame-Eddystone Gds. (R.A.T., S.P.): Eddystone Gds. (E.J.A., S.P.): Stoke Pt. Gds. (S.P.): Cattewater, probably from trawl refuse (R.A.T., S.P.).

Gonads ripe in Mar. (T.V.H.).

Echinasteridæ.

HENRICIA SANGUINOLENTA (O. F. Müller): *E. Forbes*, Hist. Brit. Starf., p. 100, fig. (as *Cribella oculata*).

Reny Rks., occasional specs. at extreme low water (R.A.T.): not uncommon on the Mewstone Gds. (R.A.T., S.P.): Eddystone Gds., occasionally on clean medium gravel (E.J.A., S.P.): Stoke Pt. Gds. (S.P.).

Asteriidæ.

ASTERIAS GLACIALIS, Linnæus: *H. Ludwig*, Fauna Flora Neapel, vol. xxiv, p. 364, fig.

More or less common at all stations below low-water mark, but somewhat uncertain in its occurrence (S.P.): large specs. generally from deeper water, 30 fms. and over (E.J.A.): the Breakwater, not uncommon; Yealm R., not uncommon in dredgings, large specs. occasionally on the Sand-bank (R.A.T.): Eddystone Gds., most abundant where *Pecten opercularis* is plentiful (E.J.A.).

ASTERIAS RUBENS, Linnæus: *E. Forbes*, Hist. Brit. Starf., p. 83, fig. (as *Uraster*).

Occurs below tide-marks at most stations, but in very varying abundance in different years: it is generally plentiful, but occasionally it would seem to be almost absent:* a smaller, violet-coloured var. is met with on coarse ground in 15–30 fms. (E.J.A., S.P.).

Ophiolepidæ.

OPHIURA ALBIDA, Forbes: *F. J. Bell*, Catal. Brit. Echinod. Brit. Mus., p. 108.

Lives generally on coarser soil and is less abundant than *O. ciliaris* (E.J.A.): Mewstone Gds. (R.A.T.): Stoke Pt. Gds., fairly common; Rame-Eddystone Gds. (S.P.): Eddystone Gds. (E.J.A., S.P.).

OPHIURA CILIARIS (Linnæus): *F. J. Bell*, Catal. Brit. Echinod. Brit. Mus., p. 106.

Common, 15–35 fms., on gravel and sand (S.P.): most frequent on fine hard sand (E.J.A.): Mewstone Gds. (R.A.T., S.P.): Stoke Pt. Gds. (S.P.): Rame-Eddystone Gds. (E.J.A., R.A.T., S.P.): Eddystone Gds. (E.J.A., S.P.): Looe-Eddystone Gds. (S.P.).

Breeding: May (R.A.T.): Aug. (S.P.).

* Not a single spec. of *A. rubens* was obtainable from towards the end of Oct. 1903 until well on in the spring of 1904, although repeated search was made for it both in the Sound and in Cawsand B. (S.P.).

[**Echinoderma**—*contd.*]

Amphiuridæ.

OPHIOCNIDA BRACHIATA (Montagu): *F. J. Bell*, Catal. Brit. Echinod. Brit. Mus., p. 116, fig.

Common in muddy sand on a *Zostera* bed S. of Batten Castle (E.J.A., R.A.T., S.P.): Jennycliff B., single spec. (R.A.T.).

AMPHIURA CHIAJII, Forbes: *F. J. Bell*, Catal. Brit. Echinod. Brit. Mus., p. 117: two mouth papillæ on each side, two tentacle scales, 5–8 arm spines.

Millbay Ch., single spec. (R.A.T.): 2 m. S. of the Breakwater, single spec. (E.J.A.).

AMPHIURA ELEGANS (Leach): *F. J. Bell*, Catal. Brit. Echinod. Brit. Mus., p. 119: three mouth papillæ on each side, two tentacle scales.

Common at most stations in the Sound, L.W.–20 fms. (S.P.): Rame-Eddystone Gds., 27 fms., single spec. (R.A.T.): Yealm R. (S.P.).

Breeding: May–Sept. (W.G.).

AMPHIURA FILIFORMIS (O. F. Müller): *F. J. Bell*, Catal. Brit. Echinod. Brit. Mus., p. 119: two mouth papillæ on each side, no tentacle scales, arms very long.

Single spec., 2 m. W.S.W. of the Eddystone (E.J.A.).

OPHIACTIS BALLI (Thompson): *F. J. Bell*, Catal. Brit. Echinod. Brit. Mus., p. 124.

Common, but rather local, 15–35 fms., in crevices of rock and stones and on *Chætopterus* tubes (S.P.): Millbay Ch. and Pit, not uncommon (R.A.T., S.P.): Asia Sh. (T.V.H., S.P.): Mewstone Gds.; Rame-Eddystone Gds. (R.A.T., S.P.): abundant around the Eddystone (E.J.A.): Stoke Pt. Gds., not uncommon (S.P.).

Gonads ripe: Sept. (S.P.).

Ophiocomidæ.

OPHIOCOMA NIGRA (O. F. Müller): *E. Forbes*, Hist. Brit. Starf., p. 50, fig. (as *O. granulata*).

This form is almost invariably found associated with *Ophiothrix fragilis*, but is generally far less abundant than the latter species, although occasionally it is the predominant form; at most stations the specimens are brilliantly coloured, but sometimes, as on the Mallard Sh., it is possible to get a pure gathering of the typical black form (S.P.): Mallard Sh., in abundance together with *Antedon* (W.G., S.P.): Millbay Pit, common; Mewstone 'Echinoderm' Gd. (R.A.T., S.P.): Eddystone Gds., occasional specs. on stony and rocky ground, 15–30 fms. (E.J.A., S.P.): Rame-Eddystone Gds.; Stoke Pt. Gds.: not uncommon but very local (S.P.).

Gonads ripe: Apr.; July. Spent individuals, Sept. (S.P.).

OPHIOPSILA ARANEA, Forbes: *A. E. Grube*, Die Insel Lussin (Breslau, 1864), p. 104.

Mewstone Ledge, not uncommon in rock crevices (E.J.A., R.A.T., S.P.): Stoke Pt. Gds., fairly common in crevices of the local red rock, especially in old *Pholadidea* crypts, 15–25 fms. (S.P.).

Gonads ripe in Aug. (R.A.T.).

Ophiothricidæ.

OPHIOTHRIX FRAGILIS (O. F. Müller): *E. Forbes*, Hist. Brit. Starf., p. 60, fig. (as *Ophiocoma rosula*).

Generally distributed and enormously abundant at certain stations, L.W.–35 fms.: a small, solitary, greyish-coloured form occurs under stones on the shore: in deeper water it grows to a much larger size and is usually very brilliantly coloured; this latter form favours a coarse gravel ground and lives in such profusion where it occurs that the dredge will frequently come up completely filled with a practically pure gathering of this species alone (S.P.).

Gonads ripe: Mar.–June (R.A.T.): Aug.–Sept. (S.P.). Spawning: Oct. (R.A.T.).

Echinidæ.

ECHINUS ACUTUS, Lamarck: *F. J. Bell*, Catal. Brit. Echinod. Brit. Mus., p. 146.

Not uncommon in 15–35 fms., chiefly on the finer grounds (R.A.T., S.P.): more common in deeper water, where it replaces *E. esculentus* (E.J.A.): Mewstone Gds. (R.A.T.): Stoke Pt. Gds. (S.P.): Rame-Eddystone Gds. (R.A.T., S.P.): Eddystone Gds. (E.J.A., S.P.): Looe-Eddystone Gds. (S.P.).

The Polychæte *Siphonostoma affinis* is often found associated with this form, crawling among its spines (R.A.T.).

Breeding in July (W.G.).

ECHINUS ESCULENTUS, Linnæus: *A. Agassiz*, Illustr. Catal. Mus. Harvard, No. vii, p. 491, fig.

Queen's Gd., occasionally; moderately common in 15–35 fms., especially on the Mewstone 'Echinoderm' Gd.; Rame-Eddystone Gds. (R.A.T., S.P.): Eddystone Gds. (E.J.A., S.P.): Mewstone Ledge; Stoke Pt. Gds., common (S.P.): Cattewater, probably from trawl refuse (R.A.T., S.P.).

The Polychæte *Scalesetosus assimilis* is often found among the oral spines of this species (R.A.T.).

Gonads ripe: Mar. (R.A.T.): May (S.P.).

ECHINUS MILIARIS, Linnæus: *E. Forbes*, Hist. Brit. Starf., p. 161, fig.

Common under stones at all shore stations, and frequently met with in dredgings, L.W.–35 fms. (S.P.): specs. from the deeper water stations are usually small; largest ones from Church Reef, Wembury B. (R.A.T.): Yealm R., very common near the oyster beds (E.J.A.).

Breeding: May (W.G.).

Clypeastridæ.

ECHINOCYAMUS PUSILLUS (O. F. Müller): *F. J. Bell*, Catal. Brit. Echinod. Brit. Mus., p. 160, fig.

Not uncommon on gravel bottom, 10–35 fms. (S.P.): Queen's Gd., occasionally (R.A.T., S.P.): Mewstone Ledge shell gravel, very occasionally; Mewstone '*Amphioxus*' Gd., moderately common (R.A.T.): Eddystone Gds. (E.J.A.).

Spatangidæ.

SPATANGUS PURPUREUS, O. F. Müller: *F. J. Bell*, Catal. Brit. Echinod. Brit. Mus., p. 165.

Moderately common in coarse sand and gravel, 15–35 fms. (S.P.): Eddystone Gds. (E.J.A., S.P.): Stoke Pt. Gds.: Rame-Eddystone Gds. (R.A.T., S.P.): Looe-Eddystone Gds. (S.P.): Mewstone Ledge (R.A.T.): Queen's Gd. (S.P.[1]).

The Mollusc *Montacuta substriata* is very commonly attached to the oral spines of this species (R.A.T., S.P.).

ECHINOCARDIUM CORDATUM (Pennant): *E. Forbes*, Hist. Brit. Starf., p. 190, fig (as *Amphidotus*): anterior ambulacrum in a deep groove.

Not uncommon buried in sand between tide-marks in the Yealm Estuary; and in Rum B., on the *Zostera* beds; occasionally dredged in Cawsand B., and outside in 15–35 fms. on fine sand (R.A.T.): Rame-Eddystone Gds. (R.A.T., S.P.): Eddystone Gds. (E.J.A., S.P.): Looe-Eddystone Gds.: common 6 m. S. of Breakwater (S.P.).

The Mollusc *Tellimya ferruginosa* is found associated with this species (R.A.T.).

ECHINOCARDIUM PENNATIFIDUM,* Norman: *F. J. Bell*, Catal. Brit. Echinod. Brit. Mus., p. 170, fig.: anterior ambulacrum not in a groove, postero-lateral ambulacrum with generally 14 and 12 pores.

Not uncommon 15–30 fms.: Rame-Eddystone Gds.: Stoke Pt. Gds.; Looe-Eddystone Gds. (S.P.).

ECHINOCARDIUM FLAVESCENS (O. F. Müller): *F. J. Bell*, Catal. Brit. Echinod. Brit. Mus., p. 171, fig.: anterior ambulacrum not in a groove, postero-lateral ambulacrum with generally 7 and 6 pores, spines thick-set and silky.

Looe-Eddystone Gds., rare, associated with *E. pennatifidum*, but its habitat is probably on finer ground than that of the latter species (S.P.).

TURBELLARIA.

(**Nomenclature** that of F. W. Gamble, British Marine Turbellaria. Quart. Journ. Micr. Sci., xxxiv, 1893.)

Proporidæ.

PROPORUS VENENOSUS (O. Schmidt).

Not uncommon at low water Wembury B. and Drake's I. (F.W.G.).

MONOPORUS RUBROPUNCTATUS (O. Schmidt).

Not uncommon at low water, Wembury B. and Drake's I. (F.W.G.).

Aphanostomidæ.

APHANOSTOMA DIVERSICOLOR, Oersted.

Various localities between tide-marks (F.W.G.).

APHANOSTOMA ELEGANS, Jensen.

One specimen amongst *Ulva* at Redding Pt. (F.W.G.).

CONVOLUTA SALIENS, v. Graff.

Among *Zostera* from Cawsand B., rare (F.W.G.).

* The specimen recorded, Journ. Mar. Biol. Assoc., ser. 2, vol. v, p. 530, as *E. pennatifidum*, was really *E. flavescens* (E.J.A.).

CONVOLUTA PARADOXA, Oersted.
Littoral zone, widely distributed, nowhere abundant (F.W.G.).

CONVOLUTA FLAVIBACILLUM, Jensen.
Among sand in creeks at Picklecombe Fort, Wembury B. and Bovisand B. (F.W.G.).

Microstomidæ.

MICROSTOMA GRŒNLANDICUM, Lev.
Among *Ulva*, Redding Pt. (F.W.G.).

Mesostomidæ.

PROMESOSTOMA MARMORATUM (Schulze).
Not uncommon in tide-pools in Wembury B., Drake's I., and Redding Pt. (F.W.G.).

PROMESOSTOMA OVOIDEUM (O. Schmidt).
Occasionally dredged near Duke Rk. (F.W.G.).

PROMESOSTOMA SOLEA (O. Schmidt).
Abundant in dredging from all localities (F.W.G.).

PROMESOSTOMA AGILE (Levinsen).
Among *Zostera* in Cawsand B. (F.W.G.).

BYRSOPHLEBS GRAFFI, Jensen.
Drake's I., low spring-tide; amongst algæ (F.W.G.).

BRYSOPHLEBS INTERMEDIA, v. Graff.
Drake's I., low spring-tide; amongst algæ (F.W.G.).

PROXENETES COCHLEAR, v. Graff.
Plymouth Sound (E.G.G.).

PROXENETES FLABELLIFER, Jensen.
Tide-pools on north side of Cawsand B. (F.W.G.).

MESOSTOMA NEAPOLITANUM, v. Graff (?).
One specimen among Fuci on inner side of Breakwater (F.W.G.).

Proboscidæ.

PSEUDORHYNCHUS BIFIDUS (McIntosh).
Plymouth Sound (E.G.G.).

ACRORHYNCHUS CALEDONICUS (Claparède).
Tide-pools near Picklecombe and Redding Pt.; less commonly in Wembury B. (F.W.G.).

MACRORHYNCHUS NAEGELI (Kölliker).
Plentiful in August on inner side of Breakwater (F.W.G.).

MACRORHYNCHUS CROCEUS (Fabricius).
Dredged once on New Gds. (F.W.G.).

MACRORHYNCHUS HELGOLANDICUS (Metschnikoff).
Once on New Gds. (F.W.G.).

GYRATOR HERMAPHRODITUS, Ehrbg.
Tide pools on rocks in front of Laboratory: water sometimes brackish. In early winter, not in spring (E.G.G.).

HYPORHYNCHUS ARMATUS (Jensen).
Among *Zostera* in Cawsand B.; tide-pools Redding Pt. (F.W.G.).
Tanks in Laboratory (E.G.G.).

[**Turbellaria**—*contd.*]

HYPORHYNCHUS PENICILLATUS (Schmidt).
One specimen among *Zostera* in Cawsand B. (F.W.G.).

Vorticidæ.

PROVORTEX BALTICUS (Schultze).
Between tide-marks, chiefly at Wembury B. (F.W.G.).

PROVORTEX AFFINIS (Jensen).
Drake's I. among algæ (F.W.G.).

PROVORTEX RUBROBACILLUS, Gamble.
Dredged off New Gds. (F.W.G.).

FECAMPIA ERYTHROCEPHALA: *A. Giard*, C. R. Acad. Paris, vol. ciii, p. 499.
Encysted stage common on all stony shores at low water (W.I.B., S.P.).

Plagiostomidæ.

PLAGIOSTOMA DIOICUM (Metschnikoff).
Duke Rk. and Wembury B. (F.W.G.).

PLAGIOSTOMA ELONGATUM, Gamble.
Wembury B., among sand; Breakwater (F.W.G.).

PLAGIOSTOMA PSEUDOMACULATUM, Gamble.
Among weed-tubes of *Polydora cæca* in Hamoaze (F.W.G.).

PLAGIOSTOMA SAGITTA, Uljanin.
Tide-pool Redding Pt. (F.W.G.).

PLAGIOSTOMA CAUDATUM, Levinsen.
One specimen among *Zostera* in Cawsand B. (F.W.G.).

PLAGIOSTOMA VITTATUM (Frey u. Leuckart)
Abundant littoral species in all localities. Egg capsules from Breakwater in September (F.W.G.).
The tanks in the Laboratory swarm with them (E.G.G.).

PLAGIOSTOMA KORENI, Jensen.
Breakwater and Redding Pt. Tank in Laboratory (F.W.G.).

? PLAGIOSTOMA SIPHONOPHORUM (Schmidt).
A specimen from Millbay Ch. (F.W.G.).

PLAGIOSTOMA GIRARDI (Schmidt).
Low spring-tides, Wembury B.; tide-pools north side of Cawsand B. Not uncommon Duke Rk. and Millbay Ch. (F.W.G.).

VORTICEROS AURICULATUM (O. F. Müller).
An abundant littoral species in all localities (F.W.G.).

VORTICEROS LUTEUM, v. Graff.
One specimen New Gds.; one on inner side of Breakwater (F.W.G.).

ENTEROSTOMA AUSTRIACUM, v. Graff.
Common in Sound below 5 fms. (F.W.G.).

ENTEROSTOMA FINGALIANUM, Claparède.
Among *Florideæ*, Wembury B. (F.W.G.).

CYLINDROSTOMA QUADRIOCULATUM, (R. Leuckart).
Abundant among *Florideæ*, Wembury B. (F.W.G.).
Tanks in Laboratory (E.G.G.).

CYLINDROSTOMA INERME (Hallez).
Duke Rk., Millbay Ch., Hamoaze (F.W.G.).

CYLINDROSTOMA ELONGATUM, Levinsen.
Tide-pools, Wembury B. (F.W.G.).

MONOOPHORUM STRIATUM (v. Graff).
Duke Rk., a single specimen (F.W.G.).

Monotidæ.

MONOTUS LINEATUS (O. F. Müller).
Not uncommon amongst *Ulva*, Redding Pt. (F.W.G.).

MONOTUS FUSCUS (Oersted).
Abundant among *Balani*, *Ulva*, and generally throughout the littoral zone (F.W.G.).

MONOTUS ALBUS, Levinsen.
Tide-pools below Picklecombe Fort (F.W.G.).

AUTOMOLOS UNIPUNCTATUS (Oersted).
Rarely among algæ, Duke Rk. (F.W.G.).

AUTOMOLOS HORRIDUS, Gamble.
One specimen from Hamoaze (F.W.G.).

(?) AUTOMOLOS OPHIOCEPHALUS (Schmidt).
Millbay Ch. (F.W.G.).

Planariidæ.

FOVIA AFFINIS, Stimpson.
In a sandy creek, Wembury B. (F.W.G.): Cawsand B.; Whitsand B.; on drift weed (W.I.B.).

Leptoplanidæ.

CRYPTOCELIS ALBA, Lang.
Millbay Ch.; Mewstone *Amphioxus* Gd., Nov., 1899 (W.I.B.). Confirmed F. W. Gamble.

LEPTOPLANA TREMELLARIS (O. F. Müller).
Generally, under stones and shells, from littoral zone to 15 fms. (F.W.G., W.I.B.): plentiful in July and August, scarcer in September. Difficult to find in February (F.W.G.): Millbay Pit; about 2 m. S. of Mewstone; Yealm R. (W.I.B.).

LEPTOPLANA DRÆBACHENSIS, Oersted.
Plymouth Sound (F.W.G.)

LEPTOPLANA FALLAX (Quatrefages).
Millbay Ch. (F.W.G.).

Planoceridæ.

STYLOCHOPLANA MACULATA, Quatrefages.
Cawsand B., common on trawled weed, July, 1898 (W.I.B.).

Euryleptidæ.

PROSTHECERÆUS VITTATUS (Montagu).
Off Stoke Pt. (J.T.C.): Sound (W.G.) [F.W.G.]: Queen's Gd., occasionally; Yealm R., not uncommon, sometimes very large (W.I.B.).

CYCLOPORUS PAPILLOSUS, Lang.
On Ascidians and sponges dredged in Cattewater and outside Sound (F.W.G.): on Botryllus under stones below the Laboratory (E.J.A.): Barn Pool, var. *laevigatus*; Mt. Edgcumbe; on *Fucus* with Botrylloids; Queen's Gd.; Duke Rk. (W.I.B.): common on *Botryllus* (S.P.).

[**Turbellaria**—*contd.*: **Nemertini**]

EURYLEPTA CORNUTA (O. F. Müller).

Occasionally dredged on Duke Rk. and in Yealm R. (F.W.G.): Drake's I., N. shore; Yealm R.; off the Mewstone, on gravel and rough ground; Rame-Eddystone Gds. (W.I.B.): Asia Sh.; Queen's Gd.; etc. (S.P.).

OLIGOCLADUS SANGUINOLENTUS (Quatrefages).

Duke Rk.; Millbay Ch.; Cawsand B.; Stoke Pt. (F.W.G.): Queen's Gd.; Mallard Sh.; Mewstone '*Cellaria*' and 'Echinoderm' Gds.; Yealm R., common (W.I.B.).

STYLOSTOMUM VARIABILE, Lang.

Estuary of Yealm, Duke Rk. Young stages between tide-marks at Redding Pt. and round Mallard Buoy in September (F.W.G.): not uncommon on stony bottom in the Sound and Yealm R.; Cawsand B., on drift weed; Millbay Docks, on Piles with *Ascidiella* (W.I.B.).

Prosthiostomidæ.

PROSTHIOSTOMUM SIPHUNCULUS (Delle Chiaje): *A. Lang*, Die Polycladen d. Golf. Neapel, p. 595, fig.

Drake's I. (F.W.G.).

NEMERTINI.

Nomenclature:—Bürger. Nemertinen des Golfes von Neapel. 1895. (Unless otherwise stated.)

Carinellidæ.

CARINELLA LINEARIS, McIntosh.

Two specimens Duke Rk. (1892) (T.H.R.).

CARINELLA POLYMORPHA (Renier).

One specimen, Stoke Pt., 25 fms. 22.3.92 (T.H.R.): Mewstone *Amphioxus* ground, 10.9.95; about half-way between Rame and Eddystone, 20.12.28; 4 m. W. of Eddystone, 9.4.00, one specimen on each occasion (W.I.B.).

CARINELLA SUPERBA (Kölliker) (= *C. annulata*, Montagu of Riches and of Bürger's earlier works).

Six miles S.E. of Mewstone, one specimen (T.H.R.): sand-bank in Yealm (R.C.P., W.I.B.): Drake's I., Mewstone Gds., Rame to Eddystone and Eddystone Gds. (W.I.B.).

CARINELLA ANNULATA, Montagu (= *C. McIntoshii* of Bürger's earlier papers and of Riches; = *C. aragoi*, Joubin).

Not uncommonly dredged 5–20 fms. (T.H.R.): Millbay Ch. (W.I.B., R.A.T.): Queen's Gd., Asia Sh. (W.I.B., R.A.T., A.J.S.): Duke Rk., Yealm R., Mewstone Gds., 6 m. S.W. of Rame: Eddystone Gds. (W.I.B.).

Cephalothricidæ.

CEPHALOTHRIX BIOCULATA, Oersted.

Common between tide-marks, in clean, coarse sand and among corallines (T.H.R.): Drake's I., Rum B., Mt. Edgcumbe (E.J.A., W.I.B.): Millbay Ch. (W.I.B.).

Breeding: Apr. to Aug.: pelagic larvæ as late as Dec. (T.H.R.).

CEPHALOTHRIX LINEARIS (Rathke), Oersted.

Rum B. in sand between tide-marks; dredged outside Breakwater (T.H.R.).

Breeding in March (W.G.).

Eunemertidæ.

EUNEMERTES NEESI (Oersted).

Abundant on Breakwater, rare elsewhere (T.H.R.): the Bridge, Drake's I., common (R.A.T., W.I.B.): Wembury B. (E.J.A., T.V.H.).

Breeding: Feb. (R.A.T.): March to Oct. (T.H.R.).

EUNEMERTES GRACILIS, Johnston.

Breakwater, among Laminaria roots (T.H.R.): Drake's I. (R.A.T., W.I.B.).

EUNEMERTES ECHINODERMA (Marion).

Yealm, one specimen dredged 25.1.99, one from sand-bank 1.2.00 (W.I.B.): Yealm at low water (R.C.P.).

NEMERTOPSIS FLAVIDA (McIntosh) Beaumont (= *Tetrastemma flavidum*, McIntosh, Riches, Joubin, *nec* Bürger).

NEMERTOPSIS TENUIS, Bürger (= *Tetrastemma flavidum*, var. *longissimum* Joubin).

Beaumont: Fauna and Flora Valencia Harbour, Proc. Roy. Irish Acad., 1900, pp. 817 and 818, where reasons are given for relegating *Tetrastemma flavidum* to genus *Nemertopsis* Bürger.

Bürger, Naples Monograph.

The doubtful status of *Nemertopsis tenuis* as a species distinct from *N. flavida*, and the fact that they have rarely been distinguished with certainty make it expedient to consider them together (W.I.B.).

Very common in Plymouth Sound, between tide-marks and from dredgings, especially Duke Rk. and Millbay Ch. (T.H.R.).

Breakwater (between tide-marks), Asia Sh., Duke Rk., Millbay Ch., R. Yealm (dredging-ground); both forms occur in R. Yealm and Millbay Ch. (W.I.B.).

Amphiporidæ.

AMPHIPORUS PULCHER (Johnston): *McIntosh*, Mon. Brit. Annel. i. Nemertines, Ray Soc., 1874. *Beaumont*, Proceed. Roy. Irish Acad., v, 1900, p. 819. This is not the *A. pulcher* of Bürger's Monograph.

Taken on one or two occasions on Eddystone Gds. (W.I.B.).

AMPHIPORUS LACTIFLOREUS (Johnston).

Common between tide-marks, under stones (T.H.R.): Drake's I. (E.J.A., T.V.H., R.A.T.): Rum B. (W.I.B.): Mt. Edgcumbe (E.J.A.); Wembury B. (T.V.H.).

Breeding in early spring (T.H.R.), March (W.G.).

AMPHIPORUS DISSIMULANS, Riches, Journ. Mar. Biol. Assoc., N.S., iii, p. 10.

In considerable abundance, Millbay Ch. (T.H.R.).

Once between tide-marks, Drake's I.; dredged, Asia Sh., Millbay Ch. (common); R. Yealm (W.I.B.).

Breeding in spring and in Oct. (T.H.R.).

[**Nemertini**—*contd.*]

AMPHIPORUS BIOCULATUS, McIntosh.

One specimen dredged in Millbay Ch., 18.11.92, (T.H.R.).

DREPANOPHORUS SPECTABILIS (Quatrefages).

Among weeds dredged in Cawsand B. (one specimen); dredged off Stoke Pt. (four) (T.H.R.).

Taken several times on Mewstone Ledge; Queen's Gd. (once); Eddystone Gds. (W.I.B.).

Queen's Gd., Millbay Ch., Cawsand B. (R.A.T.): 5 m. S. of Mewstone (A.J.S.).

Tetrastemmidæ.

TETRASTEMMA AMBIGUUM, Riches: Journ. Mar. Biol. Assoc., N.S., iii, p. 19.

Found Nov., 1902 (T.H.R.).

{TETRASTEMMA CANDIDUM (O. F. Müller).
T. VERMICULATUM (Quatrefages).
T. MELANOCEPHALUM (Johnston).

Until the British *Tetrastemmidæ* have been thoroughly revised, any attempt to deal with the distribution of the so-called species, *T. candidum*, *T. vermiculatum*, and *T. melanocephalum*, is of doubtful value. Nemertines recorded under each of these names have been commonly dredged in Plymouth Sound, and occasionally found between tide-marks and among *Zostera* in Cawsand B. *T. candidum*—so-called—has also been found on the Mewstone ledge, on the inner trawling grounds, where it is abundant among *Cellaria*, and on the Eddystone Gds. But it may hereafter be found that two distinct species (perhaps more) have been confused as *T. candidum* (W.I.B.).

TETRASTEMMA CEPHALOPHORUM, Bürger.

Millbay Ch., Duke Rk. (as *Prosorhochmus Claparedii* by mistake) (T.H.R.): dredged Millbay Ch., Queen's Gd., Duke Rk., R. Yealm (W.I.B.).

OERSTEDIA DORSALIS (Zool. Dan.).

Very common in dredgings, especially in early summer among *Zostera* in Cawsand B. (T.H.R.): Queen's Gd., Millbay Ch. (R.A.T.): Asia Sh. (W.I.B., R.A.T.): Cawsand B. (R.A.T.): 5 m. S. of Penlee Pt. (R.A.T.): Eddystone Gds. (W.I.B., E.J.A.): found almost everywhere from shore down to 30 fms. or more—a yellow form (Bürger's var. *cincta*) abundant among *Cellaria* (W.I.B.).

Breeding in autumn (T.H.R.): Sept., Oct., Nov. (W.G.).

OERSTEDIA NIGRA (Riches): Journ. Mar. Biol. Assoc., N.S., iii, p. 14.

On *Codium* and other weeds from Laminarian zone (T.H.R.): Rum B. and Batten among corallines (W.I.B.).

OERSTEDIA IMMUTABILIS (Riches): Journ. Mar. Biol. Assoc. N.S., iii, p. 14.

Coralline pools in Wembury B., many specimens; among weeds on shore and dredged at Duke Rk. (T.H.R.).

Malacobdellidæ.

MALACOBDELLA GROSSA (O. F. Müller).

In branchial cavity of *Cyprina islandica*, never more than one in a mollusc (T.H.R., S.P.).

Ripe females in autumn (T.H.R.).

Eupoliidæ.

EUPOLIA CURTA, Hubrecht.

Off Borough I.: off Prawle Pt.; Eddystone Gds. (T.H.R., E.J.A.): Millbay Ch., 2 specimens, October, 1900 (A.J.S.): Queen's Gd., one small (R.A.T.): Mewstone Ledge; about 4 m. S. of Mewstone; 2 m. W. of Eddystone (W.I.B.).

OXYPOLIA BEAUMONTIANA, Punnett: Quart. Journ. Micr. Sci., vol. xliv, p. 555.

Dredged off Mewstone 10.6.97 and 23.11.99, one specimen on each occasion (W.I.B., R.C.P.).

Lineidæ.

MICRELLA RUFA, Punnett: Quart. Journ. Micr. Sci., vol. xliv, p. 548.

Yealm shore, low water, one (R.C.P.).

LINEUS LONGISSIMUS, Gunn (= *L. marinus* of McIntosh).

Dredged in Yealm and outside Breakwater, occasionally on shore (T.H.R.): occasional specimens dredged and found on the shore from all parts of the Sound; Wembury B.; Yealm; Mewstone Ledge (W.I.B., R.A.T.): Eddystone Gds. (E.J.A.).

LINEUS GESSERENSIS (O. F. Müller) = *L. obscurus*, Desor.

Common everywhere in Sound between tide-marks (T.H.R., R.A.T.): Yealm (T.V.H.): Wembury B. (R.A.T.): common everywhere under stones at about mid-tide level (W.I.B.).

Breeding: Jan. (W.G.): Feb. (R.A.T.): March (T.H.R.).

LINEUS LACTEUS (Grube).

North side of Drake's I., between tide-marks; Cawsand B., not common (T.H.R.).

LINEUS BILINEATUS (? Renier), McIntosh.

Common 5 to 20 fms., especially at Duke Rk. (T.H.R.): occasionally in sand and gravel between tide-marks, Rum B. (W.I.B.): Drake's I. (R.A.T.): Yealm Sand-bank (W.I.B., R.A.T., A.J.S.): dredged on all stony grounds in Sound (W.I.B., R.A.T.), Yealm R., S.W. of Penlee (1½ miles), Eddystone Gds. (W.I.B.).

MICRURA FASCIOLATA, Ehrenberg.

Common in Sound, especially Duke Rk. (T.H.R.): dredged from stony ground in all parts of Sound (W.I.B., T.V.H., R.A.T.): Rame-Eddystone Gds., Eddystone Gds. (W.I.B.).

Breeding: Oct. to end of year (T.H.R.).

MICRURA PURPUREA (Dalyell), J. Müller.

Common in Sound, especially Duke Rk.; also outside Breakwater (T.H.R.): in dredgings from stony ground in all parts of Sound (W.I.B., R.A.T.): Yealm R., Mewstone Ledge, Eddystone Gds. (W.I.B.).

MICRURA AURANTIACA (Grube).

Between tide-marks, Wembury B., one spec., 10.6.92 (T.H.R.): Mewstone Ledge, Mallard, Queen's Gd., Yealm (dredged) (W.I.B.): Asia Sh. (A.J.S.), one spec. only from each locality.

MICRURA LACTEA (Hubrecht) (= *M. candida*, Bürger).

Stoke Pt., 10.11.92, one dredged (T.H.R.).

CEREBRATULUS FUSCUS (McIntosh).

Jennycliff B., Mallard and Cobbler Shoals, few (T.H.R.): Mallard, Queen's Gd., Drake's I., Mewstone Gds. (W.I.B.): Rum B.: Millbay Ch. (R.A.T.): Eddystone Gds., with *Lepralia foliacea* (W.I.B.).

CEREBRATULUS PANTHERINUS, Hubrecht (= *C. marginatus* (pars) Joubin).

One dredged off Stoke Pt. (T.H.R.).

ARCHIANNELIDA.

DINOPHILUS TAENIATUS, Harmer: Journ. Mar. Biol. Assoc., N.S., vol. i, p. 119, Pls. ix. and x.

Rock-pools in Sound far above low-water, in March and April: not found in June (S.F.H.): pools high up on limestone rock below the Laboratory and in front of West Hoe Terrace (E.J.A.).

POLYGORDIUS (APOGON McIntosh?): *Fraipont*, Le Genre Polygordius, Faun. Flor. Neapel, 1887, p. 87.

Clean shell gravel off Mewstone (T.V.H., E.J.A.): Eddystone Gds. (E.J.A.).

PROTODRILUS LEUCKARTI, Hatschek: Arbeit. Zool. Inst. Wien., vol. iii, 1880, p. 79, Pl. 2.

Reared from townettings taken in September (E.J.B.).

HISTRIOBDELLA HOMARI, van Beneden: *Foettinger*, Archiv. Biologie, vol. v, 1884, p. 435.

Frequent on the eggs of lobsters taken by Plymouth fishermen. Breeding during the summer months (E.J.A.).

POLYCHÆTA.

Syllidæ.

TYPOSYLLIS PROLIFERA, Krohn: *Langerhans*, Wurmfauna v. Madeira. Zeitschr. wiss. Zool., vol. xxxii, 1879, p. 531.

Drake's I., Millbay Ch., Queen's Gd., buoys in Sound, amongst weeds: Yealm, in red sponge (E.J.A.).

TYPOSYLLIS ALTERNOSETOSA, de St. Joseph: Ann. Sci. Nat., Zool., i, 1886, p. 150.

Eddystone Gds. (W.F.R.W.).

SYLLIS (EHLERSIA) CORNUTA, Rathke: *Langerhans*, Wurmfauna v. Madeira, Zeitschr. wiss Zool., vol. xxxii, 1879, p. 537.

Eddystone Gds. (W.F.R.W.).

SYLLIS GRACILIS, Grube: *Langerhans*, Wurmfauna v. Madeira, Zeitschr. wiss. Zool., vol. xxxii., 1879, p. 540.

Amongst dredgings from Millbay and Queen's Gd. (E.J.A.).

ODONTOSYLLIS CTENOSTOMA, Claparède: *Marion et Bobretzky*, Annél. Golfe Marseille, 1875, p. 42.

From the shore, under stones and amongst weeds, sponges, etc., on Drake's I., Rum B., and below Laboratory (E.J.A.).

ODONTOSYLLIS FULGURANS, Claparède: *Langerhans*, Wurmfauna v. Madeira, Zeitschr. wiss. Zool. xxxii, 1879, p. 554.

Dredgings from Queen's Gd. (E.J.A.).

[**Polychæta**—*contd.*]

ODONTOSYLLIS GIBBA, Claparède: *Marion et Bobretzky*, Annél. Golfe. Marseille, 1875, p. 38.

In dredgings from Queen's Gd. and Asia Sh. (E.J.A.).

TRYPANOSYLLIS ZEBRA (Grube): *Langerhans*, Wurmfauna v. Madeira, Zeitschr. wiss. Zool., xxxii, 1879, p. 556.

Frequent in dredgings from Millbay Ch. and Asia Sh. Yealm dredging (E.J.A.).

AMBLYOSYLLIS SPECTABILIS (Johnston): Catal. Brit. Non-paras. Worms, p. 195. Pl. xvi. (as *Gattiola*).

Common in dredgings from Millbay Ch.: less numerous Queen's Gd., Mallard, Asia (E.J.A., R.A.T., T.V.H.): Eddystone Gds., occasional (E.J.A.): sometimes in large numbers in sponges from Millbay Ch. (W.G.).

SPHAEROSYLLIS OVIGERA, Langerhans: Wurmfauna v. Madeira, Zeitschr. wiss. Zool., xxxii, 1879, p. 567.

One spec. from Queen's Gd. dredging (E.J.A.).

AUTOLYTUS PICTUS (Ehlers): Borstenwürmer, 1863, p. 256.

Fairly common among stones from Millbay Ch. (W.G.): very plentiful in dredgings from Asia Sh., especially amongst sponges and *Alcyonidium*: occasionally dredged Millbay Ch. and Queen's Gd. (E.J.A.).

AUTOLYTUS RUBROPUNCTATUS (Grube): *Marion & Bobretzky*, Ann. Golfe Marseille, 1875, p. 44 (as *P. ornata*): *Langerhans*, Wurmf. Madeira, p. 579.

Frequent in dredgings from Queen's Gd. (E.J.A.).

MYRIANIDA PINNIGERA (Montagu): Trans. Linn. Soc., ix, p. 111 (*M. fasciata*, Aud. et Edw.).

Frequently met with in Plymouth Sound (W.G.): dredgings from Millbay Ch., Asia and Queen's Gd. (T.V.H., R.A.T., E.J.A.): amongst Ascidians and sponges from piles at Millbay Dock (R.A.T.).

Hesionidæ.

KEFERSTEINIA CIRRATA (Keferstein): *Claparède*, Beobachtungen, 1863, p. 55, Taf. xiv.

On shore at low-water mark under stones, Drake's I., Mt. Edgcumbe, Rum B.: amongst dredgings from Millbay Ch. and Asia Sh. (E.J.A.).

CASTALIA PUNCTATA (Müller): *Johnston*, Brit. Mus. Cat. Worms, 1865, p. 182: *Grube*, Jahresber. Schles. Gessellsch, 1879 (1880), p. 19.

Common in dredgings from Millbay Ch. and Asia Sh.: occasionally from Queen's Gd. (E.J.A.).

MAGALIA PERARMATA, Marion et Bobretzky: Annél. Golfe Marseille, 1875, p. 54, Pl. 7.

Not uncommon in dredgings from Queen's Gd., Asia Sh., and Millbay Ch. (E.J.A.).

Aphroditidæ.

APHRODITA ACULEATA, Linn.: *McIntosh*, Mon. Brit. Annel., ii, Ray Soc., 1900, p. 247.

On most fine-sand grounds off Plymouth, between 20 and 30 fms. (T.V.H., R.A.T., E.J.A.).

[**Polychæta**—*contd.*]

HERMIONE HYSTRIX (Savigny): *McIntosh*, Mon. Brit. Annel. ii, Ray Soc., 1900, p. 264.

Most frequently on gravel grounds in the neighbourhood of the Eddystone (T.V.H.): occasionally on similar ground in about 20 fms. (R.A.T., E.J.A.).

LEPIDONOTUS SQUAMATUS (Linn.): *McIntosh*, Mon. Brit. Annel. ii, Ray Soc., 1900, p. 274.

Under stones and amongst weeds, Hydroids, Polyzoa, etc.: from low-tide mark to 30 fms. and over, common and widely distributed (T.V.H., E.J.A.).

LEPIDONOTUS CLAVA (Montagu): *McIntosh*, Mon. Brit. Annel. ii, Ray Soc., 1900, p. 280.

Everywhere on the shore under stones, especially at extreme low water (T.V.H.): less frequently in dredgings from the Sound (E.J.A.).

GATTYANA CIRROSA (Pallas): *McIntosh*, Mon. Brit. Annel. ii, Ray Soc., 1900, p. 285.

In dredgings from the neighbourhood of the Eddystone (T.V.H.): Yealm Sandbank and east shore, commensal in tubes of *Amphitrite Johnstoni* (E.J.A.).

EUNOA NODOSA (M. Sars): *McIntosh*, Mon. Brit. Annel. ii, Ray Soc., 1900, p. 292.

Stony ground off Prawle Point, 30 fms. (W.F.R.W.).

LAGISCA FLOCCOSA (Savigny): *McIntosh*, Mon. Brit. Annel. ii, Ray Soc., 1900, p. 298.

Between tide-marks and in dredgings throughout the whole area to 30 fms. (T.V.H.).

LAGISCA EXTENUATA (Grube): *McIntosh*, Mon. Brit. Annel. ii, Ray Soc., 1900, p. 307.

Not uncommon: most frequently under laminarian roots at the Breakwater, more rarely on Eddystone Gds. (T.V.H.).

LAGISCA RARISPINA (Sars): *Malmgren*, Nordiska Hafs-Annulater, 1865, p. 65.

Eddystone Gds. (W.F.R.W., T.V.H.): Mewstone Gds. (T.V.H.).

HARMOTHOË IMBRICATA (Linn.): *McIntosh*, Mon. Brit. Annel. ii., Ray Soc., 1900, p. 314.

Between tide-marks amongst *Laminaria* roots on the Breakwater: amongst Hydroids, Polyzoa, etc. on Eddystone Gds. (T.V.H.).

HARMOTHOË SPINIFERA (Ehlers): *McIntosh*, Mon. Brit. Annel. ii., Ray 1900, p. 327.

Amongst dredgings from Millbay, Queen's Gd., Asia Sh., etc., and Yealm R.: common (T.V.H., R.A.T., E.J.A.).

HARMOTHOË LUNULATA (Delle Chiaje): *McIntosh*, Mon. Brit. Annel. ii., Ray Soc., 1900, p. 342.

On the Breakwater, among *Laminaria* roots and under stones at low-water mark (T.V.H.).

HARMOTHOË SETOSISSIMA (Savigny): *McIntosh*, Mon. Brit. Annel. ii., Ray Soc., 1900, p. 345.

Among Polyzoa (*Cellaria*) and *Chætopterus* tubes from Eddystone Gds. (T.V.H.).

HARMOTHOË AREOLATA (Grube): *McIntosh*, Mon. Brit. Annel. ii., Ray Soc., 1900, p. 349.

Amongst Polyzoa and *Chætopterus* tubes on Eddystone Gds.: not uncommon (T.V.H.).

EVARNE IMPAR (Johnston): *McIntosh*. Mon. Brit. Annel. ii., Ray Soc., 1900, p. 353.

Common between tide-marks and amongst dredgings throughout the Plymouth area (T.V.H., E.J.A.): Eddystone Gds. (T.V.H.).

SCALISETOSUS COMMUNIS (Delle Chiaje): *McIntosh*, Mon. Brit. Annel. ii., Ray Soc., 1900, p. 372.

On the shore at Mt. Edgcumbe: amongst dredgings Millbay Ch. and Asia Sh. (R.A.T., E.J.A.).

SCALISETOSUS ASSIMILIS (McIntosh): *McIntosh*, Mon. Brit. Annel. ii., Ray Soc., 1900, p. 377.

Amongst spines of *Echinus esculentus* from Mewstone and Eddystone Gds. (T.V.H., R.A.T.).

MALMGRENIA CASTANEA, McIntosh: Mon. Brit. Annel. ii., Ray Soc., 1900, p. 379.

Commensal on the surface of *Spatangus purpureus*, near the mouth of the Echinoderm: not uncommon (T.V.H.).

HALOSYDNA GELATINOSA (M. Sars): *McIntosh*, Mon. Brit. Annel. ii., Ray Soc., 1900, p. 384.

On shore under stones; occasionally in deep water (T.V.H.): Wembury B., Drake's I., rocks below Laboratory (R.A.T.): Millbay Ch., Asia Sh., Queen's Gd. (R.A.T.): Eddystone Gds. (T.V.H., E.J.A.).

POLYNOE SCOLOPENDRINA, Savigny: *McIntosh*, Mon. Brit. Annel. ii., Ray Soc., 1900, p. 389.

Millbay Ch. and Eddystone Gds. (T.V.H.): Millbay Ch. and Asia Sh., Mt. Edgcumbe, common in tubes of *Polymnia nebulosa* (R.A.T., E.J.A.).

Breeding: March (R.A.T.).

ACHOLOË ASTERICOLA (Delle Chiaje): *McIntosh*, Mon. Brit. Annel. ii., Ray Soc., 1900, p. 397.

In the ambulacral groove of *Astropecten irregularis*: common (T.V.H., R.A.T., E.J.A.)

STHENELAIS BOA (Johnston): *McIntosh*, Mon. Brit. Annel., ii., Ray Soc., 1900, p. 408.

Common in sand between tide-marks, Rum B., Drake's I., Mt. Edgcumbe, Wembury B., Yealm R. (T.V.H., R.A.T., E.J.A.): occasionally amongst dredgings from Millbay and Asia Sh. (T.V.H., E.J.A.): Mewstone Gds. (T.V.H.).

PHOLOË MINUTA (Fabricius): *McIntosh*, Mon. Brit. Annel. ii., Ray Soc., 1900, p. 437.

Common amongst dredgings from Millbay Ch., less frequent from Asia Sh. and Queen's Gd. (E.J.A.).

Amphinomidæ.

EUPHROSYNE FOLIOSA, Aud. et Edw.: *McIntosh*. Mon. Brit. Annel., part ii., Polychaeta, Ray Soc., 1900, p. 234. Pl. xxiv.

Occasional specimens in dredgings from Queen's Gd., Asia Sh., Millbay Ch. (T.V.H., R.A.T., E.J.A.): Eddystone Gds. (E.J.A.).

[**Polychæta**—*contd.*]

Phyllodocidæ.

EULALIA VIRIDIS (Müller): *Johnston*, Catal. Worms. Brit. Mus., 1865, p. 178. Pl. xvi.

Common on rocky shores all round the Sound (R.A.T., E.J.A.): Eddystone Gds. (E.J.A.).

EULALIA PUNCTIFERA (Grube): *de St. Joseph*, Ann. Sci. Nat. Zool., v., 1888, p. 289. Pl. xii.

In dredgings from Millbay Ch., Asia Sh., and Yealm; on the shore at Mt. Edgcumbe and in Yealm estuary (E.J.A.).

EULALIA AUREA, Gravier: Recherches sur les Phyllodociens., Bull. Sci. France et Belg. xxix., 1896, p. 309.

Common in dredgings from Millbay Ch., Asia Sh., and Queen's Gd., occasionally from Yealm (E.J.A.).

Breeding: March, April, May, June, July (E.J.A.).

EULALIA CLAPARÈDEI, de St. Joseph: Ann. Sci. Nat. Zool., v., 1888, p. 285. Pl. xi.

Not infrequent in dredgings from Millbay Ch., Asia Sh., and occasionally Queen's Gd.

Breeding: May, eggs brick-red (E.J.A.).

EULALIA OBTECTA, Ehlers: Borstenwürmer, 1868, p. 169. Pl. vii.

Frequent in dredgings from Queen's Gd.: occasionally from Asia Sh., Millbay Ch., and Mewstone Echinoderm Gd. (E.J.A.).

EULALIA ORNATA, de St. Joseph: Ann. Sci. Nat. Zool., v., 1888, p. 291.

In dredgings from Millbay Ch. and Asia Sh. (E.J.A.).

Breeding: April–July (E.J.A.).

EULALIA PALLIDA, Claparède: *de St. Joseph*, Ann. Sci. Nat. Zool., v., 1888, p. 294.

Very numerous in dredgings from Millbay Ch., Asia Sh., and Queen's Gd. (E.J.A.).

Breeding: May to July: eggs green (E.J.A.).

PTEROCIRRUS MACROCEROS (Grube): *de St. Joseph*, Ann. Sci. Nat. Zool., v., 1888, p. 300. Pl. xii.

Occasional specimens Queen's Gd. (E.J.A.).

PHYLLODOCE LAMINOSA, Savigny, *de St. Joseph*, Ann. Sci. Nat. Zool. v., 1888, p. 274. Pl. xi.

Between tide-marks Drake's I., Breakwater: in dredgings Millbay Ch., Asia Sh., Duke Rock (T.V.H., E.J.A.).

PHYLLODOCE MACULATA (Müller): *Johnston*, Catal. Worms. Brit. Mus., 1865, p. 177.

Common in dredgings from Millbay Ch. and Asia Sh. (often in great numbers) (W.G., T.V.H., E.J.A.): shore at Drake's I. (E.J.A.): Yealm dredgings (T.V.H.).

Breeding: Jan. Feb. (W.G.): April, May. Eggs orange-brown (E.J.A.).

PHYLLODOCE RUBIGINOSA, de St. Joseph: Ann. Sci. Nat. Zool. v, 1888, p. 282.

Frequent in dredgings from Millbay Ch., Asia Sh., and Drake's I. (E.J.A.).

PHYLLODOCE PARETTI, Blainville: *Cuvier*, Règne animal, Annélides. Pl. 13. Fig. 1.

Mewstone Ledge (E.J.A.): Stoke Pt. Gds. (S.P.).

ETEONE PICTA, Quatrefages: Hist. Nat. Annel. ii, p. 147. Pl. 18.

Occasional specimens from dredgings, Millbay Ch., Asia Sh., Queen's Gd., Barn Pool (E.J.A.).

Tomopteridæ.

TOMOPTERIS HELGOLANDICA, Greef: *Apstein*, Alciopiden und Tomopteriden der Plankton-Expedition, Kiel, 1900, p. 38. Pl. x.

In townettings Oct. (T.V.H.): Dec. Jan. June (L.H.G.).

Nereidæ.

NEREIS CULTRIFERA, Grube: *Ehlers*, Borstenwürmer, 1868, p. 461. Pl. xxi.

Common on the shores, especially in muddy gravel, all round the Sound, Wembury B., Yealm Estuary (R.A.T., E.J.A.).

NEREIS DIVERSICOLOR, O. F. Müller: *Ehlers*, Borstenwürmer, 1868, p. 554. Pl. xxii.

Common in the mud flats of the Tamar and Plym estuaries, seldom in the Sound; found only where the density of the water is low (E.J.A.).

NEREIS DUMERILII, Aud. et Edw.: *Ehlers*, Borstenwürmer, 1868, p. 535. Pl. xx.

Small specimens common in all dredgings from the Sound, Millbay, Asia Sh., Queen's Gd., and from Yealm R.; larger specimens chiefly from Queen's Gd.: occasional specimens on the shore under Laboratory and Barn Pool (E.J.A.).

NEREIS FUCATA, Savigny: *Ehlers*, Borstenwürmer, 1868, p. 546. Pl. xxi.

In shells of *Buccinum undatum* inhabited by *Eupagurus Bernhardus*; Mewstone Gds., Rame to Eddystone Gds., Eddystone Gds. (E.J.A.): Yealm R. (S.P.).

Breeding: May (W.G.).

NEREIS IRRORATA, Malmgren: *de St. Joseph*, Ann. Sci. Nat., Zool., v, 1888, p. 263, and xx, 1895, p. 215.

Not uncommon in sand between tide-marks, Drake's I., Mt. Edgcumbe, Jennycliff (rare), Wembury B., Yealm Estuary south shore. Small specimens amongst dredgings Queen's Gd. and Asia Sh. (E.J.A.).

NEREIS LONGISSIMA, Johnston: *de St. Joseph*, Ann. Sci. Nat., Zool., v, 1898, p. 304. Pl. xvi. and xvii.

Occasional specimens in fine sand between tide-marks, Drake's I. and Mt. Edgcumbe: more common on shores of Yealm estuary; one specimen of Heteronereis stage taken in Cattewater (E.J.A.). In mud-bank of Cattewater near Oreston (J.T.C.).

NEREIS PELAGICA, Linnaeus: *Ehlers*, Borstenwürmer, 1868, p. 511. Pl. xx.

Frequent amongst weeds on rocky shores and from dredgings in all parts of the Sound; also Wembury B. and Yealm R. (T.V.H., E.J.A.).

[**Polychæta**—*contd.*]

Nephthydidæ.

NEPHTHYS CÆCA (Fabricius): *de St. Joseph*, Ann. Sci. Nat., Zool., xvii, 1894, p. 16.

Large specimens on sandy shores, especially Drake's I., Rum B., and Yealm Sand-bank (T.V.H., R.A.T., E.J.A.).

NEPHTHYS HOMBERGI, Aud. et Edw.: *de St. Joseph*, Ann. Sci. Nat., Zool., xvii, 1894, p. 3.

Shore between tide-marks, Drake's I., Jennycliff, Bovisand (R.A.T., E.J.A.): dredged on Mewstone '*Amphioxus*' Gd. (R.A.T.), and Eddystone Gds. (T.V.H.).

NEPHTHYS CIRROSA, Ehlers: Borstenwürmer, 1868, p. 624. Pl. xxiii.

In sand between tide-marks, Drake's I. and Yealm estuary (E.J.A.).

Eunicidæ.

EUNICE HARASSI, Aud. et Edw.: *Ehlers*, Borstenwürmer, 1868, p. 312. Pls. xiii & xiv.

On the shore Drake's I., Rum B., Breakwater (R.A.T., E.J.A.): Wembury B. (E.J.A.): in dredgings from Duke Rk. (W.G., T.V.H.): Queen's Gd., Asia Sh., Millbay Ch. (R.A.T., E.J.A.): south of Breakwater Fort (W.G.): Rame to Eddystone Gds. (E.J.A.).

ONUPHIS CONCHILEGA, M. Sars: *Oersted*, Grönlands Annulata Dorsibranchiata, 1843, p. 20, Pl. iii. (as *O. Eschrichtii*): cf. *de St. Joseph*, Ann. Sci. Nat. Zool., v, 1888, p. 194.

On coarse shell-gravel grounds, in depths from 20 to 30 fms. off the Mewstone, off Stoke Pt., S. of Rame Head, and off Eddystone (E.J.A., R.A.T.).

HYALINŒCIA TUBICOLA (Müller): *Ehlers*, Borstenwürmer, 1868, p. 297.

Common on muddy-gravel grounds from 20 to 30 fms.: off Mewstone, Rame to Eddystone and Eddystone Gds. (E.J.A., R.A.T.)

MARPHYSA SANGUINEA (Montagu): *de St. Joseph*, Ann. Sci. Nat., v, 1888, p. 201.

Frequent on the shore in crevices of rock, especially on the bridge between Drake's I. and Mt. Edgcumbe; also Rum B., Wembury B., and Yealm Estuary (W.G., T.V.H., R.A.T., E.J.A.).

MARPHYSA BELLI, Aud. et Edw.: Hist. Nat. Lit. France, ii, p. 149, Pl. iii.

On the shore between tide-marks N. side Drake's I., Rum B.; most frequent in *Zostera* beds at mouth of Yealm R. (E.J.A.).

LYSIDICE NINETTA, Aud. et Edw.: Hist. Nat. Lit. France, ii, p. 161, Pl. iii^{b}.

Frequent in Plymouth Sound, on the shore between tide-marks (Rum B., Drake's I.), and in dredgings (Asia Sh., Millbay Ch., Queen's Gd.); on shore Wembury B. and Reny Rks.; dredged in Yealm R. (E.J.A.).

NEMATONEREIS UNICORNIS (Grube): *de St. Joseph*, Ann. Sci. Nat., v, 1888, p. 207.

Between tide-marks N. side of Drake's I. and Mt. Edgcumbe; amongst dredgings from Queen's Gd., Asia Sh., and Millbay Ch. (E.J.A.).

LUMBRICONEREIS IMPATIENS, Claparède: *de St. Joseph*, Ann. Sci. Nat. Zool., v, 1898, p. 279.

Coarse grounds between Eddystone and Rame; very abundant on Queen's Gd. in spring of 1903 (E.J.A.).

LUMBRICONEREIS LATREILLEI, Aud. et Edw.: *de St. Joseph*, Ann. Sci. Nat. Zool., v, 1898, p. 276.

Shores of the Sound, between tide-marks (Drake's I., Mt. Edgcumbe, Rum B.): amongst dredgings from Millbay Ch., Asia Sh., Queen's Gd., Yealm R., and Eddystone Gds. (E.J.A.).

MACLOVIA IRICOLOR (Montagu): *Willey*, Journ. Mar. Biol. Assoc., vi, 1900, p. 98 = *M. gigantea* (Quatrefages).

Occasional specimens at low-water mark on shores of Sound (E.J.A.).

STAUROCEPHALUS RUBROVITTATUS, Grube: *Ehlers*, Borstenwürmer, 1868, p. 424.

Frequent in dredgings from Millbay Ch., Queen's Gd., and Asia Sh. (E.J.A.).

STAUROCEPHALUS CILIATUS, Keferstein: *Ehlers*, Borstenwürmer, 1868, p. 440.

Recorded once from Queen's Gd. dredging (E.J.A.).

STAUROCEPHALUS PALLIDUS, Langerhans: Zeits. wiss. Zool., xxxiii, 1879, p. 300.

Recorded once from Asia Sh. dredging; resembles *S. ciliatus*, Kef., excepting for absence of eyes (E.J.A.).

OPHRYOTROCHA PUERILIS, Clpd. et Meczn.: *de St. Joseph*, Ann. Sci. Nat. Zool., xx, 1895, p. 210 (as *Paractius mutabilis*, n. sp.).

Dredgings from Duke Rk. (T.V.H.): often common in Laboratory tanks (E.J.A.).

Breeding: Aug. (W.G.). Spawned in tanks, May (A.J.S.).

Glyceridæ.

GLYCERA CONVOLUTA, Keferstein: *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 27, Pl. ii.

Between tide-marks Drake's I., Jennycliff, Yealm Estuary; in dredgings from Millbay Ch., Rame to Eddystone and Eddystone Gds. (E.J.A.).

GLYCERA LAPIDUM, Quatrefages: *Arwidsson*, Studien über die Familien Glyceridae und Goniadidae, Bergens Mus. Aarb., 1898, p. 15, Figs. 7, 8, and 55.

Between tide-marks Wembury B. (T.V.H., E.J.A.): dredged in shell gravel off Mewstone (T.V.H., E.J.A.) and near Queen's Gd. (E.J.A.).

GLYCERA GIGANTEA, Quatrefages: *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 22, Pl. ii.

Between tide-marks, Drake's I. (W.G., R.A.T.): Mewstone *Amphioxus* Gd. (E.J.A.).

GONIADA MACULATA, Oersted: *Ehlers*, Borstenwürmer, 1868, p. 704, Pl. xxiv.

One specimen from Plymouth Breakwater (E.J.A.).

[**Polychæta**—*contd.*]

Sphærodoridæ.

EPHESIA GRACILIS, Rathke: *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 38, Pl. iii = *Sphærodorum peripatus*, Johnston.

Frequent in dredgings from Millbay Ch. and Asia Sh.; occasionally also from Queen's Gd. and from between tide-marks on Drake's I. and Mt. Edgcumbe (E.J.A.).

Ariciidæ.

ARICIA CUVIERI, Aud. et Edw.: *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 91.

One specimen dredged off the Mewstone (E.J.A.).

SCOLOPLOS ARMIGER (Müller): *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 94, Pl. v.

In dirty sand and between layers of shale at Rat I. (Hamoaze) (W.G.): in sand at Drake's I., Rum B., and the Yealm Estuary (E.J.A.).

Spionidæ.

SCOLELEPIS VULGARIS, Johnston (probably the same as *S. fuliginosa* Claparède, *var. macrochæta major* of Mesnil: Bull. Sci. France et Belg., xxix, 1896, p. 138).

Mud between tide-marks, Rum B. and Wembury B.; numerous (E.J.A.).

SCOLELEPIS GIARDI (de Quatrefages): *Mesnil*, Bull Sci. France et Belg., xxix, 1896, p. 140.

One specimen from mud in Rum B. (E.J.A.).

NERINE CIRRATULUS (Delle Chiaje): *Mesnil*, Bull. Sci. France et Belg., xxix, 1896, p. 152.

Fine gravel between tide-marks on eastern side of Plymouth Sound (E.J.A.).

NERINE CONIOCEPHALA, Johnston (= *N. foliosa*, Aud. et Edw.: *Mesnil*, Bull. Sci. France et Belg., xxix, 1896, p. 165).

In sand between tide-marks, E. side of Drake's I. (E.J.A.): Wembury B. (T.V.H.).

AONIDES OXYCEPHALA (Sars): *Mesnil*, Bull. Sci. France et Belg., xxix, 1896, p. 242, Pl. x.

In *Zostera* bed at low-water mark, eastern shore of Yealm mouth; very numerous (E.J.A.).

POLYDORA CILIATA (Johnston): *Mesnil*, Bull. Sci. France et Belg., xxix, 1896, p. 210, Pl. xiv.

Boring in limestone of the Breakwater and in limestone dredged from Millbay Ch. (E.J.A.).

POLYDORA FLAVA, Claparède: *Mesnil*, Bull. Sci. France et Belg., xxix, 1896, p. 182, Pl. xi.

At Rum B. and Rat I. (Hamoaze); common in crevices of shale (W.G.): Rum B. in crevices of shale (E.J.A.): dredgings from Yealm R. (E.J.A.).

Breeding: Feb. (W.G.).

POLYDORA CÆCA, Oersted: *Mesnil*, Bull. Sci. France et Belg., xxix, 1896, p. 191, Pl. xii.

Eddystone Gds. (T.V.H.).

POLYDORA HOPLURA, Claparède: Annél. Chétop. Golfe Naples, 1868, p. 318, Pl. xxii.

Boring in the limestone of the Plymouth Breakwater (E.J.A.).

Disomidæ.

PŒCILOCHÆTUS SERPENS, Allen: Quart. Journ. Micr. Sci., vol. xlviii, 1904, p. 79, Pls. 7–12.

In sand at low tide, S. of Batten Castle; larvæ not uncommon in the plankton during the summer months (E.J.A.).

Chætopteridæ.

CHÆTOPTERUS VARIOPEDATUS, Renier: *Joyeux-Laffuie*, Arch. Zool. Exp. et Gen., viii, 1890, p. 244, Pls. 15–20.

Common in muddy gravel on Eddystone Gds. and between Rame and Eddystone (E.J.A.): occasional specimens Duke Rk. (T.V.H.), Asia Sh. (R.A.T.), Millbay Ch. (R.A.T., E.J.A.), and Mewstone *Echinoderm* Gd. (R.A.T.): Stoke Pt. Gds. (S.P.).

Larvæ in townettings July to October (W.G.).

Magelonidæ.

MAGELONA PAPILLICORNIS, Fr. Müller: *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 83.

In fine sand near low-water mark at Jennycliff B. (R.A.T., E.J.A.), under Batten Castle, and on S. shore of Yealm Estuary (E.J.A.).

Larvæ in townets in July and August (E.J.A.): in September (E.J.B.).

Ammocharidæ.

OWENIA FUSIFORMIS (Delle Chiaje): *de St. Joseph*, Ann. Sci. Nat. Zool., v, 1898, p. 397, Pl. xxii.

In fine sand near low-water mark at Jennycliff B. (R.A.T., E.J.A.) and under Batten Castle (E.J.A.).

Cirratulidæ.

AUDOUINIA TENTACULATA (Montagu): *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 49, Pl. iii.

Common in gravel and sand just below high-water mark on all shores, both inside and outside the Sound (T.V.H., R.A.T., E.J.A.): occasional small specimens from dredgings at Millbay Ch. (E.J.A.).

DODECACERIA CONCHARUM, Oersted: *de St. Joseph*, Ann. Sci. Nat. Zool., v, 1898, p. 346, Pl. xx.

Boring in limestone on Plymouth Breakwater, abundant; Millbay Ch. (E.J.A.).

Terebellidæ.

AMPHITRITE GRACILIS, Grube: *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 198.

Common in sand between tide-marks and between layers of shale in Rum B. and at Mt. Edgcumbe, Yealm Sand-bank, and Wembury B.; dredged Millbay Ch. and Eddystone Gds. (E.J.A.).

Polychæta—*contd.*]

AMPHITRITE JOHNSTONI, Malmgren: *de St. Joseph*, Ann. Sci. Nat. Zool., v, 1898, p. 421.

In sand and gravel near low-water mark along the S. shore of the Yealm R.; most common on east shore where the stream divides (R.A.T., E.J.A.).

TEREBELLA LAPIDARIA (Kähler), Linn.: *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 202, Pls. viii. and ix.

Common in crevices of shale at Rum B. (R.A.T., E.J.A.).

POLYMNIA NEBULOSA (Montagu): *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 219, Pl. ix.

Very common between tide-marks at Mt. Edgcumbe (R.A.T., E.J.A.): occasional specimens on the shore at Rum B. and in dredgings from Millbay Ch., Asia Sh., Queen's Gd., and Yealm R. (R.A.T., E.J.A.): Eddystone Gds. (T.V.H.).

POLYMNIA NESIDENSIS (Delle Chiaje): *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 225, Pl. x.

Between tide-marks, Rum B., Mt. Edgcumbe, Wembury B.; dredged at Asia Sh., Yealm R., and Cawsand B. (E.J.A.).

LANICE CONCHILEGA (Pallas): *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 211.

Common on sandy shores inside and outside the Sound; occasionally dredged Queen's Gd.: Eddystone Gds. (T.V.H., R.A.T., E.J.A.).

NICOLEA ZOSTERICOLA (Oersted): *Malmgren*, Nordiska Hafs-Annulater, Öfer. K. Vet. Akad. Förh., 1865, p. 381, Pl. 26.

Common between tide-marks on Reny Rks., less frequent Drake's I., N. side; also from dredgings in Yealm R. (E.J.A.).

THELEPUS SETOSUS (Quatrefages): *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 230, Pl. x.

Dredged at Millbay Ch., Queen's Gd., Eddystone Gds. (E.J.A.).

POLYCIRRUS AURANTIACUS, Grube: *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 239.

Common in dredgings from Millbay Ch. and Yealm R.; less frequent in those from Asia Sh., Queen's Gd., and Duke Rk. (T.V.H., R.A.T., E.J.A.): Eddystone Gds. (E.J.A.).

Breeding: July (W.G.); April (E.J.A.).

POLYCIRRUS CALIENDRUM, Claparède: *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 237.

In dredgings from Millbay Ch., Queen's Gd., and Asia Sh. (E.J.A.).

LOIMIA MEDUSA (Savigny): *Malmgren*, Nord. Hafs-Ann., p. 380, Pl. xxv; Annul. Polych., p. 217, Pl. xiv.

Amongst shell gravel near low-water mark on N. side of Drake's I.; tubes from Queen's Gd.; Yealm R. shore (E.J.A.).

TEREBELLIDES STROEMI, Sars: *Malmgren*, Nord. Hafs-Annul., 1865, p. 396, Pl. xix, Fig. 48.

One specimen dredged four miles S.W. by S. of Rame Head (E.J.A.).

Ampharetidæ.

MELINNA ADRIATICA, v. Marenzeller: Adriatische Anneliden. Sitzb. Akad. Wien, lxix, 1874, p. 472, Pl. vii.

Common in soft mud in Plymouth Sound, on the shore and in deeper water (E.J.A.).

AMPHICTEIS CURVIPALEA, Claparède: *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 163, Pl. vii.

One specimen dredged four miles S.W. by S. of Rame Head (E.J.A.).

Amphictenidæ.

PECTINARIA (LAGIS) KORENI, Malmgren: *de St. Joseph*, Ann. Sci. Nat. Zool., v, 1898, p. 405, Pls. xxii and xxiii.

Common in sand near low-water mark S. of Batten Castle (E.J.A.).

PECTINARIA (AMPHICTENE) AURICOMA (Müller): *Malmgren*, Nord. Hafs-Annulat., 1865, p. 357, Pl. 18.

Eddystone Gds. (T.V.H.).

Capitellidæ.

CAPITELLA CAPITATA (Fabricius): *Eisig*, Die Capitelliden des Golfes von Neapel, 1887, p. 849.

Common in black mud from between tide-marks, Wembury B. and Rum B. (E.J.A.).

NOTOMASTUS RUBICUNDUS, Keferstein: *Eisig*, Die Capitelliden des Golfes von Neapel, 1887, p. 863.

South shore of Yealm Estuary (near the mouth), common (E.J.A.).

NOTOMASTUS LATERICEUS, Sars: *Sars, Koren, Danielsen*, Fauna littoralis Norvegiae, ii, 1856, p. 9, Pl. ii.

Shore near low-water mark, Yealm Estuary; not frequent (E.J.A.).

Opheliidæ.

AMMOTRYPANE AULOGASTER, Rathke: Beiträge zur Fauna Norwegens, 1840, p. 188, Pl. x.

Dredged off Duke Rk. (W.G.): Mewstone *Amphioxus* Gd. (E.J.A.).

POLYOPHTHALMUS PICTUS (Dujardin): *de St. Joseph*, Ann. Sci. Nat. Zool., v, 1898, p. 385.

Between tide-marks Wembury Bay (A.J.S.): Reny Rks. (E.J.A.).

Arenicolidæ.

ARENICOLA MARINA, Linn.: *Gamble*, Anatomy and Classification of Arenicolidae: Quart. Journ. Micr. Sci., xliii, p. 419.

Fine sand between tide-marks Rum B., Drake's I., Mt. Edgcumbe, Wembury B., Yealm R. (T.V.H., R.A.T., E.J.A.).

Postlarval stages of *Arenicola* in townettings February (W.G., W.B.B.).

ARENICOLA GRUBEI, Claparède: *Gamble*, Anatomy and Classification of Arenicolidae, Quart. Journ. Micr. Sci., xliii, p. 419.

With *A. ecaudata* near the bases of rocks in a deposit composed of sand and small stones (F.W.G.): Rum B., Wembury B., Drake's I. (E.J.A.).

[**Polychæta**—*contd.*]

ARENICOLA ECAUDATA, Johnston: *Gamble*, Anatomy and Classification of Arenicolidae, Quart. Journ. Micr. Sci., xliii, p. 419.

With *A. Grubii* near the bases of rocks in a deposit composed of sand and small stones (F.W.G.): Rum B., rocks below Laboratory (R.A.T.): Wembury B. (R.A.T., E.J.A.): Drake's I. (T.V.H.).

Scalibregmidæ.

SCALIBREGMA INFLATUM, Rathke: *Ashworth*, Quart. Journ. Micr. Sci., xlv, 1902, p. 237.

In muddy gravel at low-water mark on southern shore of Yealm R., just below the junction of the two rivers; two specimens, 10/9/00 (E.J.A.).

SCLEROCHEILUS MINUTUS, Grube: *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 104, Pl. v.

Frequent in dredgings from Millbay Ch.; occasionally from Asia Sh. and off the Mewstone (E.J.A.).

Chlorhæmidæ.

STYLARIOIDES (TROPHONIA) PLUMOSA (Müller): *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 101.

Dredgings from Millbay Ch. and Asia Sh.; also 2½ miles off Stoke Pt. (E.J.A.).

SIPHONOSTOMA (FLABELLIGERA) AFFINIS, M. Sars: *Newbigin*, Ann. Mag. Nat. Hist., ser. 7, vol. v, 1900, p. 190, Pl. iv.

Between tide-marks at Drake's I. (R.A.T., T.V.H., E.J.A.): Renny Rks. (R.A.T., E.J.A.): under Rame Head (T.V.H.): Wembury B. (E.J.A., A.J.S.): in dredgings from Millbay Ch., Queen's Gd. (R.A.T., T.V.H.): Mewstone Gds. (E.J.A., R.A.T.): on *Echinus acutus* (R.A.T.).

Sabellidæ.

SABELLA PAVONINA (Savigny): *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 267, Pls. x. and xi.

Common on the shore in Yealm R. and also found in Yealm dredgings (R.A.T., E.J.A.): Eddystone Gds. (E.J.A.).

BRANCHIOMMA VESICULOSUM (Montagu): *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 300, Pl. xi.

Occasional specimens Yealm Sand-bank, Rum B. (R.A.T.): Drake's I., Yealm south shore near mouth, Barn Pool, and shore S. of Batten Castle (E.J.A.).

DASYCHONE BOMBYX (Dalyell): *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 309, Pls. xi and xii.

In dredgings from Duke Rk., Queen's Gd., Asia Sh., and Millbay Ch., occasionally (E.J.A.): Eddystone Gds. (T.V.H.).

POTAMILLA RENIFORMIS (Müller): *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 292, Pl. xi.

Large specimens from shore in Jennycliff B.; found also in Wembury B. (shore); not uncommon boring in limestone of Breakwater (E.J.A.).

POTAMILLA TORELLI, Malmgren: *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 296.

Common in dredgings from Millbay Ch. and from Yealm R. (E.J.A.).

POTAMILLA INCERTA, Langerhans: *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 299.

Recorded once from Yealm dredging (E.J.A.).

BISPIRA VOLUTACORNIS (Montagu): *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 286.

In cracks between rocks at extreme low-tide mark on Renny Rks.; Jennycliff B. shore (R.A.T.).

MYXICOLA INFUNDIBULUM (Renier): *de St. Joseph*, Ann. Sci. Nat. Zool., v, 1898, p. 433, Pl. xxiii.

North side Drake's I. (R.A.T.): Barn Pool (E.J.A.): Rams Cliff Point (S.P.).

Serpulidæ.

SERPULA VERMICULARIS, Linnæus: *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 328.

Occasionally in the Sound: Mewstone Gds. (R.A.T.): Rame to Eddystone Gds., and Eddystone Gds. (E.J.A.).

POMATOCEROS TRIQUETER (Linn.): *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 353, Pl. xiii.

Common attached to shells and stones on all grounds from the shore to 30 fms. (E.J.A.).

HYDROIDES NORVEGICA (Gunn.): *de St. Joseph*, Ann. Sci. Nat. Zool., v, 1898, p. 440.

Common on stones and shells, 0–30 fms. (E.J.A.).

FILOGRANA IMPLEXA (Berkeley): *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 335, Pls. xii and xiii.

In quantity Millbay Ch., piles of Promenade Pier (E.J.A.): on piles at entrance to Millbay Docks (R.A.T.): Breakwater (T.V.H.): occasionally met with in all dredgings from Sound and outside to Eddystone Gds. (E.J.A.).

SPIRORBIS BOREALIS, Daudin: *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 345, Pl. xiii.

Common on weeds, especially *Fucus*, and on stones on all shores. (E.J.A.).

PROTULA TUBULARIA (Montagu): *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 362, Pl. xiii.

Mewstone Gds., Rame-Eddystone Gds., Eddystone Gds. (R.A.T., E.J.A.).

Hermellidæ.

SABELLARIA ALVEOLATA (Linn.): *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 160.

Common attached to rocks on sandy shores at Whitsand B. (E.J.A.).

SABELLARIA SPINULOSA, Leuckart: *de St. Joseph*, Ann. Sci. Nat. Zool., xvii, 1894, p. 154.

Attached to shells, etc., in dredgings from Queen's Gd., Duke Rk., Asia Sh., Millbay Ch., and Eddystone Gds. (E.J.A.).

Breeding: May (W.G.); September (E.J.A.).

PALLASIA MURATA, Allen: see p. 299.

One specimen from gravel off Stoke Pt.; tubes frequent on Mewstone shell-gravel Grounds (E.J.A.).

MYZOSTOMARIA.

MYZOSTOMUM CIRRIFERUM, Leuckart: *Benham*, Cambridge Nat. Hist., Worms, etc., fig. 186.

Common on *Antedon bifida* from the Sound (E.J.A.).

OLIGOCHÆTA.

CLITELLIO ARENARIUS, Claparède: *Beddard*, Journ. Mar. Biol. Assoc., N.S., i, p. 69.

Mud at Drake's I. and on the shores of the Sound (F.E.B.).

CLITELLIO ATER, Claparède: *Beddard*, Journ. Mar. Biol. Assoc., N.S., i, p. 70.

Mud on Drake's I. and on shores of Sound (F.E.B.).

PACHYDRILUS sp.: *Beddard*, Journ. Mar. Biol. Assoc., N.S., i, p. 69.

Common in gravel between tide-marks, Rum B. (F.E.B.).

GEPHYREA.

Nomenclature:—*Selenka. E.*, Die Sipunculiden., Reisen. Archipel. Philipp. Semper., Bd. iv, 1883–1885.

PETALOSTOMA MINUTUM, Keferstein.

Rum B., common in crevices of shale (T.V.H., R.A.T., E.J.A.).

PHASCOLION STROMBI, Montagu.

Frequently met with in shells of *Aporrhais pes-pelecani*; Mewstone Gds. (T.V.H., E.J.A.).

THALASSEMA NEPTUNI, Gaertner.

Common in holes in rock, Rum B., Wembury B., Drake's I.; one spec. Yealm Sand-bank; in stones dredged from Millbay Ch., Asia Sh., and (rarely) Queen's Gd. (R.A.T.).

PHORONIS HIPPOCREPIA, Wright: *Shipley*, Cambridge Nat. Hist., 1896.

Abundant in the Sound (W.G.): Duke Rk. (T.V.H.): Millbay Ch. (T.V.H., E.J.A.): Asia Sh.; Queen's Gd. (S.P.).

HIRUDINEA.

PONTOBDELLA MURICATA, Linnæus: *W. C. McIntosh*, Mar. Invert. & Fishes St. Andrews, p. 114, fig.

Occasionally on the outside grounds; parasitic on the skate (S.P.).
Breeding: July (E.W.L.H.).

CHÆTOGNATHA.

SAGITTA BIPUNCTATA (Quoy & Gaimard): *Grassi*, I Chetognati, Fauna u. Flora Golf. Neapel., v.

In townettings throughout the year (L.H.G.).

BRANCHIOPODA.

EVADNE NORDMANNI, Lovén: *C. Apstein*, Nordisches Plankt., pt. vii, Cladoc., p. 12, fig.

1892, appeared beginning of July and still present in Oct. (E.J.B.): 1895, constantly present in Aug., disappeared early Oct. (T.V.H.): Apr.–May, 1899 (P.T.C.): May, July, Sept., 1903: Mar.–June, 1904 (L.H.G.).

Carrying ova: Aug. (T.V.H.). Winter eggs produced from about mid-Sept. (E.J.B.).

PODON INTERMEDIUS, Lilljeborg: *C. Apstein*, Nordisches Plankt., pt. vii, Cladoc., p. 15, fig.

1892, became less abundant in July and disappeared about mid-Sept. (E.J.B.): 1895, constantly present in Aug., disappeared early in Oct. (T.V.H.): Plymouth neighbourhood, Apr.-Sept., 1903; Apr.–July, 1904 (L.H.G.).

Carrying ova: Aug. (T.V.H.)

PODON LEUCKARTI, G. O. Sars: *C. Apstein*, Nordisches Plankt., pt. vii, Cladoc., p. 13, fig.

Plymouth neighbourhood, Apr. 1904, rare (L.H.G.).

OSTRACODA.

Cypridinidæ.

PHILOMEDES INTERPUNCTA, Baird: *G. S. Brady & Norman*, Trans. Dublin Soc., ser. 2, vol. v, p. 656, fig.

Plymouth (A.M.N.).

Asteropidæ.

ASTEROPE MARIÆ (Baird): *G. S. Brady & Norman*, Trans. Dublin Soc., ser. 2, vol. v, p. 630, fig.

Plymouth (A.M.N.).

Cytheridæ.

CYTHERE OBLONGA, Brady: *G. S. Brady*, Trans. Linn. Soc., vol. xxvi, p. 400, fig.

Plymouth (A.M.N.).

CYTHERE QUADRIDENTATA, Baird: *G. S. Brady*, Trans. Linn. Soc., vol. xxvi, p. 413, fig.

Plymouth (A.M.N.).

CYTHERE EMACIATA, Brady: *G. S. Brady*, Trans. Linn. Soc., vol. xxvi, p. 414, fig.

Plymouth (A.M.N.).

CYTHERE RUNCINATA, Baird: *G. S. Brady & Norman*, Trans. Dublin Soc., ser. 2, vol. iv, p. 160, fig.

Plymouth (A.M.N.).

COPEPODA.

Calanidæ.

CALANUS FINMARCHICUS (Gunnerus): *G. O. Sars*, Crust. Norway, vol. iv, p. 9, fig.

Plymouth, 1899, more or less common, Apr.–Aug., Oct. (P.T.C.): 1903–4, common in summer (L.H.G.).

Paracalanidæ.

PARACALANUS PARVUS (Claus): *G. O. Sars*, Crust. Norway, vol. iv, p. 17, fig.

Plymouth, 1888–9, in great abundance except from Sept.–Mar., when it appeared absent (G.C.B.): 1899: Mar.–Apr., fairly plentiful; June, very common: July–Aug., more or less rare; Sept.–Oct., more or less abundant; Nov., rare; Dec., more or less rare (P.T.C.): 1903, abundant all the year, except during May and July: 1904, abundant Jan.–July (L.H.G.).

[**Copepoda**—*contd.*]

Pseudocalanidæ.

Pseudocalanus elongatus, Boeck: *G. O. Sars*, Crust. Norway, vol. iv, p. 20, fig.

One of the commonest species, in immense numbers during autumn, winter, and spring, 1888–9 (G.C.B.): 1899, Feb.–Apr., more or less rare (P.T.C.): very common in 1903 and 1904 (L.H.G.).

Centropagidæ.

Centropages typicus, Kröyer: *G. O. Sars*, Crust. Norway, vol. iv, p. 75, fig.

Plymouth, 1888–9, abundant except during winter, when it is scarce (G.C.B.): 1899, Jan.–Feb., rare; Mar.–Apr., in fair numbers; May, rare; June, more or less rare; July–Aug., rare; Sept., very rare (P.T.C.): 1903, Jan.–Feb.; Apr.–June; Aug.–Oct.; 1904, Jan.–July (L.H.G.).

Isias clavipes, Boeck: *G. O. Sars*, Crust. Norway, vol. iv, p. 79, fig.

Plymouth, June 1899 (P.T.C.): Dec. 1902: Sept. 1903; Mar.–June 1904 (L.H.G.).

Temoridæ.

Temora longicornis (O. F. Müller): *G. O. Sars*, Crust. Norway, vol. iv, p. 97, fig.

Plymouth, 1888–9; scarce during winter months, becoming more common in Apr., and reaching maximum abundance Aug.–Sept. (G.C.B.): 1899; Mar., somewhat rare: Apr., very common; June–Oct., rare (P.T.C.): 1903–4, rare in winter (L.H.G.).

Pontellidæ.

Anomalocera Patersoni, Templeton: *G. O. Sars*, Crust. Norway, vol. iv, p. 139, fig.

Plymouth, 1888–9, abundant in autumn and late summer, absent in winter (G.C.B.): 1904, July (L.H.G.).

Labidocera Wollastoni, Lubbock: *G. O. Sars*, Crust. Norway, vol. iv, p. 142, fig.

Plymouth; 1902, Dec.; 1904, Apr.–July (L.H.G.): near the Eddystone, in small numbers, Aug. and Oct., 1888 (G.C.B.).

Parapontellidæ.

Parapontella brevicornis (Lubbock): *G. O. Sars*, Crust. Norway, vol. iv, p. 145, fig.

Near Eddystone, few specs. Sept. 1888; the Cattewater, Mar. 1889 (G.C.B.): Plymouth, rare, Mar.–Apr. 1899 (P.T.C.): 1903, May–July; 1904, Feb.–May, July; rare in winter (L.H.G.).

Acartiidæ.

Acartia Clausi, Giesbrecht: *G. O. Sars*, Crust. Norway, vol. iv, p. 150, fig.

Plymouth, 1899; Jan., rare; Mar.–Apr., more or less abundant; June–Aug., common; Sept.–Oct., in fair numbers; Nov.–Dec., very rare (P.T.C.): 1903, except during Mar. and May; 1904, Jan.–July (L.H.G.).

Acartia longiremis (Lilljeborg): *G. O. Sars*, Crust. Norway, vol. iv, p. 149, fig.

One of the most common species at all seasons, 1888–9 (G.C.B.).

Longipediidæ.

LONGIPEDIA SCOTTI: *G. O. Sars*, Crust. Norway, vol. v, p. 11, fig.
Plymouth (G.C.B.).

Ectinosomidæ.

MICROSETELLA NORVEGICA (Boeck) [= *Ectinosoma atlanticum*, Brady]: *G. O. Sars*, Crust. Norway, vol. v, p. 44, fig.
Plymouth; Jan.–Feb. 1899, rare (P.T.C.).

Harpacticidæ.

EUTERPE ACUTIFRONS (Dana): *C. Claus*, Frei lebend. Copep., p. 110, fig. (as *E. gracilis*).
Plymouth, very abundant late winter and spring, 1889 (G.C.B.): 1899; Jan.–Feb., rare; Mar.–May, somewhat rare; July, fairly plentiful; Aug., rare; Sept., fairly common; Oct.–Dec., more or less rare (P.T.C.).

THALESTRIS MYSIS, Claus: *G. S. Brady*, Monogr. Free & Semip. Copep. Brit. Is., vol. ii, p. 121, fig.
The Cattewater (G.C.B.).

Cyclopidæ.

OITHONA PLUMIFERA, Baird: *W. Giesbrecht*, Fauna Flora Neapel, vol. xix, pp. 548, etc., fig.
Very abundant Feb.–Apr., practically absent during late summer and autumn, 1888–9 (G.C.B.).

OITHONA SIMILIS, Claus.: *W. Giesbrecht*, Fauna Flora Neapel, vol. xix, pp. 548, etc., fig.
Plymouth, 1899, more or less common throughout the year (P.T.C.).

CYCLOPINA LITTORALIS (Brady): *G. S. Brady*, Monogr. Free & Semip. Copep. Brit. Is., vol. i, p. 92, fig.
Plymouth, few specs. Apr. 1889 (G.C.B.).

Corycæidæ.

CORYCÆUS ANGLICUS, Lubbock: *G. S. Brady*, Monogr. Free & Semip. Copep. Brit. Is., vol. iii, p. 34, fig.
Plymouth (G.C.B., P.T.C., T.V.H.).

CORYCÆUS VENUSTUS, Dana: *W. Giesbrecht*, Fauna Flora Neapel, vol. xix, pp. 674, etc., fig.
Plymouth, Nov. 1899, very rare (P.T.C.).

ONCÆA MEDITERRANEA (Claus): *W. Giesbrecht*, Fauna Flora Neapel, vol. xix, pp. 602, etc., fig.
Plymouth (G.C.B., P.T.C.).

ONCÆA MINUTA: *W. Giesbrecht*, Fauna Flora Neapel, vol. xix, pp. 603, etc., fig.
Plymouth, 1899, very rare Jan.–Mar., rare in Dec. (P.T.C.).

ONCÆA SUBTILIS: *W. Giesbrecht*, Fauna Flora Neapel, vol. xix, pp. 603, etc., fig.
Plymouth, Mar. 1899, very rare (P.T.C.).

SACCOPSIS ALLENI: *É. Brumpt*, C. R. Acad. Paris, vol. cxxiv, p. 1464, fig.
Plymouth, on *Polycirrus aurantiacus* (E.B.).

CIRRIPEDIA.

Balanidæ.

BALANUS BALANOIDES (Linnæus): *C. Darwin*, Monogr. Cirrip., Balanidæ, p. 267, fig.

Rocks between tide-marks in the Sound, etc. (S.P.).

BALANUS CRENATUS, Bruguière: *C. Darwin*, Monogr. Cirrip., Balanidæ, p. 261, fig.

Common in dredgings from the Sound, etc., on stones and shells (S.P.): Eddystone Gds. (E.J.A.).

BALANUS PERFORATUS, Bruguière: *C. Darwin*, Monogr. Cirrip., Balanidæ, p. 271, fig.

Abundant on rocks between tide-marks; rocks under the Laboratory; Millbay Dock, on piles: Drake's I.; etc. (S.P.).

BALANUS SPONGICOLA, Brown: *C. Darwin*, Monogr. Cirrip., Balanidæ, p. 225, fig.

Rame-Eddystone Gds., attached to the upper valve of *Pecten opercularis*; etc. (S.P.).

PYRGOMA ANGLICUM, Leach: *C. Darwin*, Monogr. Cirrip., Balanidæ, p. 360, fig.

Common on *Caryophyllia Smithi*, 15–35 fms. (R.A.T., S.P.).

CHTHAMALUS STELLATUS (Poli): *C. Darwin*, Monogr. Cirrip., Balanidæ, p. 455, fig.

Rocks between tide-marks in the Sound, etc. (S.P.).

Breeding: Jan.–Mar.: Aug.–Sept. (W.G.).

Verrucidæ.

VERRUCA STROEMIA (O. F. Müller): *C. Darwin*, Monogr. Cirrip., Balanidæ, p. 518, fig.

Common on shells, stones, etc., L.W.–35 fms.: the Sound: Stoke Pt. Gds.; Rame-Eddystone Gds.; etc. (S.P.).

Lepadidæ.

LEPAS ANATIFERA, Linnæus: *C. Darwin*, Monogr. Cirrip., Lepadidæ, p. 73, fig.

Occasionally on drift-wood, etc. (R.A.T., S.P.).

SCALPELLUM VULGARE, Leach: *C. Darwin*, Monogr. Cirrip., Lepadidæ, p. 222, fig.

Common on *Halecium*, *Antennularia*, *Aglaophenia*, etc., 15–35 fms. (R.A.T., S.P.).

Peltogastridæ.

SACCULINA CARCINI, Thompson: *P. J. v. Beneden*, Rech. Faune Litt. Belgique, Crust. [Bruxelles, 1861], p. 154, fig.

Common, parasitic on *Carcinus mænas* (S.P.).

Breeding: May–Sept. (W.G.).

LEPTOSTRACA.

NEBALIA BIPES (Fabricius): *G. O. Sars*, Fauna Norvegiæ, vol. i, p. 9, fig.

Common under stones, at low tide; Drake's I.; Mt. Edgcumbe; Rum B., etc. (R.A.T., S.P.): Asia Sh., not uncommon (S.P.): Millbay Ch., occasionally: Whitsand B. (A.J.S.). Often abundant on the bait in lobster pots (E.J.A.).

Breeding: Apr.–July (W.G.).

AMPHIPODA.

Hyperiidæ.

HYPERIA GALBA (Montagu): *G. O. Sars*, Crust. Norway, vol. i, p. 7, fig.
Occasionally taken on *Rhizostoma*, *Chrysaora*, etc. (R.A.T.).

PARATHEMISTO OBLIVIA (Kröyer): *G. O. Sars*, Crust. Norway, vol. i. p. 10, fig.
Eddystone Gds. (G.C.B.).

Orchestiidæ.

TALITRUS LOCUSTA (Pallas): *G. O. Sars*, Crust. Norway, vol. i, p. 23, fig.
Abundant on all sandy shores, under weed and stones, at the high-water mark of spring tides (S.P.).

ORCHESTIA LITTOREA (Montagu): *G. O. Sars*, Crust. Norway, vol. i, p. 24, fig.
Abundant everywhere at high water, under weed and stones, and in rock crevices (S.P.).

ORCHESTIA MEDITERRANEA, A. Costa: *C. S. Bate & Westwood*, Brit. Sess.-eyed Crust., vol. i, p. 31, fig.
Drake's I.; Knap Buoy (T.V.H.).

Lysianassidæ.

LYSIANAX [=LYSIANASSA] COSTÆ (Milne-Edwards): *G. O. Sars*, Crust. Norway, vol. i, p. 42, fig.
Millbay Ch. (T.V.H.[1]).

ORCHOMENE BATEI, G. O. Sars: *G. O. Sars*, Crust. Norway, vol. i, p. 60, fig.
Millbay Ch.; Queen's Gd. (T.V.H.).

ORCHOMENELLA NANA (Kröyer): *G. O. Sars*, Crust. Norway, vol. i, p. 69, fig. (as *O. ciliata*).
Plymouth (T.V.H.[1]).

TRYPHOSA SARSI (Bonnier): *G. O. Sars*, Crust. Norway, vol. i, p. 76, fig. (as *T. nana*).
Queen's Gd. (T.V.H.[1]).

Pontoporeiidæ.

BATHYPOREIA PELAGICA, Spence Bate: *G. O. Sars*, Crust. Norway, vol. i, p. 129, fig.
Whitsand B. (T.V.H.[1]).

Ampeliscidæ.

AMPELISCA SPINIPES, Boeck: *G. O. Sars*, Crust. Norway, vol. i, p. 173, fig.
Cawsand B., occasionally; Mewstone Gds., not uncommon on fine and medium gravel (R.A.T.).
Females bearing ova: Mar. (R.A.T.).

AMPELISCA TENUICORNIS, Lilljeborg: *G. O. Sars*, Crust. Norway, vol. i, p. 167, fig.
Duke Rk. (A.O.W.[1]): near the Mewstone (A.M.N.).

[**Amphipoda**—*contd.*]

Amphilochidæ.

AMPHILOCHUS MANUDENS, Spence Bate: *G. O. Sars*, Crust. Norway, vol. i, p. 217, fig.

Inside Drake's I. (A.M.N., A.O.W.).

AMPHILOCHOIDES ODONTONYX (Boeck): *G. O. Sars*, Crust. Norway, vol. i, p. 221, fig.

Plymouth, 8 fms., 1887 (A.M.N.).

Stenothoidæ.

STENOTHOE MARINA (Spence Bate): *G. O. Sars*, Crust. Norway, vol. i, p. 236, fig.

Duke Rk. (A.O.W.[1]).

STENOTHOE MONOCULOIDES (Montagu): *G. O. Sars*, Crust. Norway, vol. i, p. 240, fig.

Plymouth (A.M.N.).

STENOTHOE SETOSA: *A. M. Norman*, Ann. Mag. Nat. Hist., ser. 7, vol. vi, p. 39, fig.

Plymouth, single spec., the type (A.M.N.).

Leucothoidæ.

LEUCOTHOE SPINICARPA (Abildgaard): *G. O. Sars*, Crust. Norway, vol. i, p. 283, fig.

Millbay Ch., moderately common (T.V.H., R.A.T.): Cattewater; Queen's Gd.; Duke Rk. (T.V.H.): Yealm R., not uncommon (R.A.T.).

Œdiceridæ.

MONOCULODES CARINATUS, Spence Bate: *G. O. Sars*, Crust. Norway, vol. i, p. 295, fig.

Plymouth (A.M.N.).

Iphimediidæ.

IPHIMEDIA MINUTA, G. O. Sars: *G. O. Sars*, Crust. Norway, vol. i, p. 379, fig.

Queen's Gd. (T.V.H., R.A.T.): Yealm R. (R.A.T.).

IPHIMEDIA OBESA, Rathke: *G. O. Sars*, Crust. Norway, vol. i, p. 377, fig.

Plymouth Hr. (T.V.H.[1]).

Calliopiidæ.

APHERUSA BISPINOSA (Spence Bate): *G. O. Sars*, Crust. Norway, vol. i, p. 439, fig.

Inside Drake's I. (A.M.N. & A.O.W.[1]): Yealm Estuary, very rare (R.A.T.).

Atylidæ.

PARATYLUS SWAMMERDAMI (Milne-Edwards): *G. O. Sars*, Crust. Norway, vol. i, p. 463, fig.

Cawsand B., not uncommon (R.A.T.): Rum B. (T.V.H.): Whitsand B. (R.A.T.).

Females carrying ova: Jan., May (R.A.T.): Dec. (T.V.H.).

DEXAMINE SPINOSA (Montagu): *G. O. Sars*, Crust. Norway, vol. i, p. 475, fig.

Inside Drake's I. (A.M.N. & A.O.W.): Millbay; Cawsand B.; Knap Buoy; Whitsand B. (T.V.H.): Yealm Estuary, occasionally (R.A.T.).

Breeding: July (R.A.T.).

Gammaridæ.

GAMMARUS CAMPYLOPS, Leach: *G. O. Sars*, Crust. Norway, vol. i, p. 500, fig.

Queen's Gd.[1]; Duke Rk.[1] (T.V.H.).

GAMMARUS LOCUSTA, Linnaeus: *G. O. Sars*, Crust. Norway, vol. i, p. 499, fig.

Very common under stones and among weeds, etc., between tide-marks to 5–6 fms. (R.A.T.).

Females with ova: Jan. (R.A.T.): Dec. (R.A.T., T.V.H.).

GAMMARUS MARINUS, Leach: *G. O. Sars*, Crust. Norway, vol. i, p. 497, fig.

Common on the shore (R.A.T., S.P.): Rum B. (R.A.T.): Drake's I.; the Breakwater: Mt. Edgcumbe; Wembury B. (T.V.H.): Reny Rks, (R.A.T.): Queen's Gd., occasionally (R.A.T., T.V.H., S.P.).

Females with ova: Feb. (R.A.T.): Mar. (T.V.H.).

MELITA GLADIOSA, Spence Bate: *T. R. R. Stebbing*, Ann. Mag. Nat. Hist., ser. 4, vol. v, p. 77, fig.

Queen's Gd., occasionally (R.A.T.).

MELITA OBTUSATA (Montagu): *A. M. Norman*, Ann. Mag. Nat. Hist., ser. 6, vol. iv, p. 132.

Not uncommon, Millbay Ch. and Pit: Queen's Gd.; Cawsand B. (R.A.T.): Duke Rk. (T.V.H.).

Females with ova: Jan., Apr., Dec. (R.A.T.).

MELITA PALMATA (Montagu): *G. O. Sars*, Crust. Norway, vol. i, p. 508, fig.

Occasionally between tide-marks in the Sound (R.A.T.).

MÆRA GROSSIMANA (Montagu): *C. S. Bate & Westwood*, Hist. Brit. Sess.-eyed Crust., vol. i, p. 350, fig. (♂ only): *C. Heller*, Denkschr. Akad. Wien, vol. xvi, p. 41, fig. (♀ only, as *M. Donatoi*).

Occasionally taken between tide-marks (R.A.T.): Bovisand Cove (J.T.C.).

MÆRA OTHONIS (Milne-Edwards): *G. O. Sars*, Crust. Norway, vol. i, p. 518, fig.

Millbay Ch., occasionally (R.A.T.): Duke Rk.[1]; Yealm R.[1] (T.V.H.).

MÆRA SEMISERRATA (Spence Bate): *C. S. Bate & Westwood*, Hist. Brit. Sess.-eyed Crust., vol. i, p. 401, fig. (as *Megamæra*).

Nr. Eddystone, 30 fms. (A.O.W.).

GAMMARELLA BREVICAUDATA (H. Milne-Edwards): *T. R. R. Stebbing*, Ann. Mag. Nat. Hist., ser. 4, vol. xiv, p. 13, fig.

Plymouth (A.O.W.[1]).

CHEIROCRATUS SUNDEWALLI (Rathke): *G. O. Sars*, Crust. Norway, vol. i, p. 524, fig.

The Sound, occasionally (R.A.T.).

Photidæ.

AORA GRACILIS (Spence Bate): *G. O. Sars*, Crust. Norway, vol. i, p. 545, fig.

The Sound, occasionally (R.A.T.).

GAMMAROPSIS ERYTHROPHTHALMA (Lilljeborg): *G. O. Sars*, Crust. Norway, vol. i, p. 558, fig.

Millbay Ch. (T.V.H.).

[**Amphipoda**—*contd.*]

Podoceridæ.

AMPHITHOE RUBRICATA (Montagu); *G. O. Sars*, Crust. Norway, vol. i, p. 579, fig.

Not uncommon in dredgings from the Sound and occasionally between tide-marks (R.A.T.): Yealm R. (T.V.H.).

Female carrying young: Feb. (R.A.T.).

ISCHYROCERUS MINUTUS, Lilljeborg: *G. O. Sars*, Crust. Norway, vol. i, p. 589, fig.

Duke Rk., 5 fms. (T.V.H.[1]).

PODOCERUS FALCATUS (Montagu): *G. O. Sars*, Crust. Norway, vol. i, p. 594, fig.

Abundant on the buoys, hulks, and piles in the Sound, Millbay Docks, and Cattewater (R.A.T.).

A female with ova: Nov. (T.V.H.).

ERICHTHONIUS ABDITUS (Templeton): *G. O. Sars*, Crust. Norway, vol. i, p. 602, fig.

Millbay Ch.; Queen's Gd.; common (R.A.T., S.P.): Yealm R. (R.A.T.): Eddystone Gds. (E.J.A.).

Corophiidæ.

COROPHIUM BONELLII, Milne-Edwards: *G. O. Sars*, Crust. Norway, vol. i, p. 616, fig.

Millbay[1]; Queen's Gd.[1]; Duke Rk.[1] (T.V.H.).

COROPHIUM CRASSICORNE, Bruzelius: *G. O. Sars*, Crust. Norway, vol. i, p. 615, fig.

Millbay Ch. and Pit, very common; Queen's Gd., not uncommon (R.A.T., T.V.H.): West Ch.: Yealm R. (T.V.H.).

Females with ova: Nov. (T.V.H.).

UNCIOLA CRENATIPALMA (Spence Bate): *C. S. Bate & Westwood*, Hist. Brit. Sess.-eyed Crust., vol. i, pp. 488, 489, fig. (♂ as *Dryope irrorata*, ♀ as *D. crenatipalmata*).

Plentiful among stones and shells on muddy bottom, 20 fms. (W.G., A.M.N.).

Cheluridæ.

CHELURA TEREBRANS, Philippi: *G. O. Sars*, Crust. Norway, vol. i, p. 627, fig.

Common in drift-wood (R.A.T., S.P.).

Caprellidæ.

PHTISICA MARINA, Slabber: *G. O. Sars*, Crust. Norway, vol. i, p. 646, fig.

Inside Drake's I. (E.J.A.): N. of the Breakwater (T.V.H.[1]): Whitsand B., single spec. (J.T.C.): Eddystone Gds. (E.J.A.).

PROTELLA PHASMA (Montagu): *G. O. Sars*, Crust. Norway, vol. i, p. 649, fig.

Moderately common, Millbay Ch.; Asia Sh.; Drake's I.; Queen's Gd.; Yealm R. (R.A.T.): 4 miles W. of the Eddystone, single spec. (R.A.T.).

Females with ova: Mar.–Apr. (R.A.T.).

PARIAMBUS TYPICUS (Kröyer): *G. O. Sars*, Crust. Norway, vol. i, p. 655, fig.

Cawsand B.: Jennycliff B. (T.V.H.).

CAPRELLA ACANTHIFERA, Leach: *G. O. Sars*, Crust. Norway, vol. i, p. 666, fig.

Millbay Ch.; Eddystone, on sponge (T.V.H.).

CAPRELLA ÆQUILIBRA, Say: *G. O. Sars*, Crust. Norway, vol. i, p. 663, fig.

The Sound, common on buoys and hulks (R.A.T.).

CAPRELLA LINEARIS (Linnæus): *G. O. Sars*, Crust. Norway, vol. i, p. 657, fig.

Drake's I., at low water (J.T.C.[1]): Millbay Ch.[1]; Queen's Gd.[1]; Yealm R.[1] (T.V.H.).

CAPRELLA TUBERCULATA, Guerin: *C. S. Bate & Westwood*, Hist. Brit. Sess.-eyed Crust., vol. ii, p. 68, fig.

Occasionally in the Sound (R.A.T.).

ISOPODA.

Apseudidæ.

APSEUDES LATREILLEI (Milne-Edwards): *A. M. Norman & Stebbing*, Trans. Zool. Soc., vol. xii, p. 82, fig.

Drake's I., common among mud at roots of corallines (W.G.): common under stones and in rock crevices; Jennycliff B.; Drake's I. (S.P.).

Females carrying ripe ova in Aug. (S.P.).

APSEUDES TALPA (Montagu): *A. M. Norman & Stebbing*, Trans. Zool. Soc., vol. xii, p. 81.

Not uncommon between tide-marks: Rum B.; Reny Rks.; Wembury B. (R.A.T.): Millbay Ch. (R.A.T.).

Ova hatching: Feb. (R.A.T.).

Tanaidæ.

TANAIS TOMENTOSUS, Kröyer: *G. O. Sars*, Crust. Norway, vol. ii, p. 12, fig.

Common in crevices of the limestone of Plymouth Breakwater (R.A.T.).

Anthuridæ.

ANTHURA GRACILIS (Montagu): *A. M. Norman & Stebbing*, Trans. Zool. Soc., vol. xii, p. 122, fig.

Occasional specimens in dredgings from the Sound: Asia Sh.; Queen's Gd.; Millbay Ch. (R.A.T.).

Gnathiidæ.

GNATHIA MAXILLARIS (Montagu): *G. O. Sars*, Crust. Norway, vol. ii, p. 52, fig.

Common under stones between tide-marks, and in dredgings from the Sound (R.A.T., S.P.): Mewstone Gds. (R.A.T.).

Females with ova: Jan.; Feb. (R.A.T.): March (S.P.): May (R.A.T.). Hatching out: Feb. (R.A.T.).

Ægidæ.

ROCINELA DAMNONIENSIS, Leach: *J. C. Schiødte & Meinert*, Naturhist. Tidsskr., ser. 3, vol. xii, p. 383, fig.

Occasional specs., 20–30 fms. (R.A.T., S.P.).

Breeding: Feb. (R.A.T.).

[Isopoda—*contd.*]

ROCINELA DUMERILI (Lucas): *J. C. Schiødte & Meinert*, Naturhist. Tidsskr., ser. 3, vol. xii, p. 391, fig.

Occasional specs., 20–30 fms. (R.A.T., S.P.).

Hatching out: Aug. (R.A.T.).

Cirolanidæ.

CIROLANA HIRTIPES, H. Milne-Edwards: *H. J. Hansen*, Danske vid. Selsk. Skr., ser. 6, Naturvid., vol. v, p. 326, fig.

Drake's I. (A.O.W.).

CONILERA CYLINDRACEA (Montagu): *H. J. Hansen*, Danske vid. Selsk. Skr., ser. 6, Naturvid., vol. v, p. 358, fig.

West Entrance: Mewstone Ledge; occasionally (R.A.T.): Mewstone Gds, not uncommon (R.A.T., S.P.): Stoke Pt. Gds. (S.P.): Rame-Eddystone Gds. (R.A.T., S.P.).

Breeding: Apr. (R.A.T.): June–Aug. (S.P.).

A dead, but fresh specimen of *Scyllium canicula* brought to the Laboratory in Sept. 1899, contained about 400 *C. cylindracea*, of which over 300 were living: having eaten through the wall of the stomach of the dogfish, they were feeding on the heart and liver (R.A.T.).

Cymothoidæ.

NEROCILA NEAPOLITANA: *J. C. Schiødte & Meinert*, Naturhist. Tidsskr., ser. 3, vol. xiii, p. 41, fig.

Single spec., 5–6 m. S. of the Mewstone (A.M.N.).

Breeding: Sept. (A.M.N.).

DYNAMENE RUBRA, Leach: *C. Spence Bate & Westwood*, Brit. Sess.-eyed Crust., vol. ii, p. 419, fig.

Rum B., common; Reny Rks., occasionally (R.A.T.).

Breeding: Feb. (R.A.T.).

Sphæromidæ.

NÆSA BIDENTATA (Adams): *C. Spence Bate & Westwood*, Brit. Sess.-eyed Crust., vol. ii, p. 431, fig.

Not uncommon in empty barnacle shells, etc., between tide-marks in the Sound (R.A.T.): Jennycliff B., abundant in rock crevices; Mt. Edgcumbe, under stones; the Breakwater; etc. (S.P.).

SPHÆROMA CURTUM, Leach: *C. Spence Bate & Westwood*, Brit. Sess.-eyed Crust., vol. ii, p. 412, fig.

Drake's I. (A.O.W.).

SPHÆROMA SERRATUM (Fabricius): *C. Spence Bate & Westwood*, Brit. Sess.-eyed Crust., vol. ii, p. 405, fig.

Under stones; Drake's I.; Rum B. (R.A.T., S.P.).

Limnoriidæ.

LIMNORIA LIGNORUM (Rathke): *G. O. Sars*, Crust. Norway, vol. ii, p. 76, fig.

Common in drift wood, etc., in the Sound (R.A.T., S.P.).

Idotheidæ.

IDOTHEA BALTICA (Pallas) [=*I. tricuspidata*, Desmarest]: *G. O. Sars*, Crust. Norway, vol. ii, p. 80, fig.

Queen's Gd., on *Antennularia*[1]: Cawsand B., on *Zostera*; Whitsand B. (S.P.).

IDOTHEA EMARGINATA (Fabricius): *G. O. Sars*, Crust. Norway, vol. ii, p. 85, fig.

Jennycliff B., common (T.V.H., R.A.T.): Whitsand B. (S.P.).

IDOTHEA LINEARIS (Linnæus): *C. Spence Bate & Westwood*, Brit. Sess.-eyed Crust., vol. ii, p. 388, fig.

Common among *Zostera;* Drake's I.: Jennycliff B.: Cawsand B.: Whitsand B.: Yealm Est. (S.P.).

IDOTHEA NEGLECTA: *G. O. Sars*, Crust. Norway, vol. ii, p. 84, fig.

Drake's I., abundant under stones at low-water: Jennycliff B., Mt. Edgcumbe, etc., occasionally (S.P.).

Breeding: Mar. (S.P.).

IDOTHEA PRISMATICA (Risso): *C. S. Bate & Westwood*, Brit. Sess.-eyed Crust., p. 391, fig. (as *I. parallela*).

Cawsand B., single spec. inhabiting a dead *Zostera* stem (W.G.).

IDOTHEA PELAGICA, Leach: *G. O. Sars*, Crust. Norway, vol. ii, p. 81, fig.

Single spec., between Breakwater Lt. and Queen's Gd. Buoy (J.T.C.).

Carrying embryos: Dec. (J.T.C.).

Arcturidæ.

ASTACILLA LONGICORNIS (Sowerby): *G. O. Sars*, Crust. Norway, vol. ii, p. 88, fig.

Not uncommon clinging to the spines of *Echinus esculentus;* Eddystone Gds. (R.A.T., S.P.): Mewstone Ledge, occasionally (R.A.T.).

Breeding: Apr. (R.A.T.).

ASTACILLA INTERMEDIA (Goodsir): *C. Spence Bate & Westwood*, Brit. Sess.-eyed Crust., vol. ii, p. 371, fig. (as *Arcturus*).

The Breakwater (W.H.): Queen's Gd. (T.V.H.).

Janiridæ.

JANIRA MACULOSA, Leach: *G. O. Sars*, Crust. Norway, vol. ii, p. 99, fig.

Common in Millbay Pit and between tide-marks at Mt. Edgcumbe and Drake's I.: less common in dredgings from Queen's Gd. and Asia Sh. and on the Reny Rks.: occasionally outside in 33 fms. (R.A.T.).

Females carrying ova: Mar.–Apr. (R.A.T.).

JÆRA MARINA (Fabricius) [= *J. albifrons*, Leach]: *G. O. Sars*, Crust. Norway, vol. ii, p. 104, fig.

Rocks under the Hoe: Queen's Gd.: the Breakwater: not uncommon (R.A.T.): Hollow Rock B., common under stones at low-water (S.P.): Reny Rks., common (R.A.T.).

Breeding: Feb. (R.A.T.).

Munnidæ.

MUNNA KRÖYERI, Goodsir: *G. O. Sars*, Crust. Norway, vol. ii, p. 109, fig.

Millbay Ch.; Asia Sh.; Queen's Gd.: Yealm R.: not uncommon (R.A.T.).

Ligiidæ.

LIGIA OCEANICA (Linnæus): *G. O. Sars*, Crust. Norway, vol. ii, p. 156, fig.

Common in rock-crevices, etc., above high-water mark in the Sound (R.A.T., S.P.): abundant on quay walls in the Cattewater (S.P.): the Breakwater (A.O.W., S.P.).

Breeding: June (A.J.S.).

Bopyridæ.

BOPYRUS SQUILLARUM, Latreille: *G. O. Sars*, Crust. Norway, vol. ii, p. 197, fig.

Not uncommon on *Leander serratus;* Cawsand B.: etc. (R.A.T.).

GYGE GALATHEÆ: *C. S. Bate & Westwood*, Brit. Sess.-eyed Crust., p. 225, fig.

Rum B., on *Galathea squamifera* (R.A.T.).

Cryptoniscidæ.

CRYPTOTHIR BALANI, Spence Bate: *G. O. Sars*, Crust. Norway, vol. ii, p. 236, fig.

Rocks below the Hoe, not uncommon among barnacles (R.A.T.).

CUMACEA.

Cumidæ.

IPHINOE TRISPINOSA (Goodsir): *G. O. Sars*, Crust. Norway, vol. iii, p. 14, fig.

Abundant 1892 (W.G.): Whitsand B., May 1902, May 1903 (A.M.N.).

Leuconidæ.

EUDORELLA TRUNCATULA, Spence Bate: *G. O. Sars*, Crust. Norway, vol. iii, p. 37, fig.

Cawsand B.: 1889: Apr. 1900: June 1903 (A.M.N.).

Diastylidæ.

DIASTYLIS BRADYI: *A. M. Norman*, Ann. Mag. Nat. Hist., ser. 5, vol. iii, p. 59.

Cawsand B., Apr. 1900: Whitsand B., May 1902, and common in May 1903 (A.M.N.).

DIASTYLIS LAEVIS [? = *D. rostrata* (Goodsir)]: *A. M. Norman*, Ann. Mag. Nat. Hist., ser. 5, vol. iii, p. 60.

Sept. 1889: 3 m. N.E. of the Eddystone, Sept. 1900 (A.M.N.).

DIASTYLIS RATHKEI (Kröyer): *G. O. Sars*, Crust. Norway, vol. iii, p. 44, fig.

Whitsand B. (A.J.S.).

Pseudocumidæ.

PSEUDOCUMA CERCARIA (P. J. v. Beneden): *G. O. Sars*, Crust. Norway, vol. iii, p. 74, fig.

Cawsand B., Apr. 1900; Whitsand B., May 1902, and abundant in May 1903 (A.M.N.).

STOMAPODA.

SQUILLA DESMARESTI, Risso: *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 354, fig.

Single spec. near New Ground Buoy, Dec. 1900 (R.A.T.).

The larvæ are occasionally met with in townettings (E.J.A.).

SCHIZOPODA.

Euphausiidæ.

NYCTIPHANES COUCHI: *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 346, fig. (as *Thysanopoda*).

Occasionally taken in the townets, in the Sound and outside (R.A.T.): single spec., 3 m. off Rame Hd., June 1898 (E.W.L.H.): Cawsand B. and 2½ m. S. of Breakwater, few immature specs., Feb. 1899 (W.I.B.).

Siriellinæ.

SIRIELLA ARMATA (Milne-Edwards): *G. O. Sars*, Arch. Math. Naturvid., vol. i, p. 96, fig.

June 1893, Drake's I. (W.G.): Cawsand B., few specs. Apr., May, June, Sept. 1899, Apr. 1900; Jennycliff B., few specs. Sept. and Oct. 1899: Whitsand B., abundant Aug. 1898 and Oct. 1899: Bovisand B., Oct. 1899; Yealm Est., Oct. 1899 and Apr. 1900 (W.I.B.).

Breeding: Apr.: Oct. (W.I.B., R.A.T.).

SIRIELLA CLAUSI: *G. O. Sars*, Arch. Math. Naturvid., vol. i, p. 81, fig.

Cawsand B., few specs. Apr. June, and Sept.; Jennycliff B., few specs., June and Oct.; Yealm Est., several specs. among decaying *Zostera*, Oct.; 2½ m. S. of the Breakwater Fort, single spec. at surface, Feb.; 1899 (W.I.B.).

SIRIELLA JALTENSIS, Czerniavsky: *G. O. Sars*, Arch. Math. Naturvid., vol. i, p. 89, fig. (as *S. crassipes*).

At the surface 1 m. S. of the Breakwater Fort, Sept. 1892; Drake's I., abundant among weeds June 1893 (W.G.): Rum B., single spec. Feb. 1901 (R.A.T.): Jennycliff B. (F.W.G. & W.I.B.).

Breeding: June (W.G., R.A.T.).

Gastrosaccinæ.

GASTROSACCUS SANCTUS (v. Beneden): *G. O. Sars*, Arch. Math. Naturvid., vol. i, p. 56, fig.

Whitsand B., Aug. 1892 (W.G.): July 1898 (E.W.L.H.): Oct. 1899, abundant (W.I.B.): May 1903, abundant (S.P.): Cawsand B., immature spec. in Apr.: Yealm Est., single spec. among decaying *Zostera*, Oct.; 1899 (W.I.B.).

Breeding: July (E.W.L.H.): Aug. (W.G.): Oct. (W.I.B., R.A.T.). Hatching out: May (R.A.T.).

HAPLOSTYLUS NORMANI: *G. O. Sars*, Arch. Math. Naturvid., vol. i, p. 65, fig. (as *Gastrosaccus*).

At the surface about 1 m. S. of the Breakwater Fort, Sept. 1892 (W.G.): Mewstone '*Amphioxus*' Gd., Oct. 1899 (W.I.B.).

Breeding: Sept. (W.G.): Oct. (W.I.B.).

ANCHIALIS AGILIS: *G. O. Sars*, Arch. Math. Naturvid., vol. i, p. 70, fig.

Plymouth, 1889: 1890 (A.M.N.): Aug. 1898, 3 m. S. of Rame Hd. (E.W.L.H. & W.I.B.): 1899: Cawsand B., few specs. in Feb.; Mewstone '*Amphioxus*' Gd., several in Oct.; W. of Hand Deeps, 33 fms., sand, abundant in June: about 4 m. S. of the Breakwater, abundant in Mar.: etc. (W.I.B.): Whitsand B., single spec., May 1903 (S.P.).

Breeding: June (W.I.B., R.A.T.).

Heteromysinæ.

HETEROMYSIS FORMOSA, S. I. Smith: *A. M. Norman*, Ann. Mag. Nat. Hist., ser. 6, vol. x, p. 158, fig.

Millbay Ch.; Queen's Gd.; Cawsand B.; Yealm R.: off Stoke Pt.: a few at a time (W.G.): Jan. 1899, Millbay Ch.; Feb. 1900, Asia Sh. (W.I.B.).

Breeding: Oct.–Nov. (W.G.).

[**Schizopoda**—*contd.*]

Leptomysinæ.

ERYTHROPS ELEGANS (G. O. Sars): *G. O. Sars*, Carcinol. Bidr. Norges Fauna, Mysider, Pt. i, p. 33, fig. (as *E. pygmæa*).

3 m. S.W. of Rame Hd., Aug. 1898 (E.W.L.H. & W.I.B.): Rame-Eddystone Gds.: Mewstone '*Amphioxus*' Gds.: etc.: several specs. Mar., June, Oct. and Nov. 1899 (W.I.B.).

Breeding: June: Oct. (W.I.B.): Oct., late embryos only (W.G.).

MYSIDOPSIS ANGUSTA, G. O. Sars: *G. O. Sars*, Carcinol. Bidr. Norges Fauna, Mysider, Pt. ii, p. 27, fig.

Occasionally in 15–33 fms. (R.A.T.): W. of Hand Deeps, June; 4 m. S.S.W. of Rame Hd., and Mewstone '*Amphioxus*' Gd., Oct.: 1 m. W. of Stoke Pt., Nov.: 1899 (W.I.B.).

Breeding: June–Oct. (W.I.B., R.A.T.).

MYSIDOPSIS GIBBOSA, G. O. Sars: *G. O. Sars*, Carcinol. Bidr. Norges Fauna, Mysider, Pt. ii, p. 23, fig.

Cawsand B., several occasions 1893–4 (W.G.): Aug. 1898, few specs. 3 m. S.W. of Rame Hd. (E.W.L.H. & W.I.B.): 1899: single spec., Cawsand B. in Apr.: three specs. W. of Hand Deeps in June (W.I.B.): Apr. 1902, Jennycliff B. (F.W.G.).

Breeding: Apr. (W.I.B., R.A.T.): July (W.G.).

LEPTOMYSIS GRACILIS (G. O. Sars): *G. O. Sars*, Carcinol. Bidr. Norges Fauna, Mysider, Pt. iii, p. 31, fig.

Aug. 1896, 3 m. W. by S. of the Eddystone (W.I.B.): Aug. 1898, 3 m. S.W. of Rame Hd. (E.W.L.H. & W.I.B.): June 1899, fairly abundant W. of Hand Deeps (W.I.B.).

Breeding: June (W.I.B., R.A.T.).

LEPTOMYSIS LINGVURA (G. O. Sars): *G. O. Sars*, Carcinol. Bidr. Norges Fauna, Mysider, Pt. iii, p. 35, fig.

Cawsand B.: Rame Hd., on the shore among *Fucus*; Whitsand B.: 4 m. S.S.W. of Rame Hd.: W. of Hand Deeps, on sand: Yealm Est., among decaying *Zostera*; several specs., Feb.–Oct. 1899 (W.I.B.).

Breeding: Apr.: Oct. (W.I.B., R.A.T.).

LEPTOMYSIS MEDITERRANEA: *G. O. Sars*, Arch. Math. Naturvid., vol. i, p. 37, fig.

Cawsand B.: common June 1893 (W.G.): Aug. 1898 (E.W.L.H. & W.I.B.): several specs. Feb., Apr., May, June, Sept. Oct. 1899 (W.I.B.). Jennycliff B.: single specs. Oct. and Dec. 1899 (W.I.B.): Apr. 1902, single spec. (R.A.T.). Bovisand B.: Whitsand B.; Yealm Est., among decaying *Zostera*; Oct. 1899 (W.I.B.).

Breeding: Apr. (W.I.B., R.A.T.): June (W.G.): Oct.: Dec. (W.I.B., R.A.T.).

Mysinæ.

HEMIMYSIS LAMORNÆ (Couch): *G. O. Sars*, Carcinol. Bidr. Norges Fauna, Mysider, Pt. iii, p. 65, fig. (as *Mysis*).

Cawsand B.: July 1893 (W.G.): a doubtful spec. Apr. 1900 (W.I.B.). Drake's I., single spec. (R.A.T.).

MACROMYSIS FLEXUOSA (Müller) and M. NIGRA: *F. Keeble & Gamble*, Phil. Trans. Roy. Soc., ser. B., vol. cxcvi, pp. 332, etc., fig.

Together these two species include, but they do not respectively coincide with, the *Macromysis flexuosa* and *M. neglecta* of Sars and of Norman. Both are known to occur in the Plymouth area, but they have only been quite lately differentiated, and consequently their distribution has not yet been fully determined. The evidence at present available points to the conclusion that *M. flexuosa* is essentially an estuarine form, and *M. nigra* more strictly marine. This is in agreement with the experience of Gamble. The *Macromysis* which swarms about the shores of the Tamar at Saltash (especially in the summer months) appears to be exclusively *M. flexuosa*. In Plymouth Sound *M. nigra* is the predominant form: it occurs commonly in the shallows, especially in Cawsand Bay: but *M. flexuosa* has been found in small numbers also. Both species are known to occur in the R. Yealm. *M. nigra* has been found in Whitsand Bay once (W.I.B.).

MACROMYSIS INERMIS (Rathke): *G. O. Sars*, Carcinol. Bidr. Norges Fauna, Mysider, Pt. iii, p. 54, fig.

Plymouth, 1889 (A.M.N.): Sept. 1892 (W.G.): 1898: Cawsand B., Bigbury B. in July (W.I.B.): 1899: Cawsand B.: Jennycliff B.: Bovisand B.: Whitsand B.: Yealm Est. among decaying *Zostera* few specs., Feb.–Oct.: Apr. 1900 (W.I.B.).

Breeding: Apr.: Oct. (W.I.B.).

SCHISTOMYSIS ARENOSA: *G. O. Sars*, Arch. Math. Naturvid., vol. i, p. 16, fig. (as *Mysis*).

Cawsand B.: 1893 (W.G.): Feb. 1899, four specs.; Apr. 1900, single spec. (W.I.B.). Whitsand B.: 1892–3 (W.G.): 1896 (T.V.H.): Oct. 1899 (W.I.B.): May 1903, several specs. (S.P.). Bovisand B.: Yealm Est., on sand with decaying *Zostera*; Oct. 1899 (W.I.B.).

Breeding: June (W.G.): Oct. (W.I.B., R.A.T.).

SCHISTOMYSIS ORNATA (G. O. Sars): *G. O. Sars*, Carcinol. Bidr. Norges Fauna, Mysider, Pt. iii, p. 62, fig. (as *Mysis*).

R. Tamar, Saltash: Mar.: Dec.: 1899 (W.I.B.): Feb. 1901 (W.I.B. & R.A.T.). 3 m. S.W. of Rame Hd., few specs. Aug. 1898 (E.W.L.H. & W.I.B.): Rame-Eddystone Gds.: Mewstone Gds. etc.: several specs. Mar.–Nov. 1899 (W.I.B.).

Breeding: Feb.: Apr.: Oct. (W.I.B., R.A.T.).

SCHISTOMYSIS PARKERI: *A. M. Norman*, Ann. Mag. Nat. Hist., ser. 6, vol. x, p. 256, fig.

Whitsand B., 1896 (T.V.H.): Tregantle, 1897 (E.W.L.H.).

SCHISTOMYSIS SPIRITUS, Norman: *G. O. Sars*, Carcinol. Bidr. Norges Fauna, Mysider, Pt. iii, p. 58, fig. (as *Mysis*).

Whitsand B.: abundant July 1892 (W.G.): 1897 (E.W.L.H.): Aug. 1898, abundant (E.W.L.H. & W.I.B.): May 1903 (S.P.). Cawsand B., single specs. in Feb. and Apr. 1899 (W.I.B.). 3 m. S.W. of Rame Hd., Aug. 1898 (E.W.L.H. & W.I.B.).

Breeding: Apr. (W.I.B., R.A.T.): June; July; Aug., late stages only (W.G.). Large individuals almost disappeared by Aug., young ones numerous (W.G.).

NEOMYSIS VULGARIS (Thompson): *G. O. Sars*, Carcinol. Bidr. Norges Fauna, Mysider, Pt. iii, p. 80, fig. (as *Mysis*).

Laira, 1897 (E.W.L.H.): R. Lynher; tidal pool opposite Saltash; Summer 1898 (E.W.L.H. & W.I.B.): R. Tamar, just above Saltash Bridge, few specs. Mar. and Dec. 1899: Jennycliff B., single young spec. Sept. 1899 (W.I.B.): Saltash, Feb. 1901 (R.A.T.).

Breeding: Feb. (R.A.T.).

DASYMYSIS LONGICORNIS (Milne-Edwards): *G. O. Sars*, Arch. Math. Naturvid., vol. i, p. 22, fig. (as *Mysis*).

W. of Hand Deeps, June 1899; 4 m. S.S.W. of Rame Hd., Oct. 1899; several specs. (W.I.B.).

Breeding: June; Oct. (W.I.B.).

MACROPSIS SLABBERI (v. Beneden): *G. O. Sars*, Arch. Math. Naturvid., vol. i, p. 28, fig.

Saltash, very abundant Mar. and Dec. 1899: Cawsand B., single spec. Apr. 1900 (W.I.B.): Tregantle, single spec. Dec. 1897 (E.W.L.H.): Whitsand B., several specs. May 1903 (S.P.).

MACRURA.

Palæmonidæ.

LEANDER SERRATUS (Pennant): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 302, fig. (as *Palæmon*).

More or less common everywhere among weed (R.A.T., S.P.).

Breeding: Jan.–Feb. (W.G., R.A.T.): Mar.–Apr. (W.G., R.A.T., S.P.): May (W.G., R.A.T.): June (W.G.): Nov. (W.G., R.A.T.): Dec. (W.G.).

LEANDER SQUILLA (Linnæus): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 305, fig. (as *Palæmon*).

The Sound, not uncommon between tide-marks (R.A.T.).

Breeding: May (R.A.T.): July, and earlier (W.G.). Hatched out in Aug. (R.A.T.).

PALÆMONETES VARIANS (Leach): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 309, fig. (as *Palæmon*).

Common in brackish water; Saltram; Laira; etc. (R.A.T.): Erth, R. Lynher, common in pools on a salt-marsh (W.I.B.): tributaries of R. Plym, very common (W.F.R.W.).

Breeding: Apr. (R.A.T.): May–June (W.G., R.A.T.): July; Aug., late stages only (W.G.).

Pandalidæ.

PANDALUS MONTAGUI, Leach: *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 297, fig. (as *P. annulicornis*).

Occasionally abundant during short periods, at other times apparently quite absent (S.P.): Nov. 1887, large numbers in Batten B. (W.H.): Feb. 1896, single spec. Cawsand B. (T.V.H.): Aug. 1897; Sept. 1898 (E.W.L.H.): July–Aug. 1902: Aug. 1903 (S.P.).

Breeding: Jan. (W.G.): Feb. (W.G., T.V.H., R.A.T.): Nov. (W.G., R.A.T.): Dec. (W.G.).

PANDALUS BREVIROSTRIS, Rathke: *C. Heller*, Crust. südl. Europa, p. 247, fig.

Common in the Sound, especially on clean coarse gravel and clinker grounds, 5–10 fms.; common on '*Cellaria*' grounds, 15–20 fms. (R.A.T.).

Females in berry: Mar. (R.A.T., S.P.): Apr. (W.G., R.A.T.): May–July (R.A.T.). Zoæa stage: Mar.–June (R.G.).

Hippolytidæ.

HIPPOLYTE FASCIGERA, Gosse: *A. Wollebæk*, Rept. Norweg. Fish. & Mar. Invest., vol. i, No. 4, p. 27 (as *Virbius*).

Cawsand B. (R.A.T.).

Breeding: Apr. (R.A.T.).

HIPPOLYTE VARIANS, Leach: *C. Heller*, Crust. südl. Europa, p. 288, fig. (as *Virbius*).

More or less common everywhere among weed, L.W.–5 fms.; occasionally taken outside in 15–30 fms. (R.A.T.).

Breeding: Feb. (R.A.T.): Mar. (R.A.T., S.P.): Apr. (R.A.T.): May–July (W.G., R.A.T.): Aug.: Nov. (R.A.T.).

HIPPOLYTE VIRIDIS (Otto): *C. Heller*, Crust. südl. Europa, p. 286, fig. (as *Virbius*).

Yealm Est., not uncommon (R.A.T.).

Breeding: July (R.A.T.).

SPIRONTOCARIS CRANCHII (Leach): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 288, fig. (as *Hippolyte*).

Moderately common in the Sound, L.W.–25 fms., and on the outside grounds, 15–30 fms. (R.A.T.).

Breeding: Feb. (W.H.): Apr. (W.G., R.A.T.): May (W.G.): June: Aug. (R.A.T.). A female spawned in a Lab. tank in Apr. (R.A.T.).

Alpheidæ.

ALPHEUS RUBER, Milne-Edwards: *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 271, fig.

Single spec., Church Reef, Wembury B., under a stone (R.A.T.).

ATHANAS NITESCENS (Leach): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 281, fig.

Not uncommon in rock-pools and among corallines, *Fucus*, etc. (S.P.): generally gregarious, 3–4 specs. under one stone (R.A.T.): Rum B.: Mt. Edgcumbe: Wembury B. (R.A.T., S.P.): Tinside (R.G., R.A.T.): Cawsand B., occasionally between tide-marks: occasional specs. on the outside grounds, 15–30 fms. (R.A.T.).

Breeding: May (R.G.): July (S.P.): Aug. (R.A.T.).

Crangonidæ.

CRANGON ALLMANNI, Kinahan: *A. Wollebæk*, Rept. Norweg. Fish. & Mar. Invest., vol. i, No. 4, p. 21, fig.

Very rare, 15–30 fms. (R.A.T.): 3 m. S.S.W. of Rame Hd., common Aug. 1898 (W.I.B.)

CRANGON VULGARIS (Linnæus): *T. Bell*. Hist. Brit. Stalk-eyed Crust., p. 256, fig.

More or less abundant everywhere on sand, L.W.–10 fms. (R.A.T., S.P.).

Breeding: Jan.–Aug. (W.G., R.A.T.): Nov. (R.A.T.): Dec. (W.G.).

[**Macrura**—*contd.*]

EGEON FASCIATUS, Risso: *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 259, fig. (as *Crangon*).

Rum B.: Jennycliff B.: Cawsand B.: sand-patch N. of Drake's I.; not uncommon, L.W.–5 fms. (R.A.T.): West Entrance (J.T.C.).

Breeding: Mar.–Apr. (R.A.T.): May (W.G.). Hatching out: Apr. (R.A.T.). Zoæas: May: July–Sept. (R.G.).

EGEON SCULPTUS: *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 263, fig. (as *Crangon*).

Occasionally, 15–30 fms. (R.A.T.).

Breeding: June (W.G.): Aug. (R.A.T.).

PONTOPHILUS SPINOSUS, Leach: *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 261, fig. (as *Crangon*).

Mewstone Gds.: 1 m. W. of Stoke Pt.: not uncommon on coarse sand and medium gravel (R.A.T.): Rame-Eddystone Gds. (E.W.L.H.).

Females in berry: Jan.: Mar.–Apr. (R.A.T.): Dec. (E.W.L.H.). Hatching out: Apr. (R.A.T.). Zoæa stage: Apr.–May, (R.A.T., R.G.).

CHERAPHILUS NANUS (Kröyer): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 268, fig. (as *Crangon bispinosus*).

At the surface in the Sound, Feb. 1887 (W.H.).

Females in berry: June–July (R.A.T.). Zoæa stage: June; Aug.–Sept. (R.G.).

CHERAPHILUS TRISPINOSUS (Hailstone): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 265, fig. (as *Crangon*).

The Sound, occasionally: Yealm Est., occasionally: Whitsand B., common (R.A.T.): Cawsand B. (W.I.B.).

Females in berry: Apr. (T.V.H.): May–June (R.A.T.): July (W.G.): Aug. (J.T.C.). Hatching: May (R.A.T.). Zoæa stage: Apr.–May: Sept. (R.G.).

Nikidæ.

NIKA EDULIS, Risso: *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 275, fig.

The Sound, occasionally, but rare (W.G.): Cawsand B., sometimes moderately common; occasionally outside in 20–30 fms. (R.A.T.): Jennycliff B. (A.J.S.).

Females in berry: Feb. (S.P., A.J.S.): May (W.G.): July (R.A.T.). Hatching: Apr. (R.A.T.). Zoæa stage: Apr.–June: Aug.–Sept. (R.G.). Late stages: Sept. (R.G.).

Nephropsidæ.

HOMARUS VULGARIS,* Milne-Edwards: *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 242, fig.

Common among rocks, occasionally between tide-marks: Rum B.: Wembury B.: etc. (R.A.T.): occasionally on sand; Eddystone Gds. (E.J.A.).

Females in berry: May–June (R.A.T.): July (W.G., R.A.T.): Aug. (W.G.): Sept.–Dec. (R.A.T.). Hatching: May–June (W.G.): July (R.A.T.). Larvæ, newly hatched and first moult, very abundant at the surface, July 1897 (W.I.B.): larvæ at the surface, Aug. 1897 (E.W.L.H.).

* If the "law of priority" is to be rigidly followed, this species must be termed *Astacus gammarus* (Linn.).

Scyllaridæ.

ARCTUS URSUS, Dana: *C. Heller*, Crust. südl. Europa, p. 195 (as *Scyllarus arctus*).

Millbay Dock, single spec., Apr. 1892 (R.A.T.): off the Breakwater Lt., single spec. in a crab-pot, Aug. 1897 (J.T.C.): 5 m. S. of the Eddystone, single spec. Jan. 1900 (R.A.T.).

Breeding: Mar. (S.P.).

Palinuridæ.

PALINURUS VULGARIS, Latreille: *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 213, fig.

Common among rocks; the Sound; etc. (R.A.T.).

Females in berry: Apr.–May (R.A.T.): Dec. (W.H.) Hatching: July (J.T.C.). Phyllosoma stage: Mar. (R.G.).

Galatheidæ.

GALATHEA DISPERSA, Spence Bate: *J. Bonnier*, Bull. Sci. France Belg., ser. 3, vol. i, p. 154, fig.

Abundant everywhere, 10–30 fms. (S.P.): Queen's Gd., common; Duke Rk., common: Cawsand B., occasionally (R.A.T.): Millbay Pit (W.I.B., R.A.T.): Rame-Eddystone Gds.: Mewstone Gds.: etc. (W.I.B., R.A.T., S.P.): Eddystone Gds., on all the grounds and in almost every haul (E.J.A.).

Breeding: Mar. (W.G., R.A.T.): May (S.P.).

GALATHEA INTERMEDIA, Lilljeborg: *J. Bonnier*, Bull. Sci. France Belg., ser. 3, vol. i, p. 130, fig.

Asia Sh.: Millbay Ch.; 3 m. S.S.W. Breakwater Lt.; 5 m. S.W. Penlee; 1 m. S.S.W. Yealm Hd. (W.I.B.): Queen's Gd.: Mewstone Gds.; Rame-Eddystone Gds. (R.A.T. & W.I.B.).

Breeding: Mar. (W.G., R.A.T.).

GALATHEA SQUAMIFERA, Leach: *J. Bonnier*, Bull. Sci. France Belg., ser. 3, vol. i, p. 143, fig.

Abundant under stones on all rocky shores, L.W.–3 fms. (S.P.): Millbay Ch.: Queen's Gd.: Yealm R.: occasionally (R.A.T.).

Breeding: Jan.–May (R.A.T.).

GALATHEA STRIGOSA (Linnaeus): *J. Bonnier*, Bull. Sci. France Belg., ser. 3, vol. i, p. 160, fig.

The Breakwater, occasionally; Mt. Edgcumbe (R.A.T., S.P.): Drake's I. (T.V.H.): off Batten Breakwater[1]: off Yealm Hd., 18 fms.[1] (J.T.C.).

Callianassidæ.

UPOGEBIA STELLATA (Montagu): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 223, fig. (as *Gebia*).

Occasional specs. between tide-marks in the Yealm and under Mt. Edgcumbe, also in dredgings from Queen's Gd., and a single spec. 5 m. W. ¼ S. of Rame Hd. (R.A.T.).

Breeding: Aug. (R.A.T.).

Thaumastochelidæ.

CALOCARIS MACANDREÆ: *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 233, fig.

Zoœa stage: Aug.–Sept. (R.G.).

[**Macrura**—*contd.*]

Paguridæ.

EUPAGURUS BERNHARDUS (Linnæus): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 171, fig. (as *Pagurus*).

Generally distributed on sand, gravel and stones, 3–30 fms. (R.A.T., S.P.).

The shell inhabited by this species usually affords lodgment for one or more specs. of *Adamsia polypus* [=*Sagartia parasitica*], or else it is invested with a colony of *Hydractinia echinata*; also its apical whorls are occupied by the Polychæte *Nereis fucata* (R.A.T., S.P.).

Females in berry: Feb. (R.A.T.): Apr. (W.G., R.A.T.). Zoæa stage: Mar. (R.G.).

EUPAGURUS CUANENSIS (Thompson): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 178, fig. (as *Pagurus*).

Mewstone Gds., not uncommon, generally with *Suberites*; Rame-Eddystone Gds., occasionally (R.A.T.): Eddystone Gds., never in large numbers, and confined to the gravel grounds in the neighbourhood of the Eddystone (E.J.A.): Yealm R., occasionally (R.A.T.).

Females in berry: Mar.–Apr. (R.A.T.).

EUPAGURUS PRIDEAUXI (Leach): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 175, fig. (as *Pagurus*).

Moderately common, 15–30 fms. (R.A.T.): Eddystone Gds., absent on the fine sand of the 'inner' and 'outer' trawling grounds (E.J.A.).

Almost always associated with *Adamsia palliata* (R.A.T., S.P.): a spec. trawled 2 m. S.W. of Penlee had an *Adamsia polypus* upon its shell as well as the normal *A. palliata* (E.W.L.H.): occasionally the shell is invested with a colony of *Hydractinia echinata* in place of the *Adamsia palliata*, and very rarely both are present upon the same shell (S.P.).

Females in berry: Jan. (R.A.T.): Mar.–July (W.G., R.A.T.): Sept. (S.P.). Hatching out: Mar.–Apr. (R.A.T.): June (S.P.): July–Aug. (R.A.T.). Zoæa stage: Mar.–Apr. (R.G.).

EUPAGURUS SCULPTIMANUS (Lucas): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 186, fig. (as *Pagurus Forbesi*).

Rame-Eddystone Gds., in *Suberites* (R.A.T.).

DIOGENES VARIANS, Costa: *C. Heller*, Crust. südl. Europa, p. 170, fig.

Whitsand B. (T.V.H.).

Breeding: July (W.G.).

ANAPAGURUS LÆVIS (Thompson): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 184, fig. (as *Pagurus*).

Common on the Mewstone Gds. with *Epizoanthus incrustatus*; the Sound, occasionally: moderately common on other grounds, 15–30 fms. (R.A.T.): Eddystone Gds. (E.J.A.).

Breeding: Feb. (R.A.T.): Apr. (W.G., R.A.T.): May (W.G.): July (R.A.T.): Aug. (S.P.).

BRACHYURA.

Porcellanidæ.

PORCELLANA LONGICORNIS (Linnæus): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 193, fig.

More or less abundant on all grounds, L.W.–30 fms. (S.P.).

Females in berry: Mar.–Apr. (W.G., R.A.T., S.P.): May (W.G., S.P.): June (W.G., R.A.T.): July (W.G., R.A.T., S.P.): Aug. (R.A.T.). Zoæa stage: Mar. (R.G.).

PORCELLANA PLATYCHELES (Pennant): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 190, fig.

Under stones on all rocky shores, L.W.–3 fms. (S.P.).

Females in berry: Mar. (R.A.T.): Apr. (W.G., R.A.T.): May (W.G.): June–July (W.G., S.P.): Aug. (R.A.T.). Zoæa stage: Aug. (R.G.).

Dromiidæ.

DROMIA VULGARIS, Milne-Edwards: *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 369, fig.

Not yet observed in the Plymouth district, although specs. are occasionally taken a little outside the district on the Cornish coast (S.P.).

Leucosiidæ.

EBALIA CRANCHII, Leach: *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 148, fig.

Cawsand B.[1]; Whitsand B.[1] (T.V.H.): Eddystone Gds., on sandy gravel, E. of Hand Deeps (E.J.A.).

EBALIA TUBEROSA (Pennant): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 141, fig. (as *E. Pennanti*).

Millbay Ch. (T.V.H.): not uncommon, 20–30 fms.: Mewstone Gds.; Rame-Eddystone Gds.: etc. (R.A.T.): Eddystone Gds., together with *E. tumefacta* (E.J.A.).

Females in berry: May–June (R.A.T.).

EBALIA TUMEFACTA (Montagu): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 145, fig. (as *E. Bryeri*).

Duke Rk., single spec. (T.V.H.): Eddystone Gds., abundant on coarse sandy gravel W. of the Eddystone, constantly present but less abundant on clean shell-gravel grounds (E.J.A.).

Inachidæ.

MACROPODIA EGYPTIA: *A. Milne-Edwards*, Hist. Nat. Crust., vol. i, p. 280.

Not uncommon on weedy ground (W.G.): very rare, 15–30 fms. (R.A.T.).

MACROPODIA LONGIROSTRIS (Fabricius): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 6, fig. (as *Stenorynchus tenuirostris*).

Queen's Gd., not uncommon; Cawsand B., occasionally; moderately common outside the Sound, 15–30 fms.; Mewstone Gds.; Rame-Eddystone Gds.; etc. (R.A.T.): Eddystone Gds., especially abundant where the prevailing Hydroid is *Sertularella Gayi* (E.J.A.): Yealm R., occasionally (R.A.T.).

Breeding: Feb.–Apr. (R.A.T.): May (W.G.): July–Aug. (R.A.T.).

[**Brachyura**—*contd.*]

MACROPODIA ROSTRATUS (Linnæus): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 2, fig. (as *Stenorynchus phalangium*).

Occasionally in dredgings from the Sound; Cawsand B., moderately common; Yealm R., not uncommon (R.A.T.).

Breeding: May (W.G.): Aug. (R.A.T.).

ACHÆUS CRANCHII, Leach: *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 10, fig.

Queen's Gd.; Duke Rk. (T.V.H.): Yealm R. (R.A.T.).

Breeding: Aug. (R.A.T.): Sept. (S.P.).

INACHUS DORSETTENSIS (Pennant): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 13, fig.

Queen's Gd., occasionally; common in 15–30 fms. outside the Sound; Mewstone Gds.; Rame-Eddystone Gds.; etc. (R.A.T.): Eddystone Gds. (E.J.A.): Yealm R., not uncommon (R.A.T.).

Females in berry: Jan.–Apr. (R.A.T.): June–Aug. (R.A.T., S.P.): Sept. (S.P.). Zoæa stage: Mar.: July (R.G.).

INACHUS DORYNCHUS, Leach: *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 16, fig.

Millbay Ch., occasionally; Duke Rk.: Yealm R., not uncommon (R.A.T.).

Female in berry: Mar. (R.A.T.).

Maiidæ.

MAIA SQUINADO (Herbst): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 39, fig.

Moderately common in the Sound, among rocks and on sand with *Zostera*, etc., 5 fms. (R.A.T.): common amongst the rocks outside Plymouth Sound (E.J.A.): Cawsand B., not uncommon (R.A.T., S.P.): Mewstone 'Echinoderm' Gd.: Rame-Eddystone Gds.: occasionally (R.A.T.): Eddystone Gds. (E.J.A.): Yealm R., moderately common (R.A.T.).

Breeding: Mar.–Apr. (R.A.T.): May (S.P.): June (R.A.T.).

PISA BIACULEATA (Montagu): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 27, fig. (as *P. Gibbsi*).

Mewstone Ledge, single spec.; Yealm R., single spec. (R.A.T.).

Breeding: May (R.A.T.).

HYAS ARANEUS (Linnæus): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 31, fig.

Yealm R. (E.J.A., E.W.L.H., R.A.T., T.V.H.): the Mewstone (T.V.H.).

HYAS COARCTATUS, Leach: *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 35, fig.

Occasionally in 15–30 fms.; Rame-Eddystone Gds.: etc. (R.A.T.): Eddystone Gds., occasionally on the fine sand grounds (E.J.A.): Cawsand B., fairly common (A.J.S.).

Breeding: Mar.–Apr.; July (R.A.T.): Aug. (W.G.): Dec. (R.A.T.).

Parthenopidæ.

EURYNOME ASPERA (Pennant): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 46, fig.

Fairly common, 10–30 fms., on gravel and sand (S.P.): Millbay Ch. and Pit, not uncommon; Asia Sh.; Queen's Gd. (R.A.T., S.P.): Duke Rk.; the Breakwater, between tide-marks[1]; Yealm R., occasionally in dredgings (R.A.T.): Rame-Eddystone Gds.: Mewstone '*Amphioxus*' Gd. (R.A.T., S.P.): Eddystone Gds. (E.J.A., S.P.): Stoke Pt. Gds. (S.P.).

Breeding: Jan.–Feb. (W.G., R.A.T.): Mar.–Apr. (W.G., R.A.T., S.P.) May–June (S.P.): July (R.A.T., S.P.): Sept. (S.P.).

Cancridæ.

CANCER PAGURUS, Linnæus: *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 59, fig.

Small specs. common among stones between tide-marks on all rocky shores: large specs. seldom seen above low-water mark (S.P.).

Breeding: Jan. (R.A.T.): Feb., onwards (W.G.): Mar.–July; Dec. (R.A.T.).

PIRIMELA DENTICULATA (Montagu): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 72, fig.

Drake's I., not uncommon on clean coarse shelly gravel (W.G., S.P.): Rum B. (R.A.T.): Yealm R. (T.V.H.): Stoke Pt. Gds. (S.P.).

Breeding: Feb.; Apr. (R.A.T.).

XANTHO HYDROPHILUS (Herbst): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 54, fig. (as *X. rivulosa*).

Between tide-marks on all rocky shores, not uncommon under stones, etc. (S.P.).

Breeding: Mar. (R.A.T.): May (W.G., S.P.): June (W.G.).

XANTHO INCISUS, Leach: *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 51, fig. (as *X. florida*).

Common between tide-marks on all rocky shores (S.P.).

Breeding: Apr. (R.A.T.): May (W.G.): June (W.G., R.A.T.).

Eriphidæ.

PILUMNUS HIRTELLUS (Linnæus): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 68, fig.

Not uncommon on all rocky shores under stones and in crevices, L.W.–5 fms. (S.P.): common in *Lepralia foliacea*; Mewstone Ledge; etc. (R.A.T., S.P.).

Breeding: Mar. (S.P.): Apr. (W.G., R.A.T.): May–June (W.G.): July (S.P.).

Portunidæ.

PORTUNUS ARCUATUS, Leach: *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 97, fig.

Queen's Gd. (R.A.T.): Cawsand B. (T.V.H., E.W.L.H.): Yealm R., not uncommon (R.A.T., T.V.H.): Laira (T.V.H.).

Breeding: Mar. (W.G.): Apr.–May (W.G., R.A.T.).

PORTUNUS CORRUGATUS (Pennant): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 94, fig.

Queen's Gd.; Millbay Ch.; not uncommon (R.A.T.): Drake's I., between tide-marks (T.V.H.[1]): Cawsand B. (E.W.L.H.): Bovisand B. (J.T.C.).

Breeding: June; Aug. (R.A.T.).

PORTUNUS DEPURATOR (Linnæus): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 101, fig.

Generally distributed, 3–30 fms., sometimes in large numbers (R.A.T., S.P.).

Breeding: Jan.–Feb. (R.A.T.): Mar.–Apr. (W.G., R.A.T., S.P.): May–July (W.G., R.A.T.): Aug. (W.G.): Sept.; Nov. (R.A.T.).

[**Brachyura**—*contd.*]

PORTUNUS HOLSATUS, Fabricius: *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 109, fig.

Queen's Gd.: Cawsand B.; Whitsand B. (E.W.L.H.).

Breeding: Mar. (W.G.).

PORTUNUS MARMOREUS, Leach: *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 105, fig.

Breeding: May (W.G.).

PORTUNUS PUBER (Linnæus): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 90, fig.

Common among stones on all rocky shores, between tide-marks–5 fms. (S.P.).

Females in berry: Feb.–May; July (R.A.T.). Zoæas hatching out: Mar.–May (R.A.T.).

PORTUNUS PUSILLUS, Leach: *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 112, fig.

Not uncommon in dredgings from the Sound and outside grounds, 15–30 fms.; Queen's Gd., occasionally; Drake's I., occasionally between tide-marks; Yealm R., not uncommon (R.A.T.): Eddystone Gds., on gravel, and occasionally on sand grounds adjoining the gravel (E.J.A.).

Females in berry: Feb.–May (R.A.T.). Hatching out: Mar.; June (R.A.T.).

BATHYNECTES LONGIPES (Risso): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 361, fig. (as *Portunus*).

Near the Eddystone, on fine sand (W.G.).

CARCINUS MÆNAS (Pennant): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 76, fig.

Common everywhere, tide-marks–3 fms. (R.A.T., S.P.): Millbay Ch., occasionally (R.A.T.).

Females in berry: Jan.–Apr. (W.G., R.A.T.): May-Aug. (W.G.): Nov. (R.A.T.): Dec. (W.G., R.A.T.). Zoæa stage: Feb.–Apr. (R.G.): July (R.A.T.).

PORTUMNUS BIGUTTATUS (Risso): *C. Heller*, Crust. südl. Europa, p. 94 (as *Platyonichus nasutus*).

Drake's I., occasional specs. burrowing in fine gravel (W.G., R.A.T.).

Females in berry: Aug. (R.A.T.). Megalops stage: Aug. (R.G.).

POLYBIUS HENSLOWI, Leach: *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 116, fig.

The ♂ is not uncommon at times on the shrimp-trawling grounds, particularly in Cawsand B., also swimming near the surface at the deeper water stations, but the ♀ has only twice been recorded at the Laboratory (S.P.).

Females in berry: Sept. (R.A.T., W.I.B.). Hatched: Sept. (R.A.T.).

Corystidæ.

ATELECYCLUS SEPTEMDENTATUS (Montagu): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 153, fig. (as *A. heterodon*).

Moderately common 15–30 fms. (R.A.T.): local but common where it occurs, generally on muddy gravel (S.P.): Rame-Eddystone Gds.; Mewstone Gds. (R.A.T., S.P.): Eddystone Gds., abundant on muddy gravel about 1 m. E. of the Eddystone, on gravelly sand about 3 m. W. of the Eddystone, and occasionally at other stations (E.J.A.).

Breeding: Apr.–July (R.A.T.).

CORYSTES CASSIVELAUNUS (Pennant): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 159, fig.

Generally distributed on clean fine sand, 15–30 fms.; Cawsand B., not uncommon (R.A.T., S.P.).

Females in berry: May–July; Nov. (R.A.T.). Zoæa stage: Feb.–May (R.G.). Megalops stage: Apr. (R.G.).

Pinnotheridæ.

PINNOTHERES PISUM (Linnæus): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 121, fig.

Mewstone '*Amphioxus*' Gd.[1], in the mantle-cavity of *Cardium norvegicum* and of *Glycimeris* (W.G. & R.A.T.).

Breeding: July–Aug. (R.A.T.).

Ocypodidæ.

GONOPLAX RHOMBOIDES (Linnæus): *T. Bell*, Hist. Brit. Stalk-eyed Crust., p. 130, fig. (as *G. angulata*).

Cawsand B., rare: Jennycliff B.[1] (S.P.): occasionally in 15–30 fms.: Rame-Eddystone Gds.; Mewstone Gds. (R.A.T., S.P.): Eddystone Gds. (E.J.A.,[1] S.P.).

Hatched out in June (R.A.T.).

PYCNOGONIDA.

Pycnogonidæ.

PYCNOGONUM LITTORALE (Strœm): *G. O. Sars*, Zool. Norske Nordhavs-Exped., Pycnog., p. 7, fig.

Yealm R.: Breakwater (T.V.H.).

Phoxichilidæ.

PHOXICHILUS SPINOSUS (Montagu): *P. P. C. Hoek*, Arch. Zool. expt., vol. ix, p. 518, fig.

Queen's Gd., occasionally (R.A.T.): Millbay Pit, several specs.; Yealm R. (T.V.H.).

Phoxichilidiidæ.

ANAPLODACTYLUS PETIOLATUS (Kröyer): *G. O. Sars*, Zool. Norske Nordhavs-Exped., Pycnog., p. 25, fig.

Asia Sh. (A.M.N., S.P.).

Pallenidæ.

PALLENE BREVIROSTRIS, Johnston: *P. P. C. Hoek*, Arch. Zool. expt., vol. ix, p. 511, fig.

Asia Sh. (S.P.).

Nymphonidæ.

NYMPHON GALLICUM: *P. P. C. Hoek*, Arch. Zool. expt., vol. ix, p. 501, fig.

Occasionally between tide-marks in the Sound and in 2–5 fms. in Cawsand B. (R.A.T.).

Males carrying ova in Feb. (R.A.T.).

NYMPHON GRACILE, Leach: *P. P. C. Hoek*, Arch. Zool. expt., vol. ix, p. 498, fig.

Duke Rk., rare: Yealm R. (T.V.H.).

A male was observed carrying ova in May (R.A.T.).

NYMPHON RUBRUM, Hodge: *G. O. Sars*, Zool. Norske Nordhavs-Exped., Pycnog., p. 58, fig.

Asia Sh. (A.M.N.[1]).

Ammotheidæ.

AMMOTHEA ECHINATA (Hodge): *P. P. C. Hoek*, Arch. Zool. expt., vol. ix, p. 508, fig.

Not uncommon, Millbay Ch. and Pit, Asia Sh., Queen's Gd., Yealm R., Rum B., Duke Rk., etc. (R.A.T.).

Breeding, Aug. (W.G.).

BRYOZOA.

Aeteidæ.

AETEA ANGUINA (Linnæus): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 4, fig.

Queen's Gd., occasionally on Algæ; common on rocky ground S. of the Breakwater (R.A.T.).

AETEA RECTA, Hincks: *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 6, fig.

Not uncommon on shells, etc., 20–35 fms.; Mewstone Gds.; Rame-Eddystone Gds. (R.A.T.).

Eucrateidæ.

EUCRATEA CHELATA (Linnæus): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 14, fig.

On a hulk near the Breakwater (R.A.T.): between Rame Hd. and the Eddystone, on *Bowerbankia* (E.J.A.).

Cellulariidæ.

SCRUPOCELLARIA REPTANS (Linnæus): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 52, fig.

Plymouth (S.F.H.).

SCRUPOCELLARIA SCRUPEA, Busk: *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 50, fig.

Mewstone, 25 fms. (S.F.H.).

SCRUPOCELLARIA SCRUPOSA (Linnæus): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 45, fig.

Common S. of the Breakwater, 20–35 fms.; Mewstone Gds.; Rame-Eddystone Gds.; Stoke Pt. Gds. (R.A.T., S.P.): Eddystone Gds., plentiful on the fine sand and gravels, generally attached to Polychæte tubes or to *Cellaria*, rare on the shell-gravel grounds (E.J.A.).

CABEREA BORYI (Audouin): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 61, fig.

Plymouth (S.F.H.).

Bicellariidæ.

BICELLARIA CILIATA (Linnæus): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 68, fig.

Moderately common, 5–35 fms., on *Cellaria* and on Hydroids (R.A.T.): Millbay Pit: Asia Sh. (R.A.T., S.P.): Queen's Gd., not uncommon (S.P.): Duke Rk. (E.J.A.): Mewstone Ledge, occasionally (R.A.T.): Rame-Eddystone Gds. (R.A.T., S.P.): Eddystone Gds., not uncommon on various Hydroids (E.J.A., S.P.).

With ovicells: March (R.A.T.).

BUGULA AVICULARIA (Linnæus): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 75, fig.

Eddystone Gds. (E.J.A, S.P.): Rame-Eddystone Gds. (S.P.).

BUGULA FLABELLATA, J. E. Gray: *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 80, fig.

Common in dredgings from the Sound (R.A.T., S.P.): Mewstone Ledge, moderately common (R.A.T.): Eddystone Gds., occasionally (E.J.A.).

Breeding: July, Sept. (R.A.T.).

BUGULA PLUMOSA (Pallas): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 84, fig.

Plymouth, common (S.F.H.).

BUGULA TURBINATA, Alder: *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 77, fig.

Moderately common in dredgings from the Sound (R.A.T., S.P.).

Flustridæ.

FLUSTRA PAPYRACEA, Ellis & Solander: *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 118, fig.

Millbay Ch., occasionally (S.P.): Queen's Gd. (R.M.P.).

FLUSTRA (? sp.) SECURIFRONS (Pallas): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 120, fig.

Millbay Ch., occasionally (R.A.T.).

Membraniporidæ.

MEMBRANIPORA AURITA, Hincks: *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 159, fig.

Mewstone, 20 fms. (T.H.T.[1]).

MEMBRANIPORA CATENULARIA (Jameson): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 134, fig.

Mewstone Gds. (R.A.T.): Eddystone Gds. (E.J.A.).

MEMBRANIPORA CURVIROSTRIS, Hincks: *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 153, fig.

Eddystone Gds. (R.M.P.).

MEMBRANIPORA DUMERILI (Audouin): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 156, fig.

Eddystone Gds. (E.J.A.).

MEMBRANIPORA FLEMINGI, Busk: *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 156, fig.

Eddystone Gds. (E.J.A.).

MEMBRANIPORA FLUSTROIDES, Hincks: *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 151, fig.

Mewstone, 25 fms. (S.F.H.).

[Bryozoa—*contd.*]

MEMBRANIPORA IMBELLIS, Hincks: *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 160, fig.
Plymouth, a doubtful fragment (S.F.H.).

MEMBRANIPORA LACROIXI, Audouin: *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 129, fig.
Plymouth (R.M.P.).

MEMBRANIPORA LINEATA (Linnæus): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 143, fig.
Cawsand B. (T.H.T.).

MEMBRANIPORA MEMBRANACEA (Linnæus): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 140, fig
Generally distributed, on *Laminaria*, etc. (R.A.T., S.P.).

MEMBRANIPORA PILOSA (Linnæus): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 137, fig.
Common everywhere on *Fucus*, etc., between tide-marks (R.A.T., S.P.).

MEMBRANIPORA ROSSELII (Audouin): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 166, fig.
Queen's Gd.; Cawsand B.; Mewstone, 20 fms. (S.F.H.).

Microporidæ.

MICROPORA CORIACEA (Esper): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 174, fig.
Mewstone, 25 fms. (S.F.H.).

Cellariidæ.

CELLARIA FISTULOSA (Linnæus): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 106, fig.
Common with *C. sinuosa*, especially on fine sand grounds, 15–30 fms. (E.J.A.).

CELLARIA SALICORNIOIDES, Lamouroux: *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 112, fig. (as *C. Johnsoni*).
Eddystone Gds. (E.J.A.).

CELLARIA SINUOSA (Hassall): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 109, fig.
Common with *C. fistulosa*, especially on fine sand grounds 15–30 fms. (E.J.A.).

Tubicellariidæ.

LAGENIPORA SOCIALIS, Hincks: *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 235, fig.
Mewstone, 25 fms. (S.F.H.).

Cribrilinidæ.

CRIBRILINA FIGULARIS (Johnston): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 196, fig.
Mewstone 'Echinoderm' Gd. (R.A.T.); Eddystone Gds. (E.J.A.).
With ovicells: Apr. (R.A.T.).

CRIBRILINA PUNCTATA (Hassall): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 190, fig.
Mewstone, 25 fms. (S.F.H.).

CRIBRILINA RADIATA (Moll): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 185, fig.

Mewstone Ledge, very common (S.F.H.): Rame-Eddystone Gds., on *Pecten maximus* (R.A.T.): Eddystone Gds. (E.J.A.).

MEMBRANIPORELLA NITIDA (Johnston): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 200, fig.

Common on *Lepralia foliacea* (S.F.H.): Mewstone, 20 fms. (T.H.T.).

Microporellidæ.

MICROPORELLA CILIATA (Pallas): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 206, fig.

Mewstone, 20 fms., var. *personata* (S.F.H.): Rame-Eddystone Gds., occasionally, on *Pecten maximus* (R.A.T.): Eddystone Gds. (E.J.A.).

MICROPORELLA IMPRESSA (Audouin): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 214, fig.

Common on red sea-weeds (S.F.H.).

MICROPORELLA MALUSII (Audouin): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 211, fig.

Mewstone Ledge, very common (S.F.H.): Eddystone Gds. (E.J.A.).

MICROPORELLA VIOLACEA (Johnston): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 216, fig.

Mewstone Ledge (S.F.H.): Eddystone Gds. (E.J.A.).

Escharidæ.

LEPRALIA FOLIACEA (Ellis & Solander): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 300, fig.

Millbay Pit, occasionally: Queen's Gd., not uncommon: Mewstone Ledge, abundant; more or less common on all the outside grounds, 10–30 fms. (S.P.).

LEPRALIA PALLASIANA (Moll): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 297, fig.

Yealm R., 1½ fms. (T.H.T.[1]): Yealm Sand-bank, between tide-marks (R.M.P.).

LEPRALIA PERTUSA (Esper): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 305, fig.

Yealm R.[1]: Eddystone Gds. (E.J.A.).

UMBONULA VERRUCOSA (Esper): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 317, fig.

Drake's I., on rocks, between tide-marks (R.A.T., E.J.A.): Wembury B. (E.J.A.).

CHORIZOPORA BRONGNIARTI (Audouin): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 224, fig.

Rame-Eddystone Gds., on *Pecten maximus* (R.A.T.): Eddystone Gds. (E.J.A.).

PORELLA CONCINNA (Busk): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 323, fig.

Mewstone, 20 fms. (S.F.H.[1]): Eddystone Gds. (E.J.A.).

ESCHAROIDES QUINCUNCIALIS (Norman): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 339, fig.

Plymouth, single spec., Apr. 1889 (S.F.H.).

[**Bryozoa**—*contd.*]

SMITTIA CHEILOSTOMA (Manzoni): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 349, fig.
Eddystone Gds. (E.J.A.).

SMITTIA LANDSBOROVII (Johnston): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 341, fig.
Mewstone Ledge (S.F.H.).

SMITTIA TRISPINOSA (Johnston): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 353, fig.
Mewstone Ledge, excessively common (S.F.H.): Eddystone Gds. (E.J.A.).

PHYLACTELLA COLLARIS (Norman): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 358, fig.
Eddystone Gds. (E.J.A.).

MUCRONELLA COCCINEA (Abildgaard): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 371, fig.
Plymouth, very common (S.F.H.): Eddystone Gds. (E.J.A.).

MUCRONELLA PEACHI (Johnston): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 360, fig.
Eddystone Gds. (E.J.A.).

MUCRONELLA VARIOLOSA (Johnston): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 366, fig.
Eddystone Gds. (E.J.A.).

MUCRONELLA VENTRICOSA (Hassall): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 363, fig.
Mewstone 'Echinoderm' Gd.; Rame-Eddystone Gds. (R.A.T.): Eddystone Gds. (E.J.A.).

PALMICELLARIA SKENEI (Ellis & Solander): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 379, fig.
Eddystone Gds. (E.J.A.).

RHYNCHOZOON BISPINOSUM (Johnston): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 385, fig. (as *Rhynchopora*).
Eddystone Gds. (E.J.A.).

HIPPOTHOA DISTANS, Macgillivray: *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 293, fig. (as *H. flagellum*).
Mewstone, 25 fms. (S.F.H.).

HIPPOTHOA DIVARICATA, Lamouroux: *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 288, fig.
Queen's Gds., 4 fms. (T.H.T.[1]): Mewstone 'Echinoderm' Gd.; Rame-Eddystone Gds., on *Pecten maximus* (R.A.T.): Eddystone Gds. (E.J.A.).

SCHIZOPORELLA ARMATA (Hincks): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 258, fig.
Mewstone, 25 fms. (S.F.H.[1]).

SCHIZOPORELLA AURICULATA (Hassall): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 260, fig.
Eddystone Gds. (E.J.A.).

SCHIZOPORELLA CECILII (Audouin): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 269, fig.
Eddystone, 20 fms. (S.F.H.).

SCHIZOPORELLA CRISTATA, Hincks: *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 254, fig.
Mewstone Ledge, two small colonies in dead *Pecten* shell (S.F.H.).

SCHIZOPORELLA HYALINA (Linnaeus): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 271, fig.
Millbay Ch. (T.H.T.): Plymouth, common; Yealm Sand-bank, abundant on Algæ (R.M.P.).

SCHIZOPORELLA JOHNSTONI, Quelch; *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 246, fig. (as *S. simplex*).
Mewstone, 25 fms. (S.F.H.).

SCHIZOPORELLA LINEARIS (Hassall): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 247, fig.
Plymouth, very common (S.F.H.): Millbay Ch. (R.A.T.): Eddystone Gds. (E.J.A.).

SCHIZOPORELLA SPINIFERA (Johnston): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 241, fig.
Plymouth (S.F.H.).

SCHIZOPORELLA UNICORNIS (Johnston): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 238, fig.
Mewstone, 25 fms. (S.F.H.).

SCHIZOTHECA FISSA (Busk): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 284, fig.
Eddystone Gd. (E.J.A.).

Celleporidæ.

CELLEPORA AVICULARIS, Hincks: *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 406, fig.
Mewstone, 20 fms. (T.H.T.): Eddystone Gds. (E.J.A.).

CELLEPORA COSTAZII, Audouin: *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 411, fig.
Cawsand B. (R.M.P.).

CELLEPORA DICHOTOMA, Hincks: *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 403, fig.
Eddystone, 20–30 fms. (S.F.H.).

CELLEPORA PUMICOSA, Linnæus: *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 399, fig.
Common at most outside stations (R.M.P.).

CELLEPORA RAMULOSA, Linnæus: *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 401, fig.
Eddystone Gds. (E.J.A., S.P.): Rame-Eddystone Gds. (R.A.T., S.P.): Stoke Pt. Gds. (S.P.).

Crisiidæ.

CRISIA ACULEATA, Hassall: *S. F. Harmer*, Quart. Journ. Micr. Sci., ser. 2, vol. xxxii., p. 132, fig.
Not uncommon, 4–5 fms., on red seaweeds, stones, and sponges (S.F.H., R.A.T.).
Ovicells: Apr., May (S.F.H., R.A.T.).

[**Bryozoa**—*contd.*]

CRISIA CORNUTA, (Linnæus): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 419, fig. [excl., var. *geniculata*, = *C. geniculata*].

Fairly common, mostly on red seaweeds (S.F.H.): Queen's Gd.; Mewstone Ledge; Rame-Eddystone Gds. (R.A.T.).

Ovicells: commonest Apr.–May (S.F.H.).

CRISIA DENTICULATA (Lamarck): *S. F. Harmer*, Quart. Journ. Micr. Sci., ser. 2, vol. xxxii., p. 129, fig.

Plymouth, seldom found (S.F.H.): Queen's Gd., not uncommon; Duke Rk., occasionally common (R.A.T.).

CRISIA EBURNEA (Linnæus): *S. F. Harmer*, Quart. Journ. Micr. Sci., ser. 2, vol. xxxii., p. 131, fig.

Eddystone Gds. (E.J.A., R.A.T.): common, almost always on red weeds or *Sertularia* (S.F.H.).

Ovicells: Feb.–May (S.F.H., R.A.T.); commonest, Mar.–Apr. (S.F.H.).

CRISIA GENICULATA: *H. Milne Edwards*, Ann. Sci. Nat., Zool., ser. 2, vol. ix, p. 197, fig.

Rare (R.A.T.).

CRISIA RAMOSA: *S. F. Harmer*, Quart. Journ. Micr. Sci., ser. 2, vol. xxxii., p. 134, fig.

Plymouth, 4–30 fms., the commonest species; generally on stones, but also on shells, red seaweeds, *Cellaria*, sponges, etc.; grows most luxuriantly in 4–6 fms. (S.F.H.): Queen's Gd., occasionally (R.A.T.): Eddystone Gds. (E.J.A.).

Breeding: Feb. (R.A.T.): Apr.–Aug., maximum in May–June (S.F.H.).

Diastoporidæ.

DIASTOPORA OBELIA, Johnston: *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 462, fig.

Eddystone Gds. (E.J.A.).

DIASTOPORA PATINA (Lamarck): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 458, fig.

Common on shells, etc., 15–35 fms. (R.A.T.): Mewstone Ledge, fairly common (S.F.H.): Rame-Eddystone Gds. (R.A.T.): Eddystone Gds. (E.J.A.).

DIASTOPORA SARNIENSIS, Norman: *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 463, fig.

Common on shells, stones, etc., 15–35 fms. (R.A.T.): Rame-Eddystone Gds. (R.A.T.): Eddystone Gds. (E.J.A.).

DIASTOPORA SUBORBICULARIS: *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 464, fig.

Mewstone Ledge (S.F.H.): Eddystone Gds. (E.J.A.).

Tubuliporidæ.

TUBULIPORA LILIACEA (Pallas): *S. F. Harmer*, Quart. Journ. Micr. Sci., ser. 2, vol. xli, p. 90, fig.

Duke Rk., very occasionally; not uncommon on shells, stones, Hydroids, etc., S. of the Breakwater, 15–30 fms.; Rame-Eddystone Gds (R.A.T.): Eddystone Gds. (E.J.A.).

TUBULIPORA PHALANGEA, Couch: *S. F. Harmer*, Quart. Journ. Micr. Sci., ser. 2, vol. xli, p. 94, fig.

Plymouth, common, 3–15 fms. (S.F.H.).

TUBULIPORA PLUMOSA, W. Thompson: *S. F. Harmer*, Quart. Journ. Micr. Sci., ser. 2, vol. xli, p. 105, fig.

Plymouth district, abundant on *Cystoseira granulata* and on *Saccorhiza bulbosa* (S.F.H.).

STOMATOPORA GRANULATA, Milne-Edwards: *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 425, fig.

Eddystone Gds. (E.J.A.).

STOMATOPORA JOHNSTONI, Heller: *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 430, fig.

Eddystone Gds. (E.J.A.).

STOMATOPORA MAJOR, Johnston: *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 427, fig.

Eddystone Gds. (E.J.A.).

Lichenoporidæ.

LICHENOPORA HISPIDA (Fleming): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 473, fig.

Common on all grounds 15–30 fms. (E.J.A.).

Alcyonidiidæ.

ALCYONIDIUM GELATINOSUM (Linnæus): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 491, fig.

In dredgings from the Sound, Mewstone Ledge, and S. of the Breakwater to 35 fms. (R.A.T., S.P.): Millbay Ch.: Asia Sh.: abundant (A.J.S., S.P.): Eddystone Gds. (E.J.A.).

ALCYONIDIUM HIRSUTUM (Fleming): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 493, fig.

Cawsand B. (T.H.T.[1]).

ALCYONIDIUM MYTILI, Dalyell: *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 498, fig.

Plymouth (S.F.H.).

ALCYONIDIUM PARASITICUM (Fleming): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 502, fig.

Plymouth, on *Sertularia cupressina* (S.F.H.).

Flustrellidæ.

FLUSTRELLA HISPIDA (Fabricius): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 506, fig.

Very abundant everywhere between tide-marks, on *Fucus*, etc. (R.M.P.).

Breeding: early Feb.–mid. July; spermatozoa more abundant Feb.–Mar.; ova, Mar.–May; larvæ, Apr.–July (R.M.P.).

Vesiculariidæ.

AMATHIA LENDIGERA (Linnæus): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 516, fig.

Penlee-Rame Gds., common on *Halidrys* (R.M.P.).

BOWERBANKIA CAUDATA (Hincks): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 521, fig.
The Cattewater (T.H.T.).

BOWERBANKIA IMBRICATA (Adams): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 519, fig.
Millbay Dock (T.H.T.).
Breeding: Aug. (A.J.S.).

BOWERBANKIA PUSTULOSA (Ellis & Solander): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 522, fig.
Plymouth, very common (S.F.H.): Duke Rk. (T.H.T.).

Cylindrœciidæ.

CYLINDRŒCIUM DILATATUM (Hincks): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 536, fig.
Eddystone Gds. (E.J.A.).

Hypophorellidæ.

HYPOPHORELLA EXPANSA, Ehlers: *J. Joyeux-Laffuie*, Arch. Zool. expt., ser. 2, vol. vi. p. 152, fig. (as *Delagia chætopteri*).
Not uncommon on the tubes of *Chætopterus variopedatus* (S.F.H.).

Triticellidæ.

TRITICELLA BOECKI: *G. O. Sars*, Forhandl. vid.-Selsk. Christiania, vol. 1873, p. 397, fig.
Rame-Eddystone Gds., on a spec. of *Gonoplax rhomboides* (R.A.T.[1]).

Pedicillinidæ.

PEDICILLINA CERNUA (Pallas): *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 565, fig.
Not uncommon, L.W.–35 fms.; Tinside: Asia Sh.; Drake's I.; Queen's Gd.; Duke Rk.; Wembury B.; Rame-Eddystone Gds., on Hydroids, *Cellaria*, Algæ, etc. (R.A.T.): Millbay Dock (T.H.T.): Penlee-Rame Gds., on *Bowerbankia imbricata* (R.M.P.): Eddystone Gds. (E.J.A.).

PEDICILLINA GRACILIS, Sars: *T. Hincks*, Hist. Brit. Mar. Polyzoa, p. 570, fig.
From 5 m. S. of the Mewstone, 27 fms. (T.H.T.).

AMPHINEURA.

Neomeniidæ.

RHOPALOMENIA AGLAOPHENIÆ (Kovalevsky & Marion): *G. Pruvot*, Arch. Zool. expt., ser. 2, vol. ix, p. 720, fig. (as *Proneomenia*).
Common on *Aglaophenia myriophyllum*, generally coiled around the base of the stem of the Hydroid (S.P., E.J.A.).

MYZOMENIA BANYULENSIS: *G. Pruvot*, Arch. Zool. expt., ser. 2, vol. ix, p. 715, fig. (as *Dondersia*).
Occasionally on *Lafoea dumosa* (R.A.T., S.P., E.J.A.).
Gonads ripe: Aug. (R.A.T.).

Ischnochitonidæ.

CALLOCHITON LÆVIS (Montagu): *J. G. Jeffreys*, Brit. Conch., vol. iii, p. 226, fig. (as *Chiton*).

The Sound, under stones at low tide (S.P.).

CRASPEDOCHILUS CINEREUS (Linnæus): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. ii. p. 402, fig. (as *Chiton*).

The Sound, under stones at low tide; Yealm R., abundant on the sand-bank (S.P.).

CRASPEDOCHILUS ONYX (Spengler): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. ii, p. 407, fig. (as *Chiton asellus*).

Abundant, 15–30 fms., especially on muddy gravel (S.P.).

Acanthochitidæ.

ACANTHOCHITES FASCICULARIS (Linnæus): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. ii, p. 393, fig. (as *Chiton*).

Rocks under the Hoe, moderately common among barnacles: Millbay Ch.: Mewstone Ledge[1]: Yealm R., occasionally in dredgings (R.A.T.): Blackstone Rks., Wembury B., abundant; Yealm Sand-bank (S.P.).

PROSOBRANCHIATA.

Patellidæ.

PATELLA VULGATA, Linnæus: *J. G. Jeffreys*, Brit. Conch., vol. iii, p. 236, fig.

More or less abundant everywhere on rocks between tide-marks (R.A.T.): Mt. Edgcumbe, very large specs. (A.J.S.).

HELCION PELLUCIDA (Linnæus): *J. G. Jeffreys*, Brit. Conch., vol. iii, p. 242, fig.

On stems of *Laminaria*, common everywhere, especially Reny Rks. and the Bridge (R.A.T.).

Acmæidæ.

ACMÆA VIRGINEA (Müller): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. ii, p. 437.

More or less common under stones on all rocky shores, L.W.–5 fms., gregarious: Drake's I., large specs. (S.P.): moderately common in dredgings from the Yealm (R.A.T.).

Fissurellidæ.

EMARGINULA CONICA, Schumacher: *E. Forbes & Hanley*, Hist. Brit. Moll., vol. ii, p. 479 (as *E. rosea*).

Not uncommon, 10–30 fms. (S.P.).

EMARGINULA FISSURA (Linnæus): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. ii, p. 477, fig. (as *E. reticulata* and *E. Mülleri*).

Millbay Ch.; Queen's Gd. (S.P.): the Breakwater, between tide-marks (R.A.T.): Mewstone Ledge; occasional specs. on the outside grounds in 15–30 fms. (R.A.T., S.P.): Eddystone Gds., constantly present, but seldom numerous, on all grounds where shells are plentiful (E.J.A.).

[**Prosobranchiata**—*contd.*]

FISSURELLA GRÆCA (Linnaeus): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. ii, p. 469, fig. (as *F. reticulata*).

Occasional specs. on all rocky stations, L.W.–10 fms. (S.P.): occasionally between tide-marks; the Breakwater: Reny Rks.; the Mewstone; Church Reef, Wembury B.; not uncommon in dredgings from the Yealm R. (R.A.T.).

Trochidæ.

EUMARGARITA GRŒNLANDICA (Chemnitz): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. ii, p. 528, fig. (as *Trochus undulatus*).

A single specimen, possibly merely an empty shell, 3 m. S.W. Penlee Pt. (R.A.T.).

GIBBULA CINERARIA (Linnaeus): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. ii, p. 516, fig. (as *Trochus*).

Abundant nearly everywhere, between tide-marks–10 fms., under stones, on *Zostera*, *Fucus*, etc. (S.P.).

GIBBULA MAGUS (Linnaeus): *J. G. Jeffreys*, Brit. Conch., vol. iii, p. 305, fig. (as *Trochus*).

Uncommon at Plymouth, occurring only on coarse shell-sand or gravel; Queen's Gd.; between the Knap and Panther Buoys, four very large specs. (S.P.): Millbay 'shell-gravel' Gd.; Mewstone '*Amphioxus*' Gd. (R.A.T.).

GIBBULA TUMIDA (Montagu): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. ii, p. 513, fig. (as *Trochus*).

Occasional specs. from the Rame-Eddystone, Eddystone, Stoke Pt., and other outside grounds (S.P.).

GIBBULA UMBILICATA (Montagu): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. ii, p. 519, fig. (as *Trochus*).

Common at most stations, but not so abundant as *G. cineraria*, and occurs at a rather higher level, H.W.–3 fms. (S.P.).

MONODONTA CRASSA (Montfort): *J. G. Jeffreys*, Brit. Conch., vol. iii, p. 317, fig. (as *Trochus lineatus*).

The distribution of this species at Plymouth appears to be a very limited one, but it is met with in some numbers upon restricted areas of the rocks, at and above high-water mark, at those stations where it occurs; N.E. Drake's I.; Blackstone Rks., Wembury B.; Yealm Sand-bank (S.P.).

CALLIOSTOMA GRANULATUM (Born): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. ii, p. 499, fig. (as *Trochus*).

Moderately common on sandy gravel, 20–30 fms. (S.P.): Mewstone 'Echinoderm' Gd., common (R.A.T.): Eddystone Gds., on gravel with sand or muddy sand (E.J.A.).

CALLIOSTOMA STRIATUM (Linnaeus): *E. Forbes & Hanley*, Hist. Brit. Moll., vol ii, p. 508, fig. (as *Trochus*).

Occasionally; Cawsand B.; Jennycliff B.; Yealm Est., common on *Zostera* (R.A.T.).

CALLIOSTOMA ZIZYPHINUS (Linnaeus): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. ii, p. 491, fig. (as *Trochus*).

Common under stones and in crevices on all rocky shores at low water; a dwarf var. is not uncommon in the deeper water of the outside grounds (S.P.): Yealm R., a characteristic var. is common on the sand-bank (R.A.T.).

Turbinidæ.

PHASIANELLA PULLUS (Linnæus): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. ii, p. 538, fig.

More or less common everywhere on Algæ and *Zostera*, L.W.–10 fms.; common among weed growing on ships'-bottoms, buoys, etc. (S.P.): Queen's Gd.: Jennycliff B.: Cawsand B.: etc. (R.A.T., S.P.).

Littorinidæ.

LACUNA DIVARICATA (Fabricius): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 62, fig. (as *L. cincta*).

Common on *Fucus*-covered rocks near low-water mark (S.P.): rocks below the Hoe, large specs. moderately common: smaller specs. common on the *Zostera* in Jennycliff B., Cawsand B., and Yealm Est.: 1 m. S. of the Mewstone, very occasionally (R.A.T.).

Breeding: Feb.–Apr. (R.A.T.).

LACUNA PALLIDULA (da Costa): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 56, fig.

Not uncommon on *Fucus*-covered rocks under the Hoe (R.A.T.).

Breeding: Feb. (R.A.T.).

LACUNA PARVA (da Costa): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 58, fig. (as *L. puteolus*).

Cawsand B. (R.A.T., S.P.).

LITTORINA LITTOREA (Linnæus): *J. G. Jeffreys*, Brit. Conch., vol. iii, p. 368, fig.

Not uncommon between tide-marks on most shores, but seldom in any quantity: this form occurs at a lower zone than *L. rudis* (S.P.): St. John's Lake, abundant: Yealm R., common (A.J.S.).

Breeding: Feb. (W.G.).

LITTORINA NERITOIDES (Linnæus): *J. G. Jeffreys*, Brit. Conch., vol. iii, p. 361, fig.

Abundant on rocks above high-water mark (S.P.).

LITTORINA OBTUSATA (Linnæus): *J. G. Jeffreys*, Brit. Conch., vol. iii, p. 356, fig.

Abundant everywhere on *Fucus*, *Zostera*, etc. (S.P.).

Breeding: Feb. (W.G.): Mar. (S.P.).

LITTORINA RUDIS (Maton): *J. G. Jeffreys*, Brit. Conch., vol. iii, p. 364, fig.

Very abundant on all rocky shores near high-water mark (S.P.).

Rissoiidæ.

RISSOIA PARVA (da Costa): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 98, fig.

Moderately common in the Sound between tide-marks: occasionally in dredgings from Millbay Ch., Asia Sh., etc. (R.A.T.).

ALVANIA CANCELLATA (da Costa): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 80, fig. (as *Rissoa crenulata*).

Dead shells only (R.A.T.).

ALVANIA RETICULATA (Montagu): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, pp. 82 and 84, fig. (as *Rissoa calathus* and *R. Beanii*).

Dead shells only (R.A.T.)

[**Prosobranchiata**—*contd.*]

MANZONIA COSTATA (J. Adams): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 92, fig. (as *Rissoa*).
Drake's I.; Millbay Pit; occasionally (R.A.T.).

ZIPPORA MEMBRANACEA (J. Adams): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 109, fig. (as *Rissoa labiosa*).
Common on *Zostera* (S.P.): Cawsand B., very common; Yealm Est., moderately common (R.A.T.).

ONOBA STRIATA (J. Adams): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 94, fig. (as *Rissoa*).
Common on all rocky shores, gregarious under stones, particularly where there is a certain amount of silt, L.W.–10 fms. (S.P.).

CERATIA PROXIMA, Alder: *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 127, fig. (as *Rissoa*).
Dead shells only (R.A.T.).

HYALA VITREA (Montagu): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 125, fig. (as *Rissoa*).
Dead shells only (R.A.T.).

CINGULA SEMISTRIATA (Montagu): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 117, fig. (as *Rissoa*).
Millbay Pit (R.A.T.).

CINGULA TRIFASCIATA, J. Adams: *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 122, fig. (as *Rissoa cingillus*).
Common between tide-marks on all rocky shores, gregarious under stones and in crevices, especially where there is a certain amount of silt; Yealm Sand-bank (S.P.).

GALEODINA CARINATA (da Costa): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 73, fig. (as *Rissoa striatula*).
Dead shells (R.A.T.).

Assimineidæ.

PALUDESTRINA STAGNALIS (Baster): *J. G. Jeffreys*, Brit. Conch., vol. iv, p. 52, fig. (as *Hydrobia ulvæ*).
Common in brackish water; the Hamoaze: Hooe Lake: etc. (R.A.T.).

Adeorbidæ.

ADEORBIS SUBCARINATUS (Montagu): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. ii, p. 541, fig.
Ram's Cliff Pt., common on rocks at low tide, Aug. 1887 (W.H.).

Skeneidæ.

SKENEA PLANORBIS (Fabricius): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 156, fig.
Common among the roots of seaweeds, and corallines, rocks under the Hoe; Drake's I.; etc. (R.A.T.).

Capulidæ.

CAPULUS HUNGARICUS (Linnæus): *J. G. Jeffreys*, Brit. Conch., vol. iii, p. 269, fig.
Occasionally on gravel grounds, 15–35 fms., generally attached to *Pecten opercularis* (S.P.): Mewstone Gds., occasionally on *P. opercularis* (R.A.T., S.P.): Eddystone Gds. (E.J.A., S.P.).
Breeding: Jan.–Mar. (W.G.).

[**Prosobranchiata**—*contd.*]

CALYPTRÆA CHINENSIS (Linnæus): *J. G. Jeffreys*, Brit. Conch., vol. iii, p. 273, fig.

The Sound, common in dredgings on stony ground, attached to stones, shells, etc.: Asia Sh.: Millbay Ch.; the Bridge: etc. (S.P.): Yealm R., always present in dredgings: Cawsand B.: etc. (R.A.T.): Yealm Sand-bank, between tide-marks (S.P.).

Breeding: July (R.A.T.): Aug.–Sept. (S.P.).

Cypræidæ.

TRIVIA EUROPÆA (Montagu): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 495, fig. (as *Cypræa*).

More or less abundant everywhere, particularly on rocky or stony ground, L.W.–30 fms.: the form occurring in deeper water is usually small and has a smooth, fawn-coloured mantle (S.P.).

OVULA (SIMNIA) PATULA (Pennant): *J. G. Jeffreys*, Brit. Conch., vol. iv, p. 407, fig.

Not uncommon on *Alcyonium digitatum*, 10–30 fms.; Mewstone Ledge; Stoke Pt. Gds.: etc. (S.P.): Mewstone Ledge, on *Eunicella*[1] (W.I.B.).

Spawn probably belonging to this species has been found in Apr., June–July (R.A.T.).

ERATO LÆVIS (Donovan): *J. G. Jeffreys*, Brit. Conch., vol. iv, p. 400, fig. (as *Marginella*).

Not uncommon on gravel grounds, 15–30 fms. (S.P.).

Naticidæ.

NATICA (LUNATIA) ALDERI, Forbes: *J. G. Jeffreys*, Brit. Conch., vol. iv, p. 224, fig.

Not uncommon on clean sand and gravel, L.W.–35 fms. (S.P.): Drake's I., sand-patch at N. end, occasionally; Cawsand B., not uncommon: Mewstone 'Echinoderm' Gd.: Rame-Eddystone Gds. (R.A.T., S.P.): Stoke Pt. Gds. (S.P.): Eddystone Gds. (E.J.A., S.P.): Yealm R., on the sand-bank opposite the Coastguard Station (R.A.T.).

Breeding: June (R.A.T.).

NATICA (LUNATIA) CATENA (da Costa): *J. G. Jeffreys*, Brit. Conch., vol. iv, p. 220, fig.

On sandy bottoms (W.G.): rare (S.P.).

Breeding: Apr. (W.G.).

Lamellariidæ.

LAMELLARIA PERSPICUA (Linnæus): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 355, fig.: p. 238, fig. (as *L. tentaculata*).

Not uncommon between tide-marks and in dredgings from the Sound, etc. (S.P.): occasionally on the outside grounds, 15–30 fms. (R.A.T., W.I.B., S.P.): Yealm R., not uncommon (R.A.T., S.P.).

Spawn: Jan.–May (W.G.).

VELUTINA LÆVIGATA (Pennant): *J. G. Jeffreys*, Brit. Conch., vol. iv, p. 240, fig.

Mewstone 'Echinoderm' Gd. (R.A.T.).

[**Prosobranchiata**—*contd.*]

Cerithiidæ.

BITTIUM RETICULATUM (da Costa): *J. G. Jeffreys*, Brit. Conch., vol. iv, p. 258, fig. (as *Cerithium*).

Not uncommon under stones on rocky shores, L.W.–10 fms. (S.P.).

TRIFORIS PERVERSA (Linnæus): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 195, fig. (as *Cerithium adversum*).

Occasional specimens not uncommon: Eddystone Gds.: Rame-Eddystone Gds.: Mewstone Gds.: Stoke Pt. Gds. (S.P.).

CERITHIOPSIS TUBERCULARIS (Montagu): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 365, fig.

Not uncommon in dredgings from the Sound, generally on sponges: occasionally on the outside grounds in 15–30 fms.; Yealm R., common on red sponge (R.A.T.).

Scalidæ.

SCALA CLATHRATULA (Adams): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 209, fig. (as *Scalaria*).

Dead shells only (R.A.T.).

SCALA CLATHRUS (Linnæus): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 206, fig. (as *Scalaria communis*).

Rum B.,[1] between tide-marks; Asia Sh.[1]; Yealm R.[1] (R.A.T.).

SCALA TURTONI (Turton): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 204, fig. (as *Scalaria*).

Stoke Pt. Gds.[1] (S.P.).

Pyramidellidæ.

BRACHYSTOMIA AMBIGUA (Maton & Rackett): *J. G. Jeffreys*, Brit. Conch., vol. iv, p. 124, fig. (as *Odostomia pallida*).

Common on the ears of *Pecten opercularis* (R.A.T., S.P.): on *P. maximus* (R.A.T.).

TURBONILLA LACTEA (Linnæus): *J. G. Jeffreys*, Brit. Conch., vol. iv, p. 167, fig. (as *Odostomia*).

Occasionally under stones, particularly where there is a certain amount of silt, L.W.–10 fms.: Drake's I.: Jennycliff B.: etc. (S.P.): Asia Sh.; Wembury B. (R.A.T., S.P.).

PYRGOSTELIS INTERRUPTA (Totten): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 245, fig. (as *Chemnitzia rufa*).

Rame-Eddystone Gds., occasionally (S.P.).

Eulimidæ.

EULIMA POLITA (Linnæus): *J. G. Jeffreys*, Brit. Conch., vol. iv, p. 201, fig.

Not uncommon on muddy gravel, 15–35 fms. (S.P.): Mewstone '*Amphioxus*' Gd., not uncommon: Mewstone Ledge, occasionally; Stoke Pt. Gds.; Rame-Eddystone Gds. (R.A.T., S.P.): Eddystone Gds. (E.J.A., S.P.).

EULIMA INCURVA (Renier) [=*E. distorta*, auctt., *nec* Deshayes]: *E. R. Sykes*, Proc. Malac. Soc., vol. v, p. 350, fig.

Common among sponges, etc.: Millbay Pit: Asia Sh.: Mallard Sh.: Yealm R.: etc. (S.P.).

EULIMA (LEIOSTRACA) BILINEATA (Alder): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 237, fig.

Occasionally: Rame-Eddystone Gds.; Eddystone Gds.; etc. (S.P.).

EULIMA (LEIOSTRACA) GLABRA (da Costa): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 235, fig. (as *E. subulata*).

Occasionally: Millbay Pit: Mewstone Gds.; etc. (S.P.).

Cæcidæ.

CÆCUM GLABRUM (Montagu): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 181, fig.

Dead shells only (R.A.T.).

CÆCUM IMPERFORATUM (G. Adams): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 178, fig. (as *C. trachea*).

Dead shells only (R.A.T.).

Turritellidæ.

TURRITELLA COMMUNIS, Lamarck: *J. G. Jeffreys*, Brit. Conch., vol. iv, p. 80, fig. (as *T. terebra*).

Common in places, on muddy and sandy gravel, 15–30 fms. (S.P.): Mewstone Gds. (R.A.T., S.P.): Rame-Eddystone Gds.: Stoke Pt. Gds. (S.P.): Eddystone Gds. (E.J.A., S.P.).

Aporrhaidæ.

APORRHAIS PES-PELECANI (Linnæus): *J. G. Jeffreys*, Brit. Conch., vol. iv, p. 250, fig.

Not uncommon, particularly on muddy gravel, 5–35 fms.; Jennycliff B., rare: Cawsand B., occasionally: Rame-Eddystone Gds.; Stoke Pt. Gds.; etc. (S.P.): Eddystone Gds. (E.J.A., S.P.).

Young shells in Aug. (A.J.S.).

Buccinidæ.

BUCCINUM UNDATUM (Linnæus): *J. G. Jeffreys*, Brit. Conch., vol. iv, p. 285, fig.

Mewstone 'Echinoderm' Gd., moderately common: Rame-Eddystone Gds.; Yealm R., moderately common in dredgings, and not uncommon on the sand-bank (R.A.T.): Eddystone Gds., numerous on the gravel and coarser sands near the Eddystone (E.J.A.): Stoke Pt. Gds. (S.P.).

Breeding: Jan.–Apr. (W.G.). Hatching: Feb.–Mar. (R.A.T.).

DONOVANIA MINIMA (Montagu): *J. G. Jeffreys*, Brit. Conch., vol. iv, p. 313 (as *Lachesis*).

Not uncommon in the Sound, under stones, L.W.–20 fms. (S.P.).

TRITONOFUSUS GRACILIS (Costa): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 416, fig. (as *Fusus islandicus*).

Dead shells only (R.A.T.).

Muricidæ.

OCINEBRA ERINACEA (Linnæus): *J. G. Jeffreys*, Brit. Conch., vol. iv, p. 306, fig. (as *Murex*).

Moderately common on rocks between tide-marks (R.A.T., S.P.): Asia Sh.: Millbay Ch.; Yealm R.; occasionally (R.A.T.).

Spawn: Apr. (R.A.T., S.P.): May (W.G.).

[**Prosobranchiata**—*contd.*]

TROPHON MURICATUS (Montagu): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 439.

Occasionally taken in 15–30 fms.: not uncommon on the Mewstone 'Echinoderm' Gd. (R.A.T.).

PURPURA LAPILLUS (Linnæus): *J. G. Jeffreys*, Brit. Conch., vol. iv, p. 276, fig.

Abundant on rocks between tide-marks everywhere (S.P.).

Spawn: Jan.–Apr. (W.G., R.A.T.): May (W.G.): July (S.P.): Nov. (W.G.).

Nassidæ.

NASSA RETICULATA (Linnæus): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 388, fig.

More or less common everywhere, L.W.–5 fms., especially on muddy sand; Cawsand B.; Jennycliff B.; Drake's I.; Yealm R.; etc. (S.P.).

Breeding: Feb. (W.G.): Mar. (W.G., R.A.T., S.P.): Apr. (W.G., R.A.T.): May (S.P.): June (R.A.T., S.P.): July (W.G.): Aug. (S.P.): Sept. (W.G.).

NASSA INCRASSATA (Ström): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 391, fig.

More or less common on all rocky shores, gregarious under stones and in crevices, particularly where there is a certain amount of silt, L.W.–10 fms. (S.P.).

Breeding: Feb.–Mar. (S.P.): Apr. (W.G., R.A.T., S.P.): June (W.G.): Aug. (W.G., S.P.): Sept. (W.G.).

Pleurotomidæ.

MANGILIA ATTENUATA (Montagu): *J. G. Jeffreys*, Brit. Conch., vol. iv, p. 377, fig. (as *Pleurotoma*).

Occasionally in muddy gravel, 20–30 fms. (S.P.).

MANGILIA NEBULA (Montagu): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 476, fig.

Queen's Gd. (R.A.T.[1]).

MANGILIA (BELLARDIELLA) GRACILIS, P. Fischer: *J. G. Jeffreys*, Brit. Conch., vol. iv, p. 363, fig. (as *Defrancia*).

Not uncommon, 20–35 fms., particularly on muddy gravel (S.P.).

CLATHURELLA LINEARIS (Montagu): *J. G. Jeffreys*, Brit. Conch., vol. iv, p. 368, fig. (as *Defrancia*).

Queen's Gd., not uncommon; Asia Sh.; occasionally on the outside grounds, 15–30 fms. (R.A.T., S.P.): the Breakwater, occasionally (R.A.T.).

CLATHURELLA PURPUREA (Montagu): *J. G. Jeffreys*, Brit. Conch., vol. iv, p. 373, fig. (as *Defrancia*).

Occasionally under stones and in rock crevices, L.W.–5 fms.; Drake's I.; Asia Sh.; Hollow Rock B., Jennycliff B.; Blackstone Rks., Wembury B.; etc. (S.P.).

Breeding: Nov. (S.P.).

CLATHURELLA RETICULATA (Renier): *J. G. Jeffreys*, Brit. Conch., vol. iv, p. 370, fig. (as *Defrancia*).

Occasionally, 15–30 fms. (S.P.).

TECTIBRANCHIATA.

Actæonidæ.

ACTÆON TORNATILIS (Linnaeus): *J. G. Jeffreys*, Brit. Conch., vol. iv, p. 433, fig.
Dead shells occasionally taken (R.A.T.).

Tornatinidæ.

TORNATINA MAMILLATA (Philippi): *J. G. Jeffreys*, Brit. Conch., vol. iv, p. 420, fig. (as *Utriculus*).
Dead shells occasionally taken (R.A.T.).

TORNATINA TRUNCATULA (Bruguière): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 510 (as *Cylichna truncata*).
Only dead shells (R.A.T.).

Scaphandridæ.

SCAPHANDER LIGNARIUS (Linnaeus): *J. G. Jeffreys*, Brit. Conch., vol. iv, p. 443, fig.
Common on the trawling grounds outside Sound (W.I.B., S.P.).

VOLVULELLA ACUMINATA (Bruguière): *J. G. Jeffreys*, Brit. Conch., vol. iv, p. 411, fig. (as *Cylichna*).
Dead shell only (R.A.T.).

BULLINELLA CYLINDRACEA (Pennant): *J. G. Jeffreys*, Brit. Conch., vol. iv, p. 415, fig. (as *Cylichna*).
Dead shells only taken (R.A.T.).

Bullidæ.

HAMINEA HYDATIS (Linnaeus): *J. G. Jeffreys*, Brit. Conch., vol. iv, p. 437, fig. (as *Bulla*).
Yealm Est. (W.G.): Jennycliff B. (R.A.T.[1]).

RONANIA UTRICULUS, Brocchi: *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 533, fig. (as *Bulla Cranchi*).
A single specimen, 4½ m. S.W. by W. Penlee Pt. (R.A.T.).

Philinidæ.

PHILINE APERTA (Linnaeus): *J. G. Jeffreys*, Brit. Conch., vol. iv, p. 457, fig.
Common on muddy sand bottom, at times very abundant; Cawsand B.; Jennycliff B.; Cattewater, etc. (W.I.B., S.P.): sandy bottom Whitsand B. (W.G.).
Breeding: Apr. (W.G.): May–July (W.G., R.A.T.).

PHILINE CATENA (Montagu): *J. G. Jeffreys*, Brit. Conch., vol. iv, p. 449, fig.
Mewstone Ledge (W.I.B.[1]): Millbay Ch. (R.A.T.).

PHILINE PUNCTATA (J. Adams): *J. G. Jeffreys*, Brit. Conch., vol. iv, p. 453, fig.
The Sound, single spec. among *Bowerbankia;* plentiful 20 fms., among shells covered with *Bugula*, 1891 (W.G.): Drake's I. (E.J.A.[1]): Asia Sh.[1]; Millbay Docks, occasionally on the piles (R.A.T.).

PHILINE SCABRA (Müller): *J. G. Jeffreys*, Brit. Conch., vol. iv, p. 447, fig.
Whitsand B., 4–12 fms. (W.H.[1]).

COLPODASPIS PUSILLA, M. Sars: *W. Garstang*, Proc. Zool. Soc., vol. 1894, p. 664, fig.

On rough ground, about 2 m. S. of the Mewstone, Feb. 1893 (W.G.).

Aplysiidæ.

APLYSIA PUNCTATA, Cuvier: *W. Garstang*, Journ. Mar. Biol. Assoc., ser. 2, vol. i, p. 401.

Queen's Gd., rare; Cattewater; Cawsand B.; Reny Rks.; Yealm R., moderately common in dredgings, very common at times on the shore, especially in May and June; Yealm Est., small specs. not uncommon on the *Zostera* (R.A.T.): E. end of Whitsand B., in quantity beneath seaweed on rocks (W.H.).

Breeding: Apr.–July (R.A.T.): June–Oct. (W.G.): maximum, May–June (A.J.S.).

Pleurobranchidæ.

PLEUROBRANCHUS PLUMULA (Montagu): *J. G. Jeffreys*, Brit. Conch., vol. v, p. 11, fig.

Jennycliff B. (A.J.S.): Wembury B., on the shore; S. of the Mewstone (W.G.).

OSCANIUS MEMBRANACEUS (Montagu): *J. G. Jeffreys*, Brit. Conch., vol. v, p. 10, fig. (as *Pleurobranchus*).

Not uncommon on the trawling grounds (W.I.B., S.P.): the Sound, unusually plentiful, especially in Millbay Ch. and the Hamoaze, 1893; young specs. common swimming at the surface in the Sound, Sept. 1892 (W.G.): Cattewater and Yealm R., very occasional (R.A.T.).

Runcinidæ.

RUNCINA CORONATA (Quatrefages): *J. G. Jeffreys*, Brit. Conch., vol. v, p. 15, fig. (as *R. Hancocki*).

Tide-pools below Hoe, very abundant Apr. 1889, small specs. in Sept. (W.G.): Rum B. (R.A.T.[1]): among corallines from rock-pools in the Sound; Yealm R. (W.I.B.).

NUDIBRANCHIATA.

Hermæidæ.

HERMÆA BIFIDA (Montagu): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 53, fig.

St. Peter's Pt., Hamoaze, single spec. on *Delesseria* (W.G.): West Entrance of Sound, in townet, single spec.; Cawsand B., single spec. (W.I.B.): off Penlee Pt., small spec. in townet (S.P.).

HERMÆA DENDRITICA (Alder & Hancock): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 53, fig.

Drake's I., two on *Bryopsis* (W.G.): inside Bovisand Pier, single spec. (R.A.T.): in Lab. tank on a stone from Bovisand B. (W.I.B.).

Breeding: June (W.G.).

STILIGER BELLULUS, d'Orbigny.

Cawsand B. (W.G.[1]).

[**Nudibranchiata**—*contd.*]

Elysiidæ.

ELYSIA VIRIDIS (Montagu): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iii, p. 614, fig.

Yealm Est., common (G.C.B., W.G.): Duke Rk.[1]: middle of the Sound[1]: tide-pools below the Hoe[1] (W.G.): Queen's Gd.: Yealm R.; uncommon (W.I.B.).

Breeding: Oct., and probably earlier (W.G.).

Limapontiidæ.

LIMAPONTIA CAPITATA (Müller): *J. Alder & Hancock*, Ann. Mag. Nat. Hist., ser. 2, vol. i, p. 402, fig. (as *L. nigra*).

Reny Rks. (W.H., W.G.): Cawsand B., abundant in tide-pools (W.G.): tide-pools below the Hoe, abundant Apr. 1890, disappeared Aug. and Sept. (W.G.): Drake's I., common on corallines (R.A.T., W.G.): Rum B., occasionally (R.A.T., S.P.).

ACTEONIA CORRUGATA: *J. Alder & Hancock*, Ann. Mag. Nat. Hist., ser. 2, vol. i, p. 403, fig.

Tide-pools below the Hoe (W.G.[1]): Jennycliff B. (S.P.): Bovisand B., single spec. among corallines (W.I.B.).

Æolidiidæ.

ÆOLIDIA PAPILLOSA (Linnæus): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 48, fig. (as *Eolis*).

Fairly common on all stony shores (W.I.B., S.P.): Yealm R., specs. common and particularly fine, among heaps of drift *Fucus*, etc. (A.J.S.).

Breeding: Feb. (R.A.T.): Mar.–May (W.G., R.A.T.): June (W.G.): July–Aug. (R.A.T.).

ÆOLIDELLA ALDERI (Cocks): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 48, fig. (as *Eolis*).

Drake's I.; Rocks below the Hoe[1] (E.J.A.): Yealm R. (W.I.B., W.G., R.A.T.): Reny Rks. (R.A.T.[1]): Wembury B., among corallines (W.I.B.).

Breeding: Aug. (W.G.).

ÆOLIDELLA GLAUCA (Alder & Hancock): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 48, fig. (as *Eolis*).

Millbay Ch., occasionally (R.A.T., W.I.B., A.J.S., S.P.): Drake's I., rarely (R.A.T., S.P.): Mallard Sh. (J.C.S.[1]): Mt. Edgcumbe (W.G.[1]): Queen's Gd. (W.I.B., R.A.T.): Asia Sh. (S.P.): Cattewater, large spec. probably from trawl refuse; 5–6 m. S.W. Breakwater Lt.: Mewstone Ledge (W.I.B.): several specs. under Laira Bridge (A.J.S.).

BERGHIA CÆRULESCENS (Guérin Méneville): *R. Bergh*, Verhandl. Zool.-bot. Ges. Wien, vol. xxxii, p. 20.

Outside the Breakwater (W.G.).

CUTHONA PEACHI (Alder & Hancock): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 50, fig. (as *Eolis*).

Two specs. with spawn on *Hydractinia*, 3–4 m. S. of the Mewstone (W.I.B.).

CAVOLINA AMŒNA (Alder & Hancock): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 51.

Occasionally on stony ground: Millbay Ch.: Asia Sh.: New Gds. (W.I.B.).

[**Nudibranchiata**—*contd.*]

CAVOLINA AURANTIA (Alder & Hancock): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 51, fig. (as *Eolis*).

On piles, Millbay Dock[1]; buoy near the Breakwater[1] (W.I.B. & R.A.T.): Millbay Ch., very rare, one on *Garveia nutans* (R.A.T., W.I.B.): Duke Rk. (W.I.B.).

Breeding: May (W.I.B., R.A.T.).

CAVOLINA OLIVACEA (Alder & Hancock): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 51, fig.

Occasionally on stony and rocky ground (W.I.B.): Queen's Gd., occasionally (W.I.B., R.A.T., S.P.): Asia Sh.: Drake's I.: Millbay Ch. and Pit (R.A.T.): Mewstone Gds. (W.G.[1]): Yealm R. (W.I.B.): Mewstone Ledge (W.I.B., S.P.).

CRATENA VIRIDIS (Forbes): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 51, fig. (as *Eolis*).

Millbay Ch., single spec. (A.J.S.[1]): Duke Rk. (W.G.[1]): Mewstone Gds. (W.G.): Rame-Eddystone '*Cellaria*' Gds. (W.I.B.): Eddystone Gds. (E.J.A.).

TERGIPES DESPECTUS (Johnston): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 52, fig.

Millbay Dock, on piles, common, Mar. 1901 (R.A.T.): Barn Pool (W.I.B.): buoy near Breakwater: Duke Rk. (R.A.T.): Mewstone Gds. (W.G.).

Breeding: Mar. (W.G., R.A.T.): Apr.–May (R.A.T.).

EMBLETONIA PULCHRA (Alder & Hancock): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 52, fig.

Asia Sh., single spec., apparently on *Antennularia* (W.I.B.).

AMPHORINA CÆRULEA (Montagu): *J. G. Jeffreys*, Brit. Conch., vol. v, p. 51 (as *Eolis*).

Asia Sh.; Queen's Gd., not uncommon (S.P.): Rame-Eddystone Gds.; Mewstone-Eddystone Gds., on '*Cellaria*' grounds (W.I.B.): Mewstone Ledge; off Tregantle (W.I.B. & R.A.T.).

GALVINA CINGULATA, Alder & Hancock: *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 51, fig. (as *Eolis*).

From among weed, etc., below the Laboratory (W.I.B.): Asia Sh. (W.I.B. & R.A.T.[1]): Millbay Dock, on *Plumularia* from the piles; Yealm Est., on *Zostera;* Yealm R., on *Antennularia* (W.I.B.): Mewstone Gds. (W.G.[1]).

Breeding: July (W.G.).

GALVINA EXIGUA (Alder & Hancock): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 52, fig. (as *Eolis*).

Duke Rk. (W.G.): Barn Pool, several specs. on *Obelia* (W.I.B.).

Breeding: Mar. (W.G.).

GALVINA PICTA, Alder & Hancock: *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., pp. 51, 52, fig. (as *Eolis picta* and *E. Farrani*).

Cawsand B., common on *Zostera;* Asia Sh.; Millbay Ch.: Queen's Gd.; Yealm Est., on *Zostera* (W.I.B.): buoy near West Hoe, among *Tubularia* (S.P.).

GALVINA TRICOLOR (Forbes): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 51, fig. (as *Eolis*).

Fairly abundant on the trawling grounds, 20–35 fms. (W.I.B., S.P.). Breeding: May: Nov. (W.G.).

CORYPHELLA GRACILIS (Alder & Hancock): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 49, fig.

Single spec., between Duke Rk. and Jennycliff: Cawsand B., single spec. (W.G.).

CORYPHELLA LANDSBURGI (Alder & Hancock): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 49, fig. (as *Eolis*).

Occasionally at most stations in the Sound and outside (W.I.B., S.P.): twice amongst Hydroids, Duke Rk. (W.G.).

CORYPHELLA LINEATA (Lovén): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 49, fig. (as *Eolis*).

Mewstone Ledge, rare (R.A.T.): on stone dredged in Firestone B.: Rame-Eddystone Gds. (W.I.B.).

CORYPHELLA RUFIBRANCHIALIS (Johnston): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 49, fig.

Fairly common on the 'Inner' trawling grounds (W.I.B., S.P.): Whitsand B. (W.G.).

CORYPHELLA SMARAGDINA [? = *C. gracilis*, var.]: *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 49, fig.

Millbay Ch.: Asia Sh.: May 1898 (W.I.B.).

FAVORINUS ALBUS (Alder & Hancock): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 49, fig.

Drake's I. (W.G., W.I.B.): Asia Sh., on *Antennularia*; Barn Pool, on *Fucus*; Batten B.: Duke Rk. (W.I.B.): Cawsand B. (W.G.): Yealm Est., on *Zostera*, fairly common in 1897 (W.I.B.).

Breeding: June (W.I.B.): Nov. (W.G.).

FACELINA CORONATA, Forbes & Goodsir: *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 49, fig. (as *Eolis*).

Millbay Dock, on piles: Millbay Ch.: Cawsand B. (W.I.B.): the Cattewater; Cobbler Buoy; Duke Rk.: off the Mewstone (W.G.): reef between Wembury Pt. and the Mewstone (E.J.A.).

Breeding: Apr.–May (W.G.).

FACELINA DRUMMONDI (Thompson): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 49, fig. (as *Eolis*).

Queen's Gd.: Cawsand B.: Yealm Est. (W.I.B.).

FACELINA PUNCTATA (Alder & Hancock): *J. Alder & Hancock*, Monogr. Brit. Nubibr. Moll., p. 49, fig. (as *Eolis*).

Millbay Ch.: Cawsand B.: rocky ground off Penlee (W.I.B.): Mewstone Gds. (W.G., W.I.B. & R.A.T.).

CALMA GLAUCOIDES (Alder & Hancock): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 50, fig. (as *Eolis*).

Queen's Gd. (W.I.B. & R.A.T.[1]): Blackstone Rks., Wembury B. (S.P.): West Entrance of Sound, amongst goby eggs, which is apparently its natural habitat (W.I.B.): Mewstone Gds., generally in *Buccinum* shells occupied by *Blennius ocellaris*, sometimes as many as 50 in

[**Nudibranchiata**—*contd.*]

one shell: resembles the eggs with which it is associated, the colour varying according to whether the eggs are those of the Goby or Butterfly Blenny (A.J.S.).

ANTIOPELLA CRISTATA (delle Chiaje): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 54, fig. (as *Antiopa*).

Rock-pool under the Hoe: Rum B. (W.G.): Queen's Gd. (S.P., W.I.B.): Millbay Docks, very large spec.: Eddystone Gds. (W.I.B.): Mewstone Gds. (W.G.): Yealm R. (R.A.T.).

Breeding: Aug. (R.A.T.).

ANTIOPELLA HYALINA, Alder & Hancock: *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 54, fig. (as *Antiopa*).

Queen's Gd., several small specs. (W.I.B.): Duke Rk. (T.V.H.[1]): Mewstone Ledge (W.I.B. & R.A.T.[1]): Mewstone 'Echinoderm' Gd.: 2–4 m. N.E. of Eddystone (W.I.B.).

HERO FORMOSA (Lovén): *J. G. Jeffreys*, Brit. Conch., vol. v, p. 63.

Not uncommon outside the Breakwater (W.G.): Eddystone Gds.: Mewstone Gds.: Stoke Pt. Gds.: 6 m. S. of the Mewstone, in considerable numbers, Jan.–June 1895: has not been seen since 1898 (E.J.A.).

Breeding: Apr. (W.G.).

Lomanotidæ.

LOMANOTUS MARMORATUS (Alder & Hancock): *W. I. Beaumont*, Proc. Irish Acad., ser. 3, vol. v, p. 846.

Fairly common on *Antennularia* in shallow water: Asia Sh.: New Gds.: Millbay: etc. (W.I.B., S.P.): about 1 m. S. of Mewstone, large spec. (W.I.B.): 3 m. S. of Mewstone* (W.G.).

LOMANOTUS PORTLANDICUS, Thompson: *W. I. Beaumont*, Proc. Irish Acad., ser. 3, vol. v, p. 842.

Very scarce: two specs., New Gds.: 4 m. S. of the Mewstone, large spec.: 3 m. S.S.W. of Rame Hd. (W.I.B.): Queen's Gd.,† young specimens on *Antennularia* (W.G.).

Spawned: Sept. (W.I.B.).

Dotonidæ.

DOTO CORONATA (Gmelin): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 48, fig.

Fairly plentiful on *Antennularia* at most stations (W.I.B., S.P.): always on calyptoblastic Hydroids (W.G.): Millbay Docks, on *Plumularia*; buoy near Breakwater: Drake's I., on the shore (W.I.B.): Yealm R. (W.I.B., R.A.T.).

Breeding: most of the year (W.I.B., S.P.).

DOTO FRAGILIS (Forbes): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 48, fig.

Common on *Antennularia*, etc., from the outside grounds, less frequent in the Sound (W.G., W.I.B., S.P.).

Breeding during the greater part of the year (W.I.B., S.P.).

* As *L. varians*. † As *L. Genei*.

DOTO PINNATIFIDA (Montagu): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 48, fig.

Generally distributed and common on *Antennularia* in the Sound and outside (W.I.B., S.P.).

Breeding most of the year (W.I.B., S.P.).

HANCOCKIA EUDACTYLOTA, Gosse: *F. W. Gamble*, Journ. Mar. Biol. Assoc., ser. 2, vol. ii, p. 193.

Between Drake's I. and Breakwater Lt. (F.W.G.[1]); Cawsand B.; Yealm Est.; on *Zostera* and on *Laminaria*, rare (W.I.B.).

Dendronotidæ.

DENDRONOTUS FRONDOSUS (Ascanius): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 47, fig. (as *D. arborescens*).

Local specimens are usually small (S.P.): occasionally in the Sound (G.C.B.): Queen's Gd. (S.P., W.I.B.): R. Tamar, near Saltash, a large spec. (W.I.B.): Mewstone Ledge occasionally (R.A.T.): Mewstone-Eddystone Gds. (W.G.): Eddystone Gds. (E.J.A.): Rame-Eddystone Gds. (W.G., S.P.).

Pleurophyllidiidæ.

PLEUROPHYLLIDIA LOVENI, Bergh: *E. Forbes & Hanley*, Hist. Brit. Moll., vol. iv, p. 290, fig. (as *Diphyllidia lineata*).

Single spec., 2 m. N. of Eddystone (J.T.C.).

Tritoniidæ.

TRITONIA HOMBERGI, Cuvier: *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 46, fig.

The habitat of this form appears to be below the 30 fm. line (W.I.B., S.P.): Mewstone Ledge (T.V.H.): common on the 'outer' trawling grounds (W.G.): Eddystone Gds. (E.J.A., W.G., S.P.): Mewstone Gds. (J.T.C.).

TRITONIA (CANDIELLA) LINEATA, Alder & Hancock: *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 47, fig.

Stoke Pt. Gds., single spec. (S.P.).

TRITONIA (CANDIELLA) PLEBEIA, Johnston: *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 47, fig.

Millbay Pit (A.J.S.): Mewstone Gds. (W.G.): Rame-Eddystone Gds. (W.I.B.): Eddystone Gds. (E.J.A., W.I.B.).

A pink variety is fairly common on *Eunicella*, especially from the Mewstone Ledge (W.I.B.).

Breeding: Aug.; Oct. (R.A.T.): Nov. (W.G.).

Dorididæ.

ARCHIDORIS FLAMMEA (Alder & Hancock): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 41, fig. (as *Doris*).

Duke Rk., single spec. on red sponge (W.G.): Queen's Gd. or Duke Rk., single spec. (W.I.B.).

ARCHIDORIS (gen.?) MACULATA, Garstang: *W. Garstang*, Journ. Mar. Biol. Assoc., ser. 2, vol. iv, p. 167 (as *Doris*).

Queen's Gd. (W.G., S.P.): Mewstone Ledge (T.V.H.): Eddystone Gds. (E.J.A., W.I.B.).

[**Nudibranchiata**—*contd.*]

Archidoris tuberculata (Cuvier): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 41, fig. (as *Doris*).

Not uncommon on most rocky shores and in dredgings from the Sound (W.G., W.I.B., S.P.): Yealm R.: Rame-Eddystone Gds.: Eddystone Gds. (W.I.B.).

Breeding: Jan.–June (W.G.).

Rostanga coccinea (Forbes): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 42, fig. (as *Doris*).

Occasionally on the shore and in dredgings from the Sound on stony ground (W.I.B., S.P.): Drake's I. (W.G., G.C.B.): Yealm R.; Downderry, on the shore (W.I.B.)

Jorunna Johnstoni (Alder & Hancock): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 42, fig. (as *Doris*).

Occasionally on rocky and stony shores, and in dredgings from the Sound (W.G., W.I.B., S.P.): Reny Rks.; Yealm Est., south shore (W.I.B.).

Platydoris (gen.?) testudinaria (Risso): *J. G. Jeffreys*, Brit. Conch., vol. v, p. 85 (as *Doris*).

Drake's I. (W.G., T.V.H.): Barn Pool (W.H., W.G.): Garden Battery (E.J.A.): Mt. Edgcumbe; Millbay Ch.; Queen's Gd., very occasionally (R.A.T.): Duke Rk. (W.G.): Yealm R. (R.A.T.): Rame-Eddystone Gds. (W.I.B.).

Polyceridæ.

Ægires punctilucens (d'Orbigny): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 44, fig. (as *Ægirus*).

Millbay Pit and Ch., very occasionally: Drake's I., single spec. among coralline (R.A.T.): Queen's Gd. (T.V.H.): Duke Rk. (W.G., T.V.H.): Yealm R. (R.A.T.): Wembury B., few small specs. among corallines (T.V.H.): Eddystone Gds. (E.J.A.).

Triopa clavigera (Müller): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 44, fig.

Millbay Pit, single spec. (W.I.B., R.A.T.): Mewstone Ledge, occasionally (R.A.T.): Mewstone Gds. (W.G., E.J.A.): Stoke Pt. Gds.; Eddystone Gds. (E.J.A.).

Thecacera pennigera (Montagu): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 44, fig.

Off Rame Hd., 20 fms., single spec. (W.G.): Queen's Gd. (S.P.).

Palio Lessoni (d'Orbigny): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 45, fig. (as *Polycera ocellata* and *P. Lessonii*).

Rum B. (W.I.B., R.A.T., S.P.): Duke Rk.; Mt. Edgcumbe; Drake's I. (W.G.): Queen's Gd. (T.V.H.): Asia Sh. (R.A.T.).

Polycera quadrilineata (Müller): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 45, fig.

In most years abundant on *Zostera* beds; Cawsand B.; Yealm Est.; etc. (W.I.B., S.P.): Drake's I., under stones (W.I.B.): Yealm R., occasionally (R.A.T., W.I.B.): Queen's Gd. (W.I.B.): Wembury B. (W.G.): Rame-Eddystone Gds.; Eddystone Gds. (W.I.B., S.P.): Bigbury B., large spec. close in, off Thurlestone (W.I.B.).

Breeding: July–Aug. (W.G.).

[Nudibranchiata—*contd.*]

ACANTHODORIS PILOSA (Müller): *J. Alder & Hancock,* Monogr. Brit. Nudibr. Moll., p. 43, fig. (as *Doris*).

Rocks under the Lab. (E.J.A.): Drake's I., occasionally (E.J.A., R.A.T.): Millbay Ch., occasionally; Asia Sh., occasionally; Queen's Gd., not uncommon; Rum B.; the Breakwater (R.A.T.): Duke Rk. (T.V.H., R.A.T.): Bovisand B. (T.V.H.): Wembury B. (W.G.): Yealm R., not uncommon (R.A.T.): 2 m. N. of the Eddystone (J.T.C.).

Breeding: May (A.J.S.).

LAMELLIDORIS ASPERA, Alder & Hancock: *J. Alder & Hancock,* Monogr. Brit. Nudibr. Moll., p. 42, fig. (as *Doris*).

Between the Mallard and Cobbler Buoys, single spec. (W.G.): Yealm Est., very rare (R.A.T.).

LAMELLIDORIS BILAMELLATA (Linnaeus): *J. Alder & Hancock,* Monogr. Brit. Nudibr. Moll., p. 43, fig. (as *Doris*).

Common; Batten B.; Jennycliff B.; Duke Rk. (W.G.): Millbay Ch.; the Breakwater; Yealm R. (W.I.B., R.A.T.): 4 m. N.E. of the Eddystone (T.V.H.[1]).

Breeding: Mar.–Apr. (R.A.T.).

LAMELLIDORIS DEPRESSA (Alder & Hancock): *J. Alder & Hancock,* Monogr. Brit. Nudibr. Moll., p. 43, fig.

Inner side of the Breakwater[1]; Mewstone Ledge[1] (W.I.B.).

LAMELLIDORIS OBLONGA, Alder & Hancock: *J. Alder & Hancock,* Monogr. Brit. Nudibr. Moll., p. 43, fig. (as *Doris*).

Extremely abundant at times on *Cellaria;* Mewstone Ledge; Rame-Eddystone Gds.; Eddystone Gds.; etc. (W.I.B.).

Breeding: Apr. (W.G.).

LAMELLIDORIS PUSILLA, Alder & Hancock: *J. Alder & Hancock,* Monogr. Brit. Nudibr. Moll., p. 43, fig.

Plymouth (W.G.).

Breeding: Feb. (W.G.).

LAMELLIDORIS SPARSA, Alder & Hancock: *J. Alder & Hancock,* Monogr. Brit. Nudibr. Moll., p. 43, fig. (as *Doris*).

Off Stoke Pt. (W.G.[1]).

GONIODORIS CASTANEA, Alder & Hancock: *J. Alder & Hancock,* Monogr. Brit. Nudibr. Moll., p. 44, fig.

Occasionally under stones on most rocky shores (S.P.): below the Lab. (E.J.A., W.G., S.P.): Millbay Ch. (W.I.B., R.A.T.): Drake's I. (E.J.A.): Cattewater: Rum B.; Bovisand Cove (W.G.): Cawsand B. (T.V.H.): Rame-Eddystone Gds.: Yealm R., occasionally (R.A.T.).

Breeding: Feb.: May: July: Sept. (W.G.).

GONIODORIS NODOSA (Montagu): *J. Alder & Hancock,* Monogr. Brit. Nubibr. Moll., p. 44, fig.

Plentiful on most shore stations and in dredgings from the Sound (W.I.B., S.P.).

Breeding: Jan.–Apr. (W.G., R.A.T.): May: Sept.: Dec. (W.G.). Adults, with spawn, in large numbers on the shores of the Sound from Feb. to May; small specimens abundant in dredgings in June, July, and Aug.; probably an annual migrating to the shores to spawn (W.G.).

IDALINA (IDALIELLA) ASPERSA (Alder & Hancock): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 46, fig. (as *Idalia*).

Yealm Est.[1]; off Penlee Pt.[1] (W.G.).

ANCULA CRISTATA (Alder): *J. Alder & Hancock*, Monogr. Brit. Nudibr. Moll., p. 45, fig.

Rocks below the Lab. (E.J.A.): near the Ladies' Bathing Pool (W.G., T.V.H.): on the piles at Millbay Dock (R.A.T.): Drake's I. (W.G., W.I.B., R.A.T.): Cawsand B. (W.G.): Batten B., amongst corallines, etc. (W.I.B.): Jennycliff B. (R.A.T.).

PULMONATA.

Otinidæ.

OTINA OTIS (Turton): *J. G. Jeffreys*, Brit. Conch., vol. v, p. 110, fig.

Common in empty barnacle shells near high-water mark on the rocks under West Hoe and below Laboratory (R.A.T.): very abundant near high-water mark in rock crevices, etc., gregarious within limited areas; Drake's I.; cave under Ram's Cliff Pt.; etc. (S.P.).

Auriculidæ.

LEUCONIA BIDENTATA (Montagu): *J. G. Jeffreys*, Brit. Conch., vol. v, p. 104, fig. (as *Melampus*).

Rocks under West Hoe, in empty barnacle shells (R.A.T.): common in crevices of rocks near high-water mark; Jennycliff B.: Drake's I.: etc. (S.P.).

SCAPHOPODA.

DENTALIUM ENTALIS, Linnæus: *J. G. Jeffreys*, Brit. Conch., vol. iii, p. 191, fig.

Not uncommon on the fine sand grounds, 15–30 fms. (R.A.T., S.P.): Eddystone Gds., on all fine sand grounds except the 'Outer' trawling ground, and occasionally on gravel (E.J.A.).

PELECYPODA.

Nuculidæ.

NUCULA NITIDA, G. B. Sowerby: *E. Forbes & Hanley*, Hist. Brit. Moll., vol. ii, p. 218, fig.

Jennycliff B., Cawsand B.; in muddy sand (R.A.T.): Eddystone Gds., in the fine sand of the 'Outer' trawling ground (E.J.A.).

NUCULA NUCLEUS (Linnæus): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. ii, p. 215, fig.

Common on muddy gravel, 10–30 fms. (S.P.): Millbay shell-gravel; Cawsand B.; Mewstone Gds. (R.A.T.): Eddystone Gds. (E.J.A.).

Anomiidæ.

ANOMIA EPHIPPIUM, Linnæus: *J. G. Jeffreys*, Brit. Conch., vol. ii, p. 30, fig.

More or less common everywhere, L.W.–30 fms., on stones, shells, rocks, etc. (R.A.T.): Eddystone Gds., wherever suitable attachment can be found, least frequent on the fine sand grounds (E.J.A.).

ANOMIA PATELLIFORMIS, Linnæus: *J. G. Jeffreys*, Brit. Conch., vol ii, p. 34, fig.

Eddystone Gds., wherever suitable attachment is to be found, least common on the fine sand grounds (E.J.A.).

Arcidæ.

GLYCIMERIS GLYCIMERIS (Linnæus): *J. G. Jeffreys*, Brit. Conch., vol. ii, p. 166, fig. (as *Pectunculus*).

Common in sandy and muddy gravel, 7–30 fms. (S.P.): moderately common on Mewstone Ledge in the patches of gravel between the rocks and occasionally from the other grounds round the Mewstone: Queen's Gd.; Cawsand B.; Rame-Eddystone Gds. (R.A.T.): Eddystone Gds. (E.J.A.).

LIMOPSIS AURITA (Brocchi): *J. G. Jeffreys*, Brit. Conch., vol. ii, p. 161, fig.

Several dead shells (S.P.).

BARBATIA LACTEA (Linnæus): *J. G. Jeffreys*, Brit. Conch., vol. ii, p. 177, fig. (as *Arca*).

Occasionally between tide-marks, among stones, etc., and in 15–30 fms., particularly on muddy gravel (S.P.): Queen's Gd. (R.A.T., S.P.): Reny Rks., occasionally (R.A.T.).

ARCA TETRAGONA, Poli: *J. G. Jeffreys*, Brit. Conch., vol. ii, p. 180, fig.

Occasionally on all rocky shores, in crevices and among stones, L.W.–30 fms. (S.P.): not uncommon in rock crevices at Drake's I. and Rum B.: occasionally from the Bridge and Millbay Ch. (R.A.T.).

Mytilidæ.

MYTILUS EDULIS, Linnæus: *J. G. Jeffreys*, Brit. Conch., vol. ii, p. 104, fig.

Very common on the coal-hulks moored in the Cattewater and on the piles of the Promenade Pier; young specs. are common between tide-marks on the rocks below the Hoe and occasionally from Drake's I. and Asia Sh. (R.A.T.): Yealm Sand-bank (S.P.).

VOLSELLA BARBATA (Linnæus): *J. G. Jeffreys*, Brit. Conch., vol. ii, p. 114, fig. (as *Mytilus*).

Occasionally between tide-marks, under boulders (S.P.): Asia Sh. (R.A.T.).

VOLSELLA PHASEOLINA (Philippi): *J. G. Jeffreys*, Brit. Conch., vol. ii, p. 118, fig. (as *Mytilus*).

Not uncommon on the outside grounds in 15–30 fms.: occasionally between tide-marks on the Breakwater and Drake's I.: Millbay Pit (R.A.T.).

MODIOLARIA MARMORATA (Forbes): *J. G. Jeffreys*, Brit. Conch., vol. ii, p. 122, fig.

More or less common, buried in the tests of Tunicates: Millbay Pit and Ch.: Mewstone Ledge: Yealm R.; etc. (R.A.T., S.P.).

Pteriidæ.

PTERIA HIRUNDO (Linnæus): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. ii, p. 251, fig. (as *Avicula tarentina*).

Very rare from the offing (R.A.T.).

[**Pelecypoda**—*contd.*]

PINNA FRAGILIS, Pennant: *J. G. Jeffreys*, Brit. Conch., vol. ii, p. 99, fig. (as *P. rudis*).

Small specs. are occasionally taken on gravel off Rame Hd., 20–30 fms.; dead shells are common (R.A.T.): Queen's Gd.; Stoke Pt. Gds., etc.; small specs. only (S.P.).

Ostreidæ.

OSTREA EDULIS, Linnaeus: *J. G. Jeffreys*, Brit. Conch., vol. ii, p. 38, fig.

Millbay Ch.; Queen's Gd.; Mewstone Ledge: Yealm R.: stray specs. occasionally dredged (R.A.T.): inside the Bridge (S.P.[1]). Extensive oyster-beds are cultivated in the Tamar R. at Saltash, and in the Yealm R. (E.J.A.).

Pectinidæ.

PECTEN MAXIMUS (Linnaeus): *J. G. Jeffreys*, Brit. Conch., vol. ii, p. 73, fig.

Mewstone 'Echinoderm' Gd., not uncommon; Rame-Eddystone Gds., etc. (R.A.T.): Eddystone Gds., moderately abundant on the various gravel grounds (E.J.A., S.P.): Mewstone Ledge; Asia Sh.; Yealm Sand-bank, between tide-marks[1] (R.A.T.).

PECTEN (HINNITES) PUSIO (Linnaeus): *J. G. Jeffreys*, Brit. Conch., vol. ii, p. 51, fig.

Not uncommon on all rocky shores, among stones, inside dead shells, etc., L.W.–30 fms. (S.P.): Drake's I.: Asia Sh.: Queen's Gd.: the Breakwater; etc. (R.A.T., S.P.).

PECTEN (CHLAMYS) VARIUS (Linnaeus): *J. G. Jeffreys*, Brit. Conch., vol. ii, p. 53, fig.

The Breakwater, not uncommon at low tide; occasional specs. from Drake's I., Asia Sh., Queen's Gd., Rum B., Yealm R. (R.A.T.).

PECTEN (ÆQUIPECTEN) OPERCULARIS (Linnaeus): *J. G. Jeffreys*, Brit. Conch., vol. ii, p. 59, fig.

More or less common everywhere in 15–30 fms., especially on the Mewstone 'Echinoderm' Gd. and about 5 m. S.W. of Penlee Pt.; occasionally from Queen's Gd. and Asia Sh.; the Breakwater, single small spec. between tide-marks (R.A.T.): Eddystone Gds., more or less abundant on all the grounds, often in beds which, while of limited extent, contain very numerous individuals (E.J.A., S.P.).

Breeding: June–Aug. (S.P.).

PECTEN (PALLIOLUM) TIGERINUS (Müller): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. ii, p. 285, fig.

Not uncommon on coarse muddy or sandy gravel: Stoke Pt. Gds.: Rame–Eddystone Gds.; etc. (S.P.): Mewstone 'Echinoderm' Gd. (R.A.T., S.P.): Eddystone Gds., not abundant, for the most part on coarse ground (E.J.A.): the Breakwater, single spec. between tide-marks (R.A.T.).

Limidæ.

LIMA HIANS (Gmelin): *J. G. Jeffreys*, Brit. Conch., vol. ii, p. 87, fig.

Abundant at extreme low tide among a small patch of stones with muddy gravel on the N. side of the Breakwater[1]; Reny Rks.[1] (R.A.T.): Drake's I. (S.P.[1]).

LIMA LOSCOMBI, G. B. Sowerby: *J. G. Jeffreys*, Brit. Conch., vol. ii, p. 85, fig.

Not uncommon on the coarse grounds W. of the Eddystone (E.J.A., S.P.): Rame-Eddystone Gds. (S.P.): Mewstone Gds. (R.A.T., S.P.): Stoke Pt. Gds. (W.G., S.P.).

LIMA SUBAURICULATA (Montagu): *J. G. Jeffreys*, Brit. Conch., vol. ii, p. 82, fig.

Dead shells only (R.A.T.).

Astartidæ.

ASTARTE SULCATA (da Costa): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 452, fig.

Not uncommon, 15–30 fms., generally on muddy or sandy gravel (R.A.T., S.P.).

Cyprinidæ.

CYPRINA ISLANDICA (Linnæus): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 441, fig.

Occasionally, 15–30 fms.: dead shells moderately common (R.A.T.).

Lucinidæ.

LUCINA BOREALIS (Linnæus): *J. G. Jeffreys*, Brit. Conch., vol. ii, p. 242, fig.

Occasionally on the *Zostera* bed N.E. of Drake's I. and on the Yealm Sand-bank; dead shells are very common in Cawsand B. (R.A.T.).

LUCINA SPINIFERA (Montagu): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. ii, p. 49, fig.

Rame-Eddystone Gds. (S.P.[1]): dead shells not uncommon (R.A.T.).

THYASIRA FLEXUOSA (Montagu): *J. G. Jeffreys*, Brit. Conch., vol. ii, p. 247, fig. (as *Axinus*).

Yealm Sand-bank, occasionally: dead shells are very common in Cawsand B. (R.A.T.).

MONTACUTA SUBSTRIATA (Montagu): *J. G. Jeffreys*, Brit. Conch., vol. ii, p. 205, fig.

Common attached to the anal spines of *Spatangus purpureus* (R.A.T., S.P.).

TELLIMYA FERRUGINOSA (Montagu): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. ii, p. 72, fig. (as *Montacuta*).

Yealm Sand-bank, common commensal with *Echinocardium cordatum* (R.A.T.).

DIPLODONTA ROTUNDATA (Montagu): *J. G. Jeffreys*, Brit. Conch., vol. ii, p. 254, fig.

Dead shells only (R.A.T.).

Leptonidæ.

KELLIA SUBORBICULARIS (Montagu): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. ii, p. 87, fig.

Not uncommon on all rocky shores, L.W.–30 fms., in crevices, inside dead shells, etc., particularly where there is a thin layer of silt; gregarious (S.P.): Drake's I.: Asia Sh.: Queen's Gd.; Rum B.;

[**Pelecypoda**—*contd.*]

Millbay Ch., in *Saxicava* borings: etc. (R.A.T., S.P.): Stoke Pt. Gds., in *Pholadidea* crypts, etc. (S.P.): Eddystone Gds.: generally in fine mud inside dead shells (E.J.A., S.P.).

LASÆA RUBRA (Montagu): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. ii, p. 94, fig. (as *Poronia*).

Abundant between tide-marks on all rocky shores, in crevices, etc. (S.P.): rocks below the Hoe, very common among barnacles and the roots of *Fucus*, etc. (R.A.T.).

LEPTON SQUAMOSUM (Montagu): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. ii, p. 98, fig.

Dead shells only (R.A.T.).

Scrobiculariidæ.

SCROBICULARIA PLANA (da Costa): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 326, fig. (as *S. piperata*).

St. John's Lake, Hamoaze, common in fine tenacious mud (R.A.T.).

Tellinidæ.

TELLINA CRASSA (Gmelin): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 288, fig.

Drake's I., occasionally between tide-marks (R.A.T.): Mewstone Gds., common: Rame-Eddystone Gds. (R.A.T., S.P.): Stoke Pt. Gds. (S.P.): Eddystone Gds. (E.J.A., S.P.): Yealm R., occasionally on coarse sand between tide-marks (R.A.T.).

TELLINA DONACINA, Linnæus: *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 292, fig.

Yealm R., occasionally in coarse sand between tide-marks (R.A.T.).

TELLINA FABULA, Gronovius: *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 302, fig.

Not uncommon in the muddy sand of the *Zostera* beds; Cawsand B.; Batten B.; Jennycliff B.; etc. (S.P.).

TELLINA SQUALIDA, Pulteney: *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 298, fig. (as *T. incarnata*).

Dead shells only (R.A.T.).

MACOMA BALTHICA (Linnæus): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 304, fig. (as *Tellina solidula*).

Saltash (E.J.A.[1]).

Donacidæ.

DONAX VARIEGATUS (Gmelin): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 336, fig. (as *D. politus*).

Dead shells only (R.A.T.).

DONAX VITTATUS (da Costa): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 332, fig. (as *D. anatinus*).

Whitsand B., occasional specimens (R.A.T.).

Mactridæ.

MACTRA STULTORUM, Linnæus: *J. G. Jeffreys*, Hist. Brit. Moll., vol. ii, p. 422, fig.

Dead shells only; these are common in West Ch. and Whitsand B. (R.A.T.).

SPISULA ELLIPTICA (Brown): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 356, fig. (as *Mactra*).

West Entrance, abundant: Cawsand B., moderately common (S.P.).

SPISULA SOLIDA (Linnæus): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 351, fig. (as *Mactra*).

Drake's I., common on sand-bank at E. end (S.P. & A.J.S.): Yealm Sand-bank (R.A.T.).

LUTRARIA ELLIPTICA, Lamarck: *J. G. Jeffreys*, Brit. Conch., vol. ii, p. 428, fig.

Drake's I., abundant in a small sandy patch on the *Zostera* bed on the N.E. side (S.P.): on the shore S. of Batten Castle and Yealm Sand-bank, occasionally (R.A.T.).

Gonads ripe: Mar.–Apr. (S.P.): May (R.A.T.).

Veneridæ.

LUCINOPSIS UNDATA (Pennant): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 435, fig.

Dead shells only (R.A.T.).

DOSINIA EXOLETA (Linnæus): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 428, fig. (as *Artemis*).

Occasionally from gravel S. of Drake's I. and in Millbay Ch.; Yealm Sand-bank, not uncommon (R.A.T.): Mewstone Gds.: Stoke Pt. Gds.: Rame-Eddystone Gds.: etc. (S.P.): Eddystone Gds. (E.J.A., S.P.).

MERETRIX CHIONE (Linnæus): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i., p. 396, fig. (as *Cytherea*).

Dead shells only (R.A.T.).

VENUS (CLAUSINELLA) FASCIATA (da Costa): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 415, fig.

Common on coarse gravel, particularly on muddy or sandy gravel, 6–30 fms.; Queen's Gd.: Mewstone Gds.: Stoke Pt. Gds.; Rame-Eddystone Gds.; Eddystone Gds. (S.P.): Yealm Sand-bank, occasionally between tide-marks (R.A.T.).

VENUS (VENTRICOLA) CASINA, Linnæus: *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 405, fig.

Occasionally on gravel grounds, 10–30 fms. (S.P.).

VENUS (VENTRICOLA) VERRUCOSA, Linnæus: *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 401, fig.

Occasionally on mixed gravel grounds, 15–30 fms.: Rame-Eddystone Gds.: Mewstone Gds.; etc. (S.P.): Millbay Ch.: Yealm Sand-bank (R.A.T.).

VENUS (TIMOCLEA) OVATA, Pennant: *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 419, fig.

Moderately common in the Sound on muddy sand and gravel, and occasionally outside in 15–30 fms. (R.A.T.).

VENUS (CHAMELÆA) GALLINA, Linnæus: *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 408, fig. (as *V. striatula*).

Cawsand B., moderately common in sand: occasionally on the

[**Pelecypoda**—*contd.*]

outside grounds, 15–30 fms.; Yealm Sand-bank, between tide-marks (R.A.T.).

TAPES AUREUS (Gmelin): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 392, fig.

Dead shells only (R.A.T.).

TAPES DECUSSATUS (Linnæus): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 379, fig.

Laira (A.J.S.): Yealm Sand-bank, not uncommon (S.P.).

TAPES PULLASTRA (Montagu): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 382, fig.

Occasionally between tide-marks and in dredgings from the Sound: the variety "*perforans*" is moderately common between tide-marks where the rocks are bored by *Saxicava*; Yealm Sand-bank, common (R.A.T.).

TAPES VIRGINEUS (Linnæus): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 388, fig.

Common in gravel in Millbay Ch.; occasional specs. from Drake's I., Jennycliff B., the Breakwater, Reny Rks., and from the outside grounds in 15–30 fms. (R.A.T.).

GOULDIA MINIMA (Montagu): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 446, fig. (as *Circe*).

Not uncommon on fine and medium gravel, 5–30 fms.; Queen's Gd., occasionally; Mewstone Gds.; Stoke Pt. Gds. (S.P.): Eddystone Gds. (E.J.A., S.P.).

Cardiidæ.

CARDIUM ECHINATUM, Linnæus: *E. Forbes & Hanley*, Hist. Brit. Moll., vol. ii, p. 7, fig.

Living specs. are seldom obtained, 15–30 fms., although dead shells are moderately common; Cawsand B., single spec. (R.A.T.): Eddystone Gds., fresh dead shells are a characteristic feature of the fine sand of the 'Inner' and 'Outer' Trawling Gds. (E.J.A.).

CARDIUM EDULE, Linnæus: *E. Forbes & Hanley*, Hist. Brit. Moll., vol. ii, p. 15, fig.

Hamoaze, abundant in places; occasional specs. from Laira, Drake's I. and Rum B.; Yealm R., abundant just below Steer Pt. (A.J.S.).

CARDIUM (LÆVICARDIUM) NORVEGICUM (Spengler): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. ii, p. 35, fig.

Common on gravel, 15–30 fms.; West Ch. and Queen's Gd., occasionally; Mewstone Ledge, moderately common in the patches of gravel between the rocks: Mewstone '*Amphioxus*' Gd.: Rame-Eddystone Gds.; etc. (R.A.T., S.P.): Eddystone Gd. (E.J.A., S.P.).

Garidæ.

GARI COSTULATA, Turton: *J. G. Jeffreys*, Brit. Conch., vol. ii, p. 394, fig. (as *Psammobia*).

Occasionally with *G. tellinella*; Rame-Eddystone Gds.; Eddystone Gds.: etc. (S.P.).

[**Pelecypoda**—*contd.*]

GARI FEROENSIS (Chemnitz): *J. G. Jeffreys*, Brit. Conch., vol. ii, p. 396, fig. (as *Psammobia*).

Small specs. not uncommon in Cawsand B., and dead shells are moderately common in 15–30 fms. (R.A.T.).

GARI TELLINELLA, Lamarck: *J. G. Jeffreys*, Brit. Conch., vol. ii, p. 392, fig. (as *Psammobia*).

Millbay Ch.: Mewstone Gds., common in gravel and coarse sand (R.A.T.): Stoke Pt. Gds.; Rame-Eddystone Gds.; etc. (S.P.).

GARI (PSAMMOCOLA) DEPRESSA, Pennant: *J. G. Jeffreys*, Brit. Conch., vol. ii, p. 398, fig. (as *Psammobia vespertina*).

Yealm R., not uncommon in coarse sand between tide-marks (R.A.T.).

Myidæ.

MYA TRUNCATA, Linnæus: *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 163, fig.

Single spec., Yealm Sand-bank (A.J.S.).

CORBULA GIBBA (Olivi): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 180, fig. (as *C. nucleus* and *C. rosea*).

Jennycliff B.: Cawsand B.: occasionally (R.A.T., S.P.): Mewstone Gds.: Stoke Pt. Gds.: Rame-Eddystone Gds., not uncommon on muddy gravel (S.P.).

Solenidæ.

SOLECURTUS ANTIQUATUS (Pulteney): *J. G. Jeffreys*, Brit. Conch., vol. iii, p. 6, fig.

Jennycliff B., single spec.; 4 m. W. by S. of Rame Hd., single spec.; dead shells are not uncommon 2–4 m. S.W. of Rame Hd. (R.A.T.).

SOLECURTUS SCOPULA (Turton): *J. G. Jeffreys*, Brit. Conch., vol. iii, p. 3, fig. (as *S. candidus*).

Eddystone Gds., single spec. (R.A.T.).

CULTELLUS PELLUCIDUS (Pennant): *J. G. Jeffreys*, Brit. Conch., vol. iii, p. 14, fig. (as *Solen*).

Jennycliff B.: Cawsand B.: common (R.A.T., S.P.): Mallard Sh., in sandy mud (S.P.).

ENSIS ENSIS (Linnæus): *J. G. Jeffreys*, Brit. Conch., vol. iii, p. 16, fig. (as *Solen*).

Yealm Sand-bank, very common: Drake's I., not uncommon in sand at the N.E. corner; sandy patch S. of Batten Castle; Cawsand B.; etc. (R.A.T.).

ENSIS SILIQUA (Linnæus): *J. G. Jeffreys*, Brit. Conch., vol. iii, p. 18, fig. (as *Solen*).

Dead shells only (R.A.T.).

SOLEN VAGINA, Linnæus: *J. G. Jeffreys*, Brit. Conch., vol. iii, p. 20, fig.

Drake's I., occasionally on muddy sand N. of the Island (S.P.): Yealm Sand-bank (R.A.T.).

Saxicavidæ.

SAXICAVA ARCTICA (Linnæus): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 141, fig.

Mewstone Gds.; Rame-Eddystone Gds. (R.A.T.): Eddystone Gds., on all grounds, attached to shells, the roots of Hydroids, etc. (E.J.A.).

[**Pelecypoda**—*contd.*]

SAXICAVA RUGOSA (Linnæus): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i., p. 146, fig.

Everywhere boring in limestone, etc., L.W.–20 fms. (R.A.T.).

Gastrochænidæ.

GASTROCHÆNA DUBIA (Pennant): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 132, fig. (as *G. modiolina*).

The Breakwater, boring in limestone; Asia Sh.: Millbay Ch. and Pit: Yealm R., single spec. boring in an oyster shell (R.A.T.).

Pholadidæ.

PHOLAS DACTYLUS, Linnæus: *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 108, fig.

Rum B., common in particular patches of shale rock (R.A.T., A.J.S.).

BARNEA PARVA (Pennant): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 111, fig. (as *Pholas*).

Rum B., common (R.A.T.).

PHOLADIDEA LOSCOMBIANA, Goodall: *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 123, fig. (as *P. papyracea*).

Rum B., common at low tide (R.A.T.): abundant in the red rock of the Mewstone Ledge, Stoke Pt., etc., 10–20 fms. (S.P.).

Teredinidæ.

TEREDO NAVALIS, Linnæus: *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 74, fig.

Not uncommon in drift and submerged wood (R.A.T.).

Breeding: July (W.G.).

Pandoridæ.

PANDORA INÆQUIVALVIS (Linnæus): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 207 (as *P. rostrata*), p. 210 (as *P. obtusa*), fig.

Cawsand B., occasionally (R.A.T.): Rame-Eddystone Gds. (R.A.T., S.P.): Eddystone Gds. (E.J.A., S.P.): Stoke Pt. Gds. (S.P.).

Lyonsiidæ.

LYONSIA NORVEGICA (Chemnitz): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 214, fig.

Cawsand B., occasionally (R.A.T.): single spec. off Stoke Pt. (E.J.A.).

Anatinidæ.

COCHLODESMA PRÆTENUE (Pulteney): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 235, fig.

Dead shells only (R.A.T.).

THRACIA FRAGILIS, Pennant: *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 221 fig. (as *T. phaseolina*).

Single spec., S. of Batten Castle, in sand (R.A.T.).

THRACIA PUBESCENS (Pulteney): *J. G. Jeffreys*, Brit. Conch., vol. iii, p. 38, fig.

Dead shells only (R.A.T.).

CEPHALOPODA.

Ommastrephidæ.

TODAROPSIS EBLANÆ (Ball): *W. E. Hoyle*, Journ. Mar. Biol. Assoc., ser. 2, vol. ii, p. 189.

Plymouth neighbourhood, single spec. (J.T.C. & W.E.H.).

Loliginidæ.

LOLIGO FORBESI, Steenstrup: *W. E. Hoyle*, Proc. Phys. Soc. Edinburgh, vol. viii, p. 459.

The Sound, occasionally (W.G.): practically absent, Jan.–June 1895 (E.J.A.): Tamar R., below Saltash Bridge: Lynher R.; small specs. common, July 1897 (E.W.L.H.): 'Inner' trawling grounds, large spec. Aug. 1897 (W.I.B.).

Breeding: Apr.–Sept. (W.G.).

LOLIGO MARMORÆ, Vérany: *A. M. Norman*, Ann. Mag. Nat. Hist., ser. 6, vol. v, p. 481.

Off the Draystone, single spec. (W.G.).

LOLIGO MEDIA (Linnæus): *A. M. Norman*, Ann. Mag. Nat. Hist., ser. 6, vol. v, p. 482.

Cawsand B.; Whitsand B.; etc. (W.G.): Jennycliff B. (R.A.T.): St. John's Lake, Hamoaze, Aug. 1898 (E.W.L.H.).

Breeding: Apr.–June (W.G.). Late embryos in Oct. (W.G.).

Sepiidæ.

SEPIA ELEGANS, d'Orbigny: *G. Jatta*, Fauna Flora Neapel, vol. xxiii, p. 160, fig.

Not uncommon on the trawling grounds (E.W.L.H., W.I.B., S.P.).

SEPIA OFFICINALIS, Linnæus: *G. Jatta*, Fauna Flora Neapel, vol. xxiii, p. 149, fig.

Comes into the bays and estuaries to spawn during July and Aug. (W.I.B.): Mewstone Gds.; Rame-Eddystone Gds.: etc., occasionally (R.A.T.): very scarce during 1904 (A.J.S.).

Breeding: July–Sept. (R.A.T.). Hatching: Oct. (R.A.T.).

Sepiolidæ.

SEPIOLA ATLANTICA, d'Orbigny: *A. M. Norman*, Ann. Mag. Nat. Hist., ser. 6, vol. v, p. 473.

Common in Cawsand B., Jennycliff B., and Whitsand B.; occasionally on the outside grounds in 15–30 fms. (R.A.T., S.P.): the Cattewater, common (R.A.T.): Tamar R., common just below Saltash Bridge; Downderry, common in sandy pools; Yealm R. (W.I.B.).

SEPIOLA SCANDICA, Steenstrup: *A. M. Norman*, Ann. Mag. Nat. Hist., ser. 6, vol. v, p. 472.

The Sound, single spec. Nov. 1887 (W.H.): Mewstone Gds., single spec. Oct. 1899 (W.I.B.).

ROSSIA MACROSOMA (delle Chiaji): *A. M. Norman*, Ann. Mag. Nat. Hist., ser. 6, vol. v, p. 469.

Two specs., autumn 1892 (W.G.): occasionally on the Trawling Gds. (A.J.S.).

Polypodidæ.

POLYPUS VULGARIS (Lamarck): *J. G. Jeffreys*, Brit. Conch., vol. v, p. 144, fig. (as *Octopus*).

On the shore and from lobster pots; generally only a few specimens are obtained during the summer months, but it varies greatly in abundance in different years (E.J.A.): exceptionally plentiful* in 1900 (W.G.).

MOSCHITES CIRROSA (Lamarck): *J. G. Jeffreys*, Brit. Conch., vol. v, p. 146 (as *Eledone*), fig.

Frequently met with on the trawling grounds (E.J.A.): commonly caught in lobster pots (A.J.S.).

TUNICATA.

Molgulidæ.

MOLGULA OCULATA, Forbes: *H. de Lacaze-Duthiers*, Arch. Zool. expt., ser. 1, vol. vi, p. 516, fig. (as *Anurella*).

Mewstone Ledge (T.V.H.): not uncommon in clean fine gravel off the Mewstone (R.A.T.): Eddystone Gds. (E.J.A.).

MOLGULA SIMPLEX, Alder & Hancock: *H. de Lacaze-Duthiers*, Arch. Zool. expt., ser. 1, vol. vi, p. 542, fig. (as *Anurella*).

Eddystone Gds., on *Chætopterus* tubes, not uncommon (E.J.A.).

Cynthiidæ.

FORBESELLA TESSELLATA (Forbes): *E. Forbes & Hanley*, Hist. Brit. Moll., vol. i, p. 39, fig. (as *Cynthia limacina*); *W. A. Herdman*, Journ. Linn. Soc., Zool., vol. xxiii, p. 578.

Rame-Eddystone Gds. (R.A.T.): Eddystone Gds., single spec. on fine gravel (E.J.A.).

STYELOPSIS GROSSULARIA, v. Beneden: *R. Hartmeyer*, Meeresf. Bergen [Bergens Mus. Publ.], pt. i, p. 46.

Abundant on rocks between tide-marks, Jennycliff B., Rum B., Mt. Edgcumbe; occasionally in dredgings from Millbay Ch., Queen's Gd., etc. (R.A.T.): Eddystone Gds., the small squat var. not uncommon on shells, particularly *Pecten* shells, on the gravels W. of the Eddystone (E.J.A.).

Breeding: May; Oct. (W.G.).

POLYCARPA POMARIA (Savigny): *R. Hartmeyer*, Fauna Arctica, vol. iii, p. 229.

Common at times in the Cattewater, but probably from trawl refuse; very plentiful on one occasion 4 m. W.N.W. of the Eddystone (R.A.T.): Eddystone Gds. (E.J.A.): Mewstone Ledge (A.J.S.).

Ascidiidæ.

CORELLA LARVÆFORMIS, Hancock: *W. A. Herdman*, Journ. Linn. Soc., Zool., vol. xxiii, p. 588.

Off the Eddystone (W.G.).

* *Journ. Mar. Biol. Assoc.*, ser. 2, vol. ii. pp. 260–73.

[**Tunicata**—*contd.*]

Corella parallelogramma (O. F. Müller): *R. Hartmeyer*, Meeresf. Bergen [Bergens Mus. Publ.], pt. i, p. 42, fig.

Duke Rk., single spec. on small stone; 2 m. S. of Mewstone, single spec. on stone (W.G.).

Phallusia mamillata, Cuvier: *M. P. A. Traustedt*, Mitth. Zool.-Stat. Neapel, vol. iv, p. 456, fig.

Moderately common in dredgings from the Yealm R., Mewstone Ledge; and occasionally from the Duke Rk., Cattewater, and West Ch. Not uncommon washed up on the Yealm Sand-bank between tide-marks (R.A.T.).

Ascidiella aspersa (O. F. Müller): *W. A. Herdman*, Journ. Linn. Soc., Zool., vol. xv, p. 281, fig. (as *Ascidia*).

Common on the piles of the Promenade Pier, and in Millbay Dock (R.A.T.): Cattewater (T.V.H.): occasionally between tide-marks, Rum B. (R.A.T.): Yealm R. (R.A.T.): Yealm Sand-bank (A.J.S., R.A.T.).

Breeding: Apr. (W.G.): June–July (R.A.T.).

Ascidiella scabra, O. F. Müller: *W. A. Herdman*, Journ. Linn. Soc., Zool., vol. xv, p. 284, fig. (as *Ascidia*).

Duke Rk.; Yealm R. (W.G.): Eddystone Gds., generally present, but particularly abundant where *Sertularella Gayi* is plentiful, growing at the base of the stem of the Hydroid (E.J.A., S.P.): Mewstone Gds. (A.J.S., R.A.T., S.P.): Rame-Eddystone Gds. (R.A.T., S.P.): Stoke Pt. Gds. (S.P.).

Ascidia venosa, O. F. Müller: *R. Hartmeyer*, Meeresf. Bergen [Bergens Mus. Publ.], pt. i, p. 36, fig.

Eddystone Gds., occasional specs. (E.J.A.).

Ascidia depressa, Alder: *W. Garstang*, Journ. Mar. Biol. Assoc., ser. 2, vol. ii, p. 125, fig.

Not uncommon on the Bolt Head shell gravel attached to stones (E.J.A.).

Ascidia mentula, O. F. Müller: *W. Garstang*, Journ. Mar. Biol. Assoc., ser. 2, vol. ii, p. 130, fig.

Reny Rks., single spec., var. *depressa* (W.G., R.A.T.): Millbay Ch.; Mewstone Gds. (E.J.A.).

Ciona intestinalis (Linnaeus): *R. Hartmeyer*, Fauna Arctica, vol. iii, p. 297, fig.

Until 1901 this Ascidian was comparatively rare, having only been recorded occasionally from Millbay Ch., the Cattewater, Yealm R., Mewstone Ledge, and the Eddystone Gds., and the specimens were never of greater length than 4–5 inches. In that year the species became for a time very abundant in Millbay Docks, completely covering the piles and rafts, and many of the specimens from the Inner Dock were of extremely large size, measuring as much as a foot in length (E.J.A.): Stoke Pt. Gds., small specimens fairly common (S.P.).

Breeding: June–July (R.A.T.): Aug.–Sept. (W.G.).

[**Tunicata**—*contd.*]

Clavelinidæ.

DIAZONA VIOLACEA, Savigny: *W. Garstang*, Journ. Mar. Biol. Assoc., ser. 2, vol. ii, p. 63.

Eddystone Gds. (W.G., R.A.T.[1]): Stoke Pt. Gds. (W.G.).

PEROPHORA BANYULENSIS, Lahille.

Duke Rk. (W.G.).

PEROPHORA LISTERI, Wiegmann: *W. Garstang*, Journ. Mar. Biol. Assoc., ser. 2, vol. ii, p. 58, fig.

Rocks under the Hoe, abundant (W.H.): Queen's Gd.: Millbay Pit; Asia Sh. (A.J.S.): Duke Rk.; Yealm Estuary (W.G.).

PYCNOCLAVELLA AURILUCENS: *W. Garstang*, Journ. Mar. Biol. Assoc., ser. 2, vol. ii, p. 53, fig.

Mewstone Gds., attached to various objects from rough ground, 10–20 fms.; once in the Sound, forming a thin growth on the stems of red weeds (W.G.): Mewstone Ledge, on *Eunicella* (R.A.T., S.P.).

CLAVELINA LEPADIFORMIS (O. F. Müller): *W. Garstang*, Journ. Mar. Biol. Assoc., ser. 2, vol. ii, p. 51.

Drake's I., occasionally at extreme low tide (W.G., R.A.T.): Queen's Gd. (R.A.T., S.P.): Mt. Edgcumbe (W.G., T.V.H.): Duke Rk. (W.G., R.A.T.): Rum B.: Millbay Ch.: Mewstone Ledge; Wembury B. (T.V.H.): very rarely, in 10–15 fms. off the Mewstone and Penlee (W.G.).

Breeding: June (W.G.): July (R.A.T.).

Distomidæ.

DISTAPLIA ROSEA, Della Valle: *W. A. Herdman*, Journ. Linn. Soc., Zool., vol. xxiii, p. 613.

On stones, dead shells, etc., at Duke Rk. and elsewhere (W.G.).

ARCHIDISTOMA AGGREGATUM: *W. Garstang*, Zool. Anz., vol. xiv, p. 422, fig.

Duke Rk., very abundant on stones; 2 m. S. of Mewstone[1] (W.G.).

Breeding: June (W.G.).

Polyclinidæ.

APLIDIUM ZOSTERICOLA: *A. Giard*, Arch. Zool. expt., ser. 1, vol. i, p. 636, fig.

Plymouth, attached to the stalks of *Bowerbankia* or *Amathia* (W.G.).

AMAROUCIUM ALBICANS (H. Milne-Edwards): *W. A. Herdman*, Journ. Linn. Soc., Zool., vol. xxiii, p. 623.

Off the Mewstone (W.G.).

AMAROUCIUM NORDMANNI (H. Milne-Edwards): *A. Giard*, Arch. Zool. expt., ser. 1, vol. i, p. 636.

Church Reef, Wembury B. (W.G.[1]).

Breeding: June (W.G.).

AMAROUCIUM PUNCTUM: *A. Giard*, Arch. Zool. expt., ser. 1, vol. ii, p. 495.

Single colony, 3 m. S. of the Mewstone (W.G.).

MORCHELLIUM ARGUS, Milne-Edwards: *W. A. Herdman*, Journ. Linn. Soc., Zool., vol. xxiii, p. 625.

Common everywhere on rocks between tide-marks (R.A.T.): Millbay Ch. (T.V.H.): Millbay Docks, on wooden piles (W.G.): Duke Rk. (E.J.A., R.A.T.): Yealm R. (T.V.H., R.A.T.).

Breeding: Sept. (W.G.).

[**Tunicata**—*contd.*]

MORCHELLIOIDES ALDERI: *W. A. Herdman*, Proc. Lit. Phil. Soc. Liverpool, vol. xl, p. 291, fig.

Asia Sh., on roots of *Laminaria* and on stones and shells; Millbay Ch., on stones and shells; Bovisand B., on stones and shells (W.G.).

FRAGARIUM ELEGANS: *A. Giard*, Arch. Zool. expt., ser. 1, vol. i, p. 638, fig.

Duke Rk., on stones (W.G.).

CIRCINALIUM CONCRESCENS: *A. Giard*, Arch. Zool. expt., ser. 1, vol. i, p. 639, fig.

Drake's I., on reef leading to the Bridge, on roots of *Laminaria* at extreme low-water: Picklecombe, E. of the Fort on roots of *Laminaria*; Devil's Pt., Stonehouse, under a stone, low-water, spring tide: Duke Rk., in crevices of stones; Wembury B., under overhanging rocks (W.G.).

Botryllidæ.

BOTRYLLUS VIOLACEUS, H. Milne-Edwards: *A. Giard*, Arch. Zool. expt., ser. 1, vol. i, p. 621, fig.

Common on rocks, under stones and on weed, at low water on all shores (W.G.).

Breeding: June–Aug. (W.G.).

BOTRYLLOIDES RUBRUM, Milne-Edwards: *A. Giard*, Arch. Zool. expt., ser. 1, vol. i, p. 632, fig.

Under the Hoe, common under stones (W.G.).

Breeding: Aug.-Oct. (W.G.).

Doliolidæ.

DOLIOLUM NATIONALIS, Borgert*: *A. Borgert*, Ergebn. Plankton Expedn., vol. ii, pt. E. a. C., p. 21, fig.

Tow-nettings, Aug. and Sept., 1893, a considerable number (W.G.): very abundant during 1895 (T.V.H.): S. of the Eddystone, several specs. Nov. 1904 (L.H.G.).

Salpidæ.

SALPA FUSIFORMIS, Cuvier: *W. A. Herdman*, Rept. Voy. Challenger, vol. xxvii. (pt. lxxvi), p. 74, fig. (as *S. runcinata-fusiformis*).

Aggregated form at surface, N. of Eddystone, Aug., 1901 (R.A.T.).

SALPA MUCRONATA, Forskål: *W. A. Herdman*, Rept. Voy. Challenger, vol. xxvii (pt. lxxvi), p. 79, fig. (as *S. democratica-mucronata*).

Large shoals visited the Sound in 1893, from the middle of June to the end of the first week in July (W.G.).

Breeding: Aug.–Oct. (W.G.).

Appendiculariidæ.

OIKOPLEURA DIOICA, Fol: *H. Lohmann*, Ergebn. Plankton Exped., vol. ii, pt. E. c., p. 76, fig.

Generally present in tow-nettings, occasionally common (R.A.T.).

Breeding: Mar.–Apr. (W.G.).

FRITILLARIA BOREALIS: *H. Lohmann*, Ergebn. Plankton Exped., vol. ii, pt. E. c., p. 49, fig.

Plymouth: Mar., Oct., Nov., 1899 (P.T.C.): Eddystone, Aug., 1903 (L.H.G.).

* Previously recorded as *D. Tritonis*, Herdman.

Pallasia murata, n. sp.: a new British Sabellarian.

By

E. J. Allen, D.Sc.

Director of the Plymouth Laboratory of the Marine Biological Association.

With Plate X.

FRAGMENTS of a large tube built of pieces of coarse gravel and shell, evidently the work of some Polychæte, have been constantly dredged for many years on the grounds in the neighbourhood of the Mewstone and Stoke Point, to the eastward of Plymouth Sound. Not until June 4th, 1903, was the worm first discovered to whose skill as a mason these tubes are due. On that day the Laboratory fisherman captured and drew attention to a tube which was occupied by a living worm. The specimen, along with a number of fragments of empty tube, was obtained on a patch of coarse gravel off Stoke Point.

The species thus discovered has proved to belong to the genus *Pallasia*, a genus which was founded by de Quatrefages to include certain foreign Hermellidæ (Sabellaridæ) which were distinguished by having two rows and not three of peristomial chætæ in the paleal crown. As will be seen from the description given below, the new worm most closely resembles *Pallasia Giardi*, McIntosh, from Port Jackson, in Australia, and *Pallasia lævispinis*, Grube, from Upolu, in the Pacific and from Ascension. The details of its structure, as well as the large size of the British specimen, indicate that it is a new species. I propose to name it *Pallasia murata*. My thanks are due to Mrs. L. E. Sexton for the excellent drawings of the specimen reproduced in Plate X.

Tube. The pieces of tube of *Pallasia* which have been dredged have sometimes reached a length of four to five inches, with an internal diameter of half an inch. It is doubtful, however, whether a complete tube has ever been obtained.

The tube is built of two layers, an internal layer consisting of comparatively small pieces of shell or thin, flat stones, arranged with considerable regularity and forming a smooth internal surface, and an external layer of large pieces of gravel and shell, forming a strong, but rugged and irregular, outer covering. (Plate X., Fig. 5). The particular tube which contained the living worm had a piece of *Halecium halecinum* growing near one end. This circumstance, combined with the fact that short pieces of empty tube only are generally taken with the dredge, seems to suggest that the tubes are sunk more or less vertically in the gravel, with one end protruding at the surface.

Colour. When removed from its tube the general colour of the body of the worm is seen to be buff, with dark chocolate-brown markings in the region of the thorax and peristomium. The branchiæ, which form two rows along the dorsal surface of the thorax, are dark olive-green, and the smooth caudal portion of the animal is also dark green.

External characters (Figs. 1 and 2). The peristomial lobes, which carry the crown of paleæ, are not fused together as in *Sabellaria*, but form distinct, elongated organs, pointed at their anterior extremities. Their dorsal surfaces are slightly concave, and each carries a row of a little over twenty papillæ on its external margin, and two rows of paleæ (peristomial chætæ), one on the external margin immediately inside the papillæ, and one on the internal margin (Fig. 4).

The outer row of paleæ contains thirty-four or thirty-five thin, straight, translucent, flattened bristles, which run out into long fine points at their distal ends.

The paleæ of the inner row, of which eleven can be seen on each side, are much stouter and stronger than those of the outer row. They are of a bright yellow colour, straight, flattened, and directed forwards. The two most posterior chætæ of this row appear much smaller than the others, their tips only protruding through the skin, and they appear to be separated from the others by a considerable interval, being situated quite at the hinder end of the inner margin of the lobe. The intervening space is not, however, free from paleæ, which are present, but have not pierced the skin.

Behind the rows of paleæ (Fig. 4), on the dorsal surface of the worm are two stout, black hooks, one on each side, embedded in fleshy papillæ and curving backwards. Outside the hooks are two conical papillæ, which seem to be the two most posterior members of the rows of papillæ which line the outer margins of the peristomial lobes. They are, however, of considerably larger size than the papillæ immediately in front of them.

The inner and ventral surfaces of the peristomial lobes (Fig. 3) are covered with numerous tentacular filaments, arranged, as is usual amongst the Sabellaridæ, in transverse rows.

The mouth lies on the ventral surface, between the bases of the peristomial lobes (Figs. 1 and 3), and is almost completely surrounded by a large, hood-shaped structure. Posteriorly the mouth, including the hinder portion of the 'hood-shaped structure,' is bordered by a curved row of ten rounded, cushion-like lobes, and laterally there is on each side a much larger conical lobe, as in *Sabellaria*.* Outside this conical lobe lies the neuropodial cirrus of the first segment, and externally to this again a small rounded lobe, from in front of which the short neuropodial bristles of this segment arise.

The two tentacles are best seen from the ventral surface of the worm. They arise behind (dorsal to) the lip, and extend a little beyond the anterior ends of the peristomial lobes. The tentacles

* After the above was written I sent the specimen of *Pallasia* to Mr. Arnold Watson, who is at present engaged in a study of the British Sabellaridæ. Mr. Watson has kindly allowed me to print here the following valuable note explaining his views as to the nature of the structures which surround the mouth :—

"The hood-shaped structure which surrounds the mouth (well shown in Figs. 1 and 3) is really formed by the upper and lower lips combined; the top portion being due to the former, and the side folds to the latter. As the result of recent study of the British Sabellaridæ (*S. alveolata* and *S. spinulosa*) I have found that the lower lips (by means of a membranous structure winding in and out between the tentacular fans) are practically extended to the distal extremities of the peristomial lobes, while the upper lip is similarly but more directly so extended right and left, a few foldings only (less than a dozen on either side) occurring anteriorly, and each fold corresponding with the position of a single tentacular filament placed in the inner margin of the peristomial lobe. The membranes which proceed from the upper and lower lips respectively coalesce at the extremity of the lobes. The result is the formation of a ciliated channel running the length of each lobe, receiving, by means of the transverse folds, the material collected by the fans and by the internal filaments, and conveying it to the mouth of the worm, there to be used for food or for building purposes. An arrangement, similar in principle, but differing in detail, appears to exist in *Pallasia*.

"The hood-shaped structure, the product of the upper and lower lips combined, is common to all. Fear of causing injury by manipulation of the tentacular filaments, etc., to the specimen *Pallasia*, has prevented my making a satisfactory examination, but by careful posing and illumination it can be seen that the margin of the upper lip, though shallower, runs forward (and not backwards, as would be needful to form a hood), and that it is intimately connected with the first of a series of filaments which border completely the inner edge of the peristomial lobe. For the reason before given, the course of the lower lips cannot be followed, but from appearances and analogy with *Sabellaria*, each lip is probably connected with the inner edge of the first external fan. An avenue or channel is thus formed between the inner and outer sets of filaments, leading to and carrying material to the mouth in the way already explained.

"The main difference to be noted is, that whereas in *Sabellaria* there are only few inner tentacular filaments, and those at varying intervals, in *Pallasia* the inner margin of the lobes is by their means completely and compactly fenced. Viewed from the dorsal surface, these inner filaments seem to have a fan-like arrangement somewhat similar to those in the outer edge, but not quite so well defined.

"The 'curved row of cushion-like lobes,' combined with the 'larger conical lobes,' forms the 'building organ' of the worm. They are glandular structures, and doubtless supply the cement with which the sand, stones, and shells are attached. I have seen the whole in action in *Sabellaria*, and by means of sections the glandular structure of the organ has been proved. The peculiar columnar arrangement of the glands is, in *Pallasia*, to some extent indicated by its external appearance. In *Sabellaria* the glandular portion, although crenate on its edge, is not distinctly divided into cushion-like lobes. Probably the latter arrangement in *Pallasia* is a modification enabling the worm to deal more easily with the very bulky material used in the construction of its tube. ARNOLD T. WATSON."

have the same general shape as the palps of Spionidæ and Disomidæ (*e.g. Pœcilochætus*), being D-shaped in section with the flattened (or grooved) surface, bordered by a crenate membrane.

Meyer (1888, p. 507) suggests that the peristomial lobes (Paleenträger) represent the notopodia of the first segment of the body. This view is supported by the striking resemblance between the relations of the parts in *Pallasia murata* and that found in *Pœcilochætus*,* where the parapodia of the first segment are much enlarged and directed forwards. It may be noted in this connection that Meyer considers that the Hermellidæ are nearly related to the Spionidæ, with which family *Pœcilochætus* also is closely allied.

The neuropodial cirrus of the second segment is seen immediately behind the mouth. It consists of a flattened, triangular lobe,† from in front of which a bundle of hair-like bristles arises. The notopodium of this segment is represented by two broad, flattened, forwardly directed, fin-like processes, extending transversely along the lateral surfaces of the body, and running out into two or three points. No notopodial chætæ can be seen. The notopodial cirrus of the second segment is well developed, springing from the dorso-lateral surface and falling inwards and backwards to meet its fellow of the opposite side, constituting with the latter the first of the pairs of gills with which the dorsal surface of the worm is furnished.

In the third segment the neuropodium consists of a very small, pointed lobe, from below and behind which a few short, flattened chætæ spring. There is no neuropodial cirrus. The notopodium consists of a broad, flattened, fin-like process, with a small secondary lobe or cirrus attached to the posterior angle of its dorsal surface, and provided with a row of strong, broad, flattened chætæ (paleæ) of a bright yellow colour. The notopodial cirrus forms a gill like that of the second segment, though slightly larger.

The fourth, fifth, and sixth segments are very similar in character to the third, and all have broad, strong chætæ in the neuropodia. These chætæ occur, therefore, in four segments and not in three as in *Sabellaria*.

In the seventh segment the parapodia take on the form which persists generally throughout the abdomen. This region comprises about forty segments, of which the last few are rudimentary, and on which the dorsal cirri (gills) persist only in the first fifteen or sixteen. The notopodia on all the segments have the form of flattened, fin-like processes, each bearing along its external margin a closely packed row of uncini. These uncini (Fig. 6) have eight teeth, of which the first is only slightly developed. The middle teeth are the longest. Two long, tendon-like filaments are attached to the lower end of each uncinus, and one

* Allen, E. J., "The Anatomy of Pœcilochætus," *Quart. Journ. Micr. Sci.*, vol. xlviii. p. 79.

† On one side of the specimen examined this lobe is bifid.

such filament is also attached to a small projecting piece behind the first rudimentary tooth. The neuropodial cirri are developed on the abdominal segments as flattened, bilobed processes arising behind the bundles of neuropodial chætæ and joined to the ventral edges of the notopodia. Of the two lobes of each cirrus the internal is rounded, the external conical and pointed: the bilobed structure becomes less pronounced posteriorly. Each neuropodium has a bundle of long, hair-like chætæ, which are longest on the most posterior segments and show the structure seen in Fig. 7.

The smooth, caudal portion of the worm is devoid of appendages, excepting for three or four pairs of rudimentary neuropodial cirri on its most anterior part. The anus is terminal and is surrounded by a large, funnel-shaped membrane with a crenate margin.

Dimensions. Total length of preserved specimen, 13 cm. (5·1 inches). Length of first segment to the tip of the peristomial lobes, 22 mm. Length of thorax, to anterior edge of mouth, about 19 mm. Length of abdomen, 66 mm. Length of caudal portion, 26 mm. Maximum breadth, not including parapodia, 10 mm. Length of tentacles, 18 mm.

Amongst the various species of Sabellaridæ (Hermellidæ) which have been described, the two species which most nearly resemble that now found at Plymouth are *Sabellaria (Pallasia) Giardi*, McIntosh (from Port Jackson, Sydney), which McIntosh thinks may be identical with Kinberg's *Lygdomis indicus*, and *Sabellaria (Pallasia) lævispinis*, Grube (from Upolu and Ascension). The three species *P. lævispinis*, *P. Giardi*, and *P. murata* form a distinct group of the genus *Pallasia* characterised by the deep division of the peristomial lobes (a character found also in *P. Johnstoni*, McIntosh), by the straight, slender and pointed paleæ of these lobes, and by the fact that the dorsal chætæ of four segments (Segts. 3, 4, 5, and 6) have the modified, stout, flattened form, instead of this modification being confined to three segments only.

The following table gives an indication of some of the points in which the three species differ from one another:—

	P. lævispinis, Grube.	*P. Giardi*. McIntosh.	*P. murata*, n. sp.
Length (preserved) .	25+ mm.	7 mm.	130 mm.
Breadth . . .	4·5 "	2 "	10 "
Number of Segments .	27	—	46
Papillæ on Peristomium	16	11	20
Paleæ—outer row .	28, straight and smooth	Denticulate at tip, slightly curved	34, straight and smooth
" inner row .	10 " "	Curved inwards	11 " "
Uncini . . .	6 teeth	9 teeth	8 teeth
Gills . . .	18 each side	—	20–21 each side

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EXPLANATION OF PLATE X.

Illustrating Dr. E. J. Allen's paper on "Pallasia murata, n. sp.: a new British Sabellarian."

Fig. 1. *Pallasia murata*, ventral view. Natural size.
Fig. 2. „ „ dorsal view. Natural size.
Fig. 3. Anterior segments, ventral view. × 2.
Fig. 4. „ „ dorsal view. × 2.
Fig. 5. Tube of *Pallasia murata*. Natural size.
Fig. 6. Uncinus.
Fig. 7. Neuropodial chæta of abdomen.

Note on two species of *Cucumaria* from Plymouth, hitherto confused as *C. Montagui* (Fleming): *C. Normani*, n. sp., and *C. saxicola*, Brady and Robertson.

By

S. Pace.

Pending the publication, in a paper now in preparation, of an account of the Holothuria of the Plymouth district, and an attempt at a revision of the European species of that group, it has appeared advisable to publish the following short note*, with the view of removing one of the most prolific of those sources of error with which the literary history of the Holothuria has come to be burdened.

Holothuria Montagui, Fleming, affords a remarkable instance of how much confusion may gather around a specific name; the species was itself founded on a misconception, and almost every author who has since made use of Fleming's name, or who has attempted to disentangle its synonymy, has but made matters rather more involved. It is not my intention to discuss the synonymy of *C. Montagui* at all fully in the present paper, as it will be more convenient to do this subsequently, when dealing with other species, and only so much of the history of the name will now be mentioned as is essential to the immediate purpose of the present note.

In 1808 Montagu (4) described and figured as "*Holothuria Pentactes*, var.," a species of *Cucumaria* which he had found on the south coast of Devonshire. This species, from Montagu's excellent description, must certainly have been one of the two forming the subject of this paper; and which has, among other names, been known as *C. Montagui*, Fleming. Now, whatever *C. Montagui* really may be, it certainly is not conspecific with Montagu's supposed variety of *C. pentactes*. Of course, it was undoubtedly Fleming's intention to honour Montagu by bestowing his name upon the species discovered by that naturalist; but, unfortunately, the description (2) of *C. Montagui* is based upon specimens of another species collected in the Firth of Forth. Fleming makes reference under the name *Montagui* to Montagu's description

* My thanks are due to Dr. E. J. Allen, Director of the Plymouth Laboratory, for allowing me to devote the necessary time to this research; to Prof. F. J. Bell for granting me facilities for working at the collections under his care at the British Museum; and to Dr. A. M. Norman for much friendly criticism.

of the Devonshire Cucumarian, but Montagu's actual form is probably the one that is described as *Holothuria pentactes* in the *History of British Animals.*

Fleming's name appears to have dropped into almost complete disuse until revived by Dr. A. M. Norman (5). Norman, however, overlooked the fact that Fleming was not dealing with the same species as Montagu: and in addition, he has failed to realise that there are two species of *Cucumaria* of somewhat similar outward appearance living upon the South Devon coast. Norman's *Cucumaria Montagui* is, in fact, a complex, and it is mainly as the result of this that subsequent authors have experienced so much difficulty in reconciling their ideas as to the identity of *C. Montagui.*

Before proceeding further, it will, perhaps, be most convenient to say something regarding the characters and habits of the two Cucumarians in question, and to call attention to the more important points of difference between them.

During life it is an easy matter to separate the two forms; and from quite an early date in the history of the Plymouth Laboratory they have there been recognised as distinct species. At Plymouth, for some years past, these species have been recorded and distributed as "*C. pentactes,*" and "*C. Planci,*" the one known by the latter name being the one figured by Montagu. However, neither of these names can be retained. Linnaeus' *Holothuria pentactes* is now generally regarded as being an indeterminate* species; and, whether Brandt's name *Planci* be eligible for the common Mediterranean species or not, it certainly cannot be applied to the very different species from Plymouth. For the moment, it will perhaps simplify matters if we refer to Montagu's "*Holothuria pentactes*, var.," as *Cucumaria sp.* 1 and to the second Plymouth form as *Cucumaria sp.* 2.

Both of these species of *Cucumaria*, *sp.* 1 and *sp.* 2, are fairly common in the neighbourhood of Plymouth Sound, being found under stones and in crevices on rocky ground from low-water mark down to a depth of a few fathoms. *Sp.* 2 is perhaps the more frequently met with, and it appears, also, to live in somewhat deeper water.

There are no very great points of difference in the *outward form* of the two species, which are also of much the same size; but *sp.* 1 is rather shorter and of less even calibre than *sp.* 2, and it has the posterior extremity more tapering. The *podia* in *sp.* 1 are numerous, appearing as though disposed in two parallel rows in each ambulacrum;

* Absolutely no useful purpose is served by guessing as to what an author had before him when founding a species. Unless, in the case of an insufficiently described species, the type-specimen is available, it is far better to entirely discard the name in question rather than to accept the interpretation of a subsequent author. The latter course is a fruitful source of error, for it is seldom possible to say definitely which later writer is the one to be followed.

while in *sp.* 2 they are so few as to appear arranged in a single zigzag series; also, in the latter species, the *podia* are less completely retractile. The arborescent *tentacles* are very similar in both forms. The general body *colour* of *sp.* 1 is a dirty, brownish white; while in *sp.* 2 it is a pure milk white, excepting the tips of the *podia*, which are yellowish. Both species are absolutely without maculation. In *sp.* 1 the neck and the bases of the tentacles are uniformly tinged a rich purple-brown colour, with more or fewer scattered pigment granules of an even darker colour. On the other hand, in *sp.* 2 these parts are typically pale, although generally they are more or less dusted with dark-coloured pigment granules, and sometimes, indeed, to such an extent as to render the neck region quite dark; but in such a case the dark pigmentation is never diffuse, as it invariably is in *sp.* 1. The interspaces between the *anal papillæ* are darkly pigmented in *sp.* 1, and in *sp.* 2 the interior of the anal orifice is reddish or orange coloured. A great difference is noticeable in the texture of the *surface.* In *sp.* 1 the test, being densely crowded with spicules, is very tough and coriaceous, and its surface is much wrinkled, while in *sp.* 2 the surface of the body is extremely smooth and delicate, marked only with transverse striæ due to the encircling fibres of the superficial muscle layer.

The spicular *deposits*, which are much more numerous in *sp.* 1 than they are in *sp.* 2, show considerable and characteristic differences. The general body spicule in *sp.* 1 is typically lozenge-shaped, perforated with four large foramina, and always bearing about twelve very prominent nodules: in *sp.* 2 the corresponding spicule is invariably absolutely devoid of nodulation, and an additional foramen is typically developed at each end of the long axis of the spicule, thus doing away with the simple lozenge shape. The upper body spicules of the two forms offer even greater diversity of structure: while in *sp.* 1 they are numerous and campanulate in form, in *sp.* 2 they are quite typical 'tables,' and, being few in number, are easily overlooked. The lateral deposits of the podia in *sp.* 1 have their foramina typically in a single series, while in *sp.* 2 they are arranged in two or more parallel rows, or with a group of three or four small foramina at each end of the spicule.

Returning now to Dr. Norman's paper on *Cucumaria Montagui*, Norman first briefly describes the external features of three spirit specimens, which he terms specimens 'A,' 'B,' and 'C,' and which with others had been collected for him by a local naturalist at Polperro, a few miles west of Plymouth. He then goes on to give a very full and remarkably lucid account of the spicules of each of these specimens individually. Specimen 'A' is certainly an example of what we have termed *Cucumaria*, *sp.* 1: the general body spicules, the campanulate deposits, and those of the podia and tentacles being well described.

Regarding his specimen 'B,' Norman says: "Body-spicule like that of A, but only a spicule here and there showing any nodulous growth, the vast majority presenting a perfectly smooth surface; nor are they so universally confined to the number of four foramina, the spicules often having an additional foramen at each end (*i.e.* four in a direct central longitudinal line). . . . No bell-shaped spicules have been found in this specimen, though they have been thoroughly sought for. Pedicels with lateral spicules, some just as in A, but here more generally with about three small foramina at each end." With reference to his specimen 'C,' Norman writes as follows: "Body-spicule exactly as in B, but here I could not find a single one that was nodulous, and no bell-shaped spicules. Pedicel-spicules as in B."

From the above quotations it will be seen that while Norman is thus describing in his specimens 'B' and 'C' the body-spicule of a Cucumarian which is evidently the same as my *Cucumaria, sp.* 2, he regards this spicule, by reason of the presence of a few scattered nodulous spicules in one of the preparations he examined, as a mere modification of that type which he had met with in his specimen 'A,' and which is characteristic of my *Cucumaria, sp.* 1. There can, however, be no doubt as to the absolute distinctness of the two spicule types, and the explanation of their apparent coexistence in Norman's specimen 'B' is probably a very simple one indeed; namely, that a few spicules of the first species were adhering to the surface of specimen 'B.' It must be remembered that all Dr. Norman's specimens had been preserved in the same bottle *; and I have been able to prove experimentally that under such condition it is a very easy matter for spicules from one individual to become transferred to the mucus, enveloping the body of another specimen; in fact, I was myself very nearly misled in this manner. It is also to be noted that Norman was unable to make out the upper body deposits, which, as already remarked, are not very easily seen in *sp.* 2, in either of his specimens 'B' or 'C'; had he observed these he would have seen immediately that he was dealing with a species different to that of his specimen 'A.'

Misled by the apparently enormous variability of the spicules of the specimens examined by him, Norman was induced to unite with *C. Montagui* a couple of other species, *Cucumaria Lefevrei*, Barrois, and *Semperia Drumondi*, Hérouard, which are probably distinct, and also to suggest the possible identity of still others: a suggestion which subsequent authors have not been slow to follow.†

* I have been able to examine the original bottle, which is now in the British Museum, and I can affirm that it contains both the species referred to in this paper.

† Kœhler (3) considers that Norman erred in uniting Hérouard's *Colochirus Lefevrei* with *H. Montagui;* but the evidence he adduces in support of this view is rather strange, and shows that he cannot have read Norman's paper at all carefully, for he instances the spectacle shape of the spicules of Norman's *Cucumaria Montagui*, and their invariable want of nodulation, as points of difference between it and *C. Lefevrei!*

Coming now to the question of the nomenclature of the two species of *Cucumaria*, which for convenience have hitherto in this paper been referred to merely as species '1' and '2.' It is unfortunate that the name *Montagui* cannot be retained for *sp.* 1, more especially as this form would in consequence appear to be as yet without a legitimate name; to meet this deficiency I would propose that the species be called *Cucumaria Normani*. Regarding the second species, this would appear to be the same as a form described more than thirty years since by Brady and Robertson (1) from the West of Ireland as *Cucumaria saxicola*, but which has since remained a 'doubtful' species.

Cucumaria Normani, n. sp.

1808: "*Holothuria Pentactes*, var.": *G. Montagu*, Trans. Linn. Soc., vol. ix. p. 112, pl. vii., fig. 4.

1893, Dec.: "*Cucumaria Montagui* (Fleming)": *A. M. Norman*, Ann. Mag. Nat. Hist., ser. 6, vol. xii. p. 469 [excl. specimens 'B' and 'C' and synonymy].

DIAGNOSIS.—Body of uniform dirty white or brownish colour, neck and bases of tentacles darkly pigmented, the pigment diffused. Test very coriaceous, densely crowded with deposits. Body-spicule typically lozenge-shaped, nodulous, and with four symmetrically disposed perforations. The foramina on the long axis of the spicule smaller and nearly circular, those of the short axis larger and elliptical in outline, the long axes of the foramina parallel to that of the spicule. Upper body-spicule campanulate, typically with four short arms which, arising from the ends of a short cross-bar, curve down to, and are inserted on a nodulous circular rim.

HABITAT.—Plymouth, on rocky ground, L.W.—10 fms. The type-specimen from Blackstone Rocks, Wembury Bay.

TYPE-SPECIMEN.—Has been acquired by the British Museum.

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Marine Biological Association of the United Kingdom.

Report of the Council, 1903-1904.

The Council and Officers.

Four ordinary and two special meetings of the Council have been held during the year, at which the average attendance has been ten. The Council have to thank the Royal Society and the Linnean Society for allowing the meetings to be held in their rooms.

The Council regret to record the death of Sir Henry Thompson, Bart., a Vice-President, as well as that of Mr. J. P. Thomasson, a Governor of the Association, through whose great generosity much of the early work of the Association in connection with fishery research was rendered possible.

Professor J. B. Farmer, F.R.S., resigned his seat on the Council during the year, and the vacancy was filled by the election of Mr. Francis Darwin, F.R.S.

The Laboratories.

Only repairs of an ordinary character have been necessary at the Plymouth Laboratory in order to maintain the buildings, machinery, and equipment in an efficient condition. The Council have still reason to regret that a good deal of the accommodation of the Laboratory, although utilised during the summer months, is unoccupied during a large part of the year owing to the limited number of workers whose services can for financial reasons be retained by the Association. A satisfactory remedy for this state of things would be found if Universities and other teaching institutions would offer scholarships to students anxious to carry on marine investigations at Plymouth.

The Lowestoft Laboratory has proved adequate for the purposes for which it was intended. It has been improved during the year by the addition of a room in which to keep small aquaria and of a dark room for photographic work.

The Boats.

The steamer *Huxley*, which was fitted out for the International Investigations in the North Sea, has proved an efficient and successful vessel for the work. She has been at sea throughout the year, and has experienced weather of all kinds without accident.

The *Oithona* worked at Plymouth during last summer. In October she was sent to Grimsby, where a new boiler is being placed on board, and the vessel is undergoing a thorough overhaul and refit. Some delay was experienced in commencing these repairs owing to lack of funds for the purpose. The Council have to thank the following persons for generously promising special contributions to enable the work to be proceeded with:—

	£
The Court of the Worshipful Company of Fishmongers	200
G. P. Bidder, Esq.	50
T. H. Riches, Esq.	50
J. Shaw, Esq.	13
Mrs. Bidder	5
H. F. Bidder, Esq.	3

The Staff.

The only change which has taken place in the Staff of Naturalists employed by the Association since the last general meeting has been the appointment of Mr. J. O. Borley, M.A., as an Assistant Naturalist at Lowestoft in place of Mr. C. Forster Cooper, who has resigned.

Occupation of Tables.

The following Naturalists have occupied tables at the Laboratory during the year:—

G. P. Bidder, M.A., Cambridge (Experiments for determining bottom currents).
W. R. G. Bond, M.A., Oxford (General Zoology).
Rev. A. Cole, Berkhamsted (General Zoology).
A. D. Darbishire, M.A., Manchester (Sponges).
L. Doncaster, M.A., Cambridge.
G. P. Farran, B.A., Dublin (Plankton).
E. G. Gardiner, Boston, Mass. (Rhabdocoels).
F. W. W. Griffin, B.A., Cambridge (Embryology of Fishes).
Miss A. Kelly, Ph.D., Strassburg (Invertebrate Physiology).
Rev. Dr. A. M. Norman, F.R.S., Berkhamsted (Crustacea).
Mrs. S. Pace, Plymouth (Polyzoa).
Miss E. Peacey, Oxford (General Zoology).
Dr. C. Shearer, Cambridge (Development of Annelida).
Miss I. Sollas, Cambridge (Echinoderma).
J. Stuart Thomson, Plymouth (Fishes).
Prof. W. F. R. Weldon, F.R.S., Oxford (Variation of Mollusca).
W. Woodland, University College, London (Echinoderma).

Six students attended a course of study in Marine Biology conducted at the Laboratory during the Easter vacation by Mr. L. Doncaster.

The Library.

The thanks of the Association are due for the following books and current numbers of periodicals presented to the Library during the past year:—

Académie Imp. des Sciences de St. Pétersbourg. Bulletin.
Agent General for New South Wales. Report.
Allgemeine Fischerei-Zeitung.
American Microscopical Society. Transactions.
American Museum of Natural History. Bulletin.
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—— Annual Report of the Inspectors, Sea Fisheries, England and Wales.
—— Report of Meetings of Fisheries Representatives.
Boston Society of Natural History. Proceedings.
British Association for the Advancement of Science. Report.
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Brooklyn Institute of Arts and Sciences. Cold Spring Harbor Monographs.
—— Science Bulletin.
Brown University. Contributions from the Anatomical Laboratory.
Bryn Mawr College. Monographs, Reprint Series.
Buffalo Society of Natural Sciences. Bulletin.
Bulletin Scientifique de la France et de la Belgique.
La Cellule.
College of Science, Tokyo. Journal.
College voor de Zeevisscherijen. Verslag van den Staat der Nederlandsche Zeevisscherijen.
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Commissioners of Inland Fisheries, Rhode Island. Annual Reports.
Conseil perm. internat. pour l'Exploration de la Mer. Bulletin des Résultats acquis pendant les Courses Périodiques.
—— Publications de Circonstance.
—— Rapports et Procès-Verbaux des Réunions.
Cuerpo de Ingenieros de Minas del Peru. Boletin.
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—— Skrifter.
Dept. of Agriculture, Cape of Good Hope. Marine Investigations in South Africa.
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Dept. of Marine and Fisheries, Canada. Annual Report.
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La Feuille des Jeunes Naturalistes.
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The Fisherman's Nautical Almanack; by O. T. Olsen.
Fishery Board for Scotland. Annual Report.
The Fishing Gazette.
Fischzucht Anstalt, Nikolsk. Aus der Fischzuchtanstalt Nikolsk.
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The Government Biologist, Cape of Good Hope. Marine Investigations in South Africa.
Government Museum, Madras. Report.
Illinois State Laboratory. Bulletin.
Indian Museum. Illustrations of the Zoology of the R.I.M.S.S. Investigator.
Indiana University. Bulletin.
R. Irish Academy. Proceedings.
—— Transactions.
Kommission zur wissenschaftlichen Untersuchung der Deutschen Meere, etc. Wissenschaftliche Meeresuntersuchungen.
Laboratoire Biologique de St. Petersbourg. Bulletin.
Lancashire Sea Fisheries Laboratory. Report.
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Norges Fiskeritvrelse. Aarsberetning vedkommende Norges Fiskerier.
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Oberlin College. The Wilson Bulletin.
Peterborough Natural History, etc., Society. Report.
Physiographiske Forening Christiania. Nyt Magazin for Naturvidenskaberne.
Plymouth Institution. Annual Report and Transactions.
Quarterly Journal of Microscopical Science. (Presented by Prof. E. Ray Lankester, F.R.S.)
Resultats des Campagnes Scientifiques . . . Albert I^{er} de Monaco.
Le Réveil Salicole Ostréicole et des Pêches Maritimes, etc.
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—— Proceedings.
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—— Report of the Sleeping Sickness Committee.
—— Report to the Government of Ceylon on the Pearl Oyster Fisheries of the Gulf of Manaar.
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—— Bulletin of the United States National Museum.
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Société Imp. Russe de Pisciculture et de Pêche. Messager de l'Industrie de la Pêche.
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Kgl. Svenska Vetenskaps-Akademien. Handlingar.
—— Bihang till Handlingar.
—— Arkiv för Botanik.
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Tokyo Imp. University. Calendar.
A Treatise on Zoology; edited by E. R. Lankester.
Ulster Fisheries and Biology Association. Report.
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Prof. C. B. Davenport. Variation in the Number of Stripes on the Sea-Anemone, Sagartia Luciæ; by G. C. Davenport.
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Dr. E. G. Gardiner. Science (odd parts).
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—— The Bionomics of *Convoluta Roscoffensis*, with special Reference to its green Cells; by F. W. Gamble and F. Keeble.
—— Ditto, Abstract.
—— The Colour Physiology of the Higher Crustacea; by F. Keeble and F. W. Gamble.
—— On the Presence of Mobile Fat in the Chromatophores of the Crustacea (Hippolyte varians); by F. Keeble and F. W. Gamble.
—— On a Collection of Turbellaria Polycladida from the Straits of Malacca; by F. F. Laidlaw.
—— On the Marine Fauna of Zanzibar and British East Africa, etc. Turbellaria Polycladida, Part I.; by F. F. Laidlaw.
—— Suggestions for a Revision of the Classification of the Polyclad Turbellaria; by F. F. Laidlaw.
Dr. H. Fowler. Über den Bau und die morphologische Auffassung der Siphonophoren; by C. Chun.
Honolulu Museum. Fauna Hawaiiensis.
The Secretary of State for the Colonies. Report of the Government Biologist, Cape of Good Hope.

To the authors of the Memoirs mentioned below the thanks of the Association are due for separate copies of their works presented to the Library:—

Bateson, W. Variation and Differentiation in Parts and Brethren.
Brown, E. T. Report on some Medusae from Norway and Spitzbergen.
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—— On the Marine Fauna of Zanzibar and British East Africa, etc. Polychæta I. and II.
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—— Wonder Horses and Mendelism.
—— Colour Inheritance in Mice.

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—— The Collembola of Cold Spring Beach, with Special Reference to the Movements of Poduridæ.

—— Report on the Freshwater Bryozoa of the United States.

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—— Drei Aphorismen zur Entwickelungsphysiologie jüngster Stadien.

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—— Über Seeigelbastarde.

Edwards, C. L. Note on Phrynosoma.

Farran, G. P. Record of the Copepoda taken on the Mackerel Fishing Grounds off Cleggan in 1901.

—— The Nudibranchiate Molluscs of Ballynakill and Bofin Harbours, Co. Galway.

Fowler, G. H. Contributions to our Knowledge of the Plankton of the Faeroe Channel. Nos. VII. and VIII.

Gerould, J. H. Studies on the Embryology of the Sipunculidae. Part I.

Giard, A. Caractères dominant transitoires chez certains hybrides.

—— Notes Ethologiques sur le Hareng des côtes du Boulonnais.

—— Exuviations métamorphiques chez les Ascarides des Poissons.

—— Dissociation de la Notion de Paternité.

—— La Mouche de l'Asperge et ses Ravages à Argenteuil.

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Giles, G. M. On Pre-pupal changes in the Larvæ of the Culicidæ.

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—— Ditto, August, 1903.

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Gurney, R. Metamorphoses of the Decapod Crustaceans Ægeon (Crangon) fasciatus and Ægeon (Crangon) trispinosus.

Hickson, S. J. On the Coelenterata collected by Mr. C Crossland in Zanzibar. I. Ceratella minima.

—— The Alcyonaria of the Maldives. Part I.

Holt, E. W. L., and Byrne, L. W. On a Young Stage of the White Sole, Pleuronectes cynoglossus.

—— The British and Irish Gobies.

Horst, R. On a case of Commensalism of a Fish (*Amphiprion intermedius*, Schleg.) and a large Sea-Anemone (*Discosoma* spec.).

—— New Species of the Genus Euphrosyne from the Siboga Expedition, with a Table of the Species hitherto known.

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Laidlaw, F. F. On a Land Planarian from Hululi Male Atoll, with a note on *Leptoplana pardalis* Laidlaw.

McIntosh, W. C. On the Distribution of Marine Animals.

—— The Story of a Pearl.

—— Marine Annelids (Polychaeta) of South Africa. Part I.

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—— British Land Isopoda. Supplement.

—— New Generic Names for some Entomostraca and Cirripidia

—— Copepoda Calanoida, chiefly Abyssal, from the Faroe Channel and other Parts of the North Atlantic.

Nutting, C. C. The Bird Rookeries on the Island of Laysan.
Punnet, R. C. The Enteropneusta of the Maldives and Laccadives.
—— Note on the Proportion of the Sexes in Carcinus maenas.
—— On Nutrition and Sex-determination in Man.
Schmidt, J. Some Preliminary Remarks on the Identification of Pelagic Postlarval forms of Gadoids.
Shipley, A. E. On the Ento-Parasites Collected by the Skeat Expedition, etc.
—— Report on the Gephyrea collected by Prof. Herdman, at Ceylon, in 1902.
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—— The Order of Insects.
—— Some Parasites from Ceylon.
Smith, J. C. The Animal Parasite supposed to be the Cause of Yellow Fever.
—— Discovery of Yellow Fever Germs.
Stenius, S. Der Osmotische Druck im Meerwasser.
Stevens, N. M. Further Studies on the Ciliate Infusoria, Licnophora, and Boveria.
Tattersall, W. M. Notes on the Classification and Geographical Distribution of the Cephalochorda.
Thompson, M. T. The Metamorphosis of the Hermit Crab.
Todd, R. A. Notes on the Invertebrate Fauna and Fish-Food of the Bays between the Start and Exmouth.
Trybom, F. Two New Species of the Genus Euconaxius.
Walker, A. O. Report on the Isopoda and Amphipoda Collected by Mr. G. Murray, etc.
—— Amphipoda of the "Southern Cross" Antarctic Expedition.
Walker, A. O., and Scott, A. Crustacea from Abd-el-Kuri.
Wallace, W. Observations on Ovarian Ova and Follicles in certain Teleostean and Elasmobranch Fishes.
Watson, A. T. Observations on the Habits of the Onuphidae, etc.
—— On the Structure and Habits of the Polychaeta of the Family Ammocharidæ.
Williams, J. L. Alternation of Generations in the Dictyotaceæ.
—— Studies in the Dictyotaceæ. Parts I. and II.
Woodcock, H. M. On Myxosporidia in Flat-Fish.
—— Notes on a Remarkable Parasite of Plaice and Flounders.

General Work at the Plymouth Laboratory.

The detailed reports on the trawling experiments in the bays on the South Devon coast, and on the study of fish scales as an index of the age of fishes, have been published in the Journal of the Association.

A report on the local distribution of the invertebrate fauna of the Plymouth neighbourhood, summarising the work which has been done in this direction by the Association, is now nearing completion. This report will, it is hoped, be published during the course of the present year.

At the request of the British Royal Commission, an exhibit has been prepared on behalf of the Association and sent to the St. Louis Exhibition. It illustrates the development and growth of sea fishes, and embodies a representative collection of the principal invertebrate animals which serve as the food of fishes. This exhibit has been successfully transported to St. Louis and set up in the Exhibition.

The collection and supply of specimens for teaching purposes and for museums has been continued as heretofore. This part of the work of the Laboratory has grown considerably during the last few years, owing to the fact that the teaching of biology is receiving more and more attention in secondary and technical schools, and that local museums are also paying more attention to the subject. It is a matter for regret, however, that the increase in these directions is accompanied by a decrease in the amount of material supplied to the Universities and University Colleges, where the number of zoological students appears to be generally diminishing.

The International Fishery Investigations.

SECTION I.—NORTH SEA WORK.

A. WORK OF THE S.S. "HUXLEY."

TRAWLING INVESTIGATIONS.—Except when required for the quarterly hydrographic cruises in the English Channel, the s.s. *Huxley* has been continuously engaged during the past year in the investigation of the North Sea fishing grounds. In carrying out this work the Association's naturalists have directed their principal attention to the analysis of hauls made on the various grounds with the large commercial trawl, the quantities and sizes of the fishes caught having been systematically recorded in every case.

Up to the end of May, 1904, the *Huxley* had made thirty-one voyages, often of two or three weeks' duration, and had taken 349 hauls of the great trawls (otter and beam), in addition to other experiments with special apparatus.

In accordance with the scheme of international co-operation, most attention has been paid by the *Huxley* to the western half of the North Sea south of latitude 56° N.; but all the important trawling grounds south of that latitude have been visited, and special voyages have been made to assist in the survey of the continental grounds where small flat-fish particularly abound. Nearly one-third of the *Huxley's* hauls (*i.e.* 110) have been taken upon or on the borders of the English and continental "nursery grounds."

FISH MEASURED.—On the voyages mentioned over 100,000 fishes have been measured on the grounds where they were caught, as shown in the following table:—

	PLAICE.	HADDOCK.	OTHERS.		TOTALS.
North Sea . .	34,809	8,388	62,106	...	105,303
English Channel .	252	—	2,059	...	2,311
	35,061	8,388	64,165	...	107,614

Marking Experiments.—Experiments have been systematically carried out in the marking and liberation of fishes, especially plaice and soles, over wide areas, in order to throw light on their migrations and rate of growth, and on the intensity of fishing under modern conditions. Altogether, up to the end of May, 1904, 2,881 fishes had been marked and set free. Of these the majority were liberated in the localities where they were caught, but during the present year about 1,200 marked plaice have been transplanted to the Dogger Bank from the English, Dutch, and Danish nursery grounds, in order to test the possibility of their rate of growth being more rapid in parts of the sea where the competition for food is apparently less keen. If these transplantation experiments should be successful, the possibility of restocking exhausted areas in the North Sea will have entered upon a new phase.

The success of the marking experiments in general is shown by the satisfactory percentage of marked fish which have been returned by the fishermen, by the general consistency of the returns, and by the interesting results obtained in regard to the seasonal migrations of the fish. Of 539 plaice liberated up to the end of May, 1903, the number of recoveries amounted twelve months later to 125, *i.e.* 23 per cent. The experiments off the north coast of Holland, referred to in the last Annual Report of the Council, were repeated during the autumn and winter of 1903. The movements of plaice again showed the same southward tendency, and a simultaneous migration in the same direction was exhibited off the English coast. Plaice marked and liberated on the Leman Ground (about fifty miles east of Cromer) on December 10th, were recovered in February off the Suffolk coast, and in March in the English Channel off Winchelsea (a minimum distance of 175 miles).

Mr. A. Meek, Lecturer in Biology at the Durham College of Science, and Director of the Marine Laboratory at Cullercoats (since destroyed by fire), has kindly co-operated with the Association's staff in the marking experiments, and, in addition to special experiments, liberated about 200 marked plaice on behalf of the Association off the coast of Northumberland during the summer of last year. Most of the fish recovered were recaught locally, but several were subsequently recovered in Scottish waters, off St. Andrews Bay and the Isle of May.

Special Experiments.—During the present year special experiments have been made on the vitality of trawl-caught fishes and on the proportion of small fishes which escape through the meshes of the trawl.

In May, drift-bottles were thrown overboard at intervals along lines between Lowestoft and Heligoland, and between the Wash and the

Dogger Bank, in order to determine the direction of drift during the spawning season of the sole and turbot.

The *Huxley* has recently completed a special survey of the spawning grounds of the sole in the western part of the North Sea, and an investigation of the distribution and abundance of the eggs of this species in the same area, in co-operation with simultaneous surveys by the *Poseidon* and *Wodan* in the German and Dutch areas respectively.

B. LABORATORY INVESTIGATIONS.

AGE OF FISHES.—Considerable attention has been paid in the Laboratory at Lowestoft to the investigation of the age and rate of growth of fishes, especially the plaice, both by Petersen's statistical method based on the periodicity of the spawning season, by Reibisch's method based on the periodicity of growth of the otoliths, and by direct observation of the increase in length of marked fishes. The result of these investigations is to show that the age of individual plaice can now be determined with considerable exactitude—a matter of much importance for the scientific treatment of fishery problems.

FOOD OF FISHES.—Extensive material has been collected and worked up for determining the physical and biological characteristics of the various grounds, and the food-contents of many thousands of fish-stomachs have been studied and recorded.

C. FISHERMEN'S RECORDS.

1903–1904.—The system of fishermen's trawling records has recently been extended to Grimsby, at which port several specially reliable trawling skippers have been selected to take part in the work. The Lowestoft records are being continued. These records deal with individual hauls of the trawl, and have been found useful for supplementing and checking the results of the *Huxley's* investigations, and in providing a kind of outside "intelligence department" for keeping the scientific staff informed of the most profitable regions for investigation from time to time.

1881–1882.—Log-books of a somewhat similar character, initiated by Mr. Olsen, of Grimsby, with the co-operation of the late Mr. Frank Buckland, were kept by a number of east coast fishermen in 1881 and 1882, and have been kindly entrusted to the Association by Mr. Olsen for analysis and report.

1892–1893.—Records more closely approximating to those now being kept were again filled up for Mr. Holt, when in the service of the Association, by various Grimsby fishermen in 1892 and 1893.

The Association is thus in the possession of a unique series of fishermen's records which distinguish the fishing ground, date and duration of fishing, and amount of fish caught for each haul of the trawl. All the records have been tabulated for the purpose of comparison, and it is hoped that light will be thrown by means of them, in conjunction with the scientific survey now in progress, upon any changes which have taken place in the distribution and abundance of fish on particular grounds during the past twenty-three years.

1865–1874.—Records of the Ramsgate trawl-fishing, covering the greater part of the period from 1865 to 1874, have also been placed in Mr. Garstang's hands by the fisherman who kept them. The same boat is still fishing from Ramsgate, and the present master has undertaken to keep a record of his catches for comparison with the old ones referred to.

The thanks of the Association are due to the Eastern and North Eastern Sea Fisheries Committees for the privilege of trawling within the waters under their jurisdiction, and to their Inspectors, Mr. Herbert Donnison and Captain R. E. Simpson, for much friendly assistance; also to the Great Central Railway Company, the Boston Corporation, and the Great Eastern Railway Company, for privileges in connection with harbour facilities at Grimsby, Boston, and Lowestoft.

At several ports the work in connection with the reception and transmission of marked fish recovered by the fishermen has been considerable. The best thanks of the Association are due to their agents in this connection, especially to Mr. O. T. Olsen, F.L.S., of Grimsby, to Mr. W. C. Edwards, Statistical Officer to the Board of Agriculture and Fisheries at Hull, and to Messrs. A. Johnson and J. Roberts, Inspectors of the Fishmongers' Company at Billingsgate.

Last, but not least, the Association is indebted to the fishing-boat owners and fishermen of the east coast for the general interest which they have displayed in the investigations in progress, and for the confidence and friendly spirit with which they have co-operated with the naturalists of the Association in the work.

Section II.—HYDROGRAPHIC AND PLANKTON WORK IN THE ENGLISH CHANNEL.

Six quarterly cruises have now been made in the English Channel, viz. in February, May, August, and November, 1903, and February and May, 1904, on each of which the programme of hydrographic and plankton observations described in last year's Report has been carried out. The material collected up to February, 1904, has been worked out and the results forwarded to the Central Bureau in Copenhagen. The observations made up to November, 1903, have already been published in the International Bulletin.

The number of stations at which observations are made has been slightly increased, three stations having been added at the eastern end of the Channel. At the same time the plankton programme has been somewhat reduced at certain of the shallower stations where no marked difference in the organisms found at different depths could be proved by the methods employed.

In addition to the work done on the cruises, samples of sea-water and of plankton are being regularly taken on a number of lightships in the Channel and on the Irish coast, and samples of water are obtained every fortnight from steamers crossing the Channel from Newhaven to Caen and from Plymouth to the Channel Islands. A number of samples have also been taken at the mouth of the English Channel and in the Bay of Biscay by officers of steamships navigating those waters.

The hydrographic observations during 1903 and the first three months of 1904 show that the direction of the flow of the waters of the English Channel is from west to east, and that they are derived from a northerly current of about 35·6 ‰ S. from the Bay of Biscay and from a southerly current of about 35·2 ‰ S. or less from the Irish Sea and Bristol Channel. The meeting-place of these waters may be roughly fixed as south of the Scilly Islands in mid-channel, and it will be generally found that the salinity of the water increases as we pass this point from west to east. Owing to the varying salinity and temperature of these two currents it has been found that at the entrance to the Channel the water is often divided into distinct layers, while the changes of their relative velocity, combined with the general drift up Channel, give rise to alternate areas of high and low salinity which follow one another eastward. On the line between the Isle of Wight and Cape Barfleur the salinity has been low on all five cruises, a state of things due in all probability to the amount of fresh water discharged from Southampton Water and the Seine. The presence of denser water south of Beachy Head, however, points to the occasional passage of a high salinity current across this line.

In February (1903) the Channel from the Land's End to the Isle of Wight was filled with water of 35·4 ‰ S., bounded by fresher water on the west and east, and by water of 35·5 ‰ near Ushant, the general features pointing to a quick movement. No observations were made east of the Isle of Wight.

In May the area of 35·4 ‰ S. had diminished in size, being encroached upon by water of 35·6 ‰ on the south-west and by fresher water on the east. In this month the area of 35·4 ‰ S. south of Beachy Head was first observed, and the increased distance between the isohalines indicated a slower movement.

In August the low-salinity water of the Irish Sea had spread south and east so as to cut off the 35·4 ‰ water of the western part of the Channel from the dense water of the Bay of Biscay *on the surface*, though there was still a connection by an undercurrent. The general velocity of the currents had reached its minimum, whilst the difference in temperature between the top and bottom was now greatest. The isolated area in the eastern part of the Channel was not well marked, but this may have been due to the want of observations far enough south.

In November there were signs of an increased velocity, and water of high salinity was now found west of Ushant, though there was still a narrow strip of fresher water between this point and the area of 35·4 ‰ S. south of Devon and Cornwall. The dense water in the eastern part of the Channel was well marked.

In February, 1904, the conditions were complicated by the great gale at the beginning of the month, and the distribution of salinity for the first ten days, as shown by the analysis of samples taken on liners, lightships, etc., differs considerably from that obtaining from February 16th to March 1st, when the observations on the *Huxley* were made. During the first period a large area of 35·6 ‰ S. extended from a point about 100 miles south of the Irish coast easterly to mid-channel south of Land's End, and thence south-west across the Bay of Biscay. This was quickly obliterated by a southerly flow from the Irish Sea, and during the latter half of the month it only appeared as an isolated area marked by a single sample in mid-channel north of Ushant, the general conditions east of this point resembling those of May in the previous year.

It would appear that during the summer and early autumn the Channel waters were derived largely from the Irish Sea, while during the rest of the year the high-salinity water of the Bay of Biscay preponderated.

An interesting conclusion regarding the effect of gales may be drawn from the work done during the period dealt with in this Report, namely, that they cause considerable variations in the physical conditions at any point, but these variations do not persist for more than a few days. The great gale at the beginning of February, 1904, caused a marked rise in salinity of the surface water at the lightships round the coast from Cardigan Bay to the East Goodwin, with the exception of the *Owers* and *Royal Sovereign* light-vessels, where an equally well-marked fall occurred. In less than a week, however, normal conditions again prevailed, and as it is impossible to make observations on a small steamer like the *Huxley* during or for a few days after a gale, it is almost certain that the results obtained on any cruise show the normal conditions for the season. The variations mentioned show that the denser waters were driven up Channel and inshore, causing a rise of salinity, the fall at the *Owers* and *Royal Sovereign* being easily explained by the fact that the Isle of Wight is always surrounded by comparatively fresh water, and that a strong gale from the south-west or west would drive this eastwards along the shore.

The plankton observations show that a large proportion of the more oceanic organisms found off the mouth of the Channel do not penetrate for any considerable distance up Channel, even along a central axis, the percentage of oceanic species having on each cruise fallen below forty at the stations on the line from the Isle of Wight to Cape Barfleur. When compared with those taken by other countries in the southern part of the North Sea, the observations indicate that very similar conditions exist in the eastern end of the English Channel (from the Isle of Wight to the Straits of Dover) to those found in the southern part of the North Sea, between a line from the Wash to Heligoland and the Straits of Dover.

The results both of the hydrographic and of the plankton work can only be interpreted on the supposition that during the period under investigation there was on the whole a constant passage of water from the Channel into the southern part of the North Sea, but the rate at which this passage of water took place must have been very slow.

Published Memoirs.

The following papers, either wholly or in part the outcome of work done at the Laboratory, have been published elsewhere than in the Journal of the Association:—

ADERS, W. M.—*Beiträge zur Kenntnis der Spermatogenese bei den Cölenteraten.* Zeitsch. Wiss. Zool., vol. 74, pp. 81-108. 1893.

DAVENPORT, C. B.—*Quantitative Studies in the Evolution of Pecten.* III. *Comparison of Pecten opercularis from three localities of the British Isles.* Proceed. American Acad. Arts and Sci., vol. xxxix., 1903, pp. 123-159.

GROSVENOR, G. H.—*On the Nematocysts of Æolids.* Proceed. Roy. Soc., vol. lxxii., 1903, pp. 462-486.

GURNEY, R.—*The Metamorphoses of the Decapod Crustaceans* ÆGEON (CRANGON) FASCIATUS Risso, *and* ÆGEON (CRANGON) TRISPINOSUS (Hailstone). Proceed. Zool. Soc., London, 1903, II., pp. 24-30.

HOLT, E. W. L., and BYRNE, L. W.—*The British and Irish Gobies. Report on Sea and Inland Fisheries of Ireland for* 1901. Part II., pp. 37-66. Published 1903.

KEEBLE, F., and GAMBLE, F. W.—*The Colour-physiology of Higher Crustacea.* Phil. Trans. Roy. Soc. Series B. vol. 196, pp. 295-388, 1904.

WALLACE, W.—*Observations on Ovarian Ova and Follicles in Certain Teleostean and Elasmobranch Fishes.* Quart. Journ. Micr. Sci., vol. xlvii. pp. 161-213.

WATSON, A. T.—*Observations on the Habits of the Onuphidæ.* Trans. Liverpool Biol. Soc., vol. xvii. pp. 303-318. 1903.

WOODCOCK, H. M.—*On Myxosporidia in Flat-Fish.* Report for 1903 on the Lancashire Sea Fisheries Laboratory, pp. 46-62.

Donations and Receipts.

The receipts for the year for the ordinary work of the Association include the grants from His Majesty's Treasury (£1,000) and the Worshipful Company of Fishmongers (£400), Special Donations (£271), Annual Subscriptions (£113), Rent of Tables in the Laboratory (£16), Sale of Specimens and Fish (£285), Admission to the Tank Room (£141).

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Dr. *Statement of Receipts and Expenditure*

	£ s. d.	£ s. d.
To Current Income:—		
H.M. Treasury	1,000 0 0	
Fishmongers' Company (including half-year's payment of £200 on account of year to 31st May, 1905)	400 0 0	
Annual Subscriptions	113 7 0	
Rent of Tables	16 12 0	
Interest on Investment	18 19 11	1,548 18 11
„ Extraordinary Receipts:—		
Donations to Fund for Repair of ss. *Oithona*—		
Fishmongers' Company ... £200 0 0		
G. P. Bidder ... 50 0 0		
J. Shaw ... 13 0 0		
Mrs. A. Bidder ... 5 0 0		
H. F. Bidder ... 3 0 0	271 0 0	
Advance on Loan	100 0 0	
Cheque drawn some years ago, but not presented for payment, written back	10 0 0	381 0 0
		£1,929 18 11

Investment held 31st May, 1904, £500 Forth Bridge Railway 4% Guaranteed Stock.

Examined and found correct,

(Signed) Edwin Waterhouse, F.C.A. Geo. P. Bidder.
E. T. Browne. E. A. Minchin.

June 28th, 1904.

for the Year ending 31st May, 1904. **Cr.**

		£ s. d.	£ s. d.
By Balance from last year, viz.:—			
Amount due to Bankers		156 3 11	
Less Cash in hand		39 2 11	117 1 0
„ Current Expenditure:—			
Salaries and Wages—			
Director		200 0 0	
Naturalist		250 0 0	
Director's Assistant		150 0 0	
Wages		421 2 7	1,021 2 7
Travelling Expenses			54 14 0
Library			87 19 1
Journal—Printing and Illustrating		245 19 8	
Less Sales of Journal		22 7 2	223 12 6
Buildings and Public Tank Room—			
Gas, Water, Coal, etc.		74 13 9	
Stocking Tanks, Feeding, etc.		29 14 3	
Maintenance and Renewals		122 14 11	
Rent of Land, Rates, Taxes, and Insurance		17 0 7	
		244 3 6	
Less Admissions to Tank Room		141 5 10	102 17 8
Laboratory, Boats, and Sundry Expenses—			
Stationery, Office Printing, Postage, etc.		85 12 10	
Glass, Chemicals, & Apparatus	£95 18 6		
Less Sales	5 18 7	89 19 11	
Purchase of Specimens		35 7 0	
Maintenance and Renewals of Boats, Nets, Gear, etc.	£257 19 0		
Less Sales	124 18 7	133 0 5	
Coal and Water for Steamer		84 17 7	
		428 17 9	
Less Sales of Specimens, etc. (including £50 from International Investigations Commission for use of ss. *Oithona*)		335 3 7	93 14 2
Interest on Bank Overdraft			3 15 6
			1,704 16 6
„ Extraordinary Expenditure—			
Cost of Exhibit sent to St. Louis Exhibition—to be refunded by the British Royal Commission		173 1 6	
Less Received on Account		52 3 7	120 17 11
„ Balance, being cash at Bank and in hand, 31st May, 1904, viz.:—			
Plant, Repairs, and Renewals Fund, including £25 added during year		116 10 8	
Donations to Fund for repair of ss. *Oithona* received per contra		271 0 0	
		387 10 8	
Less Amount overpaid on General Account		283 6 2	104 4
			£1,929 18 11

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OBJECTS

OF THE

Marine Biological Association of the United Kingdom.

THE ASSOCIATION was founded at a Meeting called for the purpose in March, 1884, and held in the Rooms of the Royal Society of London.

The late Professor HUXLEY, at that time President of the Royal Society, took the chair, and amongst the speakers in support of the project were the late Duke of ARGYLL, the late Sir LYON PLAYFAIR, Lord AVEBURY, Sir JOHN HOOKER, the late Dr. CARPENTER, Dr. GÜNTHER, the late Lord DALHOUSIE, the late Professor MOSELEY, the late Mr. ROMANES, and Professor LANKESTER.

The Association owes its existence and its present satisfactory condition to a combination of scientific naturalists, and of gentlemen who, from philanthropic or practical reasons, are specially interested in the great sea fisheries of the United Kingdom. It is universally admitted that our knowledge of the habits and conditions of life of sea fishes is very small, and insufficient to enable either the practical fisherman or the Legislature to take measures calculated to ensure to the country the greatest return from the "harvest of the sea." Naturalists are, on the other hand, anxious to push further our knowledge of marine life and its conditions. Hence the Association has erected at Plymouth a thoroughly efficient Laboratory, where naturalists may study the history of marine animals and plants in general, and where, in particular, researches on food-fishes and molluscs may be carried out with the best appliances.

The Laboratory and its fittings were completed in June, 1888, at a cost of some £12,000. Since that time investigations, practical and scientific, have been constantly pursued at Plymouth. Practical investigations upon matters connected with sea-fishing are carried on under the direction of the Council; in addition, naturalists from England and from abroad have come to the Laboratory, to carry on their own independent researches, and have made valuable additions to zoological and botanical science, at the expense of a small rent for the use of a working table in the Laboratory and other appliances. The number of naturalists who can be employed by the Association in special investigations on fishery questions, and definitely retained for the purpose of carrying on those researches throughout the year, must depend on the funds subscribed by private individuals and public bodies for the purpose. The first charges on the revenue of the Association are the working of the sea-water circulation in the tanks, stocking the tanks with fish and feeding the latter, the payment of servants and fishermen, the hire and maintenance of fishing-boats, and the salary of the Resident Director and Staff. At the commencement of this number will be found the names of the gentlemen on the staff.

In the summer of 1902 the Association was commissioned by His Majesty's Government to carry out in the southern British area the scheme of International Fishery Investigations adopted by the Conference of European Powers which met at Christiania in 1901. In connection with this work a laboratory has been opened at Lowestoft.

The purpose of the Association is to aid at the same time both science and industry. It is national in character and constitution, and its affairs are conducted by a representative Council, by an Honorary Secretary and an Honorary Treasurer, without any charge upon its funds, so that the whole of the subscriptions and donations received are devoted absolutely to the support of the Laboratory and the prosecution of researches by aid of its appliances. The reader is referred to page 4 of the Cover for information as to membership of the Association.

CONTENTS OF NEW SERIES, Vol. VII., No. 2.

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All correspondence should be addressed to the Director, The Laboratory, Plymouth.

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OF THE

MARINE BIOLOGICAL ASSOCIATION

OF

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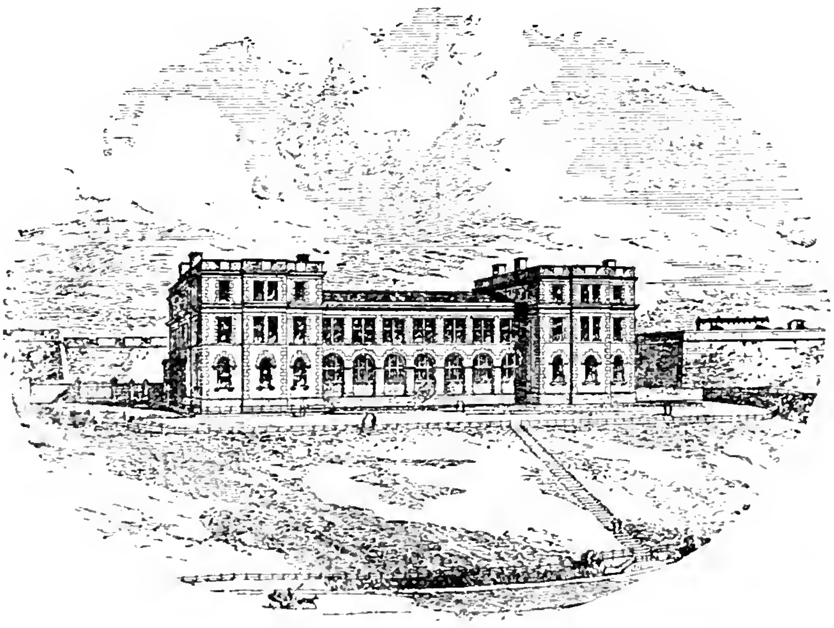

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Professor W. F. R. Weldon, F.R.S.

By the death of Professor W. F. R. Weldon, F.R.S., Linacre Professor of Comparative Anatomy in the University of Oxford, which occurred on Good Friday, 13 April, 1906, with painful suddenness in the midst of his activities, the Marine Biological Association has lost one of its oldest workers and one of its most earnest and enthusiastic supporters. It was in the autumn of 1887, before the building of the Laboratory was completed, that Professor Weldon first commenced work in connection with the Association, and from that time until his appointment to the Chair of Zoology, at University College, London, in 1891, he resided chiefly at Plymouth, and was engaged in investigations at the Laboratory. Since 1891, although the periods spent at Plymouth have not been so prolonged, visits during his vacations have taken place at frequent intervals, and many of his most important papers have been based upon researches carried out at the Laboratory and material collected there.

Professor Weldon's earlier investigations were directed to the study of the classification, morphology, and development of the Decapod Crustacea, and, although much of what he did remains unpublished, the thoroughness with which his researches upon the whole group were carried out was shown in the special courses of lectures upon it, which he subsequently delivered at University College. At the same time several important papers resulted from the work. In two memoirs, one published in the Journal of the Association on "The Cœlom and Nephridia of *Palæmon serratus*" (N.S., i. p. 162), and the other in the *Quarterly Journal of Microscopical Science*, on "The Renal Organs of Certain Decapod Crustacea" (vol. xxxii. p. 279), the structure of the green glands of various Decapods was described, and the remarkable development of the bladder of these glands in *Palæmon*, with its considerable extension backwards into the body cavity, was for the first time pointed out. In a later paper, on "The Formation of the Germ Layers in *Crangon vulgaris*" (*Quart. Journ. Micr. Sc.*, vol. xxxiii. p. 343), a careful and detailed account of the early development of a typical decapod ovum was given, and this paper well illustrates Professor Weldon's skill, both as a master of histological technique and as a powerful and accurate draughtsman.

Of Professor Weldon's later work, based upon the application of statistical methods to the study of variation, by which he will be chiefly remembered as a biological thinker of originality and force, it is not necessary to dwell at any length here, but it is of interest to record that one of his earliest, if not his first published statement on this subject, is the note on "*Palæmonetes varians* in Plymouth," published in the Journal of the Association (N.S., I., 1890, p. 459), in which the variations of the teeth on the rostrum of this species are recorded from an examination of 915 individuals. Later papers based upon work done at Plymouth or upon material obtained there are:—

"The Variations occurring in Certain Decapod Crustacea. 1. *Crangon vulgaris*" (*Proceed. Roy. Soc.*, vol. xlvii. p. 445).

"Certain Correlated Variations in *Crangon vulgaris*" (*Proceed. Roy. Soc.*, vol. li., 1892, p. 1).

"Certain Correlated Variations in *Carcinus mænas*" (*Proceed. Roy. Soc.*, vol. liv., 1893, p. 318).

"An Attempt to Measure the Death-rate due to Selective Destruction of *Carcinus mænas*, with respect to a Particular Dimension" (*Proceed. Roy. Soc.*, vol. lvii., 1895, p. 360).

"Remarks on Variation in Animals and Plants" (*Proceed. Roy. Soc.*, vol. lvii., 1895, p. 379).

"Presidential Address to the Zoological Section (on Natural Selection and Variation)" (*Report. Brit. Assoc.*, 1898).

Professor Weldon became a member of the Marine Biological Association in 1884, the year of the inauguration of the Association, and his name first appears in the list of Founders in 1887. In 1888 he was elected a Member of Council, and from that time he continued to serve the Association in this capacity, having been in recent years the representative of the British Association for the Advancement of Science. His time and energy have been freely devoted to the work of the Council, and his personal experience of the various departments of the Association's activity have given special value to his views and recommendations upon many important questions of policy, which the Council has been called upon to determine.

When the Association undertook to carry out for His Majesty's Government the programme of International Fishery Investigations in the English area, Professor Weldon gave particular attention and devoted much time to the vast amount of statistical work, which is entailed by those investigations, and the fact that both the general methods and the results so far published were subjected to his careful and critical examination has added greatly to their value and to the confidence with which the Council was enabled to regard them.

By his enthusiasm, his energy, and the keenness of his intellectual insight, Professor Weldon helped largely in the attainment of the success which has attended the efforts of the Marine Biological Association, and by his ever-ready co-operation with his colleagues on the Council, and with the members of the scientific staff, he so endeared himself to all those with whom he was associated in the work that his death has left a gap which it will hardly be possible to fill.—E. J. A.

Notes on some British Nudibranchs.

By
C. Eliot,
Vice-Chancellor of the University of Sheffield.

With Plates XI and XII.

The following notes are the result partly of an examination of various living specimens at Plymouth in the spring of 1905, and partly of the study of preserved material most kindly placed at my disposal by Mr. E. J. Allen and Mr. W. I. Beaumont, of the Laboratory, Plymouth, Mr. W. E. Hoyle, of the Manchester University Museum, and the Council of the Hancock Museum at Newcastle. I must also express my thanks and obligations to Mr. T. J. Evans, lecturer in Biology at the University of Sheffield, who has prepared for me sections of the smaller specimens and embodied the results in drawings which will add very materially to any value which this paper may have.

The following are the species noticed:—

1. *Tritonia alba*, A. & H.
2. *Staurodoris verrucosa* (Cuvier).
3. *Archidoris testudinaria* (A. & H.).
4. *Geitodoris planata* (A. & H.).
5. *Lamellidoris bilamellata* (L.).
6. *L. oblonga* (A. & H.).
7. *L. depressa* (A. & H.).
8. *L. pusilla* (A. & H.).
9. *Pleurophyllidia loveni*, Bergh.
10. *Lomanotus genei*, Vérany.
11. *L. marmoratus*, A. & H.
12. *L. flavidus*, A. & H.
13. *Hancockia dactylota*, Gosse.
14. *Doto pinnatifida*, A. & H., var. *papillifera*.
15. *Berghia cærulescens* (Laurillard).
16. *Coryphella rufibranchialis* (Johnst.).
17. *C. gracilis* (A. & H.).
18. *C. landsburghii* (A. & H.).
19. *C. beaumonti*, spec. nov.
20. *Eolis angulata*, A. & H.
21. *Amphorina aurantiaca* (A. & H).
    (= *Cuthona aurantiaca*.)

22. *Amphorina olivacea* (A. & H.).
(= *Cratena olivacea*.)
23. *Cratena amœna* (A. & H.).
24. *Calma glaucoides* (A. & H.).
25. *Antiopella cristata* (Delle Chiaje).
26. *Janolus hyalinus* (A. & H.).
27. *Janolus flagellatus*, sp. nov.
28. *Alderia modesta*, Lovén.
29. *Stiliger bellulus* (d'Orbigny).

Of the above, *Coryphella beaumonti* and *Janolus flagellatus* are new species. The first may be regarded as certain, though it offers so many peculiarities that its place in the genus Coryphella is open to question. *Janolus flagellatus* differs from other described species in its genitalia, but cannot be regarded as certain until better preserved specimens are examined. *Berghia cœrulescens* must be removed from the list of the British fauna, for the only recorded specimen is a *Facelina coronata;* but *Staurodoris verrucosa* may be added, for it seems to be certainly, though sporadically, recorded from Devonshire, the Clyde, and West Ireland.

An examination of the type specimen of *Tritonia alba*, A. & H., has enabled me to show that this species, which has been called in question, is valid and well characterized. The valuable material with which I have been supplied has, I hope, enabled me to amplify our knowledge of Lomanotus, Hancockia, Alderia, and Calma. The systematic position of the last genus appears to me to have been misunderstood; *Calma glaucoides* belongs to the same genus as the later *Forestia mirabilis* of Trinchese, but *Calma cavolini* must be removed from this group, as it does not possess the characteristic radula.

I have also attempted to elucidate the synonymy and affinities of Alder and Hancock's *Doris testudinaria*, which appears to be a fairly common form, though often confounded with *Archidoris tuberculata*, and have also examined the classification of the Cratenidæ. I think that the genus Amphorina must be referred to this group, and that the animals described as *Cratena olivacea* and *Cuthona aurantiaca* are really referable to Amphorina. *Eolis angulata* is probably a young *Æolidiella glauca*.

TRITONIA.

A species of this genus which has been called in doubt is now shown to be valid by an examination of the type specimen, and the following additions may be recorded to Tritonia and Candiella, of which Bergh recognized sixteen species in the *System der Nudibranchiaten Gasteropoden*, 1892. I do not think that the distinction between Tritonia and

Candiella can be maintained (*vide* Eliot, "On the Nudibranchiata of the Scottish National Antarctic Expedition," *Trans. Roy. Soc. Edinb.*, vol. xli. part iii. p. 523, 1905).

17. *T. alba*, A. & H.
18. *T. exsulans*, B.
19. *T. incerta*, B.
20. *T. gigantea*, B.
21. *T.* (*Candiella*) *australis*, B.
22. *T.* (*Cand.*) *ingolfiana*, B.
23. *T.* (*Cand.*) *villafranca*, Vayssière.
24. *T. appendiculata*, Eliot.
    (? = *T. challengeriana*, var.)
25. *T. olivacea*, B.
26. *T. irrorata*, B.

TRITONIA ALBA, A. & H.

(*Monogr. of the British Nudib. Mollusca*, part vii. p. 48, and Appendix, p. vi.)

Specimens of this form were found by Alder and Hancock at Cullercoats, near Newcastle, and described by them as having considerable external resemblance to young individuals of *T. hombergii*, but as differing in dentition from all known Tritonias, inasmuch as the lateral teeth were denticulate or branched. Bergh (*Mal. Unt. in Semper's Reisen*, Heft xv. pp. 734 and 736) rejects the species as doubtful, and thinks that the denticles were merely an illusion of the microscope. An examination of the original specimens preserved in the Hancock Museum at Newcastle-on-Tyne has shown me, however, that this is not the case, and that the teeth are really denticulate.

The two specimens are respectively 7 and 6 mm. long, and 2·8 and 2·2 mm. broad. One is dark brown, the other yellowish. The hard buccal parts are fortunately well preserved, otherwise few characters either external or internal can be established, which is hardly surprising, as the specimen must be at least fifty years old. There is no reason, however, to doubt the accuracy of Alder and Hancock's descriptions. The dorsal margin is large, and seems to have borne in the one specimen six, in the other eight branchiæ of various sizes. No trace of stomach plates was found.

The jaws are yellow, rather long and narrow, and bear near the edge about four rows of small prominences resembling a mosaic. The radula is very transparent, and consists of twenty-five rows, which appear to contain thirty-six teeth on each side of the rhachis when complete. The rhachidian tooth (Pl. XI., Fig. 1. a.) is tricuspid, and hollowed out below. The first lateral (Pl. XI., Fig. 1. b.) is of the usual clumsy shape, but is rather variable in outline. The second lateral (Pl. XI., Fig. 1. c.) is smooth, moderately stout, and simply hamate. The succeeding teeth become longer and slenderer towards the outside. The third lateral bears a prominence or rudimentary denticle, and the remaining laterals in the middle of the half-row (Pl. XI., Fig. 1. d. e. f.), bear from one to three long branch-like denticles, and sometimes one or two accessory shorter ones. Towards the end of the row the denticles are found only at the tip of the teeth, and the outermost (Pl. XI., Fig. 1. g.) are elongate and bifid. This peculiarity is not marked in Alder and Hancock's plate, which otherwise gives a very accurate representation of the radula.

STAURODORIS, BERGH.

It is worthy of consideration if this genus should not bear the Linnæan name of *Doris*. Bergh (*Mal. Unt. in Semper's Reisen*, xiv. p. 616) decided to discontinue the use of this name ("besser wäre es, wie hier geschieht, den Namen Doris als generische Bezeichnung ganz zu streichen"). But there seem at least two objections to this course. Firstly, if an old genus is divided into sub-genera, one of these new sub-genera should, according to the rule generally recognized, bear the name of the old genus. Secondly, it would appear that in *Staurodoris verrucosa*, Bergh, the use of the specific name really admits that the animal is the Linnæan Doris. The type of Doris is *Doris verrucosa* of the tenth edition of the *Systema Naturæ*. It is true that the animal cannot be recognized from Linnæus's description, but Cuvier identified it rightly or wrongly with a Mediterranean form, and Cuvier's animal has been renamed *Staurodoris verrucosa* by Bergh. But this form can bear the specific name *verrucosa* only on the supposition that it is the *Doris verrucosa* of Linnæus. Therefore either it is *Doris verrucosa*, or else Staurodoris with a new specific name; but it cannot logically be *Staurodoris verrucosa*.

Further, it seems a pity to abolish a well-known name used by so many eminent naturalists, and in my opinion the use of Doris is not only correct, but convenient. I cannot help thinking that the distinctions between Bergh's genera of the Archidorididæ are somewhat minute, and that a juster classification would be secured by the use of the genus Doris (type *Doris verrucosa*), to include as sub-genera at least Staurodoris, Archidoris, Anisodoris, and possibly others.

Staurodoris, Bergh, cannot in my opinion be satisfactorily separated from Archidoris, Bergh, as the two genera are connected by their less typical members. The typical Staurodoris has simply pinnate branchiæ and the back studded with clavate tubercles, which form valves round the rhinophores and branchiæ. But in the less typical form the branchiæ become bi- or tripinnate and the valvular tubercles less distinct.* The following forms would perhaps be referable to the subgenus Staurodoris :—

1. *St. verrucosa* (Cuvier).
   St. pseudoverrucosa, Jher.
   St. januarii, Bergh.
2. *St. bertheloti* (d'Orbigny).
3. *St. d'orbignyi* (Gray).
4. *St. pustulata* (Abraham).
   [See Hedley and Basedow, *Trans. Roy. Soc. S. Australia*, vol. xxix., 1905, p. 150, pl. ix.]
5. *St. maculata* (Garstang).
6. *St. depressa*, Eliot.
7. *St. calva*, Eliot.
8. *St. bicolor*, Bergh.
9. *St. rusticata* (A. & H.).
10. ? *St. pecten*, Eliot.
11. ? *St. flabellifera* (Cheeseman).

The last two species have a peculiar configuration of the branchiæ, which renders their inclusion in this genus doubtful. *St. bertheloti* and *St. d'orbignyi* are only known from very imperfect descriptions.

STAURODORIS VERRUCOSA (CUV.).

Two specimens from the Museum of the Manchester University, labelled as coming from the Firth of Clyde. The larger is 35 mm. long and 21 broad; the other slightly smaller. The details given below refer to the larger specimen, unless otherwise stated.

Both specimens are depressed, rather stiff and hard, uniform whitish yellow in colour. The back is studded with large and small tubercles. There are fifteen of the former, about 3 mm. high and 2 mm. broad. Smaller ones are scattered among them, and the tubercles decrease in size towards the edge of the mantle, which is fairly wide. The foot is broad; no groove or notch is visible on the anterior margin. The tentacles are ridge-like.

The rhinophore pockets are protected by four tubercles (two large and two small) in the smaller specimen and by three in the other, one of the smaller tubercles not being developed. The branchiæ are simply pinnate, eighteen in the larger specimen, fourteen in the smaller. The pocket has a thin slightly raised lip, bearing eight tall, slender tubercles about 3·5 mm. high, alternating fairly regularly with quite small ones.

The intestines are yellowish, except the stomach, which is black from

* Vayssière's figure of the Mediterranean *Archidoris tuberculata* (*Opisth. de Marseille*, iii. pl. 1, fig. 1) seems to me to have the external characters of Staurodoris.

the colour of its contents. The spermatotheca is very large. The formula of the yellowish radula is 55 × about 60.0.60. The teeth are simply hamate, and rather crowded. The outermost are degraded, but not denticulate. In the anterior, but not in the posterior rows, the innermost teeth project somewhat into the rhachis, which bears longitudinal folds.

St. verrucosa has already been recorded from the British marine area by Mr. G. P. Farran, who found one specimen at Fahy Bar, Ballynakill, West Ireland (*Ann. Rep. Fish. Ireland, 1902–3*, part. ii. app. vii. [1905] pp. 207–8). Bergh in his systematic arrangement of the Nudibranchiata unites with it *St. januarii*, *St. ocelligera*, and *St. pseudoverrucosa*, and including these varieties the species is now recorded from the Mediterranean and Adriatic, the coast of Brazil, the Atlantic coast of Europe, and South Carolina.

STAURODORIS VERRUCOSA (CUV.), VAR. MOLLIS.

One specimen, labelled Salcombe, R. A. Todd, 3. VIII. 1900. The measurements are: length, 21 mm.; breadth, 12; height, 7. The colour is white, with a faint yellowish tinge; the texture soft. The foot is 17 mm. long and 6 broad, with a longish free tail; it has slight traces of a groove in front, but no notch. The mantle edge is ample, and measures about 4 mm. The tentacles consist of a ridge-like prominence on either side of the mouth; they are attached for the greater part of their length, and show slight traces of a fold. The back is somewhat sparsely tuberculate. Down the centre run six fairly regular longitudinal lines of large tubercles, about 1·5 mm. wide and 1 mm. high. Between them and on the mantle edge are smaller tubercles. A few tubercles near the branchiæ are taller and almost clavate. There is no trace of ridges connecting the various tubercles. The rhinophores are deeply perfoliate, and emerge between two tubercles. The rim of the branchial pocket is slightly raised, and bears ten tubercles of various sizes, but all quite distinct. The largest are 1 mm. high. The branchiæ are simply pinnate, the pinnæ being alternately long and short. They project about 4·5 mm. from the pocket, and lie flat on the back like a star. Seen thus they appear to be thirteen, but on opening the pocket it is seen that nine are long and separate, and four small, springing from the sides of the longer ones. All the plumes are united at the base in a common circular band, which bears papillæ outside. The anal papilla is central.

The intestines are white. In the central nervous system the cerebropleural ganglia are above the pedal, which as preserved lie below them at the side. The eyes are black and distinct.

The buccal mass is elongate. In one part of the labial cuticle is a mass of variously shaped spicules, which are apparently the remains of a fragment of food embedded in the skin, and do not represent an armature of the lips. The radula is colourless, with a maximum formula of 40 × 45.0.45. The teeth are rather straight and only slightly hamate. Towards the end of the rows the spike becomes reduced and the base increases, with the result that the tooth resembles a broad, clumsy hook. The two innermost teeth project into the rhachis, and are lower than the rest, but not denticulate.

The œsophagus is thin, and the salivary glands band-like. The stomach lies in an upper anterior cleft of the liver, but is separate from it. Its walls are thickish, with a strong irregular lamination. The genitalia seem to be as in the typical form. The light-grey hermaphrodite gland is spread over the greenish liver. The spermatotheca is large and spherical; the spermatocyst much smaller and elliptical. No armature was found.

I have compared this animal with specimens of *St. verrucosa* from the Mediterranean. It is lighter in colour, very much softer in consistency, and the tubercles are lower and, as a rule, not clavate. But these are all matters of degree, and I do not think a new species can be created on the evidence of a single specimen.

The present specimen is superficially quite unlike *St. maculata* (Garstang), which is very convex, hard, and bears a pattern of knobs connected by ridges.

ARCHIDORIS TESTUDINARIA (A. & H.).

[*Doris testudinaria*, Alder and Hancock, *Ann. and Mag. H. N.*, 1862, vol. x., 3rd series, p. 261.

? Doris testudinaria, Risso. *Hist. Nat. de l'Eur. Mer.*, iv., 1826, p. 33.

Archidoris stellifera, H. von Jhering. See VAYSSIÈRE, *Journal de Conchyl.*, vol. lii. No. 2, 1904, p. 123. *Id. Opist. de Marseille Supp.*, p. 82, 1903.

Doris testudinaria. Jeffrey's British Conchology, vol. v. p. 85 (written by Alder, as stated on p. 27).]

Both the nomenclature and the specific limits of this form present many difficulties, and it is with great diffidence that I submit it should be called *Archidoris testudinaria*, that it is identical with the *Archidoris stellifera* of Vayssière and von Jhering, and that it is probably distinct from the *Doris planata* of Alder and Hancock. Two points, however, seem certain: first, that the specimens from Plymouth here described are the *Doris testudinaria* of Alder and Hancock; second, that they are distinct from *Archidoris tuberculata*, with which they are often confounded in practice.

In 1862 Alder and Hancock described (l.c.) a new British Dorid, which they identified with the *D. testudinaria* of Risso. From some unpublished notes preserved in the Hancock Museum at Newcastle-on-Tyne, it is probable that they based this identification, not on Risso's description, but on specimens sent from the Mediterranean and labelled *D. testudinaria*, which they considered identical with their specimen from Herm Island.* Risso's description is vague, inadequate, and, as pointed out first by Philippi (*Enum. Moll. Sicil.*, vol. ii. p. 78), probably inaccurate. Bergh and others have thought that it refers to *Platydoris argo*. But since Alder and Hancock have given the name to a fully described animal, which is possibly identical with Risso's animal, it would seem that their interpretation of the name must be regarded as authoritative. After Alder and Hancock had assigned the name *D. testudinaria* to an identifiable form, von Jhering gave the name *Archidoris stellifera* to Mediterranean specimens, which seem to me to belong to the same species. His description appears to have been only in MS., and publication dates from the memoires of Vayssière, who uses the same name. As will be seen from the notes here given, stellate forms are found on the British coast, and appear to be specifically the same as the less ornate variety described by Alder and Hancock. It is remarkable, however, that Vayssière states that the mouth of his specimens is armed with a chitinous ring. I could not discover this structure in the specimen which he kindly sent to me.

Alder and Hancock, in the *Ann. and Mag. of Nat. Hist.*, l.c., expressed the opinion that *D. testudinaria* and *D. planata* are distinct though similar species. Subsequently Alder in *Jeffrey's Conchology* (l.c.) came round to the opposite view, and stated that an examination of further specimens of different sizes from the Clyde proved that *D. planata* is the young of *D. testudinaria*. It is extremely difficult to form any decided opinion on this question. The external characters are likely to vary considerably at different periods of the animal's growth, and it would appear that in *D. testudinaria* (*stellifera*) a labial armature may or may not be developed. Vayssière reports its presence, and Alder and Hancock (*Ann. and Mag. N. H.*, l.c.) say of *D. testudinaria* and *D. planata*, "the character of the tongue is similar in each." On the other hand, in a number of specimens from Plymouth which I have examined, I have found a decided labial armature in the small flat individuals and none at all in the large plump ones. It is present in the specimen of *D. planata* from Alder and Hancock's collection at Newcastle. On the whole I am inclined to think that there are two separate forms which are very much alike in their younger stages.

* It is even possible that A. & H. may have obtained the specimens from Risso, or from some one who knew the animal which he called *D. testudinaria*. They were writing about Nudibranchs in 1841, but probably began collecting earlier.

(1) *D. planata.* This is a remarkably flat form, which appears not to exceed an inch in length in British waters. The dorsal surface is finely granulated, there is a distinct labial armature, and the radula is decidedly of the type of Geitodoris, Bergh, that is to say, there are two kinds of teeth, the inner teeth being of the ordinary hamate shape, and the outer very thin and crowded together in sheaves. It is possible that some specimens (about 50 mm. long) which I have received from the Cape Verde Islands may be adults of this species. They resemble the Plymouth specimens, except that they are much larger and were red in life. The richer colour may perhaps be due to the climate.

(2) *D. testudinaria.* This is a plump form of considerable size (60 mm.). The back is covered with flat tubercles, which are sometimes arranged in a stellate pattern. In the specimens from Plymouth, which I have myself examined, there is no labial armature, but Vayssière states that it is present in the Mediterranean form, which is otherwise undistinguishable. The radula is not unlike that of the last species, but the differentiation of the teeth is less marked. The outer are thinner than the inner ones, but the change is less abrupt, and the thinner teeth are not gathered together in such distinct sheaves or packets.

The names *Platydoris testudinaria* and *Platydoris planata* would seem to be in any case incorrect, for none of the animals have the characters of Platydoris (which include a peculiar hard consistency and an armature of hooked scales on the reproductive organs). It is possible, but not demonstrable, that the *Doris testudinaria* of Risso was a Platydoris; but, if so, it is neither the *D. testudinaria* nor the *D. planata* of Alder and Hancock.

Alder and Hancock's type specimen labelled "*Doris testudinaria*, Herm," has been kindly lent me by the Council of the Hancock Museum, Newcastle.

It is 30 mm. long, 23 broad, and 15 high. The mantle margin is broken in many places, but it apparently covered the sides and the foot entirely in its original condition. The general colour of the animal is greyish yellow. Some of the dorsal tubercles are lighter than the surrounding surface. There are some reddish spots on the under side of the mantle.

The texture is soft, and the specimen is a little decayed. The back is covered with low flat warts of various sizes. No stellate arrangement is visible. The branchial and rhinophorial pockets are surrounded by tubercles which do not amount to valves. The branchiæ are retracted within the pocket, and their number could not be ascertained. The anterior part of the animal is much retracted, but the long linear tentacles are clearly visible.

The buccal parts have been extracted.

No further examination was made in order not to injure the unique specimen.

I have also examined five specimens seen alive at Plymouth in April, 1905. They vary somewhat in external appearance, and may be described separately.

A. One specimen, rather variable in shape, but flattish. When fully stretched out and moving its length is 60 mm. and its breadth 32. It is active in its motions. The main colour of the back is mottled purplish brown of various shades, the deepest of which is almost black. The general colour is lighter towards the margin, though here the darker shades are more conspicuous by contrast. There are a few irregular sandy-grey markings here and there, especially in front of the rhinophores, and twelve sandy-yellow star-like figures arranged symmetrically in four lines between the rhinophores and the branchial pocket. The back is covered with flat tubercles, very slightly prominent, and more or less of the same size (not more than 1 mm. in breadth), except those forming the centre of the stars, which are about twice as large as the others. The tubercles forming the stars appear to be set in a stellate figure, but the pattern is due to pigment rather than to the arrangement of the tubercles. The edge of the rhinophore pockets is set with small tubercles. The rhinophores are elongate, with about fifteen perfoliations. They are olive coloured, and the stalk is long compared with the laminated part. The branchial pocket is slightly raised and tuberculate. The branchiæ are six, tripinnate, sandy yellow, with purplish flecks. The anal papilla is purplish, but the edge is crenulate and distinctly margined with sandy yellow. The foot is grooved in front and the upper lamina notched. The tentacles are cylindrical and elongate, which makes the whole head look unlike that of *A. tuberculata*. The under side is white, but in this and in all the specimens there are a few purplish spots on the under side of the mantle, which is rather ample and overhangs the foot all round.

B. In a second specimen of about the same size the characters are exactly the same, but there are only four stellate figures on each side, and they are less regular both in their formation and their arrangement. The pockets of the rhinophores and the branchiæ are very distinctly crenulate and tuberculate.

C. Three similar but rather smaller specimens are paler in colour, and the stellate figures are only imperfectly developed. The branchiæ are as many as seven or eight.

The internal characters of all the specimens are much the same. The blood gland is large, double, purple or greyish. The central nervous system is not quite as in *A. tuberculata*. Seen from the upper side, the ganglia appear united in a horseshoe-shaped mass in which no divisions are clearly distinguished. Seen from below, the division between the cerebro-pleural and pedal ganglia is plain, but the cerebro-pleural ganglia are not distinctly divided into two portions. The common commissure is thick and very short.

The integuments, especially the tuberculate dorsal surface, are very spiculous, and contain a dense mass of colourless rods, often slightly bent, but not swollen in the middle, jointed, or branched.

No labial armature could be found, but on the labial cuticle in some specimens were granular markings resembling grey dust, but not forming rods or compact plates. The radula consists of about thirty rows, and the number of teeth on each side of the rhachis does not appear to much exceed forty as a maximum; but the whole radula is fragile and difficult to extend. The teeth are transparent and colourless, longer and thinner than in *A. tuberculata*, and with narrower bases. Near the rhachis (Fig. 2. a. b.) the teeth are low and with comparatively broad bases; but they increase in length and slenderness towards the outside until the last two or three, which are shorter, but often somewhat deformed (Fig. 2. f.). Teeth with abnormal lumps and projections occur in all parts of the radula (Fig. 2. d.).

The œsophagus is narrow at first, but widens and enters the liver. The stomach lies within the liver. The gall bladder is small and pear-shaped. The intestine issues from the liver about the middle of its dorsal surface, runs forward and then turns backward. The liver is of a dull orange colour; the hermaphrodite gland, spread over it, is of a dull opaque white.

The spermatotheca is large, greenish or bluish grey, and spherical. The spermatocyst is small, white or orange-white, less distinctly spherical, and sometimes pear-shaped. There is no prostate. The vas deferens is very slender, long, and convoluted. The penis small, conical, and unarmed. The duct seems to issue at the side of the tip.

Though this species is commonly confused with *A. tuberculata*, it seems to differ in the following points:—

(1) The typical coloration is different, though it is very often imperfectly developed. But there are nearly always purple spots on the lower side of the mantle, which seem not to occur in *A. tuberculata.*

(2) The general form is flatter.

(3) The shape of the tentacles and anterior part of the foot is markedly different.

(4) The tubercles are less prominent and of more equal size.

(5) The branchiæ are stouter and less voluminous.

(6) The shape of the teeth is different.

(7) The stomach is enclosed within the liver.

For purposes of comparison I have examined a specimen of *A. stellifera*, most kindly sent me from Marseilles by Professor Vayssière. It is 31 mm. long, 16 broad, and 10 high, flattish and rather smooth, with low even tubercles. The colour of the dorsal surface is dark olive-brown of various shades; the larger tubercles are yellowish, but the stellate appearance is hardly visible. The under side is pinkish, with reddish brown dots on the lower surface of the mantle. The oral tentacles are longish, conical, and somewhat flattened. The anterior margin of the foot is grooved and perhaps notched, but this is difficult to decide. The edge of the rhinophore pockets is set with small inconspicuous tubercles. The branchiæ are eight; the edge of the pocket is tuberculate, much like the rest of the back, but has no special tubercles of its own. The formula of the radula is about 18 × 30.0.30 and the shape of the teeth as described above for the Plymouth specimens.

Neither in this specimen, nor in those from Plymouth, could I find any trace of the armature described by Professor Vayssière (l.c.) as "anneau chitineux mandibulaire, complet, assez large, offrant dans la partie interne de petits et très courts bâtonnets prismatiques." Nothing was visible but a thick unarmed cuticle.

Vayssière refers this form to Archidoris, and I follow him; but if the external teeth are longer and thinner than the internal ones, and if, as Vayssière has found, a labial armature is sometimes present, it is clear that the division between Archidoris and Geitodoris is not so sharp as might be supposed. It would be interesting to have statistics as to the *uniform* presence or absence of the labial armature in various species. There certainly seems to be ground for suspecting that in some species of Archidoris and Staurodoris it is generally absent, but occasionally present, though not much developed. With reference to this and many other organs, we have little information as to the effect of age and growth on the external and internal characters of Nudibranchs.

GEITODORIS PLANATA (A. & H.).

(Alder and Hancock, Monograph, Plate VIII., and Part VII. p. 42. Eliot, *Proc. Mal. Society of London*, Sept., 1904, vol. vi. No. 3, pp. 180–1.)

In the paper cited above I have described specimens caught at Plymouth, and considered in the Laboratory to be *D. planata*, A. & H., and have also given my reasons for referring them to Geitodoris. Since writing this I have examined two other preserved specimens at Plymouth. The back is granulate, with some larger tubercles, and also with some pits, which often give the upper side a honeycombed appearance. The mantle edge is broad, and on the under side veined with anastomosing lines. The branchiæ appear to be nine, and in small specimens are very small indeed and hardly visible. There is a distinct labial armature formed of rods, and the radula consists of two kinds of teeth. In the largest specimen the formula seemed to be $25 \times 6 + 30.0.30 + 6$, the six outermost teeth being long, very thin, and compressed together so as to look almost like a single tooth. I have also examined a specimen from Alder and Hancock's collection at Newcastle labelled "Doris planata. W. R. Hughes. Sidmouth." It is only 5 mm. long and 4 broad, and entirely dried up, having unfortunately not been kept in alcohol. As far as anything can be made out under such unfavourable conditions, the external characters are much as in Alder and Hancock's plate. The colour is yellowish, the back granulated and pitted, the mantle edge very ample, the branchial pocket large and round. There is a distinct yellow labial armature composed of rods. As usual in these old specimens, the radula is decomposed and in confusion; but there are clearly visible (*a*) ordinary hamate teeth; (*b*) bundles of long, thin, almost shadowy, teeth. The whole animal is very flat.

Through the kindness of Mr. Crossland I have received from the Cape Verde Islands several specimens which are possibly well-grown adults of this form, and in any case are closely allied to it. The general characters, particularly the tentacles, branchiæ, labial armature, and radula (with a formula amounting to at least $10 + 35.0.35 + 10$) are similar. The differences are: (1) the size (50 mm.); (2) the colour, which was in life brilliant vermilion (though some individuals were pale yellow), with numerous black specks apparently visible only under a lens, whereas Alder and Hancock say that *D. planata* was reddish brown, with dark brown spots; and (3) the texture of the dorsal surface, which seems to be covered by a reticulate pattern, with pits between the ridges and flat tubercles at their junctions. But age and a warm climate may account for these differences. However, I have thought it safer to describe the Cape Verde specimens under a separate name as *Geitodoris reticulata*.

LAMELLIDORIS, A. & H.

A considerable number of species are found on the coasts of Great Britain, and seem well characterized externally and by differences in the radula. The *Doris beaumonti* of Farran (*Nudibranchiate Molluscs of Ballynakill, app. viii. to part ii. of Report on Fisheries of Ireland for 1901*, p. 4) is, no doubt, *Lamellidoris luteocincta* (M. Sars), which must thus be added to the British fauna.

L. lactea, *L. quadrimaculata*, *L. aureopuncta*, *L. miniata*, and *L. olivacea*, described by Verrill from the Bermudas, are all very doubtful forms, and in many cases it seems clear from the author's descriptions that they do not possess the characters of Lamellidoris.

In identifying the specimens noticed below as *L. oblonga*, *L. depressa*, and *L. pusilla*, I have been chiefly guided by the labels which they bear in the collection at the Plymouth Marine Laboratory. I see no reason to doubt these identifications, though it might be difficult to establish them from an examination of preserved specimens only.

LAMELLIDORIS BILAMELLATA (L.).

This common species has been fully described by Alder and Hancock and Bergh. The back is covered with distinct, tall, and sometimes clavate tubercles, not unlike those of *Staurodoris verrucosa*. The tubercles at the side of the rhinophores are not conspicuous.

The inner teeth are large, hamate, smooth, and tapering at the tip. The outer are plate-like, with a rudimentary and not very distinct hook. Between the rows there is a series of ear-shaped folds on the rhachis.

LAMELLIDORIS OBLONGA (A. & H.).

(A. & H., *Mon. of Brit. Nud.*, Fam. i., pl. 16, figs. 4–5.)

Three preserved specimens from Plymouth. It would appear that this species is recognizable by its shape. Its measurements are roughly, length, 8 mm.: breadth, 3·7 mm.; whereas *L. bilamellata* measures about 12 mm. in length and 9 mm. in breadth. The animal, as preserved, is yellowish, and covered with low, flat tubercles on the dorsal surface. The branchiæ are very inconspicuous, and are not distinguishable from the surrounding tubercles on a superficial examination. The openings of the rhinophores are closed by two tubercles. The rhinophores are exserted and very long. As preserved, the oral veil is remarkably pointed, and the anterior margin of the foot follows its outline.

The buccal crop is large, and divided into two halves by a median band. The radula is very fragile, and consists of twenty-two, thirty-three, and forty-five rows respectively in the three specimens. The inner tooth (Fig. 3. a.) has a broad base, and is divided into three parts by constrictions. The denticulations on the uppermost part are very fine, but clear. The outer tooth (Fig. 3. b.) bears a distinct hook.

LAMELLIDORIS DEPRESSA (A. & H.).

One preserved specimen from Plymouth. The mantle margin is wide, and the dorsal surface bears papillose tubercles and contains very long spicules. The colour is yellowish, with a few black and brown spots.

The radula is small and hard to find. The inner tooth (Fig. 4. a.) is squarish, with three small denticles (not one, as according to Alder and Hancock). The outer tooth (Fig. 4. b.) is a squarish plate with a rudimentary denticle.

LAMELLIDORIS PUSILLA.

(ALDER and HANCOCK, *Mon. Brit. Nud.*, Fam. i., pl. 13.)

This little species seems to be characterized in life by its white branchiæ and rhinophores.

The radula is somewhat as in *L. oblonga*. The inner tooth (Fig. 5.) has a double convexity at the side, and a few ridges, which hardly amount to denticles, near the tip.

PLEUROPHYLLIDIA.

PLEUROPHYLLIDIA LOVENI, BERGH.

(BERGH, *Bidrag til en Monogr. af Pleurophyllidierne*, 1866, p. 29; *Id. Mal. Blätter*, 1879, pp. 77–86. JEFFREY'S *Brit. Conchol.*, vol. v. pp. 17–18.)

Two specimens from Plymouth. I was informed that the animals were reddish when alive.

The larger is 35 mm. long and 26 mm. broad, tapering rather suddenly at the tail. The colour is dull yellowish brown, with about fifty rather lighter stripes on the back, of which nine are larger than the others. The branchiæ are thin, and about twenty. The side lamellæ about thirty, very thick, and generally interrupted in the middle.

The smaller specimen is much bent, but would be about 30 mm. long if straightened out and 13 broad. The colour is pale yellowish brown, with a sort of purple glazing in many places, and there are about thirty stripes on the back.

The jaws bear five rows of denticles in one specimen and six or seven in the other.

The formula for the radula is in the first 25 × 35.1.35, and in the second 34 × 32.1.32. In both the median tooth bears seven denticles on each side of the central cusp. The first lateral is larger than the rest, and bears six or seven rather coarse denticles. In the larger specimen the first twelve laterals are denticulate (generally with five to six denticles) and the thirteenth very faintly so. The rest are smooth. In the smaller specimen only eleven teeth are denticulate.

It would appear that the Pleurophyllidia found on the British coast is this species, and not *P. lineata*, as it is often described. Bergh also appears to have shown that the correct name of the Mediterranean species is *P. undulata*, not *P. lineata*, and the latter specific name should be cancelled.

P. loveni seems to differ from *P. undulata* in its colour, in having fewer and thicker side lamellæ, and in its dentition. In *P. undulata* the central tooth is much broader, and all the teeth, with the exception of the last two or three in each row, are denticulate.

LOMANOTUS, VÉRANY, 1846.

(Alder and Hancock, *Monograph*, Fam. 3, genus 10 (under name of Eumenis). Garstang, *Journ. Mar. Biol. Assoc.*, vol. i., 1889, pp. 185–9. Beaumont, *Proc. Royal Irish Acad.*, 1900, pp. 842–4.)

The members of this genus are not common, and large specimens are distinctly rare, though small ones are not infrequent in some localities, e.g. Plymouth. The body appears to be very delicate and easily torn, and most authors report that their specimens were badly preserved. The following species have been described.

1. *Lomanotus genei*, Vérany. *Catal. degli. anim. invert. di Genovæ e Nizza*, 1846.
2. *L. hancocki*, Norman. *Ann. Mag. N. H.*, vol. xx., 1877, p. 518.
3. *L. portlandicus*, Thomps. *Ann. Mag. N. H.*, 1860, vol. v. p. 50.
4. *L. cisigii*, Trinch. *Rendic. Acc. Sci. Fis. Mat.*, xxii. 3, 1883, pp. 92–4.
5. *L. flavidus*, A. & H., *Monograph*, Fam. 3, pl. 41.
6. *L. marmoratus*, A. & H., *Monograph*, Fam. 3, pl. 1.
7. *L. varians*, Garstang, l.c.

Of these names the last is proposed by Garstang for all the British species (*L. marmoratus*, *L. flavidus*, *L. portlandicus*, and *L. hancocki*), on the supposition that they are really one. But if that supposition is correct, the right course would seem to be not to introduce a new name, but to call all the forms by the earliest of the existing specific names. *L. varians* may therefore be omitted from the list. The remaining six forms may be divided into the large and the small. Of the large forms *L. genei* has undoubted priority as a name, and it is unfortunate that the authors of the remaining three large species, *L. hancocki*, *L. portlandicus*, and *L. cisigii*, did not, in describing them, state definitely in what points they considered them to differ from the typical species. It seems certain that the number of processes on the frontal veil and on the rhinophore sheaths differs in otherwise similar individuals and cannot be made a specific character. *L. portlandicus* does not seem to be distinguished from *L. genei* (l.c.) by any clear character. Norman states that the most marked character of his *L. hancocki* is "the small size of the terminal, simple, conical process, which is projected beyond the calyx-like sheath" of the rhinophores. But it is highly probable that the rhinophores were of the usual type, and that the lower laminated portion was merely hidden within the sheath. Trinchese (l.c.) has given a somewhat detailed description of *L. cisigii*, from which it appears that its most remarkable characters are: (1) that the hepatic diverticula do not extend into the marginal papillæ; and (2) that the two margins unite at the end of the body and form "una larga pinna che è l' organo principale del nuoto." But a similar organ is found in the specimen described below, and is figured in some unpublished drawings of *L. portlandicus* made by Hancock, and preserved in the Newcastle Museum. Alder and Hancock, as well as Bergh, found the hepatic diverticula in the papillæ, but I could not demonstrate their existence with certainty in the specimen which I examined. It is possible that different specimens may vary in this respect, as do Dendronotus and *Bornella excepta.* Trinchese also states that in the *young L. cisigii*, "Ogni papilla conteneva un lobo epatico bene sviluppato."

The small species are *L. marmoratus* and *L. flavidus*, both British. With regard to these the main question is, have they assumed their adult and final form, or are they immature? Trinchese states that the young of *L. cisigii* differs markedly from the adult; and if we recognize the possibility of modifications occurring during growth, it may be said that the two small species present no characters either externally or in the buccal parts which are incompatible with the idea that they are the young of *L. genei.* On the other hand, if they are mature (on which point the evidence is inconclusive), the differences in size and colour are, no doubt, sufficient specific characters. A further question is whether *L. marmoratus* and *L. flavidus* are distinct forms. If they are adults, they must certainly be regarded as separate species. But if they are immature, then considering that *L. flavidus* is smaller than *L. marmoratus*, and that Trinchese states that the young *L. cisigii* is æolidiform, it is probable that *L. flavidus* is the youngest stage of the same species. Alder and Hancock note the æolidiform characters of the type specimen.

As mentioned below, Alder and Hancock's published plates of *L. marmoratus* are wrong in representing the dorsal margin as continuous with the oral veil, and the error does not occur in an earlier drawing preserved at Newcastle.

I recognize provisionally three species:—

1. *L. genei*, Vérany.
   - *L. portlandicus*, Thomps.
   - *L. hancocki*, Norman.
   - *L. cisigii*, Trinchese.
2. *L. marmoratus*, A. & H.
3. *L. flavidus*, A. & H.

It is, however, highly probable that both of these latter will prove to be young forms of the first.

LOMANOTUS GENEI, VÉRANY.

(BERGH, *Beitr. zur Kennt. Aeolidiaden*, vi. pp. 5–8, and vii. 62–3. VAYSSIÈRE, *Moll. Opisth. de Marseille*, part iii. 87–91. GAMBLE, *Ann. Mag. N. H.*, ser. 6, vol. ix., 1892, p. 379.)

One large specimen from Plymouth Sound, kindly given me by Mr. W. I. Beaumont.

The colour of the preserved specimen is yellowish white suffused with brown, which is deepest on the pericardium, rhinophores, oral veil, mantle margin with papillæ, and on the tail. There are no white dots. Some, but not all, of the papillæ have colourless transparent tips.

The length is 26 mm., the breadth at most 8, and the height 9, including the raised margin. This margin starts from the rhinophore sheaths and is 2–3 mm. wide. It bears thirty-two papillæ on the right, and thirty on the left side, and is bent into six undulations, three upwards and three downwards. The largest papillæ are those in the centre of these undulations and are about 4 mm. high; the rest are about half the size. The papillæ (Fig. 6) are distinctly spoon-shaped, the convex surface being generally outside, but sometimes inside. At the base of the larger papillæ are two folds on the inside. The margin is entire round the tail and forms a horizontal fin. The anus is 15 mm. from the anterior end, and the genital orifices 6 mm., just behind the rhinophores. The oral veil bears four distinct digitations, two on each side, about 2 mm. long. The rhinophore sheaths are about 3 mm. high; the right bears five digitations; the left, though apparently uninjured, has only one. The foot is produced into short pointed angles and grooved. The upper lamina is much stronger and thicker than the lower.

The jaws are yellow, rather soft and flexible, and much as described by Bergh. The edges for some distance inwards are covered by a mosaic of plates or scales with denticulate edges (Fig. 8.). The masticatory process is very short.

The radula corresponds in general with the descriptions of Bergh and Vayssière. It consists of thirty-two rows. The teeth are large, crowded, and yellow at the sides of the rows; smaller, spaced, and colourless in the centre. In this specimen, and in all the smaller ones observed, the radula has a great tendency to break and become confused, and it seems impossible to spread it out evenly. It is hard to say whether there is a central tooth or not, as the arrangement appears to be not quite symmetrical. Down the rhachis run four to five irregular and not quite straight rows of very irregularly shaped teeth (Fig. 7. a.), bearing a central cusp and three to seven pointed denticles of various sizes on either side. To the right and left of these teeth the rows become more regular, and there come about ten colourless dagger-like teeth (Fig. 7. b.), with from four to ten fairly regular denticles on either side, the number of denticles increasing as the teeth are further from the rhachis. After this the teeth, as one goes outwards, become larger, yellower, hollowed, and somewhat spoon-shaped (Fig. 7. c.), bearing on either side at least twenty-five denticles, which are shorter and blunter than those of the middle teeth. The outermost teeth of all are somewhat smaller.

The internal organs are not easy to unravel, all the tissues being very thin, soft, and easily torn. The œsophagus leads into a round stomach, which gives off branches (apparently two) at the sides, and is prolonged posteriorly in a diverticulum reaching nearly to the end of the body. On this lie the liver and the hermaphrodite gland, which are both yellowish and difficult to separate from one another. The whole mass is surrounded by a network of transparent tubes, which seem to represent the kidney. The dorsal papillæ are hollow and communicate with the interior of the body, but I could not satisfactorily demonstrate the existence of branches of the liver in them (cf. what Trinchese says about *L. eisigii*). If such exist, they are represented by flocculent masses of no very definite shape, composed of reddish cells. The mucus and albumen glands are large; the ampulla of the hermaphrodite gland long and thick; the vas deferens thinner and coiled; the penis conical and unarmed; the spermatotheca small and roundish.

If any real distinction can be drawn between *L. genei* and *L. eisigii*, this animal should probably be referred to the latter in virtue of the shape of the papillæ and the apparent absence of hepatic diverticula in them. But I do not think that the two species are really distinct.

LOMANOTUS MARMORATUS, A. & H.

Four living specimens (A) examined at Plymouth in April, 1905, were about 9 mm. long and 2 mm. broad. The ground colour of the living animals is yellowish white, but largely covered with irregular markings of different shades of brown and olive, and also with small sandy dots. The colour is darkest at the sides and lighter in the centre of the back. The tips of the cerata are whitish; the hepatic diverticula within them yellowish brown.

The foot is cleft, and indented in front with strongly hooked corners. The veil is not large, with four processes, two on each side, which are somewhat bulbous at the tip. The rhinophore sheaths are rather tall for the size of the animal, being about 2 mm. high, and bear four or five processes, the number not being always the same on the right and left sheaths. In one specimen one sheath is entirely smooth. The dorsal margin starts from the rhinophore sheath; it makes four not very distinct undulations and bears about twenty-two papillæ, most of which, especially the taller ones, are carried vertically, though some of the smaller ones point sidewards. The taller papillæ bear a distinct bulb under the pointed tip, but in the smaller ones the bulb is less developed. Four of the papillæ are distinctly larger than the rest and, roughly speaking, mark the divisions between the undulations. The third of these larger papillæ is the tallest of all and is about 2 mm. high (Fig. 9. c.).

Another specimen (B), which was about 7 mm. long when at rest and 8 mm. when crawling, was brownish white, with yellowish-brown mottlings down the centre of the back and deep purplish-brown mottlings on the cerata. The other external characters are much as in the specimens already described, but the papillæ are not so long and there are only obscure indications of the subterminal bulb. The dorsal margin is more clearly a web connecting the papillæ. The rhinophore sheaths bear five processes each.

Three other specimens of about the same size were so macerated that nothing could be done with them except to examine the buccal parts.

The jaws and radula are much the same in all eight specimens. The jaws are not denticulate, but near the edge is a mosaic formed of tile-like prominences denticulate on the anterior edge. The radula is very irregular in appearance and could not be laid out straight in any specimen. There is a wide naked rhachis bearing folds, and on each side of the rhachis fifteen to twenty rows of teeth, each containing eight to ten teeth on either side. More could not be made out with certainty. The teeth are longer than in Alder and Hancock's and Bergh's plates, and more uniform. They are dagger-shaped, but slightly bent at the end, bearing at least twelve denticles on either side and perhaps considerably more, but the denticles are hard to see, even with a high power. The innermost are slightly shorter and stouter; the outermost longer and thinner.

The animals are very delicate. They die in captivity without apparent cause, and the body becomes decayed and macerated very rapidly.

This form, especially the specimen called B, approaches the *L. marmoratus* of Alder and Hancock sufficiently nearly to bear the name. Their plate (*Eumenis marmorata*, Fam. 3, pl. 1. a.) contains one of the few inaccuracies to be found in their works, inasmuch as it represents the dorsal margin as continuous with the oral veil, not as starting from the rhinophores. But in a preliminary study for the drawing preserved in a bound volume of Alder's drawings, belonging to the Hancock Museum at Newcastle-on-Tyne, the disposition of the parts is somewhat indistinct, and it is quite probable that it was meant to represent the dorsal margin as starting from the rhinophores. When this study was copied for the plate as published, the artists themselves probably misinterpreted their earlier and rather indistinct drawing. But I do not think that we should insist that the continuity of the dorsal margin and oral veil is really a character of *L. marmoratus*, A. & H.

LOMANOTUS FLAVIDUS, A. & H.

A single small specimen examined alive at Plymouth resembled Alder and Hancock's figure of this species. It is only 4 mm. long and 1 mm. broad. The general colour is pale buff, due to a multitude of little specks. There are also white spots (particularly on the tops of the cerata) and a few purplish-brown spots. At the sides of the head in front of the rhinophores are two purplish-brown patches. The rhinophore sheaths bear five processes, of which the one behind and pointing outside is longer than the others. There are only about twelve papillæ on each side. They are much as in Alder and Hancock's plate—short, thick, and showing no signs of a bulb. Those in the middle are the largest. They mostly have an irregular brown ring or marking.

The animal is not like *L. marmoratus* superficially, but no difference could be found in the buccal parts. The foot, veil, and other external characters not mentioned above are also similar.

HANCOCKIA, GOSSE.

= GOVIA, Trinchese.

Bergh (*System der Nudib. Gast.*, p. 1048) adopts *Govia* (Trinchese, 1886) as the name of this genus in preference to *Hancockia* (Gosse, 1877), apparently on the ground that Gosse's description is inadequate. But though Gosse does not deal with the anatomy of the animal, his description is amply sufficient for its identification. There can be no reasonable doubt that his *Hancockia dactylota* is the animal described below, and that it is generically and perhaps specifically the same as the later Govia of Trinchese. The name is therefore entitled to stand.

The genus appears to be rare, and is recorded from the south of England, Brest, and the Mediterranean. Four described species are probably referable to it: *Hancockia dactylota*, Gosse; *Govia rubra*, Trinchese; *Govia viridis*, Trinchese;* and *Doto uncinata*, Hesse. In the *Jour. de Conchyl.*, 1872, p. 34, Hesse described under this name a Nudibranch captured at Brest, but Garstang seems to have proved that it is a Hancockia. Whether there is really more than one species is a

* References to the literature are given on following page.

matter of some doubt. Perhaps Trinchese's two species are distinct, and perhaps his *Govia viridis* is identical with both *Doto uncinata* and *Hancockia dactylota*, so that the genus may be tabulated as follows:—

1. *Hancockia dactylota*, Gosse, S. England.
2. *H. uncinata* (Hesse), Brest.
3. *H. viridis* (Trinchese), Mediterranean.
4. *H. rubra* (Trinchese), Mediterranean.

Hesse regarded his specimen as a Doto, and Bergh somewhat doubtfully refers the genus to the Dotonidæ. It would seem to be intermediate between that family and Lomanotus. The narrow radula indicates affinity to Doto and the true Æolids. The cerata show analogies to those of Doto, though they have not their characteristic shape. But the perfoliations on the rhinophores, the processes on the oral veil, and the manner in which the cerata arise from the dorsal margin recall the characters of Lomanotus rather than of Doto.

HANCOCKIA DACTYLOTA, GOSSE.

(Gosse, "On Hancockia dactylota," *Ann. Mag. Nat. Hist.*, ser. 4, xx., 1877, pp. 316–19. Gamble, "On two rare British Nudibranchs, Lomanotus genei and Hancockia dactylota," *ib.*, 6, ix., 1892, pp. 378–85. Trinchese, "Ricerche anatom. sul genere Govia," *Mem. della R. accad. delle sci. dell' istituto di Bologna*, ser. 5, vii pp. 183–91, 1886. Bergh, *System der Nudib. Gast.*, p. 1048, 1892, *sub voce* Govia.)

Two specimens labelled "Plymouth district, Sept. '97 and '98." They are of much the same size, one being rather more elongate than the other. Measurements in millimetres:—

	Length.		Breadth.		Height.
(1)	7	...	1·2	...	2
(2)	6	...	1·5	...	2

The colour is greyish green, and the shape rather stiff and rectangular. The animals are not very well preserved either externally or internally; but a small specimen subsequently given me by Mr. Allen proved to be in better condition and was sectioned.

The foot is truncate in front; no groove is visible on the anterior margin; the tail is not pointed behind, and is slightly bifid.

The oral veil is smooth in the middle and curves inwards, but the two sides are much expanded and each bears four digits, of which the second from the inside is the longest. The rhinophore sheaths, which are set on the dorsal margin, are about 1 mm. high and 5 mm. broad, straight, cylindrical, not expanded at the top, but divided into eight to ten low lobes. The upper part of the rhinophores is a smooth column; at the base are a few obliquely vertical perfoliations. From the rhinophore sheaths runs backwards a not very distinct marginal ridge, on which are set five processes on the left side and four on the right. The processes in the first pair are opposite one another. Then they gradually become alternate. They bear lobes with a rather irregular outline, so that the whole process looks like a short, thick branchial plume. The first pair have eight lobes, four on each side, and are folded along the median line, the concave surface being turned outwards. The second, third, and fourth pairs are similarly folded, but bear only seven lobes, three on each side and one terminal. The fifth process (found on the left side only) has five lobes and is irregular in shape. The genital orifices are close to one another, on the flank of the body, between the rhinophores and the first process. The vent is between the first and second processes, close to the dorsal margin.

The nervous system is yellowish. The ganglia are hard to separate, but as seen from above appear to be as described by Trinchese. The cerebro-pleural ganglia are large and triangular, showing no sign of division. The pedal ganglia, which are smaller, lie at their side on a lower level. The buccal ganglia are large. The eyes are large and of an intense bluish black.

The jaws bear a row of distinct but irregularly shaped denticles on the masticatory process. Higher up on the jaw itself there seem to be numerous projections near the edge. The radula resembles that of Galvina, and consists of thirty-one rows of three teeth each. The median teeth (Pl. XI., Fig. 10. a.) are very strong and distinct, with four well-developed denticles on each side of a large raised median cusp. The laterals (Fig. 10. b.) are very thin and hard to see, but are much as in *Galvina*, broad, but with a sharply pointed summit.

The animals being small and indifferently preserved, it was difficult to make out the digestive system by ordinary dissection, and the following details are derived almost entirely from the specimen which was sectioned. A fairly long œsophagus (Pl. XII., Fig. 11. a.) leads from the buccal mass to the stomach and gives rise about midway to a curved diverticulum (Fig. 11. b.). The stomach (Fig. 11. c.) is roundish and not very large. From the top of it rises the intestine (Fig. 11. d.), which sends out a tube to the anal papilla (Fig. 11. e.) on the right. The anterior lower part of the stomach is prolonged into two diverticula (Fig. 11. f.), which supply the first pair of cerata and then run straight forward, terminating in the anterior part of the foot. The termination is trifid. Posteriorly the stomach gives rise to a long and fairly wide tube (Fig. 11. i.), which extends to the hinder part of the body and sends off branches (Fig. 11. g.) to the cerata. These branches are at first simple, but before they enter the cerata they divide into as many ramifications (Fig. 11. h.) as there are lobes to supply. These secondary ramifications arise at different levels. At their termination they open externally by orifices (Pl. XII., Fig. 13. e.) which appear to be cnidocysts. They consist of a fairly broad tube, which is narrowed by a constriction when it reaches the integuments and forms outside the constriction a cup-shaped aperture. There are traces of similar openings on the anterior margin of the foot; but it is unusual to find cnidocysts in this position, and the structure of the organ is not clear. Abundant mucous glands are scattered over the whole surface of the body, and the mucus can be seen under the microscope in the act of exuding.

The hermaphrodite gland (Pl. XII., Fig. 12. l, n.) is large and fills all the posterior part of the body cavity with large yellowish packets. The anterior genital mass is also well developed, but hardened and not well preserved. No trace of armature was found, and the spermatotheca appeared to be surrounded by the albumen gland.

DOTO, OKEN.

A considerable number of species have been referred to this genus, but it is greatly in need of a revision based on a study of a large series of living animals. The internal characters offer few points of difference, and the external characters, such as coloration and the shape of the rhinophore sheaths, are somewhat variable, and liable to be either distorted or obliterated in preserved specimens. Bergh, in his *System der Nudib. Gast.*, registers sixteen species, described chiefly by Alder and Hancock, Hesse, and Trinchese. Of these it would appear that *D. arbuscula*, Agassiz, and *D. minuta*, Forbes, are mere names. *D. australis*, Angas, is perhaps a *Melibe* and not a *Doto* at all, and the later *D. ocellifera* of Simroth (*Die Gasteropoden der Plankton Expedition, 1895*, pp. 168–70) is of very doubtful affinities. The forms which probably belong to the genus may be enumerated as follows:—

1. *Doto coronata* (Gm.).
2. *D. formosa*, Verrill.
3. *D. cuspidata*, A. & H.
4. *D. fragilis* (Forbes).
5. *D. crassicornis*, M. Sars.
6. *D. costæ*, Trin.
7. *D. cornaliæ*, Trin.
8. *D. rosea*, Trin.
9. *D. aurea*, Trin.
10. *D. cinerea*, Trin.
11. *D. pinnatifida* (Mtg.).
    = *D. splendida*, Trin.
12. *D. paulinæ*, Trin.
13. *D. indica*, Bergh.
14. *D. africana*, Eliot.
15. *D. floridicola*, Simroth.
    perhaps = *Dotilla* (?) *pygmæa*, Bergh.
16. *D. annuligera*, Bergh.

DOTO PINNATIFIDA (MONT.), VAR. PAPILLIFERA.

Three specimens from Plymouth, nearly a centimetre long. The coloration, cerata, etc., seem typical of the species as described by Alder and Hancock, but there are numerous papillæ on the back, each with a black spot at the tip; and there are two or in some places three rows of such papillæ on the sides. The rhinophore sheaths are ample in front, but slit behind, and bear two or three papillæ (Fig. 14.). All these papillæ are too much developed to be called tubercles, and are half or even three-quarters of a millimetre in height. The anal papilla is very large.

The buccal mass is very small and the radula minute, though it contains more than 100 closely fitting teeth. The teeth bear at least three denticles on each side of the central cusp and perhaps other accessory denticles and ridges; but it is difficult to get a distinct view of any tooth, even under the highest power.

This form is probably a variety of *D. pinnatifida* with the tubercles more developed. All the proportions of the animal are larger than those described by A. & H., and it is possibly merely the normal adult form.

BERGHIA CŒRULESCENS (LAURILLARD).

The specimen preserved at Plymouth under this name is really a *Facelina coronata*, and has neither the rhinophores nor the dentition of *Berghia*. *Berghia* should probably be removed from the list of the British fauna, as there appears to be no other record of its occurrence.

The cerata are set in eight groups. At the interior end of several of them (that is at the sides of the clear space in the middle of the back) are a number of quite small tubercular papillæ, hardly half a millimetre high, and similar ones are found here and there in the middle of the rows. These tubercles probably represent cerata which have been bitten off and are in process of reproduction. See Bergh, *Beiträge zur Kenntniss der Æolidiaden*, v. p. 826. Alder and Hancock mention that the animals of this species (*F. coronata*) have the habit of eating one another's cerata.

ÆOLIDIELLA, BERGH.
EOLIS ANGULATA, A. & H.

I think that the *Eolis angulata* of Alder and Hancock (*Monogr.*, Fam. 3, pl. 23) is really referable to this genus, and merely a broad and probably immature specimen of *Æolidiella glauca*. Professor Herdman kindly gave me a specimen from Port Erin in the Isle of Man which was identified by him when alive as possessing the external characters of *Eolis angulata*. The preserved specimens also seemed to have these characters, as far as they could be recognized, except that the cerata were more numerous. When dissected it was found to possess the jaws and characteristic radula of *Æolidiella glauca*.

If this specimen is really Alder and Hancock's *Eolis angulata*, I do not think that species can be separated from *Æolidiella glauca*. As shown in Alder and Hancock's plates the coloration and general appearance are much the same, and it is noticeable that in both the rhinophores are represented as showing indications of slight annulation. Since *Eolis angulata* was four lines long and *Æolidiella glauca* nearly two inches, differences in shape and the number of cerata cannot be regarded as safe specific characteristics.

The anatomy of *Æolidiella glauca* is described by Bergh in his *Beitr. zur Kenntn. der Æolidiaden*, viii., 1885, pp. 24–8. The known distribution of the species extends from Scandinavia to the Mediterranean.

CORYPHELLA.

This genus consists of Æolids, with a triseriate radula, somewhat elongate bodies, and unperfoliated rhinophores. It is noticeable, however, that in several species the rhinophores show traces of rings or wrinkles, or bear minute lumps. The details submitted below seem to show that *C. gracilis* and *C. smaragdina* are varieties of one species. *C. beaumonti*, now first described, offers many peculiarities, and almost merits generic rank.

Bergh in his *System der Nudibranchiaten Gasteropoden* recognizes twenty-three species, of which several must be regarded as doubtful (e.g. *C. alderi*, *C. parvula*, *C. semidecora*, *C. forelisi*, *C. ocellata*), since the radula is unknown. To this list may be added:—

C. cooperi, Cockerell (*Jour. of Mal.*, 1901, viii. 3, p. 85).

C. californica, Bergh (*Mal. Unt. in Semper's Reisen*, vi. 1, 1904, p. 6).

C. sarsi, Friele (*Bergen's Museums Aarbog*, 1902, No. 3, p. 12).

Cockerell (*J. of Malac.*, 1901, p. 121) considers Cooper's *Æolis iodinea* to be a *Coryphella*, but Bergh refers it to *Flabellina*. Verrill's *Coryphella (?) pallida* is somewhat doubtful.

CORYPHELLA RUFIBRANCHIALIS (JOHNST.).

(ALDER and HANCOCK, *Monog. of British Nudib.*, Fam. 3, pl. 14.)

One living specimen, Plymouth, April, 1905. The animal is very elongate, 15 mm. long and only 3 mm. broad. The foot is produced in front into fairly long tentacular angles, which are very distinctly grooved. The oral tentacles are 5 mm. or more long, and are carried in a curved position. The rhinophores are 7 mm. long, straight, and covered with rows of little lumps set in fairly regular rings. There are about twenty-five rings, and about eight lumps in each.

The cerata look less thick than in Alder and Hancock's plate. They are slender and cylindrical, but often irregularly constricted near the tips, as if injured. The last two are set medianly on the caudal ridge. The anus is lateral, but high up. The tail not long.

The body is transparent and colourless, with only a very little opaque white on the oral tentacles and rhinophores. The hepatic ramifications within the cerata are of a bright, light scarlet, and somewhat irregular in outline. Above the scarlet is a broad opaque white ring, and above that a pellucid point. There is a faint yellow tinge in the rhinophores and down the centre of the back.

The jaws bear eight to nine rows of irregular denticles. The radula consists of thirteen rows. The median tooth has a strong central cusp, and seven rather long and thin denticles, curving slightly inwards. The side teeth bear twelve longish slightly curved denticles. Alder and Hancock (*Tongues of the Eolididæ*) say that the apex of the side teeth points outwards, but this did not seem to be the natural position in the present specimen, though the teeth are easily displaced.

In spite of this and some other small points of difference, I think this specimen must be referred to *C. rufibranchialis.* It can hardly be *C. pellucida*, which it also resembles, as that animal is said to have smooth lateral teeth.

CORYPHELLA GRACILIS (A. & H.).

One living specimen, Plymouth, April, 1905, 6 mm. long, and rather elongate. The body is of a not very transparent white, with a good deal of opaque white, especially on the oral tentacles, rhinophores, and tail. The cerata have opaque white pigment at the top, which sometimes, but not always, forms a distinct ring. The hepatic diverticula are of a reddish orange. The anterior angles of the foot are produced, but are not very long. The oral tentacles are distinctly longer than the rhinophores, which are smooth. The cerata are rather thick and elliptical, and are set in four groups, containing on each side eight, five, five, and three cerata respectively.

The radula consists of eleven teeth. The central tooth bears four to six (generally five) denticles on each side of the median cusp. The laterals bear six denticles.

This appears to be a fairly typical specimen of *C. gracilis.* Alder and Hancock say it has four denticles on the central tooth, Bergh that it has five.

Another living specimen seen at Plymouth at the same time was 9 mm. long and 2·5 broad. It was very active, and fond of swimming foot uppermost.

The tail is long; the anterior angles of the foot are produced into distinct but short horns. The oral tentacles are moderately long, with a few scattered opaque white dots. The rhinophores are long, wrinkled, but not perfoliate, transparent and colourless, except that the tips are covered with opaque white dots. The eyes are small, but black and distinct. The cerata are set in five groups, composed on the right side of three, four, two, four, three, and on the left of three, three, four, two, three cerata respectively. These five groups are all seen to be distinct when the animal is moving and stretched out. Otherwise the first and second and the fourth and fifth appear to coalesce, though the third always remains distinct. The general impression produced is that the cerata are few and scattered irregularly. The innermost are the largest and are rather swollen. The body is colourless and transparent. On the tail is a line of irregular bright white spots. The yellowish-grey hermaphrodite gland can be seen through the integuments. The hepatic diverticula within the cerata consist of two elements, one bright green, the other brownish yellow. As a rule the green predominates and gives the general colour, but in some of the cerata the brown pigment prevails.

The jaws are thin and colourless, with at least six rows of denticles. The radula consists of thirteen rows. The central tooth has as a rule four denticles on each side of the median cusp, but sometimes five, and only once six. The laterals have the apex turned inwards and bear five or six denticles.

A third specimen was dead when examined. Though much macerated and mutilated, it appeared to have resembled the one just described externally. The cerata were green with white tips. The radula consisted of twelve rows. The central teeth have uniformly seven denticles on each side of the median cusp. The laterals bear three to six denticles. The tips of several laterals seem to point outwards.

According to Alder and Hancock, who created both species, *C. gracilis* has orange-red cerata and four denticles on the central teeth, whereas *C. smaragdina* has green cerata and seven denticles. The second of the forms described above appears to be intermediate both in colour and dentition between *C. gracilis* and *smaragdina*, and suggests that the animals in which the green pigment predominates should be called *C. gracilis*, var. *smaragdina*.

Vayssière (*Recherches sur les Moll. Opisth. du Golfe de Marseille*, ii. p. 76), regards *C. landsburghii*, *C. rufibranchialis*, *C. pellucida*, *C. smaragdina*, and *C. gracilis* as being all synonyms. This appears to me excessive, as besides other characters the forms vary in their dentition. But it must be admitted that we require much more information to enable us to judge how far the number of denticulations may vary within the limits of one species.

CORYPHELLA LANDSBURGHII, ALDER & HANCOCK.

(ALDER and HANCOCK, *Monog. of British Nudib.*, Fam. 3, pl. 20. TRINCHESE, *Æolididæ di Genova, ii.*, Tav. lxii., lxiv., lxvi.–lxx. BERGH, *Die Nudibr. gesammelt während d. Fahrten d. Willem Barents*, p. 8.)

One living specimen, Plymouth, April, 1905. Very slender and elongate, 7 mm. long and only about 1 mm. broad. Cerata nearly 2 mm. long; rhinophores 2·3 mm. long. Foot produced into distinct tentacular angles. Oral tentacles fairly long and slightly wrinkled; rhinophores longer and more distinctly wrinkled. They bear low rings of rather irregular outline, but not perfoliations or knobs. The cerata are set in eight short rows arranged as follows on each side:—

2	
2	Three rows close together.
3	
2	Two rows close together.
3	
2	
2	Three distinct rows.
2	

The body, rhinophores, and tentacles are of a clear amethyst, with which the orange-red ramifications of the liver within the cerata form a striking contrast. The cerata bear a ring of opaque white below the pellucid tips. The foot is whitish.

The jaws bear six to seven rows of denticles near the top, but the number decreases lower down. The radula consists of thirty rows. The central tooth is rather broad and arched. It bears five denticles on each side of the central cusp, which is not much larger than the rest. The laterals are of a fair size, but somewhat difficult to see, as they are quite colourless. They have a long apex and five to six small denticles.

This appears to be a fairly typical example of Alder and Hancock's *C. landsburghii*. They do not mention that the rhinophores are wrinkled, though it is indicated in their plate, and they describe them as distinctly shorter than the oral tentacles, which is not the case here.

The most striking characteristic of this form is its strangely contrasted coloration. It is very doubtful if the specimen from Vardö referred to this species with a query by Bergh (l.c.), really belongs to it.

CORYPHELLA BEAUMONTI, *spec. nov.*

Mr. W. I. Beaumont, to whom the species is dedicated, has kindly furnished me with the following notes on the living animal.

"*Eolid from Barn Pool (Plymouth)*. Length, 16 mm., but looks as if the posterior part of the body had been lost, as it ends abruptly only 3–4 mm. behind the heart.* The outline of the anterior end of the foot is like *Eolis nana*, except that the sides are produced into small angular projections kept tucked in and consequently inconspicuous. Head nearly as wide as the foot. The oral tentacles very minute; merely short processes of angles of the oral veil. The rhinophores are long and smooth, held erect with tips bent back. The eyes do not show. Papillæ very numerous and extremely long, slender and tapering to fine points, constantly in motion, curling and uncurling, and when at rest convoluted. A group of small papillæ, apparently three rows, is wholly in front of the rhinophores on each side. Then a row on each side abreast of rhinophores. Another row between this and the next, which is abreast of the anterior end of the heart. Then a row level with the posterior end of the heart. The outer ends of the rows are not double.

"The colour of the body is red, tending to orange on the rhinophores, but elsewhere more rosy. The colour seems to be situate in the superficial tissues. The papillæ are superficially flesh-coloured. The hepatic cœca are in most of the papillæ rosy purple throughout, but in a few pale greenish purple, except at the tip, which is rosy purple in all and more deeply coloured than the rest of the organ. The cœca are slender, especially at the distal ends, and much corrugated. The extreme tips of the papillæ beyond the end of the cœca are yellowish flesh colour, deeper than the superficial colour of the rest of the papillæ."

I have examined two preserved specimens given me by Mr. Beaumont, 20 mm. and 14 mm. long respectively. The colour is dead white, not very transparent. The hepatic diverticula are yellowish white and corrugated. The external characters agree with Mr. Beaumont's description. The front of the foot is broad and expanded, but the tentacular angles are small and bent downwards and inwards. The anterior margin is not grooved. Over the mouth is a broad oral veil (5·3 mm.) expanded into short tentacles (1·7 mm.) at the sides The rhinophores are long (7·5 mm.), thin, not perfoliate, and placed close together on a slight prominence. There are three rows of cerata distinctly in front of them. The cerata are set on eight narrow, curved ridges, which are single and do not form horseshoes. The first three rows are close together, the next three not far apart, but the last two are more distant. In the perfect specimens the length of the cerata obscures this arrangement. There are four to six cerata in each row. The cerata in front of the rhinophores are short, cylindrical, and 2–4 mm. long. The posterior cerata are very long; in the specimen, which has a body 20 mm. long, they measure as much as 15 mm. and are about 1 mm. broad at the base.

* The specimens here described are much the same.—C. E.

The jaws bear two or three rows of denticles. The radula is triseriate, and consists of twenty and fourteen rows respectively in the two specimens. The central tooth (Fig. 15. a.) has a strong central cusp, which bends slightly downwards, and hence sometimes appears asymmetrical when pressed flat in a slide. On each side of it are a number of small denticles of varying shape and size. The smallest number observed was sixteen and the largest twenty-four. The laterals (Fig. 15. b.) are also broad, with slightly lower cusps, and twenty to thirty accessory denticles on the inner side. No denticles were visible on the outer side of the laterals.

The penis, which is partially protruded in one specimen, is sickle-shaped and very deeply grooved, consisting of a lamina folded down the middle and probably capable of assuming a foliaceous expansion. This part is unarmed, but the base of the penis and the end of the spermatic duct bear numerous yellow cones (Fig. 16.) terminating in a short bent appendage. They appear to be soft and not spiculous or chitinous. The spermatotheca is large and spherical.

As this species has smooth rhinophores and the radula of *Coryphella*, I provisionally refer it to that genus in order to avoid multiplying genera. But in many of its characters—such as the shortness of the oral tentacles, the length of the cerata, the position of some of the cerata in front of the rhinophores, and the conformation of the penis—it differs markedly from the described Coryphellæ, and it may ultimately prove better to make it the type of a new genus.

CRATENIDÆ, BERGH.

(BERGH, *Mal. Unt. in Semper's Reisen*, Heft i., 1870, pp. 1–4, and Heft xviii. pp. 1021–4. BEAUMONT, "Fauna and Flora of Valentia Harbour," in *Proc. Royal Irish Acad.*, 1900, pp. 834–8. FRIELE, "Mollusken der ersten Nordmeerfahrt," *Bergen's Museums Aarbog*, 1902, No. 3, p. 9.)

As the authors cited above observe, Bergh's classification of this group raises many difficulties in practice, on account of the minuteness of the generic distinctions and the doubt whether the forms really possess the characters which he attributes to them. He divides the subfamily into five genera—*Cuthona*, *Cuthonella*, *Cratena*, *Hervia*, and *Phestilla*. Of these the last named differs from the others in several particulars. *Hervia* also may be set aside as characterized by the corners of the foot being prolonged into tentacular processes. It is not recorded from British waters, though as the habitat of one species is the Northern Atlantic it may some day be added to our fauna. The other three genera, *Cuthona*, *Cuthonella*, and *Cratena*, are closely connected, and to them must be added in my opinion *Amphorina*. Bergh classes

Amphorina under the Galvinidæ, which hardly form a natural sub-family, the only character common to the component genera being that the cerata are more or less inflated. In *Amphorina* this feature is not very marked, and its other characters ally it to *Cratena*. The tropical genera *Zatteria*, *Myja*, and *Ennoia* are also probably allied, but need not be considered here.

With regard to nomenclature, Bergh appears to have proved that the names *Carolina* and *Montagua* must be rejected.

The animals which compose the four genera *Cratena*, *Cuthona*, *Cuthonella*, and *Amphorina* are small and inconspicuous, though often beautifully coloured. The rhinophores are not perfoliate, the corners of the foot are not developed into tentacular processes, and the radula is uniseriate. There is an absence of any very striking characteristics either internal or external. The most distinct genus is *Amphorina*. It has slightly inflated cerata, a style on the penis, and a long tapering radula containing from fifty to eighty teeth, which gradually increase in size. The denticles on the teeth, particularly the median cusp, arise far back, and hence have a peculiar elevated appearance. To this genus at least the following species must, in my opinion, be referred:—

1. *Amphorina alberti*, Quatrefages.
2. *A. cærulea* (Mtg.).
3. *A. molios*, Herdman.*
4. *A. aurantiaca* (A. & H.) = *Cuthona aurantiaca*.
5. *A. olivacea* (A. & H.) = *Cratena olivacea*.

Perhaps *Cratena viridis* will prove to be an *Amphorina*, as may also *E. glottensis*. In separating the other genera Bergh makes use of the structure of the auditory capsule, which he says contains a single otolith in *Cuthona*, but several otoconia in *Cuthonella* and *Cratena*. Beaumont, however, denies this, and reports the existence of single otoliths in species classified by Bergh under *Cratena* (e.g. *Cr. amœna*). In any case, the character is so minute and so difficult to determine in preserved specimens that it seems undesirable to use it, unless absolutely necessary. Setting aside possible differences in the auditory capsule, it would appear that the only clear distinction between *Cuthona* and *Cratena* formulated by Bergh is that the head is broad in the former, but not in the latter. This character seems to be clear and conspicuous, though, as it is merely a question of degree and development, one may doubt if it is really of generic value. If it is accepted, it would appear that the following are referable to *Cuthona*:—

1. *Cuthona nana*, A. & H.
2. *C. pumilio*, Bergh (Sargasso Sea).

* I agree with Mr. Beaumont (l.c.) in thinking that the specific distinctness of this species from *A. cærulea* is doubtful.

3. *C. bicolor*, Bergh (Japan).
4. *C. peachii*, A. & H. (see Beaumont, l.c.).

Eolis inornata, A. & H., and *Cuthona stimpsoni*, Verrill ("Addns. to Marine Fauna of N. America," *in American J. of Sci. and Arts*, vol. xvii. p. 314, 1879), possibly belong to this group, but are imperfectly described, and the buccal parts unknown.

The genus *Cuthonella* was founded by Bergh for a single specimen obtained by the *Challenger* in the Faroë Channel. Like *Cuthona* it has a broad head, but it differs from both *Cuthona* and *Cratena* in having the foot truncated in front, jaws armed with several series (not a single series) of denticles, and the anus opening on the back, not on the side. It will be seen that all these characters, except the last, are very slight. Friele (l.c.) examined specimens from the North Atlantic which had the general characters of the *Cratenidæ* and a dorsal anus, but a rounded foot and a rather irregular denticulation of the jaw. Not wishing to create a new genus for these trifling deviations, he referred the form to *Cuthonella*, the characteristic of which thus becomes the position of the anus, which is dorsal, but somewhat to the right of the median line.*

The genus thus contains—

1. *Cuthonella abyssicola*, Bergh.
2. *C. ferruginea*, Friele.
3. *C. berghi*, Friele.

All from the North Atlantic, but not from British waters.

There remains the large genus *Cratena*, in which can be included most of the forms not assigned to *Cuthona*, *Cuthonella*, and *Amphorina*, though some of the less-known species of this group, such as *Eolis northumbrica*, present remarkable peculiarities. In *Cratena* the head is not broad, the cerata are not inflated, and the anal papilla is on the side, not on the back. The radula is generally (but not always) short and not markedly tapering. The teeth bear a few (rarely more than ten) denticles on each side of a central cusp which is often not prominent. As a rule the penis is unarmed, but in some cases, for which it hardly seems worth while to create a new genus, it bears a style. The following species seem referable to this genus with more or less certainty:—

1. *Cratena hirsuta*, Bergh. Greenland.
2. *Cr. olrikki* (Mörch). Greenland.
3. *Cr. pustulata* (A. & H.).
4. *Cr. amœna* (A. & H.).
5. *Cr. fructuosa*, Bergh. Sargasso Sea.

* I understand this to be the case in *Cuthonella abyssicola*, but Bergh's statements in the *Challenger Report*, on p. 24 and p. 25, are not quite consistent.

6. *Cr. concinna* (A. & H.).*
7. *Cr. pilata* (Gould). North-West Atlantic.
8. *Cr. bylgia*, Bergh. Philippines.
9. *Cr. longibursa*, Bergh. Pelew Islands.
10. *Cr. stipata* (A. & H.).
11. *Cr. cavanca*, Bergh. Chile.
12. *Cr. pusilla*, Bergh. Juan Fernandez.
13. *Cr. cucullata*, Bergh. Malay Archip.

Cr. viridis (Forbes) and *Cr. glottensis* are probably Amphorinas, and it seems difficult to separate *Cratena gymnota* (Gould) from *Amphorina aurantiaca*. *Cr. arenicola* (Forbes), *Cr. veronicæ* (Verrill), *Cr. couchii* (Cocks), and *Cr. purpurascens* (Fleming) are imperfectly described. *Cr. cingulata* is placed by Alder in *Jeffrey's Conchology*, vol. v. p. 53, under *Galvina*, which implies that it has a triseriate radula. *Cr. lugubris*, Bergh, is referred to this genus with a query by the author himself.

In *Jeffrey's Conchology*, vol. v. p. 45, etc., Alder distributes the British forms between *Cuthona* and *Carolina*. The former, which is defined as having the branchiæ close set and a uniseriate radula with a central spine and lateral denticulations, includes *C. peachii*, *C. nana*, *C. stipata*, *C. angulata*, *C. inornata*, *C. concinna*, *C. olivacea*, *C. aurantiaca*, and *C. pustulata*. *Carolina*, which is defined as having the branchiæ set in rather distant rows and a uniseriate denticulated radula with the central spine a little prominent, includes *C. couchii*, *C. amœna*, *C. northumbrica*, *C. arenicola*, *C. glottensis*, *C. cærulea*, *C. viridis*, and *C. purpurascens*. Though something may be said for this division, it ignores the existence of *Amphorina* (Quatrefages, 1844), and the point on which stress is laid—whether the branchiæ are close set or in distant rows—is often difficult to determine in preserved specimens, and might be doubtful in living ones.

In the above remarks I have merely considered how the described species can be most naturally distributed among the described genera. Whether those genera are valid and necessary is another question. I doubt myself if Bergh's whole subfamily of Cratenidæ, including *Amphorina* (but perhaps excluding *Phestilla*) offers more than one good generic type; and if nature provides a great number of similar forms it seems unscientific to separate them into many genera on the strength of small points of difference. It is convenient, no doubt, to divide a large genus into sections or subgenera, but to split it into several genera if the differences between them are of less than ordinary generic value obscures the real uniformity of the animals classified.

* *Cr. concinna*. Since writing the above I have had an opportunity of examining a specimen of this species from the Menai Straits, given me by Prof. Herdman. The characters agree with A. & H.'s description. No style was found on the penis. The teeth of the radula are remarkably long, narrow, and pointed.

AMPHORINA AURANTIACA (A. & H.).

(Alder and Hancock, *Mon. Brit. Nud.*, Fam. 3, pl. 27.
Beaumont, l.c., pp. 836–7.)

One living specimen examined at Plymouth, April, 1905. The animal, which was active and seemed to resent being touched, measured 8 mm. in length and 3·5 in breadth when extended. Mr. Beaumont observes that specimens as highly coloured as Alder and Hancock's plate are rare, and the present one was decidedly less brilliant. The tentacles and rhinophores were colourless, the latter with a faint red tinge. The body was colourless and transparent, with very minute, hardly visible opaque white dots. Behind the black eyes was a reddish spot, possibly caused by some internal organ showing through the skin. The general effect of the cerata was that they were reddish with white tips. The integuments of the cerata were colourless, as could be seen at the tips, where there is no liver; below this colourless tip was a broad band of opaque white, formed by an aggregation of minute dots. The hepatic diverticula were reddish brown.

The foot is expanded anteriorly into a disk, but there are no tentacular angles. The tail does not project beyond the cerata behind. The rhinophores are somewhat longer than the tentacles. In the living animal the cerata show no distinct arrangement in rows; a bare space is visible anteriorly behind the rhinophores; further back the cerata close over and hide the dorsal surface. When stripped off, the cerata are seen to be arranged in ten rows, each containing two to four.

The jaws bear several series of minute denticles. The radula consists of a single series of seventy-six teeth, tapering markedly in breadth. They bear two or three main denticles (Fig. 17.) on each side of the median cusp, and one or two secondary smaller denticles occasionally and irregularly interposed between the main denticles. All the denticles, especially the median cusp, arise unusually far back. Mr. Beaumont states that the penis is armed with a style.

Verril in *Proc. U. S. National Mus.*, iii., 1880, p. 390, observes that *Cuthona aurantiaca*, A. & H., is very closely allied to *Cratena gymnota* (Gould), which has been described by Bergh in *Beiträge zur Kenntniss der Æolidiaden*, viii., 1885, pp. 33–5. The dentition agrees exactly, but the form and arrangement of the cerata are different, and Bergh found no armature on the penis. It may therefore perhaps be well to keep the forms provisionally distinct.

This form must, I think, be referred to *Amphorina*, for it has all the main characters of that genus. The cerata are stout (see Alder and Hancock), the penis is armed with a style (according to Beaumont), the radula is tapering, and the denticles on the teeth arise far back. Loman in his paper *Aanteekening over twee voor de nederlandsche Fauna nieuwe Nudibranchiata*, published in the *Tijdschrift der Nederlandsche Dierkundige Vereeniging*, 1893, p. 35, has already called the animal *Amphorina aurantiaca*.

AMPHORINA OLIVACEA (A. & H.).

(ALDER and HANCOCK, *Mon. Brit. Nud.*, Fam. 3, pl. 26. BEAUMONT, l.c., p. 834.)

One living specimen was seen at Plymouth in April, 1905, which I should have hesitated to identify with Alder and Hancock's *E. olivacea* on account of the differences in tint and markings; but Mr. Beaumont considered it referable to this species, and stated that the coloration is very varying. As the other characters of the animal proved to agree with *E. olivacea*, I have no doubt he is correct.

The animal is only 4 mm. long, stoutly built, with a short tail. The body colour is whitish; the tentacle, the rhinophores, and the region behind them are yellowish. There are no red markings, but the cerata and body, especially the head, are sprinkled with conspicuous dots of bright, opaque yellow. The tips of the cerata are whitish and the hepatric diverticula are olive-coloured.

The front of the foot is slightly expanded into round lobes, but there are no tentacular angles. The cerata are rather thick; the branches of the liver within them are of loose and irregular shape. The cerata are set in eight rows, fairly close together, containing three to four each.

The jaws bear a row of minute but distinct blunt denticals. The radula tapers somewhat, but not conspicuously; it consists of a single series of fifty-three teeth, with six denticles on each side of the median cusp (Fig. 18.). This cusp is elevated and rises further back than the others. I found the verge armed with a hooked style (Fig. 19.) as already described by Mr. Beaumont.

I think that this species, like *Eolis aurantiaca*, A. & H., must be referred to *Amphorina*, for it has thick papillæ, a spine on the penis, and a long somewhat tapering radula, in which the teeth have the central cusp rising far back.

CRATENA AMŒNA (A. & H.).

(ALDER and HANCOCK, *Mon. Brit. Nudib.*, Fam. 3, pl. 3. BEAUMONT, l.c., p. 834.)

One living specimen, Plymouth, April, 1905. The animal when fully extended is about 7·5 mm. long. The body is of a not very clear white, with opaque white spots, especially on the head and tail. The angles of the foot are rounded in front. The tentacles and rhinophores are as in

Alder and Hancock's plate, spotted with white and with a reddish-brown band about a third of the way down. The cerata are spotted with opaque white and brown and have white tips, below which is often, but not always a distinct reddish-brown ring; they are carried as represented by Alder and Hancock, but there are only five or at most six groups, arranged as follows:—

1}
4}
4
4
4
3

The hepatic diverticula are not nearly as green as represented by Alder and Hancock, but greyish brown with only a faint greenish tinge.

The jaws bear a single row of small but distinct blunt denticles. The radula consists of a single series of seventeen teeth, not tapering conspicuously; there are five denticles on each side of the central cusp, which is not much higher than the rest. Beaumont found the verge to be armed with a colourless spine, but I was unable to discover it.

If *Cratena* and *Amphorina* are maintained as separate genera, it is difficult to say to which this species should be referred. Beaumont found that it had a single otolith and a style on the penis, characters which belong to *Amphorina*; but the cerata are not inflated, the radula is short, and the denticulation of the teeth is not like that found in *Amphorina*. I therefore describe the animal, though with considerable hesitation, as *Cratena amœna*.

CALMA, A. & H.

Much confusion has arisen about this genus, for later authors have not paid sufficient attention to the statements made about it by Alder and Hancock, and these statements, which are scattered in various parts of the monograph, are not always plain if taken separately, though if taken all together they are clear enough. Alder and Hancock described the type species first in the letterpress to plate 22 (under the name of *Eolis glaucoides*) as a very curious *Eolis* which will probably constitute a new generic type, and pointed out the remarkable characters of the "gastro-hepatic vessel" and "the ovary." Their language about the radula in this passage is wanting in precision, but in the letterpress to plate 47 (*Tongues of the Eolididæ*) they say that the tongue is very slender, resembles a continuous band, and can only be seen in profile. The figure clearly represents the tongue as I have found it, a continuous chitinous ribbon in which the teeth are fused together and only appear as minute serrulations. On page 21 of the Appendix they create the genus *Calma* for *Eolis glaucoides*, but unfortunately mention only the external characters and do not refer to the anatomy.

Hence Trinchese, followed by Bergh (*Beit. zur Kennt. der Æolid.*, iii., 1876, pp. 643–7, and vii., 1882, pp. 61–4) and Vayssière (*Opisth. de Marseille*, ii., 1888, 81–8), regarded the genus as akin to *Flabellina*, and referred to it the *Eolis cavolini* of Vérany.

Later (*Rendiconti Accad. Sci. Fis. Mat. di Napoli*, xx. 5, 1881, pp. 121–2, and *Mem. Ac. Sci. Istit. di Bologna*, S. iv. T. x. pp. 57–61) Trinchese described under the name of *Forestia mirabilis* a Mediterranean Æolid having all the main characters of Alder and Hancock's *Calma glaucoides*—the thread-like undivided radula, the broad, simple hepatic system, and the hermaphrodite gland arranged along the two sides of the body. Friele and Hansen had also (*Bidrag til Kundskaben om de nordske Nudibranchier*, 1875, pp. 78–9) described another species from the Northern Atlantic, calling it merely *Eolis albicans*, but indicating its affinities to the genus *Calma*, A. & H. Bergh, in his *System der Nudib. Gasteropoden* (p. 1025 and p. 1034) puts *Eolis albicans* under *Forestia*, and makes the genus *Calma* consist of *C. glaucoides*, A. & H., and *C. cavolini* (Vérany).

There can, however, be little doubt that the really important characters of *Calma* are those mentioned above, and that the genus is equivalent to the later (1881) *Forestia*. It will then contain three species.

{ 1. *C. glaucoides*, A. & H. Atlantic.
{ 2. *C. albicans*, Friele and Hans. Atlantic.
3. *C. mirabilis* (Trinchese). Mediterranean.

C. albicans appears closely allied to *C. glaucoides*. *C. mirabilis* differs in having a few separate teeth, as well as the continuous chitinous band, and it would seem that the groups of papillæ do not rise from a common stalk.

It seems probable that *Calma cavolini* does not belong to this genus. It is regarded by Bergh and Vayssière as related to *Flabellina*, from which it differs in having no perfoliations on the rhinophores. The radula is not like that of *Calma glaucoides*, but has separate teeth of the usual pattern. There is some doubt whether it is triseriate or uniseriate, the laterals being in any case very small. It would seem that in some points the digestive and reproductive organs resemble those of *C. glaucoides*, but neither Bergh nor Vayssière suggest that it resembles *Forestia mirabilis*. They had perhaps not seen Trinchese's paper at the time they wrote. Whatever may be the true affinities of the form, the differences in the buccal parts prevent its being referred to *Calma*, and I would propose that it should be rebaptized *Calmella*.

I do not think that the inflated shape of the cerata and their arrangement on low pedestals are really important characters in *Calma*, and would define the genus as at present known in the following way.

Animal flattish, cerata arranged in rows and sometimes rising from a pedestal. No cnidocysts. Rhinophores simple. Corners of anterior margin of foot prolonged into tentacular processes. Penis unarmed. Jaws not denticulate. Radula a continuous band not divided into separate teeth and merely bearing serrulations on the upper surface. Digestive system much simpler and less ramified than is usual in the Æolididæ; kidney also simple and not ramified. Hermaphrodite gland symmetrically arranged on the two sides of the body.

Though the anatomy of *Calma* is characterized by a certain simplicity, this simplicity is no doubt not primitive, but secondarily acquired and connected with the unusual diet of the animal, which feeds on the eggs of fish. The nature of the food no doubt explains the degeneration of the radula and perhaps also the absence of cnidocysts (see Grosvenor, "On the Nematocysts of Æolids," *Proc. Roy. Soc.*, 1903, vol. lxxii. No. 486, p. 469). Several of my specimens seemed to be gorged and distended with gelatinous matter, and probably the creatures' habit of thus stuffing themselves accounts for the breadth and simplicity of the alimentary passages.

CALMA GLAUCOIDES, ALDER & HANCOCK

Seven specimens received from the Plymouth Laboratory. Two of them resemble Alder and Hancock's figures more than do the others, which are flatter and have swollen, almost ovate cerata. But no differences of structure were found, and as all the specimens were identified at the Laboratory with *C. glaucoides*, it is probable that they were all alike externally when alive.

The length varies from 10 to 4 and the breadth from 4 to 2 mm. The general colour is whitish or drab, but varies in detail, because the transparent integuments allow the contents both of the body and of the cerata to be seen. The broad digestive tract with its diverticula is generally coloured a pale dull yellow, but contains here and there blackish masses in the cerata as well as in the main alimentary tract. In two specimens these black portions are so large that the general colour appears to be bluish black. At the sides of the body between the cerata the white follicles of the hermaphrodite gland are distinctly visible. The integuments are generally brownish at the sides of the body and at the bases of the cerata.

The margin of the foot is expanded both in front and at the sides, so as to be considerably wider than the head and body; anteriorly the foot is rounded, and is produced on each side into a short tentacular process, which is almost invisible in many specimens. The cerata are set in from nine to twelve rows, the most common number being ten. Each row contains two or three cerata, more rarely four. The stalk or common base on which they are set is not at all conspicuous, but when an attempt is made to detach them they come off in twos or threes, and not separately. They are not at all caducous. In most specimens they are oblong-ovate in shape; but in two (as in Alder and Hancock's figures) they are cylindrical. The tentacles and rhinophores are both small, without a trace of perfoliations.

The jaws are thin, smooth, and colourless. The radula consists of a colourless, continuous ribbon, bent into a roughly semicircular shape (Fig. 20.), and bearing 60–100 denticulations like the teeth of a saw, and gradually increasing in size.* No trace of any loose, detached teeth was found. The œsophagus leads into a dilatation (Fig. 21. d.) of moderate size, which may be called the stomach. From it extends a diverticulum on either side which supplies two cerata. Posteriorly the stomach is prolonged into a very wide sacculated gut (Fig. 21. a.), which extends to the extreme end of the body and gives off simple diverticula, each of which supplies a single group of cerata. These diverticula fill the cerata entirely, and no cnidocysts were found. The contents of the digestive tract, including the cerata, resemble hardened jelly, and are probably composed of the eggs of fish, which the animal is said to eat. In this jelly are embedded moderately hard black lumps, detachable from their surroundings and easily friable, which the jelly is not. As mentioned above, in some specimens this black substance forms the major part of the contents of the digestive tract.

The lobes of the hermaphrodite gland are white, and visible through the dorsal integuments. They are composed of small pouches containing ova, scattered rather irregularly round a larger and more elongate pouch containing spermatozoa, and they alternate with the diverticula proceeding from the alimentary canal to the cerata. There is no armature on the penis. The renal organ (Pl. XII., Fig. 22.) consists of a simple sac with a few constrictions. It does not in my specimens extend as far backwards as indicated by Hecht's figures (*Contribution à l'étude des Nudibranches, Mem. Soc. Zool. de France*, viii. 1895, pl. iv. figs. 47, 48), but terminates soon after the commencement of the posterior third of the body.

JANIDÆ, BERGH.

This family superficially resembles the true Æolids, but offers several differences of organization. Except in *Madrella*, the radula is multi-

* Below the row of denticulations (a) there can be seen under a high power three or four series of minute pits and projections (b).

seriate, which would seem to be a more primitive arrangement than the extremely narrow radulæ of the Æolids; but the anal papilla is situated near the end of the back in the median line, which seems to be an instance of secondarily acquired symmetry. The digestive system offers peculiarities of its own; and the cerata, together with the hepatic diverticula, extend in front of the rhinophores along the anterior margin. There is generally a crest between the rhinophores.

Three British genera are known—*Antiopella*, *Janolus*, and *Proctonotus*. The nomenclature of the first genus is confusing. Vérany described it as *Janus* in 1844, and this name is used by Bergh, Trinchese, and Vayssière on the ground that it has priority over *Antiopa*, the name used by Alder and Hancock in 1855. But the objection to the name *Janus* (as pointed out by Alder and Hancock in the text for plate 43) is that it has been in use for a genus of Hymenoptera since 1835. But Mr. Hoyle states (*Journal of Conchology*, 1902, p. 214) that *Antiopa* is in its turn invalid for a similar reason, namely, that it was used for a genus of Diptera as early as 1800. He proposes to call the animal *Antiopella*, and it would seem that this name must stand, unless some one proves that it also is preoccupied.

Antiopella has perfoliate rhinophores with a crest between them, and jaws with denticulate edges. Only one species is properly authenticated, *A. cristata*, which is recorded from the Mediterranean and British waters. *Janus sanguineus*, Angas, is somewhat doubtful. The plate suggests that it may be an unusually red variety of *Madrella ferruginosa*, which has also the habit mentioned by Angas of discharging a yellow secretion which colours the water round it.

The genus *Janolus* was created by Bergh for a specimen obtained by the *Challenger*, and differing from *Antiopella* in having a very broad margin to the foot and remarkably large undenticulate jaws. Bergh has since shown that Alder and Hancock's *Antiopa hyalina* belongs to this group. A third species, *Janolus cæruleopictus*, Eliot, is recorded from California; and a fourth, somewhat doubtful, species is described below.

The genus *Proctonotus* was created by Alder and Hancock for two specimens found near Dublin, and is also recorded from West Ireland and Arran. The rhinophores are not perfoliate (though they bear wrinkles and tubercles), and there is no crest between them. The radula is broad and the jaws are not denticulate.

ANTIOPELLA CRISTATA (DELLE CHIAJE).

Four living specimens at Plymouth, April, 1905, the largest 30 mm. long and 8 broad. Alder and Hancock's figure of this species is not very good, and that of Trinchese (*Æolididæ del Porto di Genova*, pl. 44) is in some respects superior. The general colour is transparent white with a faint yellowish tinge. The rhinophores and the crest between them are very large and distinctly yellowish. On the back and sides of the body and on the tips of the cerata are very vivid metallic spots which appear blue in some lights and pink in others. There is a streak of the same colour on the tail. The hepatic system is of a deep, rich brown, and its ramifications can be seen clearly through the transparent skin.

The cerata are very deciduous, and in these specimens many, or even the majority, are quite small and tubercular. These are evidently new growths replacing lost appendages.

JANOLUS HYALINUS (A. & H.).

(Alder and Hancock, *Monog. Brit. Nudib.*, Fam. 3, pl. 44. Bergh, *Mal. Untersuch. in Semper's Reisen*, vi. 1, p. 8.)

Two preserved specimens from Plymouth, one 8 mm. long, the other only 4·3 mm. They agree as to external characters with Alder and Hancock's description. The colour is yellowish, with traces of lighter and darker mottlings. The cerata are crowded and irregularly set. There are generally four to five in a transverse row. The innermost are the largest and about 5 mm. high; they decrease in size outwards, and the outermost are mere tubercles. They bear knobs, as described by Alder and Hancock. The anterior margin of the foot is somewhat undulated, with a bend inwards in the middle. It is not grooved in the ordinary way, but the sides of the head are developed into lappets which extend downwards towards the sides of the foot and form a ridge parallel to them. There is a small fold round the head bearing two distinct tentacles. The rhinophores bear irregular perfoliations which do not go all round the club. The interrhinophorial crest is elongate.

The jaws are large and smooth, with no denticles. The radula consists of fifteen rows varying from 11.1.11 to 13.1.13. The teeth are hamate and increase in size from the rhachis outwards, the last but one being the largest, and the outermost of all smaller (Fig. 23.). They bear three to five (rarely seven) long ridge-like denticles, which are not very small, but difficult to see on account of the extreme transparency of the teeth. These denticles seem to have escaped the notice of both Alder and Hancock (*Tongues of the Eolididæ*) and Bergh, who describe the teeth as smooth. The denticulation is probably variable.

Alder and Hancock's figures of this species (*Monograph*, pl. 44, figs. 8 to 12) are not good, but much better unpublished drawings by Hancock are preserved in the Newcastle Museum.

JANOLUS FLAGELLATUS, *sp. nov.*

One specimen from Plymouth labelled "*Antiopa hyalina nr. Eddystone*

25. vi. 97." As preserved, it is of a uniform dull-white colour, slightly transparent on the back, but elsewhere opaque. The length is 15·5 mm.; the breadth 8; the height to the top of the pericardium 7·5, but the end of the body has burst open, and the hermaphrodite gland is protruding. The foot is broad (as much as 9·5 mm. in one place), with ample and undulated mantle margins. It is notched in front, and connected with the head by two very distinct intermediate fleshy plates. Above them are two small but distinct tentacles, forming the extremities of a narrow oral veil. The rhinophores are straight, cylindrical, moderately stout, and bear irregular but distinctly vertical perfoliations, which often join one another or end abruptly before they reach the summit. Between them is a very distinct crest, consisting of about ten transverse perfoliations, which are themselves crinkled and again perfoliate.

The only cerata preserved are minute, not more than 1 mm. high, more numerous on the right than on the left, and set in one to two rows. There are also several small cerata in front of the rhinophores. There is no trace of larger cerata, but they have probably been lost and replaced by young ones in the first stages of growth. The anus is medio-dorsal, set very far back, and cup-like. There appear to be a few tubercles on the broad tail.

The genital orifices are about 5 mm. from the head and surrounded by strong folds. The verge is exserted and extremely long. It consists of a straight cylindrical column, not tapering, 4 mm. long, and bearing at the end a flagelliform appendage 5 mm. long, so that the whole organ measures 9 mm.

The digestive organs are much compressed by the greatly developed reproductive glands and are not very well preserved, but appear to agree with Alder and Hancock's account of *Antiopa cristata*. The œsophagus is short and opens into a large laminated stomach, from which the intestine runs backwards and which receives the two principal hepatic trunks. Owing to the cerata being minute and rudimentary the course of the hepatic diverticula in them cannot be traced; but beneath the dorsal skin, and especially at the sides, there is a thick network of tubes out of which the hepatic trunks seem to arise.

The central nervous system is like that described by Bergh for *Janolus australis*, and the eyes have long connectives.

The buccal mass is large (5 mm. × 4 mm.) and yellowish white. The jaws bright, deep orange, very thick and strong, as in *Janolus hyalinus*. The radula consists of fifteen rows, with a maximum formula of 20.1.20. The lateral teeth (Fig. 24. b.) are yellow, hamate, low, with a large, broad base. The median teeth (Fig. 24. a.) are small, with a low inconspicuous hook. No denticulations could be seen.

The hermaphrodite gland is very large, and fills the whole posterior part of the body with numerous packets of yellowish-white follicles. The anterior genital mass is enormous (10 mm. × 7 mm.) for the size of the animal, and both the mucous and albumen glands are greatly swollen. The spermatotheca is elliptical. The verge is as described above; the canal follows the whole length of the flagellum to the very end.

It would seem that the flagelliform character of the verge distinguishes this species from *J. hyalinus.* No such formation is indicated in Bergh's description of *J. hyalinus*, nor have I found it myself in that animal. Also there seem to be some differences in the radula; and though the shape of the cerata is unfortunately unknown, the general appearance and dead-white colouring do not resemble *J. hyalinus.* But the species is open to doubt unless confirmed by other specimens.

ALDERIA, ALLMAN.

Three species of this genus have been described.

1. *A. modesta* (Lovén).
2. *A. comosa*, A. Da Costa. Naples (*Ann. del Museo Zoologico, Napoli*, anno iv. 1864, p. 32, and pl. ii. 3).
3. *A. harvardiensis* (Agassiz). East coast of North America (see Gould, *Invertebrata of Massachusetts*, 1870, pp. 254–5, pl. xvi. 226–8).

Alder and Hancock published some account of the anatomy of *A. modesta* in their monograph, but only the external features of the other two species are known. *A. comosa* is green, with numerous long cerata, and the anal papilla lies behind the pericardium. It must be regarded as very doubtful if *A. harvardiensis* is really distinct from *A. modesta*, which differs in being darker, in having fewer and smaller cerata, and, if Gould's figure may be trusted, in the more angular shape of the head. But the description and the figure do not quite agree as to the disposition of the cerata, and the colour of *A. modesta* is very variable.

Alderia seems allied to *Limapontia*, from which it differs chiefly in having cerata and a much greater ramification of the hepatic system. The lateral expansions of the foot remind one of the wings of *Elysia.*

ALDERIA MODESTA, LOVEN.

(ALDER and HANCOCK, *Monog.*, Genus 17, Fam. 3, pl. 41.)

I am indebted to Mr. W. I. Beaumont for several specimens of this interesting form, labelled "Ardfry, County Galway, May 1904." In some unpublished MSS. of Albany Hancock preserved in the Hancock

Museum at Newcastle-on-Tyne I have found the following notes on the living animal:—

"The foot exhibited beautiful dendritic markings.* The glands in the papillæ are considerably branched. The animal yields a quantity of mucus, has a strong sugar smell, and is sluggish in its motions. The papillæ are remarkable for their rhythmical pulsations. They dilate and contract simultaneously between thirty and sixty times a minute. The contraction is very forcible, the posterior surface of the papillæ being most contracted. This pulsation has all the appearance of being connected with the circulation. The papillæ are much depressed when in a state of contraction."

The colour of the preserved specimens varies from white to yellow, with darker mottlings on the back and upper side of the cerata. The variations in shade are considerable. Sometimes the ground colour is yellowish and the mottlings light, leaving a general impression of yellowish brown. Sometimes the mottlings are thick and dark and the ground colour opaque white. The upper surface then appears to be purplish black, with a few white markings.

The animals are stoutly built, the largest specimens measuring 5·5 mm. by about 3·5. In front the dorsal surface is bare, the cerata being set only at the sides, but behind they close over the body. The foot is white, broader than the body, with an expanded margin, but rather straight in front. No anterior groove is visible.

At the sides there is a groove between the body and this margin, so that the body, though narrower than the foot, partly overhangs it. On this lateral projection of the body are set the cerata in three not very regular longitudinal rows. As a rule only two rows are fully developed, and the third, which consists of smaller cerata, has the appearance of being crowded in. The total number of cerata on either side does not appear to exceed fifteen, which is less than the number shown in Alder and Hancock's plates. The cerata are somewhat ovate in shape. Those behind are larger and more inflated than those in front. They contain ramified hepatic diverticula which bear primary and sometimes short secondary branches.

The head bears on each side a rounded prominence, but there are neither rhinophores nor tentacles in the ordinary sense. The anus is on a prominent papilla in the medio-dorsal line and nearly terminal.

There is no trace of jaws. The radula is ascoglossan and short, containing five or six teeth in the ascending, and about as many in the descending portion. In an irregular heap lie about seven teeth of varying size, and with them a mass of minute spines, apparently repre-

* Due apparently to the ramified diverticula of the alimentary canal being seen through the semi-transparent sole.

senting the first teeth. The mature teeth (Pl. XI., Fig. 25.) are large and spoon-shaped. The outline is rather irregular, and there are generally two more or less distinct projections on the back.

There is no crop attached to the buccal mass, but from it issues a thin tube (Fig. 26. a.) which must apparently be regarded as equivalent to a stomach as well as to an œsophagus, at least in its posterior part, for from it arises the intestine (Pl. XII., Fig. 26. b.). This is a larger tube which bends slightly to the right and then runs directly backwards at first on the right under the side of the pericardium and finally above the renal organ to the anal papilla (Fig. 26. c.). The thin tube issuing from the buccal mass bears two folds inside. At its posterior extremity these folds become more numerous, and the tube bends downwards and dilates into a large stomach-like pouch (Fig. 26. e.). It is clear, however, that the intestine does not issue from this pouch, but from the narrower tube. It is probable that the animal lives on vegetable juices, and that the two folds in the tube act as strainers and valves, establishing communication alternately between the mouth and the pouch and between the pouch and the intestine, only one line of communication being open at a time. The pouch is prolonged anteriorly under the œsophagus and divides into two diverticula (Fig. 26. d.) which enter the anterior lobes of the foot. Posteriorly it extends almost to the end of the body and gives off two sets of ramifying diverticula (Fig. 26. f.). The upper diverticula (about four in number) enter the cerata and are also ramified in the body. The lower diverticula (also about four) extend downwards through the hermaphrodite gland and do not enter the cerata, but their ramifications within the body create the peculiar dendritic markings (Fig. 28. i.) visible through the sole of the foot.

The central nervous system (Pl. XI., Fig. 30.) forms a collar round the œsophagus consisting of seven principal ganglia close to one another and connected by very short commissures, the longest being that connecting the cerebral ganglia. They should probably be regarded as two cerebral, two pedal, and three visceral ganglia. Connected with the cerebral ganglia are two smaller ganglia, probably rhinophorial in function and innervating the most sensitive part of the head, although no external rhinophores are developed.

The hermaphrodite gland is large and ramified throughout the whole lower part of the body, filling up the interstices between the other organs. The ampulla and duct of the gland are short. After the bifurcation of the male and female branches (Pl. XII., Fig. 27. b.) the former runs to an orifice at the right anterior corner of the head. The vas deferens (Fig. 27. d.) is not very long or much convoluted. A rather large prostate (Fig. 27. c.) opens into it by several ducts. The penis is armed with a rather long curved spine which in some specimens at any rate points inwards when the organ is retracted. Shortly after the bifurcation the female branch receives a long duct (Fig. 27, g.) into which open the follicles of the albumen gland (Fig. 27. h.). This gland, like the hermaphrodite gland, is extensively ramified, especially in the last fourth of the body. Close to the entry of this duct and lying anteriorly is a pouch-like diverticulum (Fig. 27. f.) which is probably a spermatotheca. No second spermatotheca was found. The female branch here makes a sharp turn and runs backwards nearly to the end of the body; it then doubles on itself and runs forwards, opening anteriorly close to the male orifice. All this section (Fig. 27. i.) of the female branch after the spermatotheca is very much larger than the other parts and provided with remarkably thick glandular walls. It should probably be regarded as the uterus passing through the mucus gland. It is one of the largest and most conspicuous organs in the animal, and when sections are cut it generally expands and overlaps the heart and kidney.* This, however, appears to be the result of the disturbance caused by the cut, and not a natural arrangement. It is noticeable that near the bifurcation of the male and female branches there arises a cœcum which extends anteriorly and reaches the integument, but without forming any orifice. Pelseneer states (*Recherches sur divers Opisthobranches*, p. 62) that in *Elysia* the second female orifice is developed later than the others and is not found in young individuals. It is conceivable that this cœcum in *Alderia* may ultimately open externally.

The pericardium appears to be as usual and is medio-dorsal. The renal organ (Fig. 28. k.) lies below it and is entire in the front, but the posterior portion gives off ramifying tubes, some of which extend into the cerata.

Blood lacunæ are distributed throughout the body, including the foot. The largest lie one on either side of the renal organ below the cerata, into which they send up long diverticula; the main portion of these diverticula lies on the posterior side of the cerata, which no doubt accounts for the peculiar pulsation and contraction noticed by Alder and Hancock in this part.

STILIGER BELLULUS (D'ORBIGNY).

(= *Calliopæa bellula*, D'ORBIGNY. *Mag. de Zool.*, 1837, pp. 12 to 14.
Stiliger mariæ, BERGH. *Mal. Unt. in Semper's Reisen*, Heft iii, 1872, pp. 137, 144; *Id. Beit. zur Kennt. der Æolid.*, v. pp. 12 to 17.)

Bergh has published two detailed description of this species, which I notice here merely to mention that it apparently ought to be called *St. bellulus* and not *St. mariæ*.

* This dislocation seems due to the elasticity and expansive power of the tissues which form the walls of the uterus.

The genus was created by Ehrenberg (1831) for an animal found in the Red Sea and having the same external characters as this species, though the radula is unknown. Until the original *Stiliger ornatus* (not *modestus*, as it is sometimes quoted) is re-examined, some doubt must exist as to the identity of *Calliopæa* and *Stiliger*, though that identity is highly probable.

In 1837 d'Orbigny gave the name of *Calliopæa bellula* to a mollusc whose external characters are quite recognizable from his description. In 1865 Meyer and Möbius (*Fauna der Kieler Bucht*) described an apparently identical animal as *Embletonia mariæ*, wrongly regarding it as an Æolid. Bergh refers both forms to *Stiliger* and brackets them together, but gives the preference to Meyer and Möbius's name, although d'Orbigny's name has undoubted priority if his species is admitted to be a *Stiliger*.

Through the kindness of Mr. Farran I have received three specimens from Ballynakil, Co. Galway. They are indifferently preserved, and have lost some or all of the cerata. The best specimen is 7 mm. long and has thirteen cerata remaining. They were apparently set in two rows, and are of an ovoid shape. The posterior cerata of the inner row are relatively very large (2 mm. high). The rhinophores are distinct and white.

The ground colour is greyish white, with brownish or olive markings on the cerata and body. The foot is greyish white without markings. The opaque white internal organs, especially the hermaphrodite gland, can be seen through the integuments.

The radula contains five teeth in the ascending and twelve in the descending slightly spiral portion. They are as represented by Bergh, but so transparent that they are seen only with difficulty.

The species is recorded from Kiel, West Ireland, the Atlantic coast of France, and Trieste.

LIST OF FIGURES.

(Plates XI. and XII.)

1. *Tritonia alba.* *a.* rhachidian tooth; *b.* first lateral; *c.* second lateral; *d. e. f.* laterals from middle of half-row; *g.* outermost tooth.
2. *Archidoris testudinaria.* *a. b. c.* teeth from the inner part of the half-row; *d.* tooth with an abnormal projection; *e. f.* teeth from the outer part of the row.
3. *Lamellidoris oblonga.* *a.* inner tooth; *b.* outer ditto.
4. *Lamellidoris depressa.* *a.* inner tooth; *b.* outer ditto.

5. *Lamellidoris pusilla.* Inner tooth.
6. *Lomanotus genei.* A marginal papilla.
7. *Lomanotus genei.* Teeth. *a. a. a.* from the middle of the radula ; *b. b.* further from the middle ; *e.* still further from the middle.
8. *Lomanotus genei.* Edge of jaw with denticulate scales.
9. *Lomanotus marmoratus.* *a. b.* teeth ; *c.* a large papilla.
10. *Hancockia dactylota.* A row from the radula. *a.* median tooth ; *b. b.* laterals.
11. (Plate XII.) *Hancockia dactylota.* Diagram of the digestive system. The intestine and upper part of the stomach are drawn in yellow, the rest of the digestive system in black. *a.* œsophagus ; *b. b.* diverticulum on œsophagus ; *c.* stomach ; *d.* intestine ; *e.* anus ; *f. f.* anterior diverticula ; $g.^1$–$g.^4$ branches supplying the cerata ; *h.* secondary ramifications in the cerata existing on all the main branches, but only drawn here ; *i.* posterior prolongation of the stomach.
12. (Plate XII.) *Hancockia dactylota.* Transverse section through the anal papilla and renal opening. *a.* intestine ; *b.* stomach ; *c. d.* anterior diverticula ; *e.* anal papilla ; *f.* kidney ; *g.* renal orifice ; *h.* heart ; *i.* blood lacunæ ; *k.* pericardium ; *l.* hermaphrodite gland ; *m.* duct of albumen gland ; *n.* two lobes of hermaphrodite gland.
13. (Plate XII.) *Hancockia dactylota.* A longitudinal section through one of the cerata. *a.* the intestine running forward ; *b.* œsophagus ; *c.* anterior hepatic diverticulum ; *d. d.* branches of ditto within the cerata ; *e.* external orifice of one of these branches and cnidopore (?) ; *f.* blood lacunæ ; *g.* kidney.
14. *Doto pinnatifida,* var. *papillifera.* A rhinophore sheath with papillæ.
15. *Coryphella beaumonti.* *a.* central tooth ; *b.* lateral tooth.
16. *Coryphella beaumonti.* Cones from the penis.
17. *Amphorina aurantiaca.* Teeth.
18. *Amphorina olivacea.* *a.* a tooth.
19. *Amphorina olivacea.* End of penis with stylet.
20. *Calma glaucoides.* Radula. From a microphotograph.
21. *Calma glaucoides.* Diagram of digestive system. *a. a. a.* the gut and its prolongations into the cerata ; *b.* integuments of body and cerata ; *c.* buccal mass, ☿ hermaphrodite gland ; *d.* stomachic dilatation.
22 *Calma glaucoides* Renal organ (shown in black) with the heart and pericardium (shown in red). *r. o.* renal orifice ; *vent.* ventricle ; *aur.* auricle ; *pc.* pericardium ; *r. p. o.* reno-pericardial orifice.
23. *Janolus hyalinus.* A tooth.
24. *Janolus flagellatus.* *a.* median tooth seen from side ; *b.* a lateral tooth.
25. *Alderia modesta.* A tooth.
26. *Alderia modesta.* Diagram of digestive system. *a.* œsophagus ; *b.* intestine ; *c.* anal papilla ; *d. d.* anterior diverticula ; *e.* stomachic pouch ; *f. f.* posterior diverticula.
27. *Alderia modesta.* Diagram of reproductive system. *a.* ducts of hermaphrodite gland ; *b.* bifurcation of the male and female branches ; *c.* prostate ; *d.* vas deferens ; *e.* penis ; *f.* a pouch which is probably the spermatotheca ; *g.* the duct of the albumen gland ; *h.* the albumen gland ; *i.* main channel of the female organs, which should probably be regarded as the uterus passing through a mucus gland. The hermaphrodite portion of the organs is coloured orange, the male portion black, and the female red. The arrow indicates the point at which the section represented in Fig. 29 is cut.

28. *Alderia modesta.* A longitudinal section cut slightly to the left of the median line and not quite sagittal. It does not show the mouth and buccal mass very distinctly, but gives a better view of the rest of the digestive tract than is obtained by a median section. *a.* left side of mouth ; *b.* left side of buccal mass ; *c.* left side of central nervous system ; *d.* œsophagus ; *e.* tube with laminated walls running into the stomachic pouch ; *f.* point where the intestine commences, the intestine runs somewhat to the right but reappears for a moment at f^1 ; *g.* stomachic pouch ; *h.* anterior diverticulum of the pouch ; *i. i. i.* lateral diverticula in the foot and cerata ; *j.* albumen gland ; *k.* renal organ ; *l.* uterus (the organ marked *i.* in Fig. 27), which on being cut has expanded and spread dorsally at the expense of the renal organ and pericardium ; *m.* portions of the hermaphrodite duct containing masses of spermatozoa ; *n.* prostate. The remaining parts of the drawing are mostly lobes of the hermaphrodite gland.

29. *Alderia modesta.* Transverse section cut at the point marked by an arrow in Fig. 27. *e. h. l. n.* as in the longitudinal section (Fig. 28) ; *f.* the intestine passing over to the right side ; *i. i.* latero-dorsal diverticula of *h.* ; *m.* a prolongation of the hermaphrodite duct ; *o.* the female branch running forward into a pouch (? spermatotheca) ; *p.* ditto running backwards from the pouch ; *v.* vas deferens ; *s.* one of the prostatic tubules entering into the vas deferens.

30. *Alderia modesta.* Central nervous system. *a.* right cerebro-pleural ganglion ; *b.* right pedal ganglion ; *c.* right visceral ganglion ; *d.* median visceral ganglion ; *e.* left pedal ganglion ; *f.* left visceral ganglion ; *g.* left cerebro-pleural ganglion.

First Report of the Council of the Marine Biological Association of the United Kingdom on work carried out in connection with the International Fishery Investigations.*

To Sir Edward W. Hamilton, K.C.B., K.C.V.O.
Chairman of the North Sea Fisheries Investigation Committee.

Sir,

I am instructed by the Council of the Marine Biological Association to submit for the information of the North Sea Fisheries Investigation Committee the first Report on work done in connection with the International Investigation of North Sea Fisheries, dealing chiefly with researches carried out during the years 1902 and 1903, together with the detailed reports upon that work which have been drawn up under the Council's direction by those members of the scientific staff to whom the different sections of the investigations have been entrusted.

The Council desire to report as follows :—

I.—General.

At the request of His Majesty's Government, the Council of the Marine Biological Association undertook to conduct the scientific part of the scheme of fishery investigation adopted by the International Conference held at Christiania in 1901 in the southern portion of the area assigned to Great Britain, subject to such modifications as might be introduced by the International Council subsequently established, and in accordance with the general regulations of that Council.

The following is a list of members who have served on the Council since the commencement of the investigations in 1902 :—

President—Professor E. Ray Lankester, LL.D., F.R.S.

* Reprinted from *International Fishery Investigations. First Report on Fishery and Hydrographical Investigations in the North Sea and Adjacent Waters (Southern Area). Conducted for His Majesty's Government by the Marine Biological Association of the United Kingdom*, 1902–1903. Presented to both Houses of Parliament by Command of His Majesty. London : Printed for His Majesty's Stationery Office, 1905. *Blue Book* Cd. 2670. Price 8*s*. 9*d*.

Members of Council—Messrs. G. L. Alward, G. P. Bidder, G. C. Bourne, Prof. T. W. Bridge, F.R.S. (joined 1904), Francis Darwin, F.R.S., Prof. J. B. Farmer, F.R.S. (retired 1903), G. Herbert Fowler, S. F. Harmer, F.R.S., Prof. W. A. Herdman, F.R.S., E. W. L. Holt (joined 1905), the late Prof. G. B. Howes, F.R.S., J. J. Lister, F.R.S., Hugh Robert Mill, Prof. E. A. Minchin, Prof. Charles Stewart, F.R.S. (retired 1904), Prof. D'Arcy W. Thompson, C.B., R. N. Wolfenden, M.D.

Governors—Messrs. the late J. P. Thomasson, The Prime Warden of the Worshipful Company of Fishmongers and E. L. Beckwith (representing the Fishmongers' Company), Prof. Sir J. Burdon Sanderson, Bart., F.R.S. (representing the University of Oxford), A. E. Shipley, F.R.S. (representing the University of Cambridge), Professor W. F. R. Weldon, F.R.S. (representing the British Association for the Advancement of Science).

Hon. Treasurer—Mr. J. A. Travers (late Prime Warden of the Worshipful Company of Fishmongers).

Secretary—Mr. E. J. Allen.

The section of the international work which was undertaken by the Marine Biological Association fell into two main divisions, (1) a survey of the fishing grounds in the southern part of the North Sea, together with an investigation of the life-histories of the principal food fishes found upon them, and (2) an investigation of the physical conditions and of the plankton or minute floating organisms of the waters of the English Channel.

The following is a list of the scientific staff employed by the Council to carry out these investigations:—

Director and Secretary to the Council.—E. J. Allen, D.Sc.

Naturalist in charge of Fishery Investigations (who is also in charge of North Sea Survey)—W. Garstang, M.A.

Assistant Naturalists for Fishes—H. M. Kyle, M.A., D.Sc. (until April, 1903), F. Balfour Browne, B.A. (until January, 1903), W. Wallace, D.Sc.

Assistant Naturalists for Invertebrates—C. Forster-Cooper, B.A. (until August, 1903), R. A. Todd, B.Sc., J. O. Borley, M.A.

Assistant Naturalist for Plankton—L. H. Gough, Ph.D.

Hydrographer—D. J. Matthews

Assistants—J. Potter, A. L. Ansell, G. T. Atkinson.

The Council desire to report that in their opinion the naturalists entrusted with the different branches of the investigations have carried out their duties with efficiency and success.

In order to undertake the necessary experimental work at sea, the Council hired the steam trawler "Huxley," a vessel 115 feet long and of

191 tons gross, for a period of three years from August 21st, 1902. Some difficulty was experienced in obtaining a vessel suitable for the work with the funds available, but the Council had the good fortune to be assisted in the matter by one of its members, Mr. G. P. Bidder, who purchased the "Huxley" from her former owners and let her to the Association upon very favourable terms. The alterations required to fit her for the work of scientific exploration were made to the vessel, suitable cabins for the use of the naturalists were built in the fish hold, and a small laboratory was provided on deck. The "Huxley" made her first voyage to the fishing grounds on November 1st, 1902. Since that time she has been constantly employed in the North Sea and English Channel, and has proved suitable and efficient for the work required of her.

To carry out the North Sea work adequately, the Council found it necessary to establish a laboratory on the east coast of England. After careful consideration, and in view of the area in which the investigations were for the most part to be conducted, the port of Lowestoft was selected as the one offering the best facilities. Premises were hired near the trawl-market and fitted out temporarily to suit the requirements of the work. The laboratory work connected with the investigations in the English Channel has been done in the Association's laboratory at Plymouth, their steamer "Oithona" being used to make the observations at sea during the summer months, whilst for the winter observations the "Huxley" has come round from the North Sea.

The detailed memoirs prepared by the naturalists to whom the carrying out of the different portions of the investigations has been assigned are printed in the present volume. These memoirs deal chiefly with the work done during the first year of the commission of the Association (1903), though certain special experiments carried out in the second year (1904) also receive attention.

In considering the record of results contained in these memoirs, it is first of all essential to remember that they deal with operations undertaken in connection with one portion only of an extensive scheme of co-operative work. They must therefore be looked upon primarily as a statement of observed facts, contributed to the common stock of information which is being gradually brought together. For this reason it has been necessary to print the records of observations in considerable detail and in a form which shall be as convenient as possible for the use of other workers, but until the work done in other countries has been published in a similar way and the whole of the observations have been duly co-ordinated and considered, it will not be possible to estimate the results derived from the international undertaking.

At the same time, considering the English work alone, as it is set forth in the series of special reports by the naturalists, the Council of the Association feel confident that our knowledge of a number of the most essential matters, upon a proper understanding of which any attempts to improve the yield of the deep sea fisheries must in future be based, has already been considerably extended, and they are not without hope that at no distant date practical measures founded on a rational appreciation of the problems involved may be undertaken with certain profit to the fishing industry. Meanwhile the Council draw attention to the following points raised in the special memoirs, which in their opinion seem worthy of particular consideration.

II.—Fishery Investigations in the North Sea.

Experiments made by marking fishes, more especially Plaice, with numbered labels and returning them to the sea, where they have subsequently been recaptured by fishermen, have furnished much information on three important subjects—the migrations of the fishes, the growth of the fishes, and the intensity of the commercial fishing in the North Sea. The experiments have shown that the larger Plaice are capable of very extensive migrations in a comparatively short time. The extent and variety of the possible journeys may be illustrated by two instances. A Plaice, 33 centimetres (13 inches) long, liberated on December 12th, 1903, on the Leman Ground, in the latitude of Lincolnshire, was recovered by a Hastings trawler off Winchilsea, in the English Channel, on March 23rd, 1904, having travelled a minimum distance of 175 miles in a little over three months, whilst another fish, marked and liberated on August 12th, 1903, off the Lincolnshire coast, near Mablethorpe, was recaptured in April, 1904, eight months afterwards, in St. Andrew's Bay, having travelled 210 sea miles from the point of liberation. Such extensive migrations, however, appear to be confined chiefly to Plaice of larger size, the smaller fishes (below 8 inches) being seldom found to travel long distances at a rapid rate. During the summer months there seemed to be a general tendency for the Plaice on the shallow-water "nurseries" off the coast of Holland to move into deeper waters towards the north and west, whilst the fish marked in the southern bight of the North Sea showed a disposition to move in a northerly direction. In the winter (1902–3 and 1903–4), on the other hand, many of the larger fish (above 9 inches) moved southwards from the Leman Ground and the north-west coast of Holland towards the southern bight of the North Sea.

The intensity of commercial trawling in the North Sea is indicated by the fact that out of 855 marked Plaice above 20 centimetres (8 inches) in length liberated outside territorial limits the number recaptured within twelve months yields a total of 21 per cent, whilst experiments on the Dogger Bank in the spring of 1904 resulted in the recapture of more than 40 per cent of the Plaice exceeding 25 centimetres (10 inches) in less than twelve months. From this result it seems clear that the total annual catch of the fishermen no longer forms an insignificant proportion of the total stock of Plaice.

Trawling experiments in the area under investigation with an otter- and a beam-trawl of the ordinary commercial patterns have given extensive information as to the distribution of fishes of different sizes, and the results obtained, when combined with those of the marking experiments, have done much towards furnishing a preliminary view of the natural history of the fishes in the southern half of the North Sea, and of the Plaice in particular, its distribution at different sizes, and the seasonal movements which it undertakes.

A series of experiments on the transplantation of small Plaice from the inshore nurseries to the open waters of the Dogger Bank in the middle of the North Sea, carried out in 1904, has thrown much new light upon the condition of the fishing grounds. The increase of weight of small plaice marked and transplanted in early spring from the crowded inshore grounds to the Dogger Bank was found in the following winter to be six times the normal increase of marked fishes of the same size left on the inshore grounds. Such a result suggests that the central grounds of the North Sea possess a larger food supply suitable for the nourishment of the Plaice than is at present made use of, and that they may therefore be capable of maintaining a much larger population of Plaice than now exists upon them, whilst on the nursery grounds owing to undue competition for the food available the Plaice are unable to attain their maximum rate of growth. Whether transplantation on a commercial scale from the small-fish grounds to the Dogger Bank or other suitable localities would be a practical method of increasing the total weight of Plaice available for capture in the North Sea is a problem concerning which further information and experiment will be required. Quite apart from this question, such a result as that already indicated is of the greatest significance for the proper understanding of the condition of the Plaice fishery and of the methods proposed for improving it by the prevention of the capture of immature fish.

Particular attention has been paid to the study of the age of fishes of particular sizes and to their rate of growth. It has now been shown that by an examination of the otoliths or ear-stones a precise estimate of the age of individual fishes can be arrived at, the otoliths showing alternate white and dark rings, the white rings formed in spring and early summer, the dark in late summer and autumn. This method has been applied in detail to a considerable number of Plaice from fishing grounds in the North Sea and English Channel, and by its means it has been possible to form an estimate of the average rate of growth in different localities, a result which has direct bearings on many practical problems.

A large quantity of information has also been collected as to the food of fishes of different species and at different stages of their growth upon the various fishing grounds of the North Sea, the information being derived in part from the examination of the food-contents of many of the fishes captured in the trawl, and in part by an investigation of the fishing grounds with special apparatus.

III.—Hydrographical and Plankton Investigations in the English Channel.

Before the commencement of the International Investigations it had been shown that the character of the water filling the North Sea varied greatly from season to season and from place to place. A knowledge of such changes was obviously of the first importance in seeking to understand the migrations of the fishes and the fluctuations of the fisheries. The international programme therefore provided for a co-operative study of these phenomena over the whole area under investigation. To the English investigators was assigned the study of the waters of the English Channel, which were important not only in connection with the fisheries in the Channel itself, but also as constituting one of the sources of origin of the waters of the North Sea.

It was arranged that simultaneous periodic cruises should be undertaken by the different co-operating countries, during which observations should be made at fixed stations scattered over the whole area, and that these observations should be as far as possible supplemented by others taken between the stations and in the intervals between the cruises. There are three chief kinds of evidence which, when known over an extended area, are capable of giving an indication of the course of the prevailing currents, and the probable origin of the water at any particular place. These are (1) the salinity of the water, (2) its temperature, and (3) the character of the plankton or minute floating organisms which it contains. At each of the stations visited on the periodic cruises, therefore, samples of the sea-water were collected at different depths and brought to the laboratory, where their salinity was determined; the temperature of the water at different depths was observed, and samples of the plankton were collected for subsequent examination. Intermediate samples were taken between the fixed stations, and frequent meteorological observations were also made.

Four quarterly cruises, as arranged in the international programme, were carried out in the English Channel in February, May, August, and

November, 1903, simultaneously with similar cruises undertaken elsewhere by other countries. Samples of the surface water were obtained from time to time in the periods between the quarterly cruises, chiefly through the co-operation of officers of the mercantile marine.

Complete records of the observations made on the periodic cruises have been sent to the Bureau of the International Council, and have been published in the quarterly bulletins issued by that authority.*

The hydrographical observations during 1903 appear to show that the direction of the flow of the waters of the English Channel was from west to east, and that they were derived from a northerly current of about 35·6 per thousand salinity from the Bay of Biscay and from a southerly current of about 35·2 per thousand salinity or less from the Irish Sea and Bristol Channel. The meeting place of these waters may be roughly fixed as south of the Scilly Islands in mid-channel, and it was generally found that the salinity of the water increased as this point was passed from west to east.

Owing to the varying salinity and temperature of these two currents, it has been found that at the entrance to the Channel the water is often divided into distinct layers, whilst the changes of their relative velocity, combined with the general drift up Channel, give rise to alternate areas of high and low salinity which follow one another eastward. On the line between the Isle of Wight and Cape Barfleur the salinity has been low on all four cruises, a state of things due, in all probability, to the amount of fresh water discharged from the Hampshire basin and the Seine. The presence of denser water south of Beachy Head, however, points to the occasional passage of a high salinity current across this line.

It would appear that during the summer and early autumn of 1903 the Channel waters were derived largely from the Irish Sea, while during the rest of the year the high-salinity water of the Bay of Biscay preponderated.

The plankton observations show that a large proportion of the more oceanic organisms found off the mouth of the Channel do not penetrate for any considerable distance up Channel, even along a central axis, the percentage of oceanic species having on each cruise fallen below 40 at the stations on the line from the Isle of Wight to Cape Barfleur. When compared with those taken by other countries in the southern part of the North Sea, the observations indicate that conditions very similar to those found in the southern part of the North Sea, between a line from the Wash to Heligoland and the Straits of Dover exist in the eastern

* *Bulletin des Résultats acquis pendant les Courses Périodiques, Conseil Permanent International pour l'Exploration de la Mer.* Année 1902–1903, Nos. 3 et 4. Année 1903–1904, Nos 1 et 2.

end of the English Channel (from the Isle of Wight to the Straits of Dover).

The results both of the hydrographical and of the plankton work suggest that during the period under investigation there was on the whole a constant passage of water from the Channel into the southern part of the North Sea, but the rate at which this passage took place must have been very slow.

In conclusion, the Council of the Marine Biological Association would take this opportunity of expressing their indebtedness to all who have assisted them during the course of these investigations, to those who have acted as their agents for the receipt of marked fish returned by the fishermen at the different ports, and more especially to the fishermen themselves, as well as to those officers of the mercantile marine who have supplied samples of sea water and taken observations of its temperature in different localities.

I am, Sir,

Your obedient Servant,

E. J. ALLEN,
Director and Secretary to the Council.

MARINE BIOLOGICAL LABORATORY,
PLYMOUTH,
2 *August*, 1905.

List of Memoirs which accompany the above Report.

Marine Biological Association of the United Kingdom.

Report of the Council, 1904–5.

The Council and Officers.

Four ordinary meetings of the Council have been held during the year, at which the average attendance has been ten. Committees of the Council have visited the Laboratories at Plymouth and Lowestoft and carried out a detailed examination of the work which is being done. The thanks of the Council are again due to the Royal Society, in whose rooms their meetings have been held.

The Council record with regret the death of the Right Hon. the Earl of Morley, a Vice-President of the Association, as well as that of Professor G. B. Howes, F.R.S., a member of Council.

Professor T. W. Bridge, F.R.S., was elected a member of Council to fill a vacancy caused by the resignation of Professor Charles Stewart, F.R.S.

The Laboratories.

No alterations of importance have been made to the buildings or fittings at the Plymouth Laboratory, which continues to be maintained in an efficient state. Particular attention has been paid to the rearing of marine organisms under laboratory conditions, and a considerable measure of success has been attained.

The building rented at Lowestoft is now becoming somewhat congested, and if the amount of work to be done continues to grow, additional accommodation will be necessary.

The Boats.

The *Oithona* has this year undergone an extensive refit, a new boiler and new decks having been put in, in addition to general repairs. She is now in first-class condition, and has been used extensively in the English Channel and along the East Coast of England. She has on two occasions made the voyage from Plymouth to Ushant and Parson's Bank.

The collecting at Plymouth during the winter was done with the sailing boat *Anton Dohrn.*

The work in the North Sea in connection with the International Investigations has been again carried out by the *Huxley.*

The Staff.

Mr. S. Pace, who for the last three years has efficiently occupied the post of Assistant Naturalist for Invertebrates at Plymouth, was recently appointed Director of the Marine Biological Laboratory at Millport on the Clyde, and is consequently leaving the service of the Association. There have been no other changes in the staff.

Occupation of Tables.

The following Naturalists have occupied tables at the Laboratory during the year:—

G. P. Bidder, M.A., Cambridge (Experiments for determining bottom currents).
E. T. Browne, M.A., London (Medusae).
A. D. Cotton, Kew (Algae).
Sir Charles Eliot, K.C.M.G. (Nudibranchiata).
G. H. Grosvenor, M.A., Oxford (Nudibranchiata).
T. V. Hodgson, Plymouth (Pycnogonida).
J. J. Lister, F.R.S., Cambridge (Foraminifera).
Prof E. W. MacBride, F.R.S., Montreal (Echinoderma).
Mrs. S. Pace, Plymouth (Polyzoa).
J. Lloyd Williams, Bangor (Algae).

Six students attended a course of study in Marine Biology conducted at the Laboratory during the Easter vacation by Mr. G. H. Grosvenor.

The Library.

The thanks of the Association are due for the following books and current numbers of periodicals presented to the Library during the past year:—

Académie Imp. des Sciences de St. Pétersbourg. Bulletin.
Allgemeine Fischerei-Zeitung.
American Microscopical Society. Transactions.
American Museum of Natural History. Bulletin.
—— Memoirs.
American Philosophical Society. Proceedings.
Annaes de Sciencias Naturaes.
Australian Museum. Records.
Bergens Museum. Aarbog.
—— Hydrographical and Biological Investigations in Norwegian Fiords.
—— An Account of the Crustacea of Norway, etc.; by G. O. Sars.
Bernice Pauahi Bishop Museum, Honolulu. Occasional Papers.

Board of Agriculture and Fisheries. Annual Report of Proceedings under the Salmon and Freshwater Fisheries Acts.
—— Annual Report of Proceedings under Acts relating to Sea Fisheries.
—— Report of Meeting of Fisheries Representatives.
Boston Society of Natural History. Proceedings.
Brighton Public Library, Museum and Art Galleries. Annual Report.
Bristol Naturalists Society. Proceedings.
British Association for the Advancement of Science. Report.
Brooklyn Institute of Arts and Sciences. Cold Spring Harbor Monographs.
—— Memoirs of Natural Sciences.
—— Science Bulletin.
Bryn Mawr College. Monographs, Reprint Series.
Bulletin Scientifique de la France et de le Belgique.
The Carnegie Institution. The Coral Siderastrea radians and its Postlarval Development; by J. E. Duerden.
—— The Waterlilies. A Monograph of the Genus Nymphaea; by H. S. Conard.
La Cellule.
College of Science, Tokyo. Journal.
Colombo Museum. Spolia Zeylanica.
Comité für Unterstützung der Küsten-Bevolkerung des Russischen Nordens. Zoologische Studien im Barents-Meere . . . Vorlaufige Bericht.
The Commissioners of Fisheries, N. S Wales. Report.
Conchological Society of Great Britain and Ireland. Journal of Conchology.
Conseil perm. internat pour l'Exploration de la Mer. Bulletin des Résultats acquis pendant les Courses Périodiques.
—— Publications de Circonstance.
—— Rapports et Procès-Verbaux des Réunions.
Cuerpo de Ingenieros de Minas del Peru. Boletin.
Kgl. Danske Videnskabernes Selskab. Oversigt.
—— Skrifter.
Dept. of Agriculture, etc., Ireland. Reports.
Dept. of Marine and Fisheries, Canada. Annual Report.
Deutsche Zoologische Gesellschaft. Verhandlungen.
Deutscher Fischerei Verein. Zeitschrift für Fischerei.
Deutscher Seefischerei Verein. Mitteilungen.
La Feuille des Jeunes Naturalistes.
Field Columbian Museum. Publications.
Imp. Fisheries Bureau, Tokyo. Journal.
Fisheries Society of Japan. Journal.
The Fisherman's Nautical Almanack; by O. T. Olsen.
Fishery Board for Scotland. Annual Report.
The Fishing Gazette.
The Foreign Office. Report on the Fishing Trade of the Weser Seaports.
The Government Biologist, Cape of Good Hope. Marine Investigations in South Africa.
—— Report.
Government Museum, Madras. Report.
International Catalogue of Scientific Literature. Report.
R. Irish Academy. Proceedings.
—— Transactions.
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Dr. E. J. Allen. Beiträge zur Kenntnis der Spermatogenese bei den Cölenteraten; by W. M. Aders.
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—— The Alcyonaria of the Maldives, Part III.; by S. J. Hickson.
—— On the Bearing of Mendelian Principles of Heredity on current theories of the Origin of Species; by A. D. Darbishire.
—— Report on the Polyclad Turbellaria collected by Professor Herdman at Ceylon in 1902; by F. F. Laidlaw.
—— The Stylasterina of the Siboga Expedition; by S. J. Hickson and H. M. England.
—— On the Supposed Antagonism of Mendelian to Biometric Theories of Heredity; by A. D. Darbishire.
—— Variations; by S. J. Hickson.
Société d'Oceanographie du Golfe de Gascogne. Les Cartes Litho-Biologiques du Fond de la Mer; by Manley-Bendall and C. Bénard.
—— Les Courants de l'Atlantique nord et du Golfe de Gascogne; by C. Bénard.
—— Quelques Essais sur les Liquides Conservateurs des Animaux et des Organismes Marins; by C. Bénard and Manley-Bendall.

To the authors of the Memoirs mentioned below the thanks of the Association are due for separate copies of their works presented to the Library:—

Ashworth, J. H. and Annandale, N. Observations on some Aged Specimens of Sagartia troglodytes, and on the Duration of Life in Cœlenterates.
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Browne, E. T. Hydromedusae [of the Maldives and Laccadives] with a Revision of the Williadae and Petasidae.
—— Scyphomedusæ [of the Maldives and Laccadives].
—— and Vallentin, R. On the Marine Fauna of the Isles of Scilly.
Chadwick, H. C. Report on the Crinoidea collected by Professor Herdman, at Ceylon, in 1902.
Darbishire, A. D. On the Bearing of Mendelian Principles of Heredity on current theories of the Origin of Species.
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—— and Fletcher, J. J. On the Condition of the Median Portion of the Vaginal Apparatus in the *Macropodidæ*.
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—— and Brady, G. S. British Land Isopoda. Second Supplement.

—— and Scott, T. Crustacea Copepoda new to Science from Devon and Cornwall.

Osborn, H. F. Ornitholestes Hermanni, a New Compsognathoid Dinosaur from the Upper Jurassic.

Punnett, R. C. Merism and Sex in "Spinax niger."

Shipley, A. E. *Cladorchis Watsoni* (Conyngham), a Human Parasite from Africa.

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General Work at the Plymouth Laboratory.

A report on the local distribution of the marine invertebrate fauna occuring in the neighbourhood of Plymouth, which has been in preparation for several years, has now been published in the Journal of the Association.

In the compilation of this report, the Director of the Laboratory has been ably assisted by Mr. R. A. Todd and by Mr. S. Pace, as well as by a large number of workers who have occupied tables in the Laboratory from time to time. The Council desire to thank those naturalists who have thus voluntarily assisted in this work.

The Director has continued to devote special attention to the Polychaetes found at Plymouth, and in addition to the list contained in the report above referred to, has published a paper on the anatomy of *Pœcilochætus* (*Quart. Journ. Micr. Sci.*, vol. 48, 1904) and a description of a new British Sabellarian, *Pallasia murata*, n. sp.

Mr. Pace has worked chiefly at Echinoderms and Molluscs, and has published a paper on the local Cucumariidae in the Association's Journal.

The exhibit which, at the request of the British Royal Commission, was prepared by the Association for the St. Louis Exhibition, proved very successful, and was awarded a Grand Prize, whilst a gold medal was given for publications.

The International Fisheries Investigations.

SECTION I.—NORTH SEA WORK.

A. WORK OF THE S.S. "HUXLEY."

TRAWLING INVESTIGATIONS.—The survey of the North Sea trawling grounds has been steadily continued during the year. From June 1904 to the end of May 1905 the *Huxley* made 35 voyages, during which 304 hauls of the large commercial trawls (otter and beam) were taken, and the quantities and sizes of the fishes caught systematically recorded.

From the commencement of the investigations 66 voyages have been completed, and the results of 653 hauls with the large trawls analysed and recorded.

The work of the *Huxley* was supplemented during July 1904 by a series of investigations by the s.s. *Oithona* in the shallower waters of Bridlington Bay, the Wash, and the Thames estuary.

FISH MEASURED.—The investigation of the relative numbers of fishes of different sizes on various fishing grounds in the North Sea and of their seasonal distribution has been continued. In this connection during the past year about 100,000 fishes have been measured on the fishing grounds where they were caught, viz. 95,000 caught with the large commercial trawls of the *Huxley*, and nearly 5,000 caught with the smaller trawls of the *Oithona* and *Huxley*.

More than 210,000 fishes have been measured in this way since the commencement of the investigations, as shown in detail in the following table:—

	PLAICE.	HADDOCK.	OTHERS.		TOTALS.
I.—*Commercial Trawls.*					
Voyages I–XXXI, 1902–4	35,061	8,388	64,165	...	107,614
„ XXXII–LVI, 1904–5	27,577	7,561	60,141	...	95,279
TOTALS	62,638	15,949	124,306	...	202,893
II.—*Small Trawls.*					
Voyages I–XXXI, 1902–4 .	1,813	—	764	...	2,577
„ XXXII–LVI, 1904–5	215	1	1,305	...	1,521
S.S. *Oithona*, July 1904 .	843	—	2,100	...	3,243
TOTALS	2,871	1	4,169	...	7,341
III.—GRAND TOTALS	65,509	15,950	128,775	...	210,234

MARKING EXPERIMENTS.—During the year 2,660 marked plaice have been set free in different parts of the North Sea, of which 187 have already been recaptured.

Prior to June 1904, 2,455 marked plaice had been liberated, of which

401 have since been recaptured, making a total of 5,115 liberated and 588 recaptured up to date.

In the great majority of cases the fishermen have been able to give trustworthy particulars concerning the date and locality of recapture, and the fishes themselves have been forwarded to the laboratory at Lowestoft for examination and measurement.

These experiments have been eminently successful in throwing light upon the seasonal migrations of this species, and upon differences in the rate of growth on different fishing grounds.

The experiments in the transplantation of small marked plaice from the inshore grounds to the Dogger Bank, in the spring of 1904, which were briefly referred to in the last annual report, have yielded results of considerable scientific importance, and suggest the possibility of practical applications. The average year's growth of small marked plaice, about 20 cm. (8 ins.) in length, on the coastal grounds of the southern and eastern parts of the North Sea, has been found to be not more than 5 cm. (2 ins.); whereas on the Dogger Bank the average growth of similar fishes has been found to be 15 cm. (6 ins.) in the same time. In other words, small 8-inch plaice, weighing about 3 oz., which after a year's growth on the coastal grounds become 10-inch fish, weighing 5¼ oz., are transformed in the same time into 14-inch fish weighing 1 lb. each, by transplantation to the Dogger Bank.

As small plaice do not naturally occur upon the Bank, the problem is raised whether the yield of plaice from the North Sea could not be materially increased by the annual transplantation of large numbers of such fish on a commercial scale from the coastal grounds to the Dogger Bank.

Experiments in transplantation on a more extensive scale have been carried out during the past few months in various parts of the English area in order to provide additional information bearing upon this subject.

The marking experiments during the past year have also been extended to a considerable number of other species, including Turbot, Brill, Soles, Lemon Soles, Flounders, Dabs, and Cod.

Special Experiments.—While the investigations at sea have proceeded, in general, on the same lines as during the previous year, increased attention has been paid to special experiments upon particular problems. Among these may be mentioned:—

(i) Experiments on the vitality of trawl-caught plaice.

(ii) Experiments on the proportion of small fishes which escape through the meshes of the commercial trawl.

(iii) Investigations on the rough grounds unsuitable for commercial trawling.

(iv) Collection of samples of bottom deposits.

(v) Experiments on bottom currents by means of Mr. Bidder's drift-bottles.

(vi) Collection of fish-stomachs, for determining the food of fishes.

(vii) Collection of otoliths from trawled fish for investigations on the age of fishes at different sizes.

B. LABORATORY INVESTIGATIONS.

Age of Fishes.—Considerable progress has been made with the otolith investigations. The growth-rate of the Plaice during the first few years of its life has been definitely determined for several different parts of the coast. The results show a substantial agreement over the southern part of the North Sea, but a much more rapid growth in the western part of the English Channel than in the former area. The determination of the relation between age and size during the later years is beset with difficulties connected with the existence of local differences of growth on the offshore grounds, complicated by the migrations of the fish. These points are being carefully investigated. The method of study has been extended during the year to other suitable species, especially the Cod.

Food of Fishes.—Records of the general fauna of the different trawling grounds have been kept systematically, and have been supplemented from time to time by the results of special hauls with the dredge and other implements.

The contents of over 6,000 stomachs of fishes have been examined and recorded in detail.

The age and food of all marked fishes recaptured has been regularly recorded.

Bottom Deposits.—Samples of the sea-bottom from about 200 localities have been collected from time to time, and are under analysis with the object of determining the influence of this factor on the distribution of fishes and of the organisms upon which they feed.

C. FISHERMEN'S RECORDS.

The system of fishermen's trawling records has been continued without interruption. Three or four Lowestoft and Ramsgate smacks, and five or six Grimsby steam trawlers have been constantly engaged in providing these supplementary records of individual hauls. The number of returns provided by the fishermen during the past year amounts to a total of nearly 7,000, as follows:—

Smacks	...	1,350	hauls.
Steamers	...	5,437	,,
	Total	6,787	,,

Section II.—HYDROGRAPHIC AND PLANKTON WORK IN THE ENGLISH CHANNEL.

The quarterly hydrographic cruises required by the International programme were made in the English Channel in August and November 1904, and in February and May 1905. The usual routine work was carried out, and in addition current measurements were made with the Ekman-Nansen current-meter on Station 2 (47 miles S.W. of the Eddystone), in 50 fathoms, during the November and following cruises.

In addition to the observations made on the quarterly cruises, samples of surface water and temperature records have been received every fortnight from four steamers crossing the English Channel—from Newhaven to Caen, from Southampton to Havre and St. Malo, and from Plymouth to the Channel Islands and St. Brieue. These, together with samples obtained from lightships, have made it possible to draw up fortnightly surface charts for the Channel east of the line joining Plymouth to Guernsey.

Since September 1904, samples have been collected over the North Atlantic between Lat. 20° N. and Lat. 56° N. every noon by the kindness of the captains of fifteen of the larger passenger steamers sailing from English and Scotch ports.

In May 1904, water of 35·30 °/₀₀ S. and over extended up the Channel as far as the Isle of Wight. During the summer the salinity gradually fell, and in July the highest value found on the Plymouth-Guernsey line was 35·25 °/₀₀ S., which in August had diminished to 35·00 °/₀₀ S. During the cruise in this month, surface water as high as 35·40 °/₀₀ S. was only found at one place—near Ushant, but this high-salinity water extended west as an undercurrent to Parson's Bank, and thence north nearly to mid-Channel.

The salinity remained low, with only slight variations, until the first week in October, when water of 35·30 °/₀₀ S. was found for a short time between Plymouth and Guernsey. A decline then set in until

November 16th, when 35·30 ‰ S. again appeared on the Plymouth-Guernsey line. During the cruise in November, a narrow tongue of surface water of 35·40 ‰ S. and over was found stretching north from Ushant to near mid-Channel, when it took a sharp turn to the west. This apparent movement from east to west, against the general Channel drift, was due to a sheet of fresher water entering from the west and nearly covering a broad layer of denser water which extended at the bottom from Ushant at least as far as Parson's Bank.

About the middle of December the flow of high-salinity water increased, and during the first week in January 1905, water of 35·40 ‰ S. appeared in the Channel between Plymouth and Guernsey for the first time since February 1904. In February there was a slight fall here, but the presence of water of 35·50 ‰ S., or possibly 35·60 ‰ S., a few miles to the west showed that the Atlantic flow was still increasing, displacing the whole of the fresher water from surface to bottom. This flow reached its maximum towards the end of February with water of 35·59 ‰ S., between Plymouth and Guernsey, though it had not fallen below 35·40 ‰ S. at the end of April. The samples collected since that date have not been worked out. The general results show an increased Atlantic flow during the first few months of 1905.

The specific gravity of various samples collected in the North Atlantic between Lat. 56° N. and Lat. 20° N. has been determined directly, and so far no reason has been found for doubting the accuracy of the ratio of total halogens to specific gravity as given by Knudsen's Tables. These experiments are still in progress.

The results of the two years of hydrographic work which have now been carried out show that the western portion of the English Channel is sometimes filled with warm Atlantic water of high density entering from the south, whilst at other times the water is of low density, being derived chiefly from the Bristol Channel and St. George's Channel, and in the case of the coastal waters being diluted to a certain extent with river water. Occasionally water of both kinds may be found as distinct layers—the water of high salinity usually forming the bottom layer. These changes take place somewhat irregularly and vary in different seasons and from year to year. It seems clear that such changes must have a fundamental influence on all problems connected with the life-history and distribution of the organisms inhabiting the area—including the food fishes.

Samples of Plankton were collected at each station on the four quarterly cruises in the English Channel, whilst regular samples at weekly and fortnightly intervals have been obtained off Plymouth, between Plymouth and the Channel Islands, and from different light-ships off the English and Irish coasts. The principal species found in these samples have been identified, and tables showing the results for the stations worked on the Channel cruises have been published in the Bulletin of the International Council for the study of the sea.

The Plankton observations in 1904–5 have confirmed the conclusion arrived at from the work of the preceding year, that the proportion of oceanic to neritic species decreases in the English Channel very regularly from west to east. At the same time it has been found that the absolute number of oceanic as well as the absolute number of neritic species is highest in the western basin of the Channel, decreasing both towards the open ocean in the west and towards the meridian of the Isle of Wight in the east. It is suggested that this rise in the number of species, in a region where newly-arrived Atlantic water meets water which has been lying over a shallow bottom and has received the outflow of rivers, may be due to an increase of soluble food-substances which are necessary for the development of various organisms.

Published Memoirs.

The following papers, either wholly or in part the outcome of work done at the Laboratory, have been published elsewhere than in the Journal of the Association:—

ALLEN, E. J. *The Anatomy of Pœcilochætus.* Quart. Journ. Micr. Sci., vol. xlviii., 1904, pp. 79–152.

DANNEVIG, H. C. *On the First Successful Experiment with Importation of European Sea Fishes to Australian Waters.* Fisheries of New South Wales. Annual Report for 1902. II.

MINCHIN, E. A. *The Characters and Synonymy of the British Species of Sponges of the Genus* LEUCOSOLENIA. Proceed. Zool. Soc., Lond. 1904, vol ii., pp. 349–96.

ELIOT, Sir C. N. E. *On the* DORIS PLANATA *of Alder and Hancock.* Proceed. Malacol. Soc., vol. vi., 1904, pp. 180, 181.

ELIOT, Sir C. N. E. *Notes on two Rare British Nudibranchs,* HERO FORMOSA *var.* ARBORESCENS *and* STAURODORIS MACULATA. Proceed. Malacol. Soc., vol. vi., 1905, pp. 239–43.

RANDLES, W. B. *Some Observations on the Anatomy and Affinities of the Trochidae.* Quart. Journ. Micr. Sci., vol. xlviii., 1904, pp. 33–78.

WOODCOCK, H. M. *On* CYSTOBIA IRREGULARIS *(Minch.) and Allied "Neogamous" Gregarines.* Arch. Zool. Expér et Gén. Notes et Revue, 1904, No. 8.

Donations and Receipts.

The receipts for the year for the ordinary work of the Association include the grants from His Majesty's Treasury (£1,000) and the Worshipful Company of Fishmongers (£400), Special Donations (£55), Annual Subscriptions (£108), Rent of Tables in the Laboratory (£19), Sale of Specimens (£322), Admission to the Tank Room (£133).

Vice-Presidents, Officers, and Council.

The following is the list of gentlemen proposed by the Council for election for the year 1905-6:—

President.

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

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E. W. L. HOLT, Esq.
J. J. LISTER, Esq., F.R.S.
H. R. MILL, Esq.
Prof. E. A. MINCHIN.
Prof. D'ARCY W. THOMPSON, C.B.
R. N. WOLFENDEN, Esq., M.D.

Hon. Treasurer.

J. A. TRAVERS, Esq.

Hon. Secretary.

E. J. ALLEN, Esq., The Laboratory, Citadel Hill, Plymouth.

The following Governors are also members of the Council:—

THE PRIME WARDEN OF THE FISHMONGERS' COMPANY.
E. L. BECKWITH, Esq. (Fishmongers' Company).
Prof. Sir J. BURDON SANDERSON, Bart., F.R.S. (Oxford University).
A. E. SHIPLEY, Esq., F.R.S. (Cambridge University).
Prof. W. F. R. WELDON, F.R.S. (British Association).

Dr. *Statement of Receipts and Expenditure*

	£	s.	d.	£	s.	d.
To Balance from last year, being Cash at Bank and in hand, viz.:—						
On Plant, Repairs and Renewal Fund Account	116	10	8			
Donations to Fund for Repair of ss. *Oithona* received last year	271	0	0			
	387	10	8			
Less Amount overpaid on General Account	283	6	2	104	4	6
,, Current Income:—						
H.M. Treasury	1,000	0	0			
Fishmongers' Company (half-year's payment)	200	0	0			
Annual Subscriptions	108	2	0			
Rent of Tables	19	4	0			
Interest on Investment	9	10	5	1,336	16	5
,, Extraordinary Receipts:—						
T. H. Riches, Donation to Fund for Repair of ss. *Oithona*	50	0	0			
The late G. Brebner, per E. A. Batters	5	0	0			
British Royal Commission, for Repayment of Balance of Expenses in connection with Exhibit at St. Louis Exhibition	120	17	11			
Ditto for Sale of Exhibit, including Specimens	100	0	0			
Amount realized by Sale of £500 Forth Bridge Railway 4 % Guaranteed Stock	582	0	6	857	18	5
,, Balance, being amount due to Bankers	146	9	1			
Less Cash in hand	20	19	4	125	9	9
				£2,424	9	1

[Note.—This liability is exclusive of the amount of £100 due to Mr. G. P. Bidder in respect of advance made last year, and of the amount held to be necessary as a Plant, Repairs, and Renewals Fund which, with £25 added during the year, should stand at £141 10*s.* 8*d.*]

Examined and found correct,

(Signed) Edwin Waterhouse, F.C.A. R. Norris Wolfenden.
G. Herbert Fowler. L. W. Byrne.

27th June, 1905.

for the Year ending 31st May, 1905. Cr.

	£	s.	d.	£	s.	d.	£	s.	d.
By Current Expenditure:—									
Salaries and Wages—									
Director				200	0	0			
Naturalist				250	0	0			
Director's Assistant				150	0	0			
Wages				418	16	3	1,018	16	3
Travelling Expenses							44	17	1
Library							79	2	0
Journal—Printing and Illustrating				159	18	0			
Less Sales of Journal				18	16	0	141	2	0
Buildings and Public Tank Room—									
Gas, Water, Coal, etc.				110	1	1			
Stocking Tanks, Feeding, etc.				31	7	1			
Maintenance and Renewals				53	16	8			
Rent of Land, Rates, Taxes, and Insurance				17	5	8			
				212	10	6			
Less Admissions to Tank Room				133	18	5	78	12	1
Laboratory, Boats, and Sundry Expenses—									
Stationery, Office Printing, Postages, etc.				152	11	3			
Glass, Chemicals, and Apparatus	£99	9	10						
Less Sales	44	2	3	55	7	7			
Purchase of Specimens				29	14	4			
Maintenance and Renewals of Boats, Nets, Gear, etc	£292	18	7						
Less Sales	79	6	10	213	11	9			
Coal and Water for Steamer				89	16	6			
Insurance of Steamer (two years)				44	0	9			
				585	2	2			
Less Sales of Specimens, etc. (including £50 from International Investigations Commission for use of ss. *Oithona*)				372	0	4	213	1	10
Bank Interest							1	19	4
							1,577	10	7
,, Extraordinary Expenditure:—									
Cost of New Boiler and Repairs to ss. *Oithona*, *less* £15 received for Sale of Old Boiler							846	18	6
[Note.—This expenditure has been met as to £321 by special donation, and as to £525 18*s.* 6*d.* by part proceeds of Sale of Investment, per contra.]									
							£2,424	9	1

Marine Biological Association of the United Kingdom.

LIST
OF
Governors, Founders, and Members.

31st MAY, 1906.

I.—Governors.

The British Association for the Advancement of Science, *Burlington House, W.* £500
The University of Oxford £500
The University of Cambridge £500
The Worshipful Company of Clothworkers, 41, *Mincing Lane, E.C.* £500
The Worshipful Company of Fishmongers, *London Bridge, E.C.* £7705
Bayly, Robert (the late) £1000
Bayly, John (the late) £600
Thomasson, J. P. (the late) £970
G. P. Bidder, Esq., *Cavendish Corner, Cambridge* £800

II.—Founders.

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

1884 The Corporation of the City of London £210
1884 The Worshipful Company of Mercers, *Mercers' Hall, Cheapside* ......£341 5*s.*
1884 The Worshipful Company of Goldsmiths, *Goldsmiths' Hall, E.C.*....... £100
1884 The Royal Microscopical Society, 20, *Hanover Square, W.* £100
1884 The Royal Society, *Burlington House, Piccadilly, W.* £350
1884 The Zoological Society, 3, *Hanover Square, W.* £100
1884 Bulteel, Thos., *Radford, Plymouth* £100
1884 Burdett-Coutts, W. L. A. Bartlett, 1, *Stratton Street, Piccadilly, W.*.... £100
1884 Crisp, Frank, LL.B., B.A., Treas. Linn. Soc., 17, *Throgmorton Avenue, E.C.* £100
1884 Daubeny, Captain Giles A., *The Vicarage, Tottington, Bury, Lancs.* ... £100
1884 Eddy, J. Ray, *The Grange, Carleton, Skipton* £100
1884 Gassiott, John P. (the late) £100
‡1884 Lankester, Prof. E. Ray, F.R.S., *British Museum (Natural History), South Kensington, S.W.* £100
1884 The Rt. Hon. Lord Masham (the late) £100
1884 Moseley, Prof. H. N., F.R.S. (the late) £100

†1884 The Rt. Hon. Lord Avebury, F.R.S., *High Elms, Bromley, Kent* £100
1884 Poulton, Prof. Edward B., M.A., F.R.S., *Wykeham House, Oxford* ... £100
1884 Romanes, G. J., LL.D., F.R.S. (the late) £100
1884 Worthington, James (the late) £100
1885 Derby, the late Earl of £100
1887 Weldon, Prof. W. F. R., F.R.S. (the late) £100
1888 Bury, Henry, M.A., *Mayfield House, Farnham, Surrey* £100
1888 The Worshipful Company of Drapers, *Drapers' Hall, E.C.* £315
1889 The Worshipful Company of Grocers, *Poultry, E.C.* £120
1889 Thompson, Sir Henry, Bart. (the late) £110
1889 Revelstoke, The late Lord £100
1890 Riches, T. H., B.A., *Kitwells, Shenley, Herts* £230
1902 Gurney, R., *Ingham Old Hall, Stalham, Norfolk* £100

III.—Members.

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

1897 Adams, W. R., 16, *Belle Vue Mansions, Devonshire Road, Forest Hill, London* .... Ann.
1900 Aders, W. M., *Zeitoun, Cairo, Egypt* .... Ann.
1884 Alger, W. H., 8, *The Esplanade, Plymouth* .... *C.*
*1895 Allen. E. J., D.Sc., *The Laboratory, Plymouth* .... Ann.
*1889 Alward, G. L., *Enfield Villa, Humberstone Avenue, Waltham, Grimsby* Ann.
1892 Assheton, R., M.A., *Riversdale, Grantchester, Cambridge* £20
1904 Allalo, F. G., 14, *Westover Villas, Bournemouth* .... Ann.

1884 Bailey, Charles, M.Sc., F.L.S., *Atherstone House, North Drive, St. Anne's-on-the-Sea* .... Ann.
1902 Baker, R. J., *Glen View, Mannamead, Plymouth* .... Ann.
1884 Balfour, Prof. Bayley, F.R.S., *Royal Botanic Gardens, Edinburgh* ...... *C.*
1884 Bayliss, W. Maddock, D.Sc., F.R.S., *St. Cuthberts, West Heath Road, Hampstead* .... Ann.
1884 Bayly, Miss, *Seven Trees, Plymouth* £50
1884 Bayly, Miss Anna, *Seven Trees, Plymouth* £50
1884 Beaumont, W. I., B.A., *The Laboratory, Plymouth* .... Ann.
1885 Beck, Conrad, 68, *Cornhill, E.C.* .... *C.*
*1889 Beckwith, E. L., *The Knoll, Eastbourne* .... Ann.
1887 Beddard, F. E., F.R.S., *Zoological Society's Gardens, Regent's Park, N.W.* Ann.
1884 Beddington, Alfred H., 8, *Cornwall Terrace, Regent's Park, N.W.* ...... *C.*
1897 Bedford, Mrs., 326, *Camden Road, London, N.* .... Ann.
1903 Bidder, H. F., 10, *Queen's Gate Gardens, London, S.W.* .... Ann.
1893 Bles, A. J. S., *Palm House, Higher Broughton, Manchester* .... Ann.
*1884 Bourne, Gilbert C., M.A., *Savile House, Mansfield Road, Oxford* .... Ann.
1898 Bowles, Col. Henry, *Forty Hall, Enfield* .... Ann.
*1895 Bridge, Prof. T. W., D.Sc., F.R.S., *University of Birmingham* .... Ann.
1902 Brighton Corporation, Town Clerk, *Town Hall, Brighton* .... Ann.
1886 Brooksbank, Mrs. M., *Leigh Place, Godstone, Surrey* .... *C.*
1884 Brown, Arthur W. W., 62, *Carlisle Mansions, Carlisle Place, London, S.W.* *C.*

1893 Browne, Edward T., B.A., 141, *Uxbridge Road, W.* .... Ann.
1884 Buckton, G. B., *Weycombe, Haslemere* .... Ann.
1896 Bulstrode, H. T., M D., 4, *The Mansions, Earl's Court, S.W.* .... Ann.
1889 Burnard, Robert, 3, *Hillsborough, Plymouth* .... Ann.
1897 Byrne, L. W., B.A., 7 *New Square, Lincoln's Inn, London, W.C.* .... Ann.

1887 Caldwell, W. H., *Birnam, Chaucer Road, Cambridge* .... C.
1904 Carter, J. M., *Winters Hill, Cookham Dene, Berks* .... Ann.
†1884 Chamberlain, Rt. Hon. J., M.P., 40, *Prince's Gardens, S.W.* .... Ann.
1884 Christy, Thomas Howard, 199, *Bramhall Lane, Stockport* .... C.
1887 Clarke, Rt. Hon. Sir E., K.C., 5, *Essex Court, Temple, E.C.* £25
1884 Clay, Dr. R. H., *Windsor Villas, Plymouth* .... Ann.
1885 Clerk, Major-General H., F.R.S., "*Mountfield*," 5, *Upper Maze Hill, St. Leonards-on-Sea, Sussex* £21
1886 Coates and Co., *Southside Street, Plymouth* .... C.
1885 Collier Bros., *Old Town Street, Plymouth* .... C.
1900 Cooper, W. F., B.A., *Ashlyns Hall, Berkhamsted* .... Ann.

*1885 Darwin, Francis, F.R.S., 13, *Madingley Road, Cambridge* .... C.
1885 Darwin, W. E., *Ridgemount, Bassett, Southampton* £20
1884 Dewick, Rev. E. S., M.A., F.G.S., 26, *Oxford Square, Hyde Park, W.* .... C.
1885 Dixey, F. A., M.A. Oxon., *Wadham College, Oxford* ....£26 5*s. and* Ann.
1906 D'Morgan, W. C., c/o H. S. King & Co., 9, *Pall Mall, London* .... Ann.
1890 Driesch, Hans, Ph.D., *Philosophenweg* 5, *Heidelberg, Germany* .... C.
†1889 Ducie, The Rt. Hon. the Earl of, F.R.S., *Tortworth Court, Falfield, R.S.O.* £50 15*s.*
1884 Dunning, J. W., 4, *Talbot Square, London, W.* ....£26 5*s.*
1884 Dyer, Sir W. T. Thiselton, M.A., K.C.M.G., F.R.S., *The Ferns, Witcombe, Gloucester* .... C.

1898 Eliot, Sir C. N. E., K.C.M.G., C.B., *Endcliffe Holt, Endcliffe Crescent, Sheffield* .... Ann.
1891 Ellis, Hon. Evelyn, *Rosenais, Datchet, Windsor* .... C.
1893 Enys, John Davies, *Enys, Penryn, Cornwall* .... Ann.
1884 Evans, Sir John, D.C.L., F.R.S., *Nash Mills, Hemel Hempstead* £20
1885 Ewart, Prof. J. Cossar, M.D., *University, Edinburgh* £25

1894 Ferrier, David, M.A., M.D., F.R.S., 34, *Cavendish Square, W.* .... Ann.
1884 Fison, Sir Frederick W., Bart., 64, *Pont Street, London, S.W.* .... C.
1897 Foster, Richard, *Windsworth, Looe, R.S.O.* .... Ann.
*1885 Fowler, G. Herbert, B.A., Ph.D., 58, *Bedford Gardens, London, W.* ... Ann.
1884 Fox, George H., *Wodehouse Place, Falmouth* .... Ann.
1886 Freeman, F. F., *Abbotsfield, Tavistock, S. Devon* .... C.
1884 Fry, George, F.L.S., *Carlin Brae, Berwick-on-Tweed* £21

1892 Galton, F., F.R.S., 42, *Rutland Gate, S.W.* .... Ann.
1885 Gaskell, W. H., F.R.S., *The Uplands, Shelford, Cambridge* .... C.
1899 Gardiner, Dr. Edw. G., *Woods Hole, Mass., U.S.A.* .... C.
1897 Gibbs, Hon. Henry, 10, *Lennox Gardens, S.W.* .... Ann.
1901 Giles, Col. G. M., *Byfield, Mannamead, Plymouth* .... C.
1885 Gordon, Rev. J. M., *St. John's Vicarage, Redhill, Surrey* .... Ann.
1884 Grove, E., *Norlington, Preston, Brighton* .... Ann.
1899 Guinness, Hon. Rupert, *Elveden, Thetford* ....£35 15*s.*

†1884 Günther, Dr. Albert, F.R.S., 2, *Lichfield Road, Kew Gardens* .... Ann.
1900 Gurney, E., *Sprowston Hall, Norwich* .... Ann.

1884 Halliburton, Prof. W. D., M.D., F.R.S., *Church Cottage*, 17, *Marylebone Road, London, W.* .... Ann.
1884 Hannah, Robert, 82, *Addison Road, Kensington, W.* .... C.
*1885 Harmer, S. F., D.Sc., F.R.S., *King's College, Cambridge* .... C.
1889 Harvey, T. H., *Cattedown, Plymouth* .... Ann.
1888 Haselwood, J. E., 3, *Lennox Place, Brighton* .... C.
1884 Haslam, Miss E. Rosa, *Ravenswood, Bolton* £20
1884 Head, J. Merrick, F.R.G.S., J.P., *Pennsylvania Castle, Isle of Portland, Dorset* .... Ann.
1884 Heape, Walter, *Heyroun, Chaucer Road, Cambridge* .... C.
*1884 Herdman, Prof. W. A., F.R.S., *The University, Liverpool*................. Ann.
1884 Herschel, Col. J., R.E., F.R.S., *Observatory House, Slough, Berks.* ...... C.
1889 Heywood, Mrs. E. S., *Light Oaks, Manchester* .... C.
1884 Hickson, Prof. Sydney J., M.A., D.Sc., F.R.S., *Ellesmere House, Wilenslow Road, Withington, Manchester* .... Ann.
1897 Hodgson, T. V., 54, *Kingsley Road, Plymouth* .... Ann.
1884 Holdsworth, E. W. H., F.L.S., F.Z.S., *Lucerne House, Dartmouth* . .... Ann.
*1905 Holt, E. W. L, 15 *Castle Avenue, Clontarf, Dublin* .... Ann.
1884 Hudleston, W. H., M.A., F.R.S., 8, *Stanhope Gardens, South Kensington, S.W.* .... Ann.

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

1885 Jackson, W. Hatchett, M.A., D.Sc., F.L.S., *Pen Wartha, Weston-super-Mare* .... Ann.
1893 Jago, Edward, *Coldrenick, Liskeard, Cornwall* .... Ann.
1887 Jago-Trelawny, Major-Gen., F.R.G.S., *Coldrenick, Liskeard* .... C.

1899 Kent, W. Saville, F.L.S., *Belsito, Milford-on-Sea, Hants* .... Ann.

1897 Lanchester, W. F., B.A., *The Knott, Lady Margaret Road, Cambridge*... C.
1885 Langley, Prof. J. N., F.R.S., *Trinity College, Cambridge* .... C.
*1895 Lister, J. J., M.A., F.R.S, *St. John's College, Cambridge* .... Ann.
1888 Lopes, The Rt. Hon. Sir Massey, Bart., *Maristow, Roborough, South Devon* .... Ann.

1885 Macalister, Prof. A., F.R.S., *St. John's College, Cambridge*................. Ann.
1884 MacAndrew, James J., *Lukesland, Ivybridge, South Devon* .... Ann.
1900 Macfie, J. W. Scott, *Rowton Hall, Chester* .... C.
1884 Mackrell, John, *High Trees, Clapham Common, S.W.* .... C.
1886 MacMunn, Charles A., M.D., *Oak Leigh, Wolverhampton* .... Ann.
1902 Major, Surgeon H. G. T., 24, *Beech House Road, Croydon*................. C.
1889 Makovski, Stanislaus, *Saffrons Corner, Eastbourne* .... Ann.
1885 Marr, J. E., M.A., F.R.S., *St. John's College, Cambridge*..................... C.
1902 Martin, C. H., *The Hill, Abergavenny* .... Ann.
1906 Masterman, A. T., D.Sc., *Board of Agriculture and Fisheries, Delahay Street, London, S.W.* .... Ann.

1884 McIntosh, Prof. W. C., F.R.S., *Nevay Park, Meigle, N.B.* .... *C.*
1884 Michael, Albert D., *Cadogan Mansions, Sloane Square, S.W.* .... *C.*
*1903 Mill, H. R., D.Sc., 62, *Camden Square, London, N.W.* .... Ann.
*1899 Minchin, Prof. E. A., *University College, London, W.C.* .... Ann.
1905 Mitchell, P. Chalmers, D.Sc., F.R.S., Secretary Zoological Society, 3 *Hanover Square, London, W.* .... Ann.
1885 Mocatta, F. H., 9, *Connaught Place, W.* .... *C.*
1886 Mond, Ludwig, F.R.S., 20, *Avenue Road, Regent's Park, N.W.* .... *C.*
†1896 Murray, Sir John, K.C.B., F.R.S., *Challenger Lodge, Wardie, Edinburgh* Ann.

†1884 Newton, Prof. Alfred, M.A., F.R.S., *Magdalen College, Cambridge* £20
†1884 Norman, Rev. A. M., M.A., D.C.L., F.R.S., *The Red House, Berkhamsted, Herts* .... Ann.

1885 Phillips, Chas. D. F., M.D., 10, *Henrietta Street, Cavendish Square, W.* *C.*
1887 Phipson, Mrs., *Dasak Bungalow, Nasik Road, Deccan, India* .... Ann.
1886 Power, Henry, C.B., F.R.C.S., 37A, *Great Cumberland Place, W.* ...... Ann.
1885 Pritchard, Prof. Urban, *Combe Hurst, Nutley Terrace, Hampstead* ...... Ann.
1884 Pye-Smith, P. H., M.D., 48, *Brook Street, W.* .... *C.*

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

1884 Ralli, Mrs. Stephen £30
1885 Ransom, W. B., *The Pavement, Nottingham* .... *C.*
1888 Rawlings, Edward, *Richmond House, Wimbledon Common* .... Ann.
1892 Robinson, Miss M., *University College, London, W.C.* .... Ann.
1892 Rüffer, M. A., M.D., *Conseil Sanitaire, Maritime et Quarentenaire, Alexandria, Egypt* .... Ann.

1897 Sandeman, H. D., 4, *Elliot Terrace, Plymouth* .... Ann.
1888 Scharff, Robert F., Ph.D., *Science and Art Museum, Dublin* .... Ann.
1901 Schiller, F. W., 9, *Carlton Road, Blackheath, London, S.E.* .... Ann.
1884 Sclater, P. L., F.R.S., *Odiham Priory, Winchfield, Hants* .... Ann.
1884 Sclater, W. L., *The Museum, Cape Town* .... Ann.
1885 Scott, D. H., M.A., Ph.D., F.R.S., *Old Palace, Richmond, Surrey* ...... *C.*
1903 Scott, S. D., *Newich House, Bath Road, Cheltenham* .... Ann.
1884 Sedgwick, A., M.A., F.R.S., *Trinity College, Cambridge* .... *C.*
1888 Serpell, E. W., 19, *Hill Park Crescent, Plymouth* £50
1900 Sexton, L. E., 17, *Collings Park, Higher Compton, Plymouth* .... Ann.
1904 Shaw, Joseph, *Bryanston Square, London, W.* £13
1885 Sheldon, Miss Lilian, *The Murmurs, Exmouth* .... Ann.
*1884 Shipley, Arthur E., M.A., F.R.S., *Christ's College, Cambridge* .... *C.*
1886 Shore, T. W., M.D., *Heathfield, Alleyn Park, Dulwich, London, S.E.* ... Ann.
1894 Simpson, F. C., J.P., *Maypool, Churston Ferrers, R.S.O.* .... Ann.
1885 Sinclair, F. G., *Friday Hill, Chingford, Essex* .... *C.*
1891 Sinclair, William F., 102, *Cheyne Walk, Chelsea, S.W.* .... *C.*
1884 Skinners, the Worshipful Company of, *Skinners' Hall, E.C.* £42
1889 Slade, Commander E. J. Warre, *Phœnice Farm, Great Bookham, Surrey* *C.*
1893 Sorby, H. C., LL.D., F.R.S., *Broomfield, Sheffield* .... Ann.
1888 Spencer, Prof. W. Baldwin, M.A., F.R.S., *University of Victoria, Melbourne* Ann.

1884 Stewart, Prof. Chas., F.R.S., *Royal College of Surgeons, Lincoln's Inn Fields, W.C.* .... Ann.
1897 Straker, J., L.L.M., F.Z.S., *Oxford and Cambridge Club, S.W.* .... C.
1884 Sutherland, The Duke of, *Stafford House, St. James', S.W.* .... C.
1894 Sykes, E. R., 4, *Gray's Inn Place, Gray's Inn, London* .... Ann.

1894 Thomas, W. F., *Bishopshalt, Hillingdon, Middlesex* .... Ann.
*1899 Thompson, Prof. D'Arcy W., C.B., *University College, Dundee* .... Ann.
1890 Thompson, Sir H. F., Bart., 19, *Kensington Gardens, London, W.* .... Ann.
1884 Thornycroft, Sir John I., F.R.S., *Eyot Villa, Chiswick Mall* .... Ann.
1888 Thurston, Edgar, *Government Central Museum, Egmore, Madras* .... Ann.
1903 Torquay Natural History Society, *Torquay* .... Ann.
*1897 Travers, J. A., *Tortington House, Arundel* .... Ann.

1891 Vaughan, Henry, 325, *High Holborn, London* .... C.
1884 Venning, Mrs., 3, *Wingfield Villas, Stoke, Devonport* £50

1884 Walker, Alfred O., *Ulcombe Place, Maidstone* .... Ann.
1884 Walker, P. F., 36, *Prince's Gardens, S.W.* .... Ann.
†1884 Walsingham, The Rt. Hon. Lord, F.R.S., *Merton Hall, Thetford* £20
1906 Waterhouse, N. E., 3, *Fredericks Place, Old Jewry, London, E.C.* .... Ann.
1891 Wildy, A. G., 14, *Buckingham Street, Adelphi, London, W.C.* .... Ann.
1900 Willey, A., D.Sc., *Government Museum, Colombo, Ceylon* .... Ann.
1884 Wilson, Scott B., *Heather Bank, Weybridge Heath* .... C.
*1900 Wolfenden, R. N., M.D., 76, *Wimpole Street, Cavendish Square, London, W.* Ann.
1905 Woolf, M. Yeatman, *Wimpole House, Wimpole Street, London, W.* ... Ann.
1898 Worth, R. H., 42, *George Street, Plymouth* .... Ann.

1905 Yearsley, Macleod, 10, *Upper Wimpole Street, London, W.* .... Ann.

IV.—Associate Members.

1900 Bignell, G. C., F.E.S., *The Ferns, Home Park Road, Saltash, Cornwall.*
1889 Caux, J. W. de, *Great Yarmouth.*
1889 Dannevig, Capt. G. M., *Arendal, Norway.*
1904 Donnison, F., *Deep Sea Fishing Co., Boston.*
1904 Edwards, W. C., *Mercantile Marine Office, St. Andrew's Dock, Hull.*
1904 Freeth, A. J., *Fish Quay, North Shields.*
1904 Hurrell, H. E., 25, *Regent Street, Yarmouth.*
1904 Inskip, H. E., Capt., R.N., *Harbour Master's Office, Ramsgate.*
1904 Johnson, A., *Fishmongers' Company, Billingsgate Market, London, E.C.*
1889 Olsen, O. T., F.L.S., F.R.G.S., *Fish Dock Road, Great Grimsby.*
1904 Patterson, Arthur, *Ibis House, Great Yarmouth.*
1889 Ridge, B. J., *Newlyn, Penzance.*
1901 Sanders, W. J., *St. Elmo, Brixham.*
1889 Shrubsole, W. H., 19, *Vancovier Road, Catford, London.*
1889 Sinel, Joseph, 8, *Springfield Cottages, Springfield Road, Jersey, C.I.*
1890 Spencer, R. L., *L. and N.W. Depôt, Guernsey.*
1890 Wells, W., *The Aquarium, Brighton.*

OBJECTS

OF THE

Marine Biological Association of the United Kingdom.

THE ASSOCIATION was founded at a Meeting called for the purpose in March, 1884, and held in the Rooms of the Royal Society of London.

The late Professor HUXLEY, at that time President of the Royal Society, took the chair, and amongst the speakers in support of the project were the late Duke of ARGYLL, the late Sir LYON PLAYFAIR, Lord AVEBURY, Sir JOHN HOOKER, the late Dr. CARPENTER, Dr. GÜNTHER, the late Lord DALHOUSIE, the late Professor MOSELEY, the late Mr. ROMANES, and Professor LANKESTER.

The Association owes its existence and its present satisfactory condition to a combination of scientific naturalists, and of gentlemen who, from philanthropic or practical reasons, are specially interested in the great sea fisheries of the United Kingdom. It is universally admitted that our knowledge of the habits and conditions of life of sea fishes is very small, and insufficient to enable either the practical fisherman or the Legislature to take measures calculated to ensure to the country the greatest return from the "harvest of the sea." Naturalists are, on the other hand, anxious to push further our knowledge of marine life and its conditions. Hence the Association has erected at Plymouth a thoroughly efficient Laboratory, where naturalists may study the history of marine animals and plants in general, and where, in particular, researches on food-fishes and molluscs may be carried out with the best appliances.

The Laboratory and its fittings were completed in June, 1888, at a cost of some £12,000. Since that time investigations, practical and scientific, have been constantly pursued at Plymouth. Practical investigations upon matters connected with sea-fishing are carried on under the direction of the Council; in addition, naturalists from England and from abroad have come to the Laboratory, to carry on their own independent researches, and have made valuable additions to zoological and botanical science, at the expense of a small rent for the use of a working table in the Laboratory and other appliances. The number of naturalists who can be employed by the Association in special investigations on fishery questions, and definitely retained for the purpose of carrying on those researches throughout the year, must depend on the funds subscribed by private individuals and public bodies for the purpose. The first charges on the revenue of the Association are the working of the sea-water circulation in the tanks, stocking the tanks with fish and feeding the latter, the payment of servants and fishermen, the hire and maintenance of fishing-boats, and the salary of the Resident Director and Staff. At the commencement of this number will be found the names of the gentlemen on the staff.

In the summer of 1902 the Association was commissioned by His Majesty's Government to carry out in the southern British area the scheme of International Fishery Investigations adopted by the Conference of European Powers which met at Christiania in 1901. In connection with this work a laboratory has been opened at Lowestoft.

The purpose of the Association is to aid at the same time both science and industry. It is national in character and constitution, and its affairs are conducted by a representative Council, by an Honorary Secretary and an Honorary Treasurer, without any charge upon its funds, so that the whole of the subscriptions and donations received are devoted absolutely to the support of the Laboratory and the prosecution of researches by aid of its appliances. The reader is referred to page 4 of the Cover for information as to membership of the Association.

CONTENTS OF NEW SERIES, Vol. VII., 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 annum	1	1	0
Life Members	Composition Fee	15	15	0
Founders		100	0	0
Governors		500	0	0

Members of the Association have the following rights and privileges: they elect annually the Officers and Council; they receive the Journal of the Association free by post; they are admitted to view the Laboratory at Plymouth, and may introduce friends with them; they have the first claim to rent a place in the Laboratory for research, with use of tanks, boats, &c.; and have access to the books in the Library at Plymouth.

All correspondence should be addressed to the Director, The Laboratory, Plymouth.

New Series.—Vol. VII., No. 4—issued July, 1906.] [Price 6d.

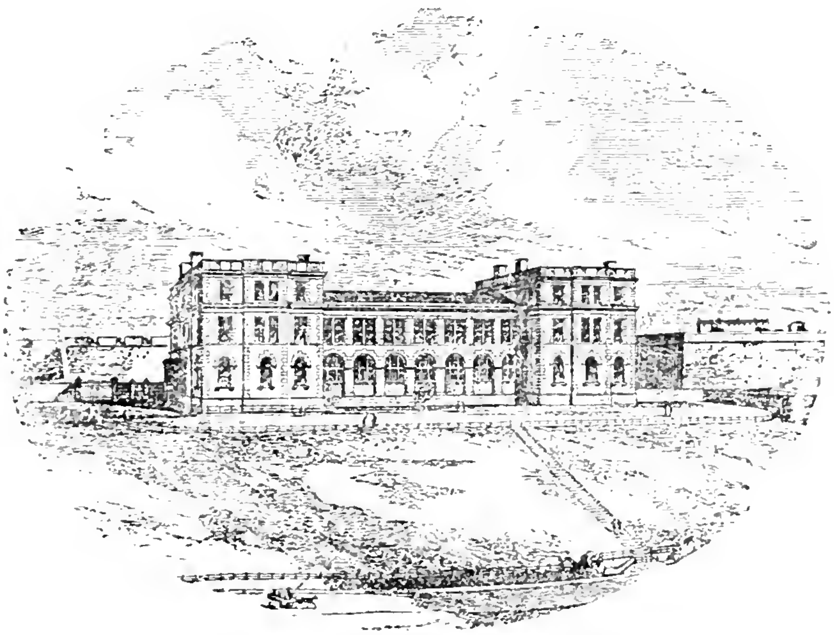
Journal

OF THE

MARINE BIOLOGICAL ASSOCIATION

OF

THE UNITED KINGDOM.



THE PLYMOUTH LABORATORY.

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Marine Biological Association of the United Kingdom.

Report of the Council, 1905-6.

The Council and Officers.

The Council have met on five occasions during the year, and the average attendance at the meetings has been ten. The meetings have been held in the Rooms of the Royal Society, and the Council have again to express their thanks to the Royal Society for their hospitality.

Committees of the Council, as in previous years, have visited the Laboratories at Plymouth and Lowestoft and inspected the work which is being carried on.

The Council have to record with regret the deaths of Sir J. Burdon Sanderson, Bart., F.R.S., the representative of the University of Oxford on the Council; of Rear-Admiral Sir W. J. L. Wharton, K.C.B., F.R.S., a Vice-President of the Association; and of Professor W. F. R. Weldon, F.R.S., a Member of Council since 1888.

The Laboratories.

A somewhat simpler system of circulating the sea water through the tanks at the Plymouth Laboratory with a new pattern of pump has been in operation during the greater part of the year and has proved successful. It is hoped that some saving in the expenses for repairs will result. Experiments on the rearing of marine organisms under laboratory conditions have been continued with success.

For the North Sea work in connexion with the International Fishery Investigations, new and larger premises have been rented at Lowestoft, which allow of the researches being carried on with much greater convenience than in the old establishment.

The Boats.

The Association's steamer *Oithona* continues to work successfully in the English Channel, and is in excellent condition both as regards efficiency and seaworthiness. The sailing boat *Anton Dohrn*, which carries on the collecting work during the winter, is also in good repair.

The steam trawler *Huxley*, which was chartered from Mr. G. P. Bidder in the first instance for a period of three years, has been retained for the further period of two years, during which the Association has been asked by His Majesty's Government to continue the International Investigations. Mr. Bidder has, with great generosity, undertaken to return to the Association each year, for the purposes of the investigations, the sum of £500 from the amount due to him for the hire of the vessel.

The Staff.

Mr. L. R. Crawshay, M.A., has been appointed Assistant Naturalist for Invertebrates at the Plymouth Laboratory in succession to Mr. S. Pace, who has become Director of the Marine Biological Laboratory at Millport. Mr. A. E. Hefford has been appointed an additional assistant on the Lowestoft staff.

Occupation of Tables.

The following Naturalists have occupied tables at the Laboratory during the year:—

E. T. Browne, M.A., London (Medusæ).
G. E. Bullen, St. Albans (Hydrozoa and Plankton).
A. D. Cotton, Kew (Algæ).
W. De Morgan, London (Crustacea).
Sir Charles Eliot, K.C.M.G. (Nudibranchiata).
R. Elmhirst, Leeds (Nudibranchiata).
Col. G. M. Giles, Plymouth (Anatomy of Insects).
G. H. Grosvenor, B.A., Oxford (General Zoology).
F. W. Headley, Haileybury (General Zoology).
C. G. Hewitt, B.Sc., Manchester (Isopoda).
T. V. Hodgson, Plymouth (Pycnogonida).
J. J. Lister, F.R.S., Cambridge (Foraminifera).
Keith Lucas, M.A., Cambridge (Physiology of Tunicata).
Prof. E. W. MacBride, F.R.S., Montreal (Echinoderma).
Miss M. Robinson, London (Crustacea).
D. J. Scourfield, Birmingham (Crustacea).
C. Shearer, D.Sc., Cambridge (Polychæta).
J. Stuart Thomson, Cape Town (Crustacea).
J. Lloyd Williams, Bangor (Algæ).

Twelve students attended a course of study in Marine Biology conducted at the Laboratory during the Easter vacation by Mr. G. H. Grosvenor.

General Work at the Plymouth Laboratory.

A commencement has been made in extending the investigations on the distribution of the fauna, which have been previously carried on in the immediate neighbourhood of Plymouth, to the deeper waters of the English Channel, and it is hoped during the coming year still further to enlarge the area the fauna of which is being mapped out. Mr. L. R. Crawshay is now associated with the Director in these researches.

Great attention has been paid to perfecting the methods of rearing marine organisms under laboratory conditions, and very promising progress has been made in this direction. A report upon the experiments which have been carried out will, it is expected, be published during the coming year.

With the assistance of special donations given for the purpose by Dr. G. H. Fowler and Mr. J. J. Lister, an investigation has been commenced into the food of the migratory fishes, especially the mackerel and pilchard, frequenting the mouth of the English Channel, with a view to ascertaining what relation exists between changes of the temperature and density of the sea water or of the floating organisms which it contains, and the fluctuations in the movements of these fishes from season to season and from year to year. Mr. G. E. Bullen has been engaged at somewhat irregular intervals in this work; but although promising progress has been made, the investigation is much hampered owing to the fact that the funds available do not permit of his being continuously employed upon it.

Regular collections are being made of young fishes found in the western part of the Channel, for which purpose a young-fish trawl on the Danish pattern has been constructed, and has been found very efficient.

Mr. T. V. Hodgson has occupied a table in the Laboratory throughout the year, for the purpose of working out material which he collected on the British Antarctic Expedition.

A collection of specimens illustrating the development and rate of growth of fishes, and containing a collection of marine invertebrates, has been sent to the Oceanographical Exhibition at Marseilles.

The supply of marine animals and plants for museums and for teaching purposes has considerably increased during the last two or three years: and although the collection, identification, and preservation of the specimens absorb a great deal of time and attention, which is by no means adequately compensated for by the amount of money received from the sale of the specimens, the work in itself appears to be of sufficient importance to justify the Association in continuing it, more particularly as it makes regular and constant collecting necessary and is some assistance to the general finances.

The Library.

The thanks of the Association are due for the following books and current numbers of periodicals presented to the Library during the past year:—

Académie Imp. des Sciences de St. Pétersbourg. Bulletin.
American Microscopical Society. Transactions.
American Museum of Natural History. Bulletin.
—— Memoirs.
—— Report.
American Philosophical Society. Proceedings.
Australian Museum. Records.
Bergens Museum. Aarbog.
—— An Account of the Crustacea of Norway, etc.; by G. O. Sars.
Bernice Pauahi Bishop Museum, Honolulu. Occasional Papers.
Board of Agriculture and Fisheries. Annual Report of Proceedings under the Salmon and Freshwater Fisheries Acts.
—— Annual Report of Proceedings under Acts relating to Sea Fisheries.
—— Report of Meeting of Fisheries Representatives.
Bristol Museum and Art Gallery. Reports of Committee.
Bristol Naturalists Society. Proceedings.
The British Museum. Catalogue of Madreporarian Corals in the British Museum. Vol. V.
Brooklyn Institute of Arts and Sciences. Cold Spring Harbor Monographs.
—— Science Bulletin.
Bryn Mawr College. Monographs, Reprint Series.
Bulletin Scientifique de la France et de le Belgique.
The Carnegie Institution. Publications.
La Cellule.
Ceylon Marine Biological Laboratory. Report.
College of Science, Tokyo. Journal.
College voor de Zeevisscherijen. Verslag van den Staat der Nederlandsche Zeevisscherijen. 1904.
Colombo Museum. Spolia Zeylanica.
The Commissioners of Fisheries, N. S. Wales. Report.
Conchological Society of Great Britain and Ireland. Journal of Conchology.
Conseil perm. internat. pour l'Exploration de la Mer. Bulletin des Résultats acquis pendant les Courses Périodiques.
—— Publications de Circonstance.
—— Rapports et Procès-Verbaux des Réunions.

Cuerpo de Ingenieros de Minas del Peru. Boletin.
Danish Biological Station. Report to the Board of Agriculture.
Kgl. Danske Videnskabernes Selskab. Oversigt.
—— Skrifter.
Dept. of Agriculture, etc., Ireland. Reports.
Dept. of Marine and Fisheries, Canada. Annual Report.
Deutsche Zoologische Gesellschaft. Verhandlungen.
Deutscher Fischerei Verein. Zeitschrift für Fischerei.
Deutscher Seefischerei Verein. Mitteilungen.
La Feuille des Jeunes Naturalistes.
Field Columbian Museum. Publications.
Imp. Fisheries Bureau, Tokyo. Journal.
Fisheries Society of Japan. Journal.
The Fisherman's Nautical Almanack ; by O. T. Olsen.
Fishery Board for Scotland. Annual Report.
The Fishing Gazette.
The Government Biologist, Cape of Good Hope. Report.
Government Museum, Madras. Report.
Illinois State Laboratory of Natural History. Bulletin.
Illustrations of the Zoology of the Royal Indian Marine Survey ship *Investigator.*
Internationale Meeresforchung. Die Beteiligung Deutschlands au der Internationalen Meeresforchung. Jahresbericht.
R. Irish Academy. Proceedings.
—— Transactions.
Italy. Ministero di Agricoltura, Industria e Commercio. Annali di Agricoltura.
Johns Hopkins University Circulars.
Kaiserliche Marine. Deutsche Seewarte. Virteljahrskarte für die Nordsee und Ostsee.
Kommission zur wissenschaftlichen Untersuchung der Deutschen Meere, etc. Wissenschaftliche Meeresuntersuchungen.
Kommissionen for Havundersögelser, Copenhagen. Meddelelser, series Fiskeri, Hydrografi, Plankton.
—— Skrifter.
Laboratoire Biologique de St. Petersbourg. Bulletin.
Lancashire Sea Fisheries Laboratory. Report.
Lancashire and Western Sea Fisheries. Superintendent's Report.
Leicester Corporation Museum and Art Gallery. Report.
Liverpool Biological Society. Proceedings and Transactions.
Liverpool Marine Biology Committee. Annual Report.
Manchester Microscopical Society. Annual Report and Transactions.
Marine Biological Association of the West of Scotland. Annual Report.
Marine Biological Laboratory, Woods Holl. Biological Bulletin.
Mededeelingen over Visscherij.
Meteorological Office. Monthly Pilot Charts, North Atlantic and Mediterranean.
—— The Beaufort Scale of Wind Force.
R. Microscopical Society. Journal.
Le Mois Scientifique.
Montpellier: l'Université. Travaux de l'Institut de Zoologie de l'Université de Montpellier et de la Station Zoologique de Cette.
Musée du Congo. Annales.
Musée d'Histoire Naturelle, Paris. Bulletin.
Musée Oceanographique de Monaco. Bulletin.
Museo Nacional, Buenos Aires. Anales.

Museo Nacional de Montevideo. Anales.
Museum of Comparative Zoology, Harvard College. Bulletin.
—— Memoirs.
—— Report.
The Museums Journal.
Naturforschende Gesellschaft in Basel. Verhandlungen.
Naturhistorischen Museum, Hamburg. Mittheilungen.
Neapel. Mittheilungen aus der Zoologischen Station.
Nederlandsche Dierkundige Vereeniging. Tijdschrift.
New York Academy of Sciences. Annals.
—— Memoirs.
New York Zoological Society. Bulletin.
—— Report.
New Zealand Institute. Transactions.
Nikolsk. Aus der Fischzuchtanstalt.
Norges Fiskeristyrelse. Aarsberetning vedkommende Norges Fiskerier.
Kgl. Norske Videnskabers Selskabs. Skrifter.
North Sea Fisheries Investigation Committee. Report of Fishery Board for Scotland.
—— Report of Marine Biological Association.
North Sea Fishery Investigations. Report of British Delegates.
La Nuova Notarisia.
Oberlin College. The Wilson Bulletin.
Physiographiske Forening. Christiania. Nyt Magazin for Naturvidenskaberne.
Plymouth Institution. Annual Report and Transactions.
Plymouth Museum and Art Gallery. Annual Report.
Quarterly Journal of Microscopical Science. (Presented by Prof. E. Ray Lankester, F.R.S.)
Queensland Museum. Annals.
Rijksinstituut voor het Onderzoek der Zee. Helder. Jaarboek.
The Royal Commission. St. Louis International Exhibition, 1904. British Section.
Royal Society of Edinburgh. Proceedings.
—— Transactions.
Royal Society of London. Philosophical Transactions.
—— Proceedings.
—— Reports of Commission for Investigation of Mediterranean Fever.
—— Report of the Sleeping Sickness Committee.
—— Report to the Government of Ceylon on the Pearl Oyster Fisheries of the Gulf of Manaar.
—— Year-Book.
Royal Society of Victoria. Proceedings.
Selskabet for de Norske Fiskeriers Fremme. Norsk Fiskeritidende.
Smithsonian Institution. Annual Report.
—— Bulletin of the United States National Museum.
—— Proceedings of the United States Museum.
Sociedad Geográfica de Lima. Boletin.
Sociedad Scientifica de São Paulo. Revista.
Societa di Naturalisti in Napoli. Bollettino.
Societas pro Fauna et Flora Fennica. Acta.
—— Meddelanden.
Société Belge de Géologie, etc. Bulletin.
Société Centrale d'Aquiculture et de Pêche. Bulletin.

Société d'Oceanographie du Golfe de Gascogne. Rapports.
Société Suisse de Pêche et Pisciculture. Bulletin.
Société Imp. Russe de Pisciculture et de Pêche. Vyestnīk R'ibopom'shlennostī.
Société Zoologique de France. Bulletin.
—— Mémoirs.
South African Museum. Annals.
Station Aquicole de Boulogne-sur-Mer. Annales.
Station de Pisciculture, etc., Toulouse. Bulletin.
Svenska Hydrografisk Biologiska Kommissioners. Skrifter.
Kgl. Svenska Vetenskaps-Akademien.
—— Arkiv för Botanik.
—— Arkiv för Zoologie.
Tuft's College. Studies.
United States Commission of Fish and Fisheries. Bulletin.
—— Report of the Commissioner.
United States National Herbarium. Contributions.
University of California. Publications. Zoology, Physiology, Botany.
University of Pennsylvania. Provost's Report.
—— Contributions from the Zoological Laboratory.
University of Toronto. Studies.
Kgl. Vetenskaps Societeten, Upsala. Nova Acta.
Welsh Museum of Natural History, Arts, and Antiquities. Report.
Wissenschaftliche Ergebnisse einer Zoologischen Expedition nach den Baikal See.
Zoological Society of Japan. Annotationes Zoologicæ Japonenses.
Zoological Society of London. List of the Fellows.
—— Proceedings.
—— Transactions.

The Secretary, Danish Legation. Fiskeri-Beretning, 1904–1905.
The Director, the Royal Gardens, Kew. Nouvelles Archives du Muséum d'Histoire Naturelle, Paris.
—— Proceedings of the Washington Academy of Sciences.
The Foreign Office. Développement de la Sole ; Fabre-Domergue and Biétrix.
Marshall Library, Owens College, Manchester. The Digestive Organs of the Alcyonaria and their relation to the Mesogloeal cell plexus ; by Edith M. Pratt.
—— Micro-organisms associated with Disease ; by S. J. Hickson.
—— Note on the Buccal Pits of Peripatus ; by C. G. Hewitt.
—— On the Isolation of the Infecting Organism ("Zoochlorella") of Convoluta roscoffensis ; by F. Keeble and F. W. Gamble.
Marine Biological Association of the West of Scotland. The Naturalist of Cumbrae ; by T. R. Stebbing.
—— The Journal of Conchology. Vol. VIII, No. 4.
—— Bathy-Orographical Map of the Clyde Basin, prepared for the British Association Meeting, 1901.
Mrs. Robertson and the Marine Biological Association of the West of Scotland. On *Pisidium fontinale* and *Planorbis complanatus*, two fresh-water shells new to Scotland, and *Helix villosa*, a land shell new to Britain ; by David Robertson.
—— The Fauna of Scotland, with special reference to Clydesdale and the

Western district. Fresh- and brackish-water Ostracoda; by David Robertson.

Mrs. Robertson and the Marine Biological Association of the West of Scotland. Amphipoda and Isopoda of the Firth of Clyde and West of Scotland; by David Robertson.

—— Notes on the Common Limpet; by David Robertson.

—— On *Saxicava rugosa*, a bivalve mollusc showing an unusual mode of repair; by David Robertson.

—— Jottings from my note-book on *Pennatula phosphorea*, Lin., *Virgularia mirabilis*, Lam., and *Pavonaria quadrangularis*; by David Robertson.

—— Notice of thirteen Cumacea from the Firth of Clyde; by David Robertson.

—— Jottings from my note-book on *Lima hians*, Gmel.; by David Robertson.

—— A list of the Algæ of Lamlash Bay, Arran, collected during September, 1894; by David Robertson.

—— Proceedings and Transactions of the Natural History Society of Glasgow. Vols. I–V, New Series.

To the authors of the Memoirs mentioned below the thanks of the Association are due for separate copies of their works presented to the Library:—

Allen, A. W. Some Notes on the Life History of *Margaritifera panasesae.*

Breitfuss, L. Skizze des Seegewerbes an der Murmanküste.

Browne, E. T. A Report on the Medusae found in the Firth of Clyde (1901–1902).

—— Notes on the Pelagic Fauna of the Firth of Clyde (1901–1902).

—— On the Freshwater Medusa *Limnocnida tanganicae* and its occurrence in the River Niger.

—— Report on the Medusae (Hydromedusae, Scyphomedusae, and Ctenophora) collected by Prof. Herdman at Ceylon in 1902.

—— and Vallentin, R. On the Marine Fauna of the Isles of Scilly.

Bruce, W. S. Some Results of the Scottish National Antarctic Expedition.

Collet, L. W. Les Concrétions phosphatées de l'Agulhas Bank. Avec Une Note sur la Glauconis qu'elles contiennent. Par Gabriel W. Lee.

Crossland, C. The Oecology and Deposits of the Cape Verde Marine Fauna.

Danton, L. Notes Ichtyologiques.

Darbishire, A. D. Professor Lang's Breeding Experiments with *Helix hortensis* and *H. nemoralis.*

Driesch, Hans. Altes und Neues zur Entwicklungsphysiologie des jungen Asteridenkeimes.

—— Skizzen zur Restitutionslehre.

—— Über das Mesenchym von unharmonisch zusammengesetzten Keimen der Echiniden.

—— Zur Cytologie parthenogenetischer Larven von Strongylocentrotus.

Duncker, G. Über Regeneration des Schwanzendes bei Syngnathiden.

Edwards, C. L. The Floating Laboratory of Marine Biology of Trinity College.

Eliot, C. Nudibranchs from the Indo-Pacific: I, Notes on a Collection dredged near Karachi and Maskat.

—— Nudibranchs and Tectibranchs from the Indo-Pacific; II., Notes on Lophocercus, Lobiger, Haminaea and Newnesia.

—— and Cockerell, T. D. A. Notes on a Collection of Californian Nudibranchs.

—— Notes on Two Rare British Nudibranchs, *Hero formosa*, var. *arborescens*, and *Staurodoris maculata.*

Eliot, C. On some Nudibranchs from the Pacific, including a new genus, *Chromodoridella*.
—— On some Nudibranchs from East Africa and Zanzibar. Part VI.
—— On the *Doris planata* of Alder and Hancock.
—— The Nudibranchiata of the Scottish National Antarctic Expedition.
Farran, G. P. Report on the Opisthobranchiate Mollusca collected by Professor Herdman, at Ceylon, in 1902.
Fowler, G. H. Biscayan Plankton collected during a cruise of H.M.S. *Research*, 1900.
Giard, Alfred. La Poecilogonie.
—— Les tendances actuelles de la Morphologie et ses rapports avec les autres Sciences.
—— Sur la prêtendue nocivité des Huitres.
Hadley, P. B. Preliminary Report on the Changes in Form and Color in the successive stages of the American Lobster.
Harmer, S. F. The Pterobranchia of the Siboga Expedition, with an account of other species.
Herdman, W. A. Presidential Address to Linnæan Society. 1905.
Hodgson, T. V. Decalopoda and Colossendeis.
Holt, E. W. L., and Tattersall, W. M. Biscayan Plankton collected during a cruise of H.M.S. *Research*, 1900. Part V. Schizopoda.
—— Report on the Schizopods collected by Mr. George Murray, F.R.S., during the cruise of the *Oceana* in 1898.
Hovey, E. O. The Grande Soufrière of Guadeloupe.
Janet, C. Anatomie de la tête du *Lasius niger*. 1905.
—— Description du Matériel d'une petite Installation Scientifique. Part I.
—— Observations sur les Fournies. 1904.
Keeble, F., and Gamble, F. W. The Colour-Physiology of Higher Crustacea. Part III.
Kiær, Hans. Om Tromsösundets fiske. En oversigt over deres udbredelse og biologi.
Kofoid, C. A. A Self-Closing Water Bucket for Plankton Investigations.
—— Craspedotella, A New Genus of the Cystoflagellata, an Example of Convergence.
—— Dinoflagellata of the San Diego Region. I. On Heterodinium, a New Genus of the Peridinidae.
—— Some New Tintinnidae from the Plankton of the San Diego Region.
Korotneff, A. Zoologische Expedition nach den Baikal-See.
Moore, J. P. A new species of Sea Mouse (*Aphrodita hastata*) from Eastern Massachusetts.
—— New species of Polychaeta from the North Pacific, chiefly from Alaskan waters. Five new species of Pseudopotamilla from the Pacific Coast of North America.
Nathansohn, A. Vertikale Wasserbewegung und quantitative Verteilung des Planktons im Meere.
Nobre, A. Mollusques et Brachiopods du Portugal.
Norman, A. M. A new Heterotanais and a new Eurydice, genera of Isopoda.
—— Greenlandic Polyzoa.
—— Irish Crustacea. Ostracoda.
—— Museum Normanianum, III. Crustacea.
—— Notes on the Natural History of East Finmark.
—— On *Cucumaria Montagui* (Fleming) and its Synonymy.

Norman, A. M. Revised Nomenclature of the species described in Bate and Westwood's "British Sessile-eyed Crustacea."
Olsen, O. T. A proposal to easily identify the Nationality of Fishing Vessels.
Paulmier, F. C. Higher Crustacea of New York City.
Mrs. Robertson. Protozoa (Foraminifera).
Schepotieff, A. Zur Organisation von Cephalodiscus.
Scott, T. A Report on the Free-swimming Crustacea found in the Firth of Clyde, 1901 to 1902.
Shipley, A. E., and Hornell, J. Further Report on Parasites found in connection with the Pearl Oyster Fishery at Ceylon.
Shipley, A. E. Notes on a Collection of Parasites belonging to the Museum of University College, Dundee.
—— On Ento-Parasites from the Zoological Gardens, London, and elsewhere.
—— The Effects of Metazoan Parasites on their Hosts.
Trybom, Filip. Atgarder för Fiskerinaringen i Sverige år 1904.
Wolfenden, R. N. Plankton Studies. Preliminary Notes upon new or interesting species. Part I. Copepoda.

The International Fisheries Investigations.

The following is a summary of the work done and of the conclusions arrived at by the scientific staff working under the direction of the Council.

Section I.—NORTH SEA WORK.

A. WORK OF THE S.S. "HUXLEY."

Trawling Investigations.—With the exception of a period of two months during the past winter, when the boat was laid up at Grimsby, the survey of the North Sea trawling grounds within the English area has made continuous progress. From June, 1905, to the end of May, 1906, the *Huxley* made nineteen fishing voyages, during which 240 hauls of the large commercial trawls were taken, and the quantities, sizes, and weights of the fishes caught systematically recorded.

From the commencement of the investigations seventy-five voyages have been completed, and the results of 893 hauls with the large trawls analysed and recorded.

Towards the close of 1905 the work accomplished during the previous three years was carefully reviewed, and a programme drawn up for the conduct of the investigations during the current year with the object of checking results obtained at corresponding seasons on the more important grounds in previous years, and of filling up gaps in the more complete series of data. The revised programme has been closely adhered to during the past half-year.

It is believed that the data are already sufficiently numerous and consistent to throw much light on the normal characteristics of the fish populations on the more important grounds, as well as upon the more important seasonal changes in such characteristics; and a series of summary reports is in course of preparation for submission to H.M. Government during the current year as each is completed.

Fish Measured.—As a rough indication of the material obtained upon these voyages, it may be stated that more than 88,000 measurements of fish, representative of the total catch on almost every occasion, were made and recorded at sea during the past year, in addition to other work.

Nearly 300,000 fishes have been measured in this way since the commencement of the investigations, as shown in detail in the following table:—

		Plaice.	Haddock.	Others.		Totals.
1902–5.	Voyages I–LVI . .	65,509	15,950	128,775	...	210,234
1905–6.	„ LVII–LXXV	24,954	10,755	52,885	...	88,594
	Totals	90,463	26,705	181,660	...	298,828

Marking Experiments.—During the past year 2042 marked plaice have been set free.

To the end of June, 1905, 5115 marked plaice had been liberated, of which 1224 have since been recaptured, yielding a percentage of 23·9 per cent.

More than 7000 marked plaice have thus been set free up to date.

The data yielded by these experiments are now sufficiently numerous to yield valuable indications of the main differences in the annual rate of growth of plaice in various parts of the English area. In certain areas they also show the progressive rate of growth from month to month. In addition to these results the experiments have thrown a continually increasing light on the seasonal migrations of the fish, the intensity of fishing in different areas, and upon differences in the rate of growth and habits of the two sexes; they add thus to our knowledge of the life history of this species in matters of considerable importance.

Transplantation experiments have been carried out during the spring months of 1905 and 1906 in order to check the results already reported as having been obtained during 1904.

The results of these experiments indicate that the rate of growth on the Dogger Bank is always markedly higher than on the coastal grounds south of 54° N. lat., though subject to variation in actual amount from year to year. Experiments have been carried out during the present year in order to determine whether this area of rapid growth is continuous between the Dogger Bank and the coastal grounds north of Flamborough Head.

Other experiments have also been devised, and are being carried out to test whether the still smaller year-old fish of a length of two to four inches can be profitably transplanted to these depleted waters.

SPECIAL EXPERIMENTS.—The special investigations enumerated in the last annual report have been continued. Further reference to the more extensive of these experiments is made in the next section.

B. LABORATORY INVESTIGATIONS.

AGE OF FISHES.—The material which has been accumulated for studying the age of plaice at different sizes on the various fishing grounds consists of more than 12,000 otoliths, of which nearly 8000 have been collected from measured fish caught on board the *Huxley* during the past year.

Much time has been spent upon the study of this material, and a report upon the data acquired up to the end of 1905 is now in preparation. The results attained by this method have been of great value in throwing light upon the distribution of the various age-groups of plaice, the rate of growth in different regions, the age of the two sexes at first maturity, and similar problems.

In consequence of the relation which has been found to exist between depth and distance from shore on the one hand and the size of plaice at a given age on the other, and in view of the irregular character of the ground off the English coast, a continuous series of hauls of the trawl was carried out in May, 1905, on a line from the Leman Ground to the Dutch coast (which represents apparently the main axis of the off-shore migrations of plaice in the southern part of the North Sea), and the otoliths of all the plaice caught were extracted.

This experiment was repeated in September last, and again in May of the current year, the collections yielding from 2000 to 3000 otoliths on each occasion.

The results of these experiments have furnished a standard by which to estimate the value of results obtained from samples in isolated localities.

FOOD OF FISHES.—The material collected bearing upon this point amounts now to about 10,000 stomachs of fish, the contents of which have been systematically recorded. During the past year the food of useful species has been more extensively studied with respect to the size of the fish—the specimens being preserved and examined according to size-groups differing by 5 cm. or 10 cm. In this way progressive changes have been shown in the feeding-habits of various species as growth advances.

Certain seasonal changes have also been shown. The plaice during the winter months have been found to abstain from feeding to a very large extent. Thus the percentage of stomachs of this species found empty has been found to vary from 99 per cent in November to 57 per cent in February, although during the rest of the year the average is less than 5 per cent.

Bottom Fauna.—The invertebrates trawled or dredged on the various expeditions prior to 1906 have been identified and recorded with the exception of a few sponges and ascidians. The total number of hauls examined amounts to 1129, of which 769 were hauls of the large trawls and 360 special collections with small dredges and trawls.

A beginning has been made in summarizing these data by means of distribution-charts for the various species, the main object in view being the delimitation, as far as possible, of definitely characterized natural areas. The North Sea lends itself well to this work, as the variety of species is relatively small, and a considerable portion of these show fairly definite limits of distribution and centres of abundance.

Bottom Deposits.—Out of 260 samples collected, nearly all (217) have now been graded, with the object of showing the relative proportion of fine and coarse particles in the deposits of different areas. For this purpose the samples are shaken through sieves of successively finer meshes, from 15 mm. to 0·5 mm. in diameter. A striking result of this sifting is the predominance of fine sand and its uniformity of character over large areas of the North Sea.

Herring Investigations.—In consequence of resolutions passed by the International Council in 1905, increased attention has been paid to the herring, and samples of this fish have been examined at Lowestoft during the past year at intervals of about a month or six weeks in accordance with a prescribed scheme. Each sample consists of 100 fish, the locality of capture of which is known; and the characters of each fish are separately recorded as regards (1) length, (2) number of vertebræ, (3) degree of maturity, and (4) amount of fat. The samples examined up to the present time have shown a high degree of uniformity as regards the number of vertebræ, which is held to be the best single index of racial peculiarities.

C. FISHERMEN'S RECORDS.

These have been continued on the same lines as hitherto. The number of returns provided by the fishermen during the past year amounts to a total exceeding 5000, as under:—

Smacks	...	1403	hauls.
Steamers	...	4006	,,
	Total	5409	,,

Section II.—HYDROGRAPHIC AND PLANKTON WORK IN THE ENGLISH CHANNEL.

During the past twelve months the quarterly cruises have been carried out as usual, and a short extra cruise covering the south-western stations was made in September, 1905. Samples have also been obtained from lightships, from steamers crossing the English Channel, and from Atlantic liners.

The most strongly marked feature of the period has been: (1) a great increase in the strength of the Gulf Stream off the south of Newfoundland in the summer of 1905, shown not only by the analyses of the samples from this region, but also by actual observations by officers of liners; and (2) a rise in the salinity of the Bristol Channel and the western part of the English Channel, which was almost certainly connected with, if not due to, the increased velocity of the Gulf Stream.

During the period under consideration the conditions have varied considerably, but at no time has there been observed any important division into layers of different density.

During the May cruise the larger part of the water in the western half of the Channel was as high as 35·4 °/₀₀ S., reaching 35·5 °/₀₀ S. a short distance west of Ushant, and 35·6 °/₀₀ S. in the Bay of Biscay just beyond the limits of the cruises. The 35·5 °/₀₀ isohaline, as shown by samples analysed at Plymouth and at Copenhagen, ran in an irregular course round the west coast of Ireland nearly to the latitude of the Orkney Islands.

During the summer the distribution of salinity altered in such a way that the saltest water found during the May cruise was close to the coasts of Devon and Cornwall instead of in mid-channel, an abnormal condition which continued, with slight modification, until the end of the year. The broad tongue of 35·5 °/ₒₒ S. off the west coasts of Ireland and Scotland was almost unchanged, though its northern extremity had retreated slightly. At the same time the salinity south of Ireland had risen to 36·0 °/ₒₒ S. as far north as latitude 50° N. It would appear, however, that the water of 35·4 °/ₒₒ S. now in the English Channel had entered from the west rather than from the Bay of Biscay; this conclusion is somewhat doubtful, as the samples taken in the Bristol Channel by various vessels do not agree very well among themselves, though it is confirmed to a certain extent by the presence in the plankton, as described below, of a large number of Pteropods of a species which is common off the west of Ireland, though known in the Bay of Biscay.

The extra hydrographic cruise in September, 1905, over the south-western stations (Nos. 1, 2, 3, 4, and 5), did not show any important change, the highest salinity, 35·39 °/ₒₒ, being found at Station 4 (55 miles west of Ushant). The high salinity water under the Cornish coast appears in the meantime to have been moving slowly eastward, keeping to the north side of the Channel and at the same time becoming slightly fresher. During the last half of September it was on the line joining the Needles to Cape La Hague, and three weeks later it was observed a short distance east of the Isle of Wight. In November, 1905, the salinity of the Channel as a whole was high, reaching 35·3 °/ₒₒ in the narrows between the Isle of Wight and Cape Barfleur and as far east as Beachy Head. Advantage was taken of the fine weather to extend the cruise further west than usual, and an extra station was worked at 47° 46′ N., 7° 50′ W., in 170 fathoms. The salinity was 35·57 °/ₒₒ at this station and 35·52 °/ₒₒ at Station 4.

During December and January the salinity of the Channel continued to rise, and at the beginning of February, 1906, water of 35·4 °/ₒₒ S. was found between Southampton and Havre, a decidedly high figure for the position.

The February cruise was carried out during the latter half of the month, and showed that water of 35·3 °/ₒₒ S. filled nearly the whole length of the Channel, with the exception of a narrow band of

35·2 °/ₒₒ S. running across Channel south of the Start. The saltest water, 35·4 °/ₒₒ S., was found at Station 4 (see above) and extended north-east nearly to Station 2 (47 miles S.W. of the Eddystone). As usual, a southerly current of comparatively fresh water from the Irish Sea was found reaching nearly to the mid-channel line south of the Scilly Islands. During March the salinity of the western half of the Channel fell, and that of the eastern part rose, reaching 35·4 on the Newhaven-Caen line in April.

As in the previous year samples of plankton have been regularly collected on the quarterly cruises, and as far as practicable in the intervals between the cruises. The records of the species found on each cruise are published in the Bulletin of the International Council.

A paper by Dr. Gough on the distribution and migrations of the Siphonophore, *Muggiæa atlantica*, in 1904, has also been published by the International Council. From this paper it appears that a shoal of Muggiæa entered the English Channel in April from the south-west, the species being first observed off Ushant. It then spread eastward into the Channel as far as Portland, where it was found in August, and also northwards, being taken off the Land's End in the beginning of June. It was found in the Irish Sea in August, and subsequently along the south coast of Ireland as far west as Fastnet, and on the west coast as far north as Galway Bay.

The plankton during the summer and autumn of 1905 was characterized by the appearance in the English Channel of a vast swarm of Pteropods, *Limacina retroversa*, Fleming. These Pteropods were first observed on the south coast of Ireland and entered the Channel from the north-west. They thus appeared to spread in a direction opposite to that taken by *Muggiæa* in the preceding year. *Limacina retroversa* is a species which is seldom met with in the Channel, being more commonly found in more northern waters. Its appearance in the Channel is therefore of interest, as it suggests a flow of water from a more northerly direction than usual, a suggestion which is supported by the results of the hydrographic work. In company with the *Limacina*, other northerly species were observed, for example *Clione limacina* and *Rhizosolenia hebetata*.

Published Memoirs.

The following papers, either wholly or in part the outcome of work done at the Laboratory, have been published elsewhere than in the Journal of the Association:—

CHUBB, G. C.—*The Growth of the Oocyte in* ANTEDON : *a Morphological Study in Cell-Metabolism.* Proceed. Roy. Soc., B. 519, 1906, pp. 384–7.

GOUGH, L. H.—*On the Distribution and the Migrations of* MUGGIAEA ATLANTICA, *Cunningham, in the English Channel, the Irish Sea, and off the South and West Coasts of Ireland in 1904.* Conseil Perm. Internat. pour l'Explor. d. l. Mer. Publications de Circonstance, No. 29, 1905, pp. 1–13.

HILL, M. D.—*Notes on the Maturation of the Ovum of* ALCYONIUM DIGITATUM. Quart. Journ. Micr. Sci., vol. 49, 1905, pp. 493–519.

MACBRIDE, E. W.—*Report on the Work done during the Occupation of the British Association Table at Plymouth, June, 1905.* (*Development of* OPHIOTHRIX FRAGILIS.) Report Brit. Assn. South Africa, 1905, pp. 183–5.

NORMAN, A. M. *On* CUCUMARIA MONTAGUI, *Fleming.* Ann. Mag. Nat. Hist., Ser. 7, Vol. XVI., 1905, pp. 352–9.

NORMAN, A. M., and SCOTT, T. *The Crustacea of Devon and Cornwall.* London, 1906, pp. 1–232.

SCHMIDT, JOHS. *The Pelagic Post-larval Stages of the Atlantic Species of Gadus.* Meddel. Komm. Havunders. Fiskeri., Bd. I, Nr. 4.

WILLIAMS, J. LL. *Studies in the Dictyotaceae.* iii., *The Periodicity of the Sexual Cells in* DICTYOTA DICHOTOMA. Annals of Botany, vol. xix., 1905, pp. 531–60.

WOODCOCK, H. M. *The Life-Cycle of* "CYSTOBIA" IRREGULARIS *(Minch.), together with Observations on other "Neogamous" Gregarines.* Quart. Journ. Micr. Sci., vol. 50, 1906, pp. 1–100.

WOODLAND, W. *Studies in Spicule Formation. Parts I–IV.* Quart. Journ. Micr. Sci., vol. 49, 1905, pp. 231–325 and pp. 533–59.

Donations and Receipts.

The receipts for the year for the ordinary work of the Association include the grants from His Majesty's Treasury (£1000) and the Worshipful Company of Fishmongers (£400), Special Donations (£525), Annual Subscriptions (£102), Rent of Tables in the Laboratory (£42), Sale of Specimens (£393), Admission to the Tank Room (£126).

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Dr. *Statement of Receipts and Payments*

	£	s.	d.	£	s.	d.
To Current Income :—						
H. M. Treasury	1,000	0	0			
Fishmongers' Company	400	0	0			
Annual Subscriptions	101	16	0			
Rent of Tables	42	2	0	1,543	18	0
,, Extraordinary Receipts :—						
G. P. Bidder, Special Donation	500	0	0			
Dr. G. H. Fowler do.	25	0	0	525	0	0
,, Balance :—						
General Account	304	18	0			
Less Repairs and Renewals Account	133	12	2			
Overdraft at Bank	171	5	10			
Less Cash in hand	20	4	0	151	1	10
				£2,219	19	10

[Note.—This liability is exclusive of the amount of £100 referred to in the last statement.]

Examined and found correct,

(Signed) N. E. Waterhouse, A.C.A. E. A. Minchin.
L. W. Byrne. Geo. P. Bidder.

26th June, 1906

for the Year ending 31*st May*, 1906. **Cr.**

		£ s. d.	£ s. d.
By Balance from last year, being amount due to Bankers ...		146 9 1	
Less Cash in hand ...		20 19 4	125 9 9
,, Current Expenditure :—			
Salaries and Wages—			
Director ...		200 0 0	
Naturalist (International Fishery Investigations) ...		250 0 0	
Director's Assistant ...		150 0 0	
Wages (including cost of preparing Marseilles Exhibit)		574 9 1	1,174 9 1
Travelling Expenses ...			54 4 0
Library...		80 0 2	
Journal...		3 5 0	
		83 5 2	
Less Sales of Journal ...		3 8 1	79 17 1
Buildings and Public Tank Room—			
Gas, Water, and Coal ...		88 18 0	
Stocking Tanks, Feeding, etc. ...		29 17 10	
Maintenance and Renewals ...		84 18 5	
Do. Repairs and Renewals Account...		32 18 6	
Rent of Land, Rates, Taxes, and Insurance ...		17 6 11	
		253 19 8	
Less Admissions to Tank Room ...		126 12 3	127 7 5
Laboratory, Boats, and Sundry Expenses—			
Stationery, Office Expenses, Printing, etc. ...		112 18 7	
Glass, Chemicals, and Apparatus (including purchases on account of Marseilles Exhibit) ...	£191 15 8		
Less Sales ...	30 3 6	161 12 2	
Purchase of Specimens ...		37 17 5	
Maintenance and Renewal of Boats, Nets, Gear, etc. ...	£250 12 4		
Less Sales ...	105 1 3	145 11 1	
Coal and Water for Steamer ...		118 8 11	
Insurance of Steamer ...		22 19 6	
		599 7 8	
Less Sales of Specimens, etc. (including £50 from International Investigations Commission for use of ss. *Oithona*) ...		443 7 0	156 0 8
Bank Interest ...			2 11 10
			1,719 19 10
,, Extraordinary Expenditure :—			
Contribution towards the expenses of the International Fishery Investigations ...			500 0 0
			£2,219 19 10

Notes and Memoranda.

Diporula verrucosa, *C. Peach,* off Plymouth.

THE type, and hitherto only recorded British specimen (Hinck's *British Polyzoa*, p. 220, Pl. XXXII. Figs. 1, 2), was procured by Peach in Lantivet Bay. When at the Biological Laboratory in 1889, I found a second example among material brought in by the dredger from deep water. The specimen is finer than the type, measuring 1·4 inches high and 1·3 inches wide. The proportionately great width is caused by a very obtuse angle of the first division of the stem; subsequently the branches are again dichotomously divided, and at their tips are the beginning of new divisions. A. M. NORMAN.

Hancockia eudactylota, *Gosse.*

IN writing of the genus Hancockia in this Journal (vol. vii., No. 3, June, 1906, pp. 353–6), I have inadvertently followed foreign zoologists in calling the species described by Gosse, *H. dactylota*. The name given by Gosse was, however, *H. eudactylota* (see *Ann. and Mag. of Nat. Hist.*, xx., 1887, p. 316). C. ELIOT.

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Published on behalf of the International Council

BY

ANDR. FRED. HÖST ET FILS,

COPENHAGEN.

OBJECTS

OF THE

Marine Biological Association of the United Kingdom.

THE ASSOCIATION was founded at a Meeting called for the purpose in March, 1884, and held in the Rooms of the Royal Society of London.

The late Professor HUXLEY, at that time President of the Royal Society, took the chair, and amongst the speakers in support of the project were the late Duke of ARGYLL, the late Sir LYON PLAYFAIR, Lord AVEBURY, Sir JOHN HOOKER, the late Dr. CARPENTER, Dr. GÜNTHER, the late Lord DALHOUSIE, the late Professor MOSELEY, the late Mr. ROMANES, and Professor LANKESTER.

The Association owes its existence and its present satisfactory condition to a combination of scientific naturalists, and of gentlemen who, from philanthropic or practical reasons, are specially interested in the great sea fisheries of the United Kingdom. It is universally admitted that our knowledge of the habits and conditions of life of sea fishes is very small, and insufficient to enable either the practical fisherman or the Legislature to take measures calculated to ensure to the country the greatest return from the "harvest of the sea." Naturalists are, on the other hand, anxious to push further our knowledge of marine life and its conditions. Hence the Association has erected at Plymouth a thoroughly efficient Laboratory, where naturalists may study the history of marine animals and plants in general, and where, in particular, researches on food-fishes and molluscs may be carried out with the best appliances.

The Laboratory and its fittings were completed in June, 1888, at a cost of some £12,000. Since that time investigations, practical and scientific, have been constantly pursued at Plymouth. Practical investigations upon matters connected with sea-fishing are carried on under the direction of the Council: in addition, naturalists from England and from abroad have come to the Laboratory, to carry on their own independent researches, and have made valuable additions to zoological and botanical science, at the expense of a small rent for the use of a working table in the Laboratory and other appliances. The number of naturalists who can be employed by the Association in special investigations on fishery questions, and definitely retained for the purpose of carrying on those researches throughout the year, must depend on the funds subscribed by private individuals and public bodies for the purpose. The first charges on the revenue of the Association are the working of the sea-water circulation in the tanks, stocking the tanks with fish and feeding the latter, the payment of servants and fishermen, the hire and maintenance of fishing-boats, and the salary of the Resident Director and Staff. At the commencement of this number will be found the names of the gentlemen on the staff.

In the summer of 1902 the Association was commissioned by His Majesty's Government to carry out in the southern British area the scheme of International Fishery Investigations adopted by the Conference of European Powers which met at Christiania in 1901. In connection with this work a laboratory has been opened at Lowestoft.

The purpose of the Association is to aid at the same time both science and industry. It is national in character and constitution, and its affairs are conducted by a representative Council, by an Honorary Secretary and an Honorary Treasurer, without any charge upon its funds, so that the whole of the subscriptions and donations received are devoted absolutely to the support of the Laboratory and the prosecution of researches by aid of its appliances. The reader is referred to page 4 of the Cover for information as to membership of the Association.

CONTENTS OF NEW SERIES, Vol. VII., No. 4.

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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 Librar at Plymouth.

All correspondence should be addressed to the Director, The Laboratory, Plymouth.

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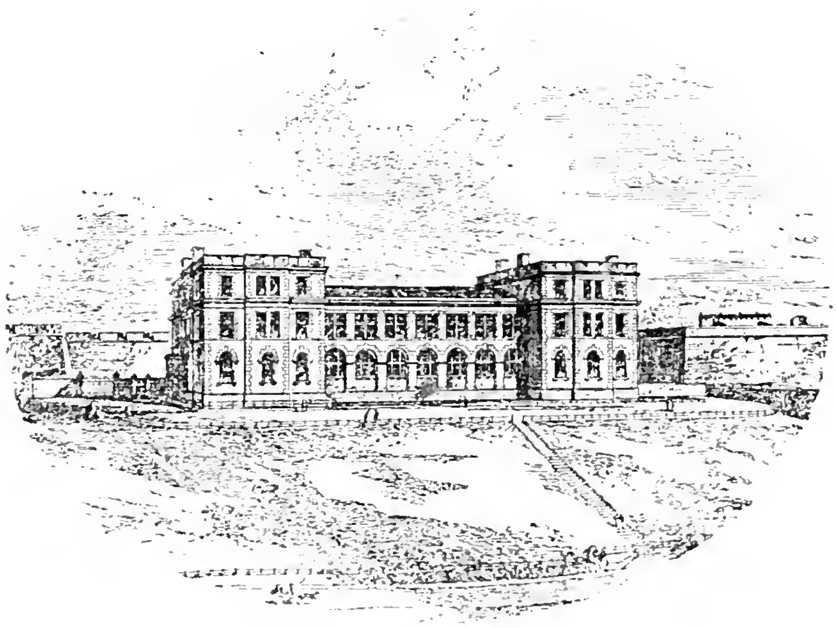

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Some Results of the International Fishery Investigations.

By

Jas. Johnstone.

It is always an unsatisfactory task to attempt to summarize the results of an extensive piece of scientific work while this is still in progress. The conclusions made during the course of a series of researches are necessarily tentative ones, and subject to more or less modification when the work comes to an end. Even the main facts elicited during the investigation do not at the time present themselves in their real proportions. One fails to appreciate the importance of some, and may be tempted to give emphasis to others which do not possess the significance assigned to them. Such considerations apply with special force to the following sketch of the main results apparent so far from the work of the International Fishery Investigations in the Northern European seas. Nine countries—Britain, Belgium, Denmark, Germany, Finland, The Netherlands, Norway, Russia, and Sweden—are engaged in these researches. Each country has its own staff of scientific men (and women); its own exploring vessels and laboratories; and its own publications.* Controlling and supervising all this work is the International Council, operating through the Bureau at Copenhagen, and the Central Laboratory at Christiania.

Common plans and programmes of work were arranged by the Council at the outset of the investigations and at various times since then; but while this is the case, each country is still at liberty to "fight for its own hand." It will easily be seen then that the co-ordination of the

* For the English reader the following are the most important publications:—

The *Rapports et Procès-verbaux* of the Council, especially vol. iii.

The English Blue books. *Fishery and Hydrographic Investigations in the North Sea and adjacent regions* (cd. 2612, 1905; and cd. 2670, 1905). *North Sea Fishery Investigations, Reports and Correspondence*, vol. i. (cd. 2966, 1905). (Vol. ii. of this Blue book is identical with *Rapports et Procès-verbaux*, vol. iii.)

The *Bulletin des Résultats* of the Council.

The *Publications de Circonstance* of the Council.

The Danish *Meddelelser fra Kommissionen for Havundersögelser* (in English).

The German *Beteiligung Deutschlands an den Internationalen Meeresforschung.*

The *Journal of the Marine Biological Association.*

There are of course other publications, but the above are the most noteworthy and generally interesting.

numerous researches, and the discussion of the results obtained in relation to each other, must be a task of considerable difficulty, and indeed cannot properly be undertaken until the conclusion of the series of investigations. It is most necessary that the reader should bear this in mind in following the present account of the International Fishery Investigations.

The International Fishery researches fall under three main categories: (1) the hydrographic work, which deals with physical investigation on the constitution and movements of the water in our northern seas; (2) the purely biological work both strictly zoological and bionomical; and (3) fishery investigations consisting of the fishery experiments involving the use of commercial and research fishing gear, and of statistical studies. I will take these main lines of research in the above order.

The Hydrographical Investigations.

I think it necessary to give a very short account of the topography of the sea bottom in the area under investigation, though our knowledge of this was obtained previous to the inception of the International Fisheries work, and has not been materially changed in the course of this. It is well known that the British Isles are situated on a submarine plateau which forms part of the European "Continental Shelf." If an imaginary line be drawn in this area so as to connect all points where the sea is 100 fathoms in depth, it will be found that the British Islands are included within it. Such a line will enclose an area which includes a considerable portion of the Atlantic to the west of Ireland and Scotland, the Irish Sea, the English Channel, and the North Sea with the exception of a deep depression which skirts the coasts of Norway and Sweden. Over the greater part of this area the sea is less than 300 feet in depth, and with the exception of two or three isolated "deeps" is everywhere less than 600 feet in depth.

From the north of Scotland, and extending in a north-westerly direction, is a submarine ridge which connects together the British submarine plateau with the plateaux on which are situated the Faeroe Isles and Iceland. Between Greenland and Iceland, and between Iceland and the Faeroe Isles, are extensive banks over which the sea is from 200 to 300 fathoms in depth. Then joining the Faeroes to the British plateau is a narrow ridge—the Wyville-Thomson Ridge. To the north-east of this ridge the sea bottom rapidly sinks down, forming a channel of over 500 fathoms in depth, deepening to form the Norwegian sea, with a maximum depth of nearly 2000 fathoms. On the south-west side of the ridge the sea bottom as rapidly sinks down into the abysses of the Atlantic Ocean. The Wyville-Thomson Ridge forms the "watershed" between two deep-water basins differing conspicuously from each other. On the top of the ridge the water may have a bottom temperature of 2° C. On the southern slopes it is washed by water with a relatively high temperature, 6° C. to 10° C., and even down to a depth of 700 metres the temperature may be as high as 6°. On the other hand, the temperature falls rapidly as we descend the northern slopes towards the Norwegian sea, until we find in the deeps of the latter a mass of sea water the temperature of which is, with one exception, lower than anywhere else in the oceans of the earth. In the deepest part of the Norwegian sea the temperature of the water is 1°·3 C. below the freezing point of fresh water.

Over practically the whole of the British and North Sea plateau, on the Norwegian coastal banks, the Faeroese and Icelandic banks, the Baltic and the coastal banks in the Barentz Sea, commercial fishing is carried on. Though the tendency is always for the extension of trawl and line fishing into deeper water, yet the greater part of the Norwegian sea is not fished over. Still this extensive area is most interesting from the point of view of the investigator, and many fishing experiments have been made therein.

This then is the nature of the area over which the International Fishery Investigations are being carried on. The accompanying Chart (Fig. 1) shows how it has been divided up so as to apportion the work between the various countries participating in the scheme of research.

Hydrographic investigations have for their aim the determination of the physical characters of the sea water in the different regions of the extensive area mentioned above. The physical characters to which I allude are: (1) the temperature; (2) the salinity, that is, the weight of solid saline matter contained in 1000 grammes of sea water; and (3) the nature and abundance of the gases (oxygen, nitrogen, carbonic acid, sulphuretted hydrogen, etc.) dissolved in it. Other characters are from time to time of importance, but the hydrographic condition of any portion of sea water is usually defined by its temperature and salinity, and the determination of these are the essentials of marine hydrographic research. Not only do these characters vary from time to time in the same region—both temperature and salinity are, for instance, different in the water covering the Dogger Bank in winter and summer—but they may vary with the locality. The water on the Dogger may be physically very different from that present in the Faeroe-Shetland channel or in the Cattegat. The determination, then, of both temperature and salinity, simultaneously over the whole area, at periodical times, is the obligatory hydrographic work at present carried on by the International Fishery organization.

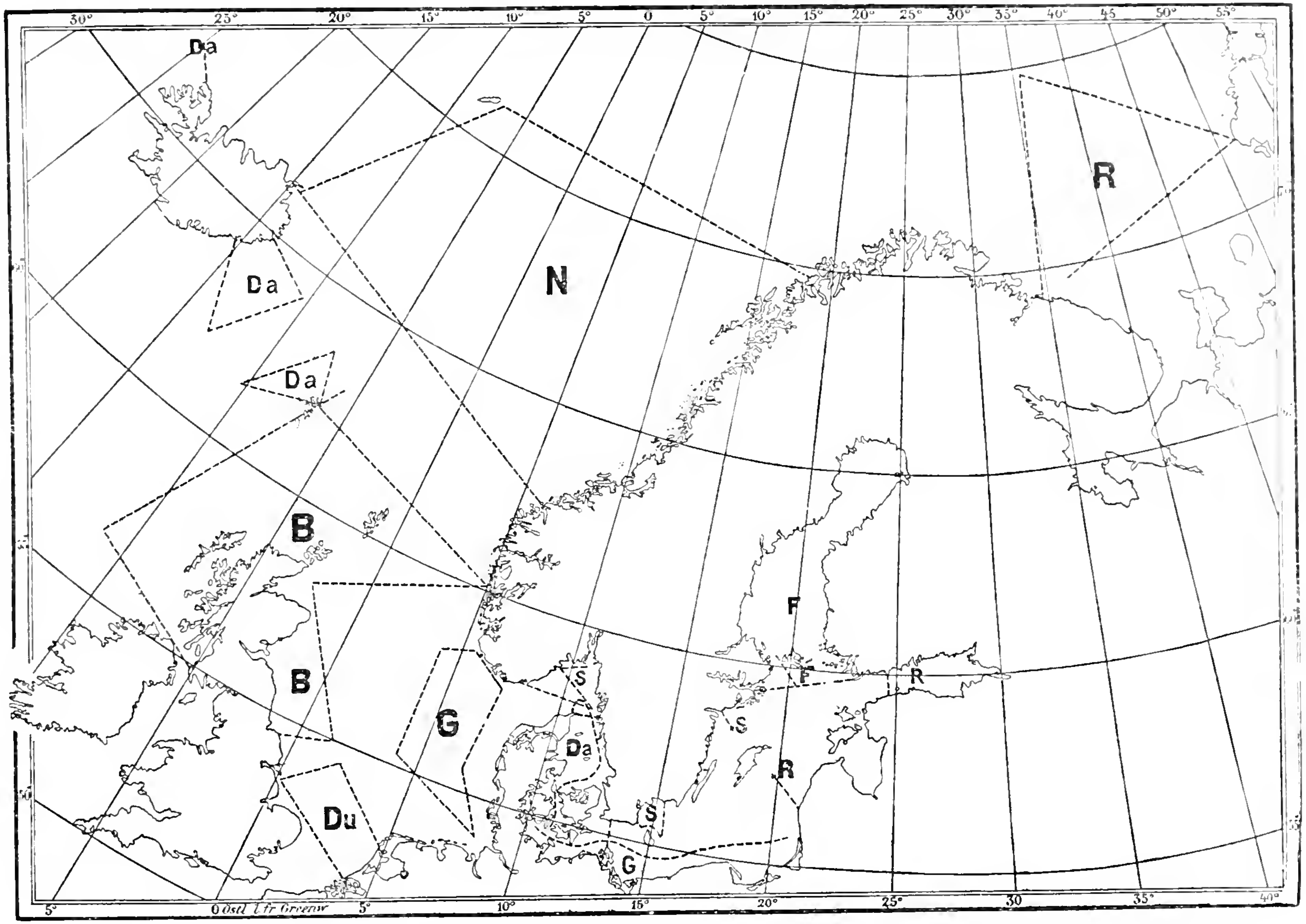


FIG. 1. CHART SHOWING THE LINES OF OBSERVATION RECOMMENDED BY THE STOCKHOLM CONFERENCE, ADOPTED WITH SLIGHT MODIFICATIONS BY THE CHRISTIANIA CONFERENCE.

A good deal of scientific work of this kind was carried on, both by the Scandinavian hydrographers and by the Scottish Fishery Board, prior to the beginning of the International Investigations. There was, for instance, a notable expedition in 1893, in the course of which results of some value were obtained; and, both in Norway and Sweden, frequent investigations, by vessels equipped for the purpose or by commercial vessels, have been made. I refer, of course, to hydrographic work in the North European area. It is well known that such research always formed a prominent part of the work of the great exploring voyages. But much of the research carried on in this part of North European waters is now known to be faulty; and the results obtained cannot be utilized for comparison with those now being procured by the International organization. Methods were faulty in the past—particularly the methods of obtaining water samples and temperatures from deep-water levels or from the sea bottom. Even the determination of the salinity of the sample was not always carried out with accuracy. It was not until the creation of the International organization that co-ordination became possible. It was essential that the work should be carried on under the supervision of a central authority, and that large numbers of observations should simultaneously be made over a very extensive area. It was further essential for strict accuracy that water samples should be obtained and temperatures observed by instruments of identical pattern. When the International scheme was initiated in 1902 all these things became practicable. The region under investigation was divided into a number of sub-areas, one or more of which were allotted to each of the participating countries. In each of these sub-areas lines were marked out traversing significant portions of the sea area, and on each line were laid down a number of "stations." A station is a stopping-place for the exploring vessel at which observations are made. On reaching the station an ordinary sounding is made and a sample of water from the surface of the sea is taken, part of which is reserved for analysis. The temperature of the sea surface being determined, a series of hydrographic soundings is then made.

Not the least creditable achievement of the International Fisheries researches is the perfection of the water-bottle. In the latest form of this instrument, which was designed by Professors Pettersson and Nansen, we have an almost perfect means of collecting samples of water from the sea bottom or at any other depth, and at the same time determining the temperature of this water *in situ*. The water-bottle in principle consists of a central chamber, in which is fixed a delicate deep-sea thermometer. Round this central chamber are a number of concentric cylinders of ebonite and brass. The bottle is lowered in an open condition, and when the required depth has been attained it is closed by means of a "messenger," which slides down the line carrying the bottle. Both central and concentric chambers are then filled with the water present at the depth to which the instrument is lowered: the thermometer registers the temperature of this water in the central chamber, and this being surrounded by three or four concentric shells of water, heat is only very slowly conducted in either direction through these water walls. In hauling the water-bottle the temperature does not, therefore, appreciably rise. These soundings are made for a number of depths, for instance, 5, 10, 20, 50, 100 metres, and the temperatures of these separate water strata are so obtained.

Each exploring vessel makes one such cruise at regular intervals, and the cruises over all the International area are made as nearly as possible at the same time. At least one cruise is made quarterly, and the months selected are February, May, August, and November. On the return of the vessel to her base, the water samples collected are sent ashore for analysis, and the salinity at least is determined. What is actually done is to estimate the percentage of chlorine (or rather total halogens) present by precipitating these substances, according to various methods, by nitrate of silver. The total solids in solution are then calculated from the values obtained in the analyses by means of hydrographic tables. The highest degree of accuracy is necessary, and this has only been made possible by means of check analyses made by the Central Laboratory, under the control of the International Council. The principal functions of this institution are the supply of the instruments of research, the preparation of "standard" sea water for checking the analyses made by the various national laboratories, and the preparation of the hydrographic tables.

The results obtained—salinities, temperatures, etc.—are then sent to the Bureau of the International Council to be published in the *Bulletin des Résultats*. The values are marked on charts of the areas under investigation, so that synoptical representations of the hydrographic condition of the sea are prepared. Such charts of temperatures and salinities, prepared for successive years or portions of a year, are pictorial representations of the circulation of the waters of the North Atlantic seas.

The immediate cause of these water movements in the North European area is the Gulf Stream circulation. It is now generally known, though one may still find it stated otherwise in the textbooks, that the actual Gulf Stream does not at any time reach the shores of the British Islands. Issuing from the Gulf of Mexico, this great current forms a closed eddy in the North Atlantic Ocean, and its waters circulate round a portion of that sea, characterized by the presence of floating seaweed and a peculiar fauna. This is the "Sargasso Sea." In 1889 the limits of the Gulf Stream eddy were investigated.* The water of 36 and 37 salinity touched the Azores in March of that year, but not the coasts of Africa or Europe. Between these coasts and the stream was water of less salinity than 36. In November a great extension of the eddy had taken place, and in that month it had actually touched the coasts of Africa and Southern Europe. With this extension of heavy and relatively warm sub-tropical water had also occurred an extension of the area containing sub-tropical microscopic drifting organisms. In March of the following year the limits of the Gulf Stream eddy had again contracted.

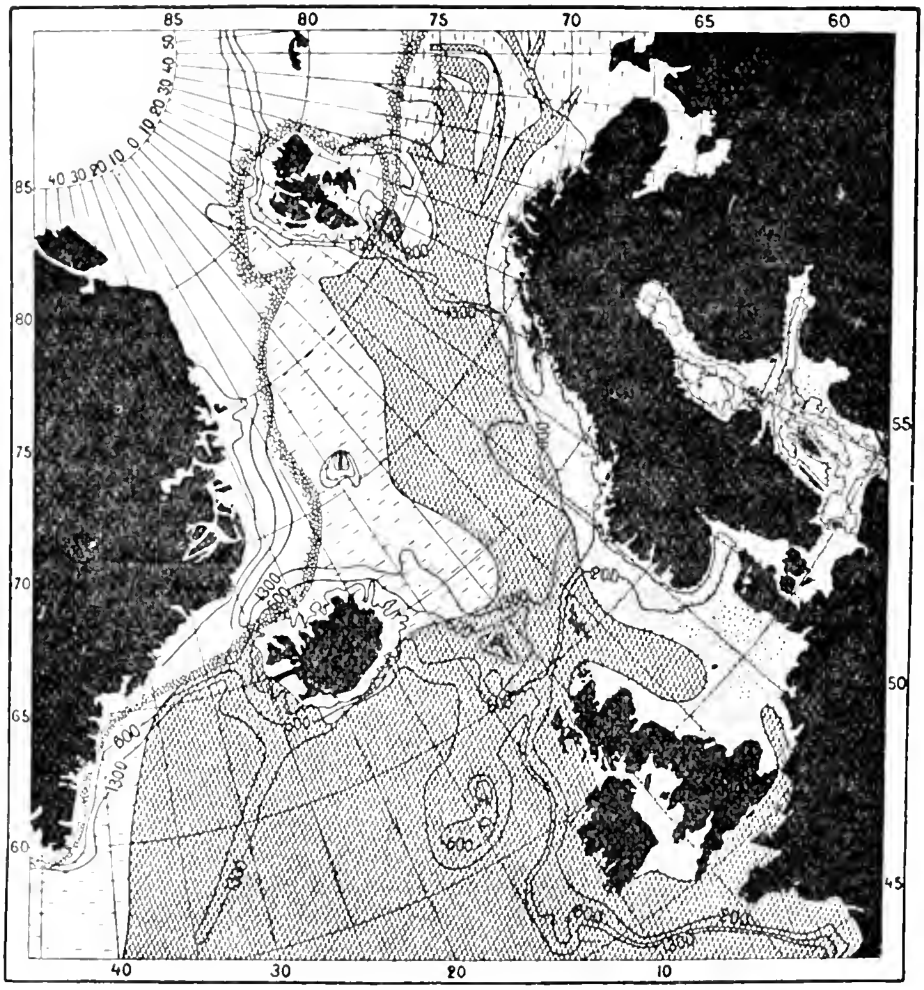
The Gulf Stream circulation, though it never actually reaches our northern latitudes, thus undergoes a periodic expansion and contraction. Now analogous to these gigantic annual pulsations there occur hydrographic events in the seas of Northern Europe. A periodic flooding of the North Sea, the Skagerak, the Norwegian sea, and even the remote Barentz Sea, with water of Atlantic origin, occurs annually in such a manner as to render it an undoubted fact that the oceanic circulation in these regions is dependent on that of the Gulf Stream, and ultimately on the equatorial current. In some way or other a great stream or drift takes origin in the Gulf Stream eddy and invades our northern seas. This is the "European stream." It is sometimes said that it is the result of the propulsion of surface water by the prevailing south-westerly cyclonic storms which reach our latitudes. This may be so, but the cause of the Norwegian stream is more probably a complex thermo-dynamical one. Anyhow, there is a continual drift of relatively warm and dense water from the south-west towards Northern Europe. Just as the Gulf Stream eddy pulsates, so does this drift of water become augmented or contracted. And with these augmentations and contractions of the European stream are correlated changes in the barometric pressure and temperature of the atmosphere, and in the prevailing fisheries of the regions into which it penetrates.

The chart† (Fig. 2) reproduced on page 444 illustrates the distribution of the European stream in August, 1896. This chart was constructed from observations made prior to the beginning of the International Investigations, and the results obtained since 1902 indicate that the distribution of the stream in 1896 was rather abnormal. A glance at the chart, however, will illustrate what may perhaps be regarded as the maximum flooding of the European seas by Atlantic water. The stream has invaded the Icelandic coastal regions, and has penetrated into the Denmark strait between Iceland and Greenland. Impinging on the

* Cleve, Ekman, and Pettersson, *Variations annuelles de l'eau de surface de l'ocean atlantique.*

† Petermann's *Mittheilungen*, 1900, Heft i. *u.* ii.; see also *Rappts. et Proc.-verb.*, vol. iii., 1905, p. 4.

western coasts of the British Isles, the stream divides, part passing through the English Channel into the North Sea. Then flowing north, it is shown filling up both the Iceland-Faeroe and the Faeroe-Shetland channels. The International researches have shown that this distribution is quite unusual; as a very general rule the Atlantic stream passes between the Faeroes and Scotland only, and to a very slight



Surface chart, August 1896

Atlantic water Arctic water Coastal and bank water

Fig. 2.

extent through the other channel. It should be noted that the whole of the oceanic basin from surface to bottom south of the Iceland-Scotland ridge is filled with Atlantic water. But the effect of the stream washing on the ridge is such that the flow of Atlantic water is interrupted, and north of the ridge this warm and dense water lies only on the surface. After passing over this ridge the stream, which is now the "Norwegian branch of the European stream," is deflected to the east, and we see that it rounds the north of Scotland and enters the North Sea.

Great attention has been directed to the flow of the European stream on the Wyville-Thomson Ridge, and the investigations made since 1902 by the Scottish hydrographers in this region have shown that the conditions here are very complicated. Not only have we to consider the fluctuations of the Atlantic stream itself, but we have also to consider the influence exerted on the flow of the current by the North Polar stream. In the chart this is represented by the broken oblique lines. The Polar stream, which consists of cold and relatively light Arctic water flowing to the south, is broken into two sub-streams. One of these, the Greenlandic stream, is an ice-bearing one, and flows through the Denmark strait. The other, which does not usually carry ice, is the east Icelandic Polar stream, and flows south past the east coast of that island. This stream attains its maximum volume in spring, and it may then obstruct the flow of Atlantic water north of the Faeroe-Shetland channel and so cause this to enter the North Sea in increased volume. In the winter, when the flow of Arctic water southwards is at its minimum, the passage northwards of Atlantic water is facilitated. Not only does the varying intensity of the Polar stream affect the northerly passage of Atlantic water, but we have also to deal with an undercurrent of Arctic water which flows beneath the Atlantic water in an opposite direction, and also with an outflowing stream of brackish water from the Baltic, which also exerts its influence on the intensity of the Norwegian stream. Altogether the hydrographic conditions in the Faeroe-Shetland channel are very complex, and it has been, and is still, a task of much difficulty to unravel the course of the currents in this locality.

After passing the Faeroes the Norwegian stream flows on to the north-east, covering a variable area of the surface of the Norwegian sea with water which is warmer and salter than that which lies beneath. Passing the meridian 25° E. it then rounds North Cape and enters the Barentz Sea. The Russian hydrographers have investigated the physical conditions of this area with great success,* and have shown that this North Cape current of Atlantic water and its ramifications possess boundaries as constant geographically as those of rivers. Annually the remote Barentz Sea is invaded by a heat wave, the result of the seasonal fluctuation of the Norwegian stream. The cold season or winter of this sea is in June. Beginning in that month is the inflow of Atlantic water, which attains its maximum intensity in November. In the interval between June and November the temperature of the bottom water in the Barentz Sea has been raised from 1° C. to about 6° C., and corresponding variations in the salinity of the water have

* *Oceanographische Studien u. d. Barentz Meer.* Petermann's *Mittheilungen*, 1904, p. 46. Also *Rappts. et Proc.-verb.*, vol. iii., 1905, p. 3.

been observed. Then in November the inflow of the genial Atlantic water ceases and the Barentz Sea is again invaded by the cold Arctic water of the Polar basin.

In the North Sea similar variations in the nature and origin of the water present have been observed. A good deal of attention was paid to this question even before the initiation of the International Investigations, but since 1902 our knowledge of these variations has been

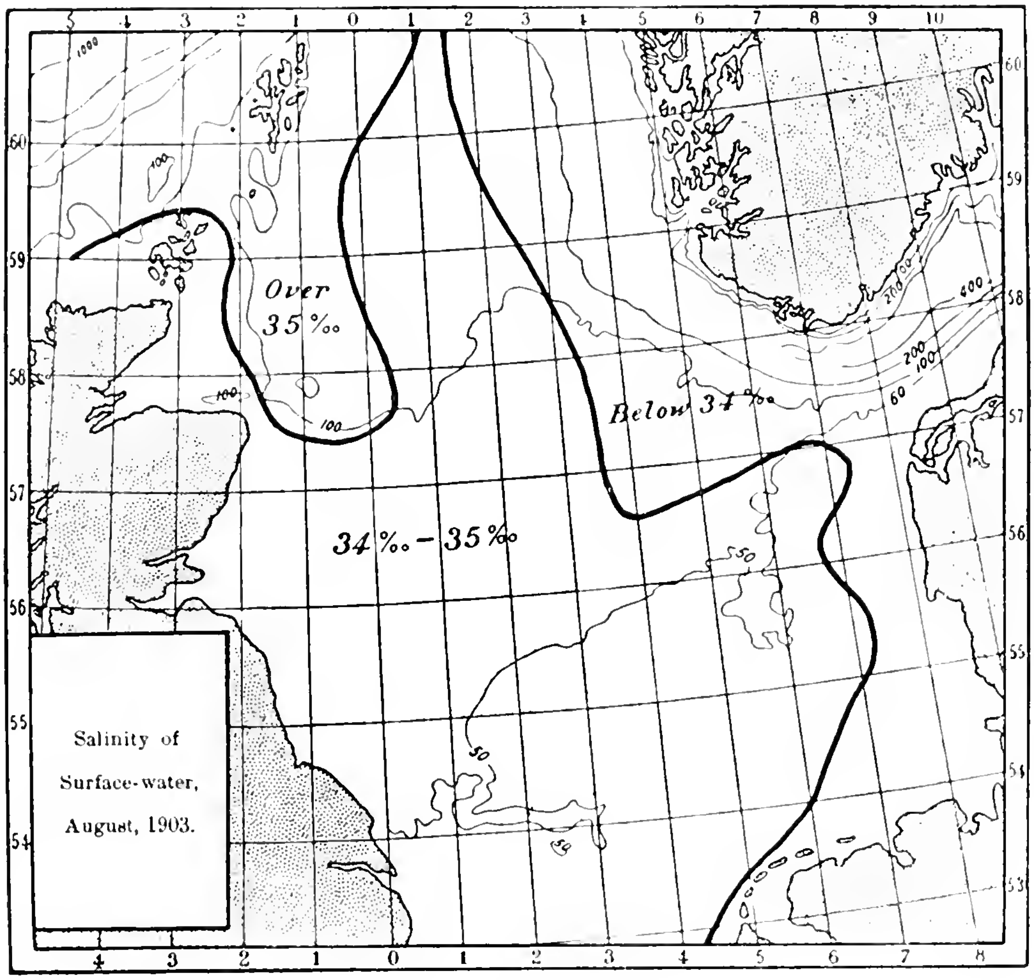


Fig. 3.

considerably increased. The effect of the seasonal fluctuations in the volume of the Norwegian stream is well shown by the investigations of the Scottish, Danish, and Dutch sections of the organization, and will easily be understood by a glance at the charts,* which illustrate the hydrographic condition of the surface of the North Sea in 1903 and 1904. Fig. 3 represents the conditions in August, 1903, and it will be seen that by far the greater portion of the area is covered with water of 34 to 35 per 1000 salinity. This may be called North Sea water.

* A. J. Robertson, *Fishery and Hydrographical Investigations in the North Sea and adjacent regions*, p. 55, 1905 (cd. 2612).

Then to the eastward there is a wide edging of water which is less salt, containing less than 34 parts of solid matter per 1000. This is Bank water, and results from the fusion of North Sea water with the fresh water from continental rivers and from the outflowing Baltic stream. In this month Atlantic water is seen to be present in the north-west part of the North Sea; that is, the Norwegian stream has begun to flow round the north of Scotland, and covers the deeper part of the North Sea, north of the Dogger Bank.

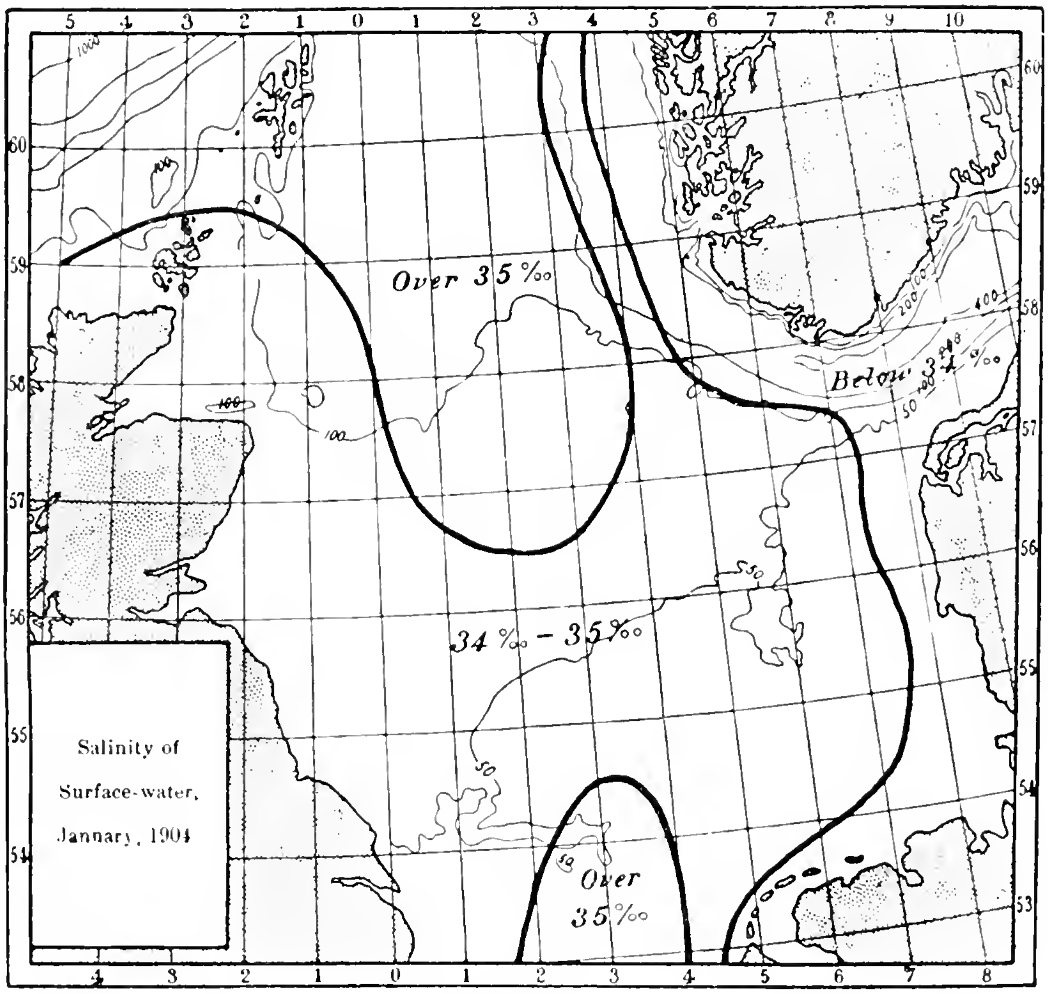


FIG. 4.

So far there is no indication of the entrance of Atlantic water into the North Sea area from the southern entrance. This, however, is represented in Fig. 4, which shows the conditions obtaining in January, 1904. Here we see that the northerly tongue of Atlantic water proceeding from the Faeroe-Shetland channel has become much larger and now covers quite an extensive area of the sea. Towards the south Atlantic water is also entering through the Straits of Dover, and these north and south influxes of salt water are apparently approximating to each other. In the next chart (Fig. 5), which represents the conditions in March, 1904, a further development of the Atlantic flooding has taken place. Both the northern and southern tongues have become largely augmented, and Atlantic water now covers quite a considerable fraction of the North Sea area. The influx of water from the European stream into the North Sea therefore begins in August, gathers force during the winter, and attains a maximum in early spring. From thence onwards the flooding diminishes.

The work of the Swedish hydrographers, carried out under the

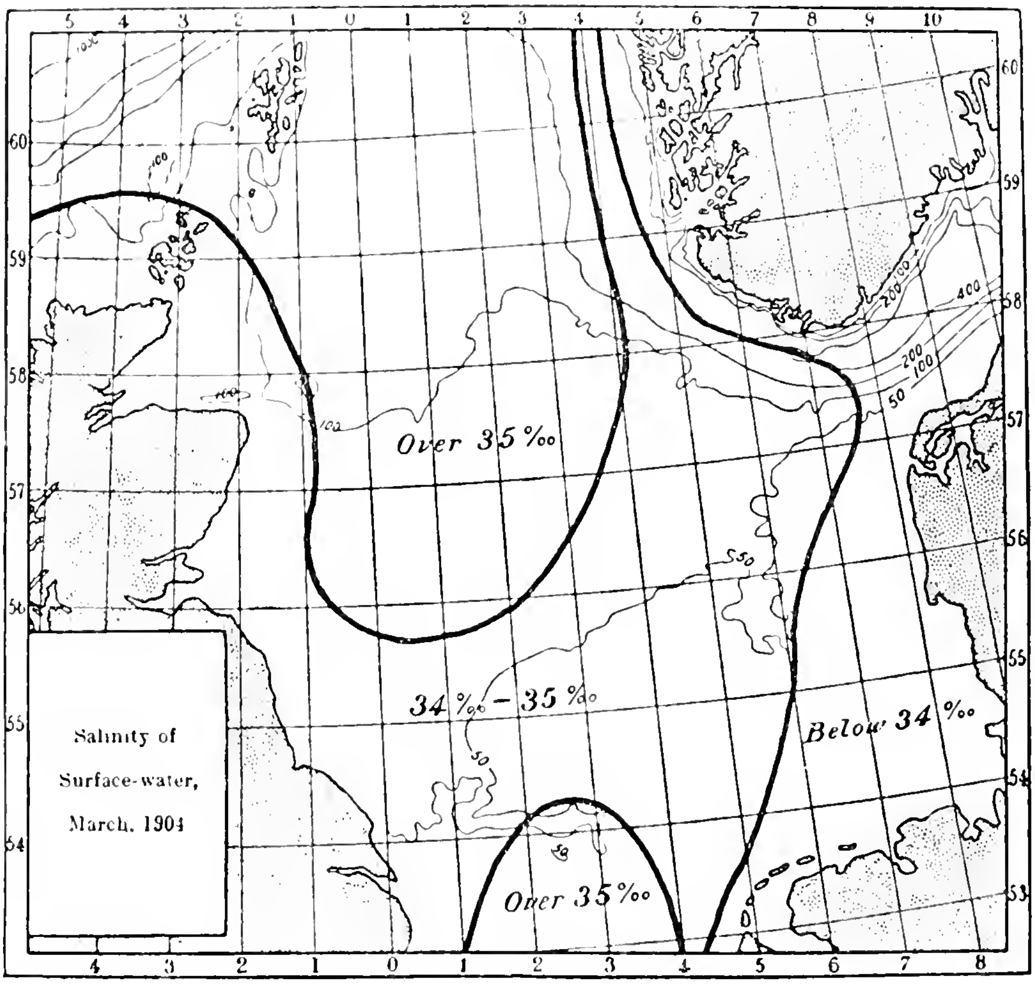


FIG. 5.

International organization, in the Skagerak, and that of the Danes in the Cattegat and the Belts, show that the same ebb and flow of Atlantic water can be felt in those seas. "During the autumn," says Pettersson,* "a heat wave from the Skagerak penetrates into the Baltic." From August until November Atlantic water accumulates in the deep layers of the Skagerak. In August this is overlain by surface water of low salinity and a relatively high temperature. When in November this accumulation of salt water has reached its maximum, both of volume

* *Rappts. et Proc.-verb.*, vol. iii., 1906, p. 8.

and temperature, it lies beneath surface water which is now much colder than that at the bottom. The effect of this flooding of the deeper regions of the Skagerak with warm dense water is that an undercurrent of relatively warm Bank water is set up, and this passes through the Cattegat and the Belt seas into the Baltic proper, where it displaces the colder water which had accumulated during the previous winter. In most years this undercurrent of warm Bank water may pass as far into the Baltic as east of Bornholm.

Finally, the hydrographic observations made in the English Channel by the Marine Biological Association* show that the same periodic flooding by warm and dense Atlantic water takes place in this area. In the Channel, on account of the rapid and complicated tidal streams and the contracted sea area, the conditions are more complex and difficult of investigation. We have here to deal with two contributory sources of water: (1) a current of relatively low salinity which flows southwards from the Irish Sea; and (2) Atlantic water which flows northwards from the Bay of Biscay. The conditions are still further complicated by the presence of coastal water. A general drift of water up Channel has been observed, and successive areas of low and high salinity water may pass to the east. During the summer and early winter of 1903 the low salinity water of the Irish Sea predominated, but in the winter the Channel was largely filled with Atlantic water flowing past Ushant in a north-easterly direction.

The main results which already appear from a study of the hydrographic work of the International Fisheries research organization are these: (1) the flooding of the seas of Northern Europe by a stream of comparatively warm and heavy Atlantic water which takes origin in the Gulf Stream circulation; and (2) the periodicity of this Atlantic drift. Once a year the area covered by the gigantic Gulf Stream swirl expands and contracts, and once a year, but a little later, the continual northerly flow from the Atlantic to Britain and Northern Europe also is augmented and diminished. It is in the remoter parts of the area invaded by the European stream that the pulsations of the latter can most easily be felt. In the English Channel, the North Sea, the Cattegat and Baltic, the shores of Iceland, and the Barentz Sea, the annual heat wave set up by the replacement of the colder and fresher waters of those seas by the warmer and salter waters of the Atlantic has now been observed and studied.

The efforts of the International organization are now being concentrated, so far as hydrographic research goes, on the study of the

* Matthews, *Report (No. 2, Southern Area) Fishery and Hydrographic Investigations in the North Sea and adjacent regions*, 1905, p. 289 (cd. 2670).

varying periodicity of the Atlantic flood and ebb. We have seen that the Gulf Stream circulation is itself periodic in that its intensity is greatest in November and least in March. But that the period of greatest intensity varies slightly from year to year is now tolerably certain, though this problem has by no means received the attention it deserves. So also with the appearance of the Atlantic stream in the ultimate seas of Northern Europe; on the whole an annual periodicity has been observed. Year after year the Atlantic flooding occurs at much the same time: the temperature of the water rises, and the salinity increases in such a manner as to eliminate the possibility that these changes are due to local climatic influences, and to render it certain now that they are due to a great oceanic water circulation affecting at nearly the same times areas far apart from each other. But there are perturbations.

The study of these perturbations belongs to the future, but already there are evidences of regular disturbances in the periodic ebb and flow of the Atlantic current. In thirty-nine years' records of the temperature of the atmosphere in the central part of Sweden, and that of the sea off the coast of Norway during the cold seasons, a two-yearly period is clearly apparent. Both in the air and in the sea maximum and minimum temperatures occur with great regularity every two years. This is the phenomenon known to meteorologists as that of the "odd and even years." As a rule, the "even" years of the last thirty have had more temperate winters than the "odd" ones. That this observation applies equally to the temperature of the sea indicates that the cause of the biennial periodicity of the air temperature is a hydrographic one. In addition to this smaller perturbation we can obtain elusive glimpses of other larger disturbances—secular variations due probably to cosmical causes—in the regularity of the yearly flow of the European stream. Biological phenomena afford indications of these larger irregularities. Since the year 859 the appearance of winter herrings in the Skagerak has been recorded, and it is observed* that the fishery has returned with intervals of, on the whole, 111 years.

Both climatic changes and changes in the abundance of the fisheries are thus connected with hydrographic phenomena. One of the most valuable means of research to the meteorologists of the future will be hydrographic investigation, and for the rational study of the fisheries this line of research will prove no less useful. Already it is beyond doubt that hydrographical and biological phenomena are closely related, and the work of the next few years is likely to furnish further instances of this connexion.

* Pettersson, *Rappts. et Procès-verb.*, vol. iii., 1905, pp. 13–19.

Biological Investigations.

The results of the strictly biological investigations carried out under the auspices of the International organization are less novel than those hydrographical results to which we have already referred. Sea fisheries research, both in Great Britain and on the continent of Europe, has in the past been largely concentrated on the elucidation of the life histories of fishes and other edible marine animals. Beginning in 1865 with G. O. Sars' classical investigation of the spawning of the cod on the fishing grounds off the Lofoten Islands, this work was developed at first principally by McIntosh and the St. Andrews school of zoologists; and when fisheries investigation received official sanction and support in this country, it was very actively pursued in Scotland by the naturalists of the Fishery Board, and afterwards in England by the Marine Biological Association. When in 1902 the International Investigations were commenced a very considerable store of knowledge of this branch of fishery science already existed,* and subsequent work in the countries participating in these researches has been devoted to filling up lacunæ in those results and in synthesizing the investigations by the adoption of methods of research on a larger scale than was previously possible and by new forms of apparatus.

It is unnecessary to recapitulate here the main features of our knowledge of the life histories of northern fishes.† The reader will remember that the great majority of North European food fishes reproduce during a limited period of the year—three months or so, some time between the end of the year and midsummer—the precise dates and durations of these breeding seasons depending both on the species of fish and on the localities under consideration. The exact incidence of the breeding season is not constant from year to year, but varies, and one of the main results of the International hydrographic investigations has been to associate the onset and duration of the breeding season with the hydrographic condition of the portion of the sea considered. Generally speaking, the majority of British food fishes spawn during the months March to June.

The eggs produced by these fishes are now fairly well known, though, of course, our knowledge on this point is not quite exhaustive. Most fish eggs belong to the pelagic type—that is, they are lighter than sea water of normal constitution and float at or near the surface. But the

* This has been admirably summarized by P. P. C. Hoek in No. 3 of the *Publications de Circonstance*, August, 1903.

† See also Cunningham's *Marketable Marine Fishes*, 1896; Holt's *Account of the Grimsby Trawl Fishery* (published by the Marine Biological Association); and McIntosh and Masterman's *Life Histories of the British Marine Food Fishes*, 1897.

eggs of the herring are of the demersal type, and when spawned by the parent sink to the sea bottom, where they adhere to whatever objects with which they come into contact. Upon this difference depend differences in the further distribution and development of the two classes of eggs. The pelagic eggs are drifted anywhere in the upper layers of the sea, according to the force and direction of the surface drift of the water, whether the latter be due to tidal streams, to the influence of prevailing or exceptional winds, or to the larger movements of sea water which we have been considering as hydrographic events. These passive migrations carry pelagic fish eggs from the regions inhabited by the parent fishes at the spawning seasons into others where the conditions influencing their further development may be very different, and it is in respect of this influence upon fish eggs and their development that hydrographic investigation may be expected in the near future to be of much service to the fishery investigators. Demersal eggs, on the other hand, being deposited in the regions chosen by the parent fishes, and at the bottom of the sea, where hydrographic changes are less violent, are assured of more constant conditions for their development. It is probably because of these facts that the great summer herring fishery of the East British coast waters is so constant in its appearance and duration; and to them is due also the well-marked variations which herring exhibit in different parts of this extensive area. "Races" of herring, if such really exist, are probably due to the fact that the various herring shoals frequent the same sea areas from year to year, and that their eggs develop in the regions where deposited.

The development of the eggs of the various species of food fishes, and the subsequent life history of the larvæ, which hatch out after a fortnight or so of incubation, have been worked out in considerable detail in the past. The tracing out of the development of the embryo and larva was a task of no great difficulty, and could easily be carried out at the marine laboratories, even at the small ones, with no great wealth of apparatus. All that was necessary was to procure the fertilized eggs of the species to be investigated. This was usually done by "stripping" mature fishes, that is, by expressing the ripe eggs and spermatozoa from the reproductive organs and then keeping the eggs and larvæ in running sea water in small tanks and patiently studying the changes taking place during the developmental period. So we find in the literature, English, Danish, Norwegian, and German, detailed descriptions of the life history of most edible fishes during the first few weeks of life. Comparatively little has been added to this literature by the International investigations of the last four or five years. It is with regard to the further life history of the fish that most recent work has been concerned. After the hatching of the larva from the egg there is a period of growth of which little is known. Some weeks after hatching the "metamorphosis" of the larva is effected. The little fish now takes on the shape of the adult, and gradually assumes the habits and food of the latter. During the period of juvenescence the life history must be studied in the sea itself, and the growth and migrations observed in specimens taken in the most diverse localities by means of special fishing apparatus. Neither the commercial nets of the fishing fleet nor the older dredges or "townets" of the naturalists afford any assistance in these investigations. Altogether new fishing apparatus have had to be devised, and it has been necessary to carry out researches far out at sea, in regions where fishery work was, under the older methods, usually quite impracticable.

Such investigations have been carried out by the naturalists of the Danish, Norwegian, and German sections of the International organization by means of specially designed fishing apparatus. The "Scherbrutnetz" was designed by Ehrenbaum and Strodtmann,* of the Heligoland Biological Station, for the capture of larval fishes. This instrument is a very large townet with a square opening. The special feature of the apparatus is the "sheering-board," a large board attached to the lower edge of the mouth of the net, and inclinable at any angle; by means of this contrivance, which acts in the same way as the otter-board of the commercial otter-trawl, the net can be towed at any desired depth. The "young-fish trawl" of Petersen† is a still more effective instrument, which is constructed on the principle of the large otter-trawl, and is able to fish at the sea bottom or at any depth from the surface. The net, being composed of material with a very fine mesh, is adapted to catch very small fishes.

The invention and use of these two forms of fishing apparatus are so important for the investigation of the pelagic or young free-swimming stages of edible fishes that one might almost say that their application begins a new era in fisheries research. The older surface townet captured pelagic larval fishes only in very small numbers, and it was always difficult to use this instrument with much success at the bottom or at intermediate sea levels. We know now that results obtained by the use of ordinary townets in the past were totally misleading so far as affording reliable information as to the distribution and abundance of young stages of sea fishes. Joh. Schmidt,‡ for instance, gives a record of a haul of the young-fish trawl taken from the Danish investigation steamer *Thor* off the coast of Iceland, at a depth of 79 metres (about 40 fathoms),

* *Wissensch. Meeresuntersuch.*, Bd. i., Abteilungen Helgoland.
† *Skrifter af Kommission for Havunersögelsen*, Nr. 1, 1904.
‡ *Meddelelser Komm. Havundersögelser*, Ser. Fiskeri. Bd. i. No. 4, 1905.

which in thirty minutes captured about seven thousand specimens of young stages of pelagic and bottom-living fishes, belonging to twenty-two different species. We are assured that this haul is "far from being the richest in individuals made by the *Thor*." No method of investigation practised in the past afforded this wealth of material. Not only are naturalists nowadays in possession of a means of research enabling them to obtain rich stores of material for the study of the developmental histories of fishes, but they are also able to form reliable estimates of the wealth of fish life in the sea at early stages, and to trace with some probability the migrations of the larvæ and young fishes. The first results of the study of developmental histories of fishes made by the help of those fishing apparatus are published in the Danish *Meddelelser*. In the paper already referred to Joh. Schmidt gives the first instalment of a study of the free-swimming post-larval stages of the fishes of the North Atlantic belonging to the genus *Gadus*. This monograph includes the cod, coal-fish, whiting, haddock, pollock, and other less known gadoid fishes, and in it the author attempts, for the first time, a systematic description of the characters of the post-larval fishes at different stages. It is well known that the recognition of young fishes in their very early life is a task of much difficulty, and some considerable degree of uncertainty has always attended the identification of nearly allied fishes, such as the cod, haddock, and whiting, in the stages following the metamorphosis, and before the little fish assumes the well-known characters of the adult. By making a systematic study of the colour markings of the young fishes, which, it should be remembered, are quite different from those of the adult, Schmidt has been able to classify the post-larval fishes of the cod family in much the same way as the adults have been treated. The identification of these young fishes has therefore been greatly facilitated for future observers. Making use of material collected also by the young-fish trawl of the *Thor*, Schmidt* has also given us by far the most complete accounts of the life histories of the halibut and torsk (or tusk) in the literature. The description of the series of stages of the halibut is particularly welcome, since the development of this fish is more obscure than that of any other of the flat-fishes. Again, the early stages of the long rough dab, a fish relatively common off the east coast of Britain, have been studied by Petersen, and our knowledge materially advanced.†

But by far the most important contribution to our knowledge of the early life histories of edible fishes is the discovery by Schmidt and Petersen‡ of the spawning place of the European fresh-water eel. The

* *Meddelelser Komm. Havundersög.*, Bd. i. Fiskeri, Nrs. 3 and 8, 1904–5.
† *Meddelelser Komm. Havundersög.*, Fiskeri, Bd. i. Nr. 1, 1904.
‡ *Ibid.*, Fiskeri, Bd. i. Nrs. 5, 6, 1905.

early development of both the fresh-water eel and the conger-eel has always been very imperfectly known. It is now well known that the peculiar flat, ribbon-like, and transparent fishes called "Leptocephali" are the young stages of the fresh-water eels. Leptocephali are very rarely found on the coasts of Britain or Northern Europe; the few finds that have been made are all recorded in the literature. Nevertheless, every year in the spring and summer enormous numbers of small flat eels of varying degrees of transparency are found all along British and continental coasts. These young eels, or "elvers," are the transformed Leptocephali returning from the sea into the rivers. When the eel approaches maturity it descends the rivers to the sea, assuming as it does so a peculiar coloration, or "bridal dress." In the sea it becomes mature, spawns, and the larva which develops becomes, at an unknown time after the hatching of the egg, the Leptocephalus. Before the latter larva reaches the coasts it undergoes metamorphosis and becomes the "elver." So much has long been known, but the further questions —the character of the eggs, their development and hatching, the development of the larvæ, the place and time of spawning, and the duration of the embryonic and larval periods—all have been profound mysteries. The Leptocephalus is, in fact, the first stage in the development of the eel; that is well known. Of the earlier stages we know next to nothing. What we do know is due to the investigations of Grassi and Raffaele in the Mediterranean, and may be summed up by saying that the eel spawns in relatively deep and warm water some distance from the land.

But this lack of knowledge of the spawning habits and development of the eels (both fresh-water and marine forms) is due, without doubt, to our hitherto very imperfect methods of investigation. Given the right form of fishing apparatus and some considerable range in the area over which this is used, and there is no doubt that all stages of the eel, from the developing egg to the Leptocephalus, should be found in abundance. This occurred to Petersen in connexion with the use of the small-fish trawl. "The Leptocephali," he says, "will surely be found, I thought, if we seek them in the right time, place, and manner." During a trip to the Faeroe Isles and Iceland in 1904 the *Thor* had to pass through warm and deep Atlantic water, and on fishing at a station* south-west from the Faeroe Isles on May 22nd, 1904, a single Leptocephalus was taken in the young-fish trawl. In 1905 Schmidt again succeeded in finding "great quantities of *Leptocephalus brevirostris* in the depths of the Atlantic."† Considered both as a contribution to the natural history of the eel, and as a fact which is likely

* 61° 21′ N.; 19° 59′ W.

† *Meddelelser Komm. Havundersög.*, Fiskeri, Bd. i. Nr. 5, 1905, p. 5.

to be of advantage for the direction of the continental eel fisheries, the importance of this discovery can hardly be over-estimated. We now know that the lack of success which has attended the innumerable attempts to find Leptocephali in shallow in-shore waters, and even in restricted sea areas, like the Baltic, the Cattegat, the North Sea, or the Irish Sea, is due to the fact that these larvæ do not frequent those waters, and that the rare captures which are recorded in the literature are those of individuals the development of which has for some reason or other been greatly retarded. There is no longer any doubt that the eel does not spawn in fresh water, but must emigrate to the open sea before it can reproduce. If it is hindered from making this migration it will die without spawning. Further, the fish spawns in deep and relatively warm water in the open Atlantic, north-west and west from Scotland. To reach this region the parents must pass through the Baltic if they have been living in some of the great continental rivers, and most of the North European fresh-water eels must make a very lengthy spawning migration, in the course of which they traverse the North Sea, the Irish Channel, or the English Channel before they attain the conditions necessary for the maturation of the reproductive organs. It will readily be seen that a complete knowledge of these migration paths and seasons, such as no doubt will soon be obtained by following up these observations, must prove of great importance, not only for the development of more rational methods of fishing, but also for the elaboration of useful legislation regulating the fishery.

Following up Schmidt's discovery of Leptocephali in the Atlantic, Johansen has materially added to our knowledge of the life history of the eel in its "elver" stages. It is well known that the elvers, which are the metamorphosed Leptocephali, ascend the rivers from the sea in immense numbers in the spring of the year. But our knowledge of the elvers in the sea itself has hitherto been very scanty. Again the explanation is that they were not looked for in the proper time and manner. The young metamorphosed eels are pelagic at night, that is, they swim at some distance from the bottom in intermediate depths. During the day, on the other hand, they live on the sea bottom. In the sea the elvers are almost colourless, though they differ greatly from the leptocephaline stages. A smoky-brown pigment first appears on the tip of the tail and on the head. As the transformation from the Leptocephalus to the elver stages proceeds this pigment gradually invades the rest of the body. At the same time the peculiar ribbon-like form of the Leptocephalus is lost; the little fish becomes thicker from side to side and less deep from back to belly. Curiously enough, too, it becomes actually shorter from head to tail. The almost colour-

* *Medd. Komm. Havundersög.*, Fiskeri, Bd. i. Nr. 6, 1905.

less elvers which have appeared in the sea off the coasts in the early spring become gradually transformed, and by the middle of summer they have taken on the form and colour of the adult eel, and have begun to grow again after the first decrease in length which accompanies the larval transformation.

This is hardly the time to say anything about the researches on the distribution and abundance of the pelagic stages of very young fry of the marine food fishes. Many observations have been made, and are actively being prosecuted, by the Danish and Norwegian naturalists on the staff of the International organization, which have for their object a complete knowledge of what becomes of the multitude of fry which are hatched out in our seas during the spawning periods. An essential part of such investigations is, however, the comparison from year to year of the records obtained, and we must wait for some time before conclusions of value have been made. Leaving aside the case of the herring, we may say that the pelagic fry of almost any marine food fish do not remain in the place where they are born. Nearly all fishes shed their eggs into the sea, and these are then drifted about from place to place at the mercy of the winds, tides, and currents. Even when the young fishes or larvæ hatch out from the eggs they are still among the feeblest creatures which exist in the sea, and with little or no powers of locomotion of their own, they are carried about over extensive sea areas. What becomes of them during these pelagic stages? The larvæ are not always present in those parts of the sea where the parents are numerous and *vice versa*.* Petersen, for instance notes as remarkable that the young stages of the witch and lemon sole are abundant in the open sea off the coasts of Denmark, but "do not at all occur in the veritable Danish waters" inside the Skagen, that is, in the restricted seas of the Danish islands. Nevertheless, both of the adult fishes are present in these narrow seas in considerable numbers, and the witch is the object of a very considerable fishery in the Cattegat. Again, the same author† notices that there may be great differences between the larvæ of fishes taken in the open sea and larvæ of the same forms taken in in-shore waters. These differences apply to the size of the fry and to their coloration. Do these differences represent the variations between identical fish species taken in different sea areas? It has long been known that such "races" do exist. Henicke, for instance, has shown that the herring captured off different parts of the British and continental coasts present such differences as, in his opinion, are sufficient to justify the view that distinct races of herring are met with in different areas. Cunningham and others have concluded that different races or varieties of plaice exist

* *Medd. Komm. Havundersög.*, Fiskeri, Bd. i. Nr. 1, p. 12, 1904. † *Ibid.*

in the North Sea and adjacent waters, from the notable differences in the size at which spawning first occurs in the fish taken from these fishing grounds. Garstang has made observations of varieties among mackerel, and Dannevig and others have also shown that distinct races of cod exist. Are these variable characters of the same species of fishes inhabiting different seas transmitted to the larvæ, and can they be recognized in these stages? This is only one of the questions which a far-reaching investigation of the distribution of the fry of fishes may be expected to solve in the near future.

The life history of the Plaice.

When the International Fishery Investigations were begun, particular attention was directed to the detailed study of a few food fishes—the plaice, cod, and herring. All these are of great economic importance: the plaice to the North Sea Fisheries of England, Denmark, and Germany; the cod to the Norwegians; and the herring to the Scottish. We may note at the outset that the problems of the distribution and migrations of the herring are intimately connected with those of the hydrography of the sea, and in the correlation of the latter researches with the statistics of the herring fisheries, the old problem of herring migration is likely to receive solution. "We are much inclined to believe that the great summer herring fishery comes and goes with this annual ebb and flow [that of the Atlantic stream in the North Sea], and much of our recent hydrographic work, since the date of that with which the present volume deals, has been directed to the study of this important subject."*

The problem of the plaice fishery, that is, the investigation of the life history of that fish with reference to the utility of legislative restrictions on the fisheries, has, however, been approached in quite a different way. The question of extreme interest to the English and continental plaice fishermen is whether or not a size limit would be of advantage to the industry. It has been proposed over and over again in this country to render it illegal by statute to land or sell a plaice which is below a certain size. With respect to the most suitable size limit very different opinions have been expressed. In official quarters, a minimum size of 8 inches of length has been favoured. Fishery investigators and some of those engaged in the fish trades have advocated higher size limits than 8 inches, and the merits of these various proposals have been very frequently discussed. Both scientific and economic questions are to be considered in any attempt which may

* D'Arcy W. Thompson, *Fishery and Hydrographical Investigations in the North Sea, etc.*, (cd 2612), 1905, p. v.

be made to elaborate legislation of this nature. Into the latter questions we cannot enter here, although it is evident that they are at least of equal importance to the scientific issues involved. But, at any rate, no one would recommend general discussion of the question apart from far-reaching and patient investigation of the natural history of the plaice in the sea at every stage of its life. In the investigation of the latter question, so far as it has been carried out, three main lines have been followed by those engaged in the International Fishery Investigations: (1) the distribution of the plaice on the various fishing grounds, with respect to the size and age of the fish present from month to month throughout the year; (2) the migrations of the fishes; and (3) the food of the plaice. Other lines of investigation have been followed, but in the main attention has been focussed on those indicated above. The distribution has been studied by means of fishing experiments, that is, numerous hauls with trawl and other nets made by the exploring steamers on the fishing grounds frequented by the commercial vessels, and statistically by means of a study of the results of the fishery by the fishing fleets themselves and by the examination of samples of fish caught by the trawlers and examined in detail afterwards. The fishery experiments have been made by the various scientific vessels and naturalists of the national staffs, while the statistical work has been mainly carried out by the Bureau of the International Council and by the English Board of Agriculture and Fisheries.

Now the method of fishing experiments is, of course, of limited application, and conclusions derived from such results must be cautiously made. Like all scientific methods which depend on the examination of "samples," it is open to the objection that the sample may not really represent the general conditions. Such objections, for instance, would apply to thermometric or barometric charts representing the meteorological conditions of an extensive land and sea area at a given time. That is, the readings of the instruments, while true for the immediate area, might differ notably from those which would be obtained in an adjacent area where no readings had been made. The results obtained by fishing with a trawl net on twelve days in the year could not be compared, with any degree of certainty, with the results obtained by fishing with the same trawl on the twelve corresponding days of the following year in the same place. That is to say, so many accidental circumstances might influence the nature and amount of the catches made by the net that it would be risky to conclude that fish were more or less numerous at the given place in one year than in the other. But though such limitations must be imposed on the usefulness of fishery experiments, it is nevertheless the case that these are essential if we wish to understand the conditions of the sea fisheries. If we wish to know, for instance, whether small plaice are more abundant near the shore than in the offing, or whether they are more abundant in shallow than in deep water, or whether the plaice near the shore are larger or smaller than those off-shore, or what is the predominant kind of fish present from time to time on any part of the sea bottom; in all these, and in many other cases, it is only by making experiments with nets of different forms that we can obtain the desired information.

Such fishery experiments, made chiefly by means of the large commercial otter-trawl net, have been carried out by both the British and continental exploring vessels. It would be unprofitable at the present time to attempt to make exhaustive analyses of the results obtained. These are still incomplete—indeed, the results of the Scottish experiments are not yet published. It is when the results of the five years' experiments are collected that they can most usefully be discussed. But while this is the case, some results of interest are already apparent. The English fishery experiments show that small plaice are much more abundant in the shallow waters near the land than in the deeper waters off-shore. Plaice of less than 8 inches in total length were, as a rule, restricted to a strip of sea lying between the land and the 10-fathom line. There they were relatively very abundant. On the shallow grounds off the coasts of Holland they were much more abundant than in corresponding depths of sea near the English coasts. On the "Eastern Grounds," that is, the shallow-water area off the islands of the Zuider-Zee, off Heligoland and the coast of Denmark, some distance from the land, the English steamer *Huxley* took average catches of from 180 to 2500 plaice of this size per hour of trawling.* On the fishing grounds of the same depths off the English coasts the *Huxley* never took more than 65 plaice per hour. Again, medium-sized plaice 10–12 inches long "were altogether absent on many of the English in-shore grounds"; but on the fishing grounds well off the land, in fact, over the greater part of the southern part of the North Sea, south of latitude 53° 30′, in what may be called the Flemish Bight, these plaice formed an extensive portion of the catch. A legal size limit, if this should be adopted on an international scale, could not be greater than 12 inches if trawling for plaice were to continue on these grounds. Up to 12 inches in length the plaice is very generally an immature fish, that is, it has not yet produced spawn. The predominant plaice population of the southern part of the North Sea is therefore an immature one.

Mature plaice in the North Sea are very generally fishes of over

* Garstang, *Fishery and Hydrographical Investigations, etc.* (cd. 2670), 1905, p. 102.

14 inches in total length. This is the average size, for the male fish when they first become sexually mature are smaller (one inch or more) than the females. Such fish spawn in the spring. It was formerly believed that during the spawning season plaice became crowded together on certain "spawning grounds." The trawling experiments of the *Huxley* lent little support to this belief, though there are certain indications that spawning migrations do occur. Such mature fish are not distributed everywhere over the fishing grounds. The *Huxley* found that they did not occur, or only very exceptionally, in the shallow waters within the 10-fathom line. On the other hand, they were relatively abundant on the Dogger Bank, and here and there in the deeper parts of the North Sea well off the shore.

All fishery experiments made by the International naturalists agree in this respect, that on the eastern side of the North Sea, off the coasts of Holland and Denmark, in what has been called the Heligoland Bight, we have a predominant small plaice population. There is further agreement as to a general law of the distribution of this fish: that the deeper the water the larger the fish. This, of course, only applies to fishing grounds where the water is less than 50 fathoms in depth. It is safe to say that plaice are absent altogether, or at least very scarce, on sea bottoms of this depth. Indeed, outside the 20-fathom line the fish is very scarce. It is most abundant near the shore, and becomes less abundant as the water gets deeper. The general law that the plaice increases in size as the water becomes deeper is nowhere stated so clearly as by Redeke.* This naturalist has analysed the results of the fishing experiments of the Dutch exploring steamer *Wodan*, made off the coast of Holland from the Hook to the Zuider-Zee. The distribution of the plaice of different sizes so constantly depends on the depth that Redeke has drawn lines on the chart which he terms "isomegalins." Each isomegalin is a line drawn approximately parallel to the coast. The isomegalin I bounds a narrow strip of sea in which only plaice of one to two years in age, and less than 10 centimetres (4 inches) in length, are to be found. Outside this, and parallel to it, is the isomegalin II, between which and the line I are only plaice of over two and less than three years of age, and from 10 to 15 centimetres (4 to six inches) in length. Outside isomegalin II is the line III, which again forms the outer limit of plaice of from three to four years of age and from 6 to 8 inches in length. The general law of distribution is stated by Redeke in these words: "The distribution of the plaice thus appears to be a function of its size, and is so uniform that one can almost say the plaice are so many centimetres long when the depth in which they are taken is so many metres."

* *Rappts. et Proc.-verb*, vol. iii., 1905. Distribution of the plaice on the Dutch coast.

Such a "law," however it may apply to the conditions off the coast of Holland, is much too definite to apply to other localities. It is altogether incorrect when applied to some areas off the coasts of Britain. It is too often forgotten that all these statements of distribution are made with respect to areas where a long-continued fishery for plaice has been carried on, and where the influence of man as fisherman is continually exerted in reducing the numbers of large plaice. Large fish are more easy to catch, and must necessarily be fewer than smaller fishes; again, the fishery is, roughly speaking, most intense near the land, and decreases in intensity as we proceed further out to sea. This influence of fishing must operate in bringing about, to some extent at least, the distribution of plaice with size varying according to the depth of the sea. It is far otherwise in the few regions which are natural "plaice grounds," and where the law prohibits trawling. There, instead of a distribution such as is indicated above, we may find that plaice of all sizes and ages are living together on the same restricted portion of sea bottom.

The determination of the age of a plaice has been arrived at by means of two methods. One is that of Petersen, and depends on the analysis of an extensive catch of plaice according to the sizes of the fish. If, say, some thousands of plaice captured on the same (restricted) fishing ground be individually measured, it will be seen that there are far more fishes of certain sizes than those of the intermediate sizes. Such a method of estimating the ages of the fishes forming a single catch cannot be easily understood without an example, and the diagram* (Fig. 6), which is based on a catch made by the Marine Biological Association off Mablethorpe, will make the reasoning clear. The figures on the vertical line represent the numbers of plaice taken, and those on the horizontal line represent the sizes of the fish. At the point of the curve marked O a line drawn horizontally shows that about 360 plaice were captured, which had an average length of about 5½ centimetres (a little over 2 inches); at the point I about 85 plaice were taken with an average length of 10 centimetres (4 inches); then at the point II 60 plaice were captured with an average length of 15 centimetres (6 inches). That is to say, in this catch three predominant sizes of plaice were present, 2 inches, 4 inches, and 6 inches. In fact we have three groups or "schools" of fish, each of which resulted from a different year's spawning. The Group O consists of fish less than one year of age, Group I of fishes over one but less than two, and Group II of plaice over two but less than three years of age.

The other method of determining age is that of otolith examination.

* Wallace, *Fishery and Hydrographical Investigations, etc.*, *Southern Area* (cd. 2670), 1905, p. 208, fig. 4.

The otoliths are the hard, calcareous stones which are found in the ears of all animals, but which are unusually large in bony fishes. The method was elaborated a number of years ago. It depends on the fact that the growth of the ear-stone or otolith is not regular, but varies from season to season. So also with the bones of the fish, as for instance the vertebræ. If the otolith be examined, even with the naked eye, it will be seen to be built up of concentric layers. Every year a new layer is added to those already laid down, and by counting the number of concentric rings in the otolith, or vertebra, the number of years of age of the fish can be determined. Up to the fifth year of life both

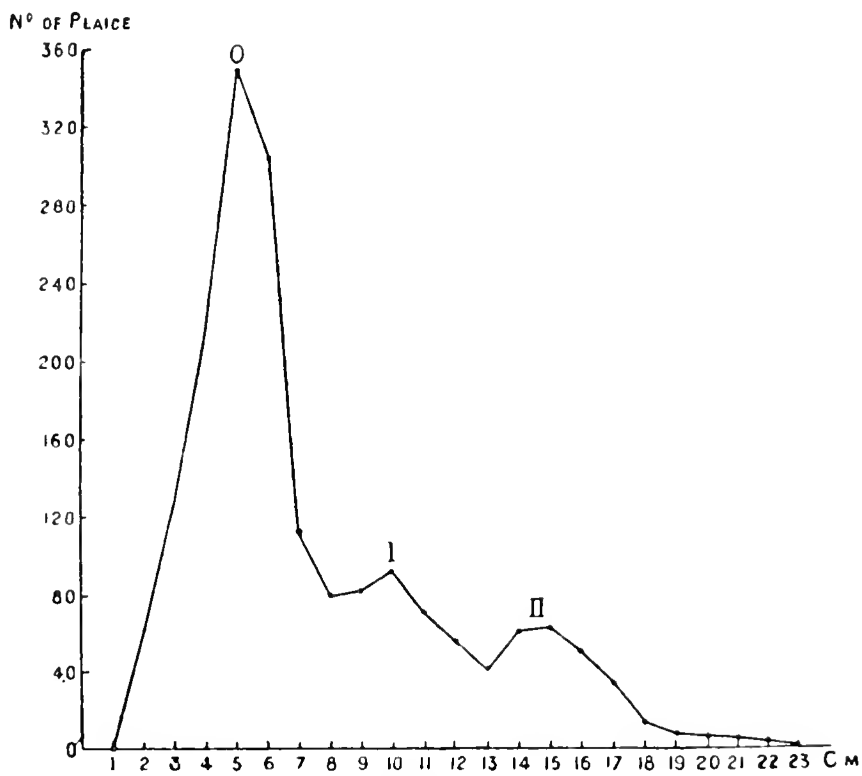


FIG. 6.

methods are reliable, but after this period the results are somewhat uncertain. By the application of these two methods, particularly the first, results have been obtained in all the countries participating in the International Investigations, and the plaice of different localities are now being investigated, not only with respect to their abundance according to the depth of water, but also with regard to size and age.

A third method of age determination is a direct one, and depends on the marking and liberation of a plaice, and its subsequent recapture. This brings us to the consideration of the fish-marking experiments which have now been carried out on a very extensive scale in Sweden, Denmark, Germany, Holland, and England. This method of investigation is, of course, an old one, and was practised in Scotland by the

Fishery Board, and in America by the Fish Commission, many years ago. It is only since the inception of the International Investigations, however, that it has been carried out on a scale adequate to the furnishing of reliable and useful results.

Various methods of marking the fish (usually plaice), so as to identify it afterwards, have been practised. In Petersen's method (the one now mostly adopted), a stout silver wire is pushed through the body of the fish just underneath the dorsal fin. One end of this wire passes through a bone button and is looped; the button is on the lower side of the fish. The other end passes through a hole in a brass disk and is also looped; the brass disk is on the upper side of the fish and bears a number. Experience has shown that this label can be attached to the plaice in the manner described without permanent damage, and apparently without permanent discomfort to the fish. The living fish, being measured and marked, is then put back into the sea, the size and place of liberation being recorded. Most careful arrangements have to be made for the return of marked fishes recaptured by the fishermen, and rewards are paid for these. In Great Britain the reward varies from 1s. 6d. to 2s. Obviously success depends on the return of marked fishes recaptured by the fishing vessels, and while the proportion returned is most gratifying, it is still the case that many recaptured marked fishes must escape recognition and return. The first published summary of the results of all the plaice-marking experiments carried on by the various national staffs is given below.

	No. of plaice marked up to 31st December, 1903.	No. of plaice recovered up to 30th June, 1904.	Percentage.
Sweden	1178	101	8 %
Denmark	1220	387	29 %
Germany	1919	157	8 %
Holland	459	12	3 %
England	1463	286	17 %
Total	6239	943	14 %

The "percentage" is the proportion of marked fish recovered within twelve months after the date of liberation.

Of course, these returns are very incomplete. A large number of fishes have been marked and subsequently recovered since the end of 1903, but at the present time the figures are not easily available, and the results have not been collated. The above statement applies to the fish-marking experiments carried on by the naturalists attached to the staff of the International organization. But in addition to these experiments, a large number of plaice and other fishes have been marked and liberated (according to the International methods) by the Irish Fishery Branch of the Board of Agriculture and Technical Instruction, and by the Lancashire and Western Sea Fisheries Committee, both experiments being carried out chiefly in the Irish Sea.

The plaice-marking experiments were designed to give information on the following subjects:—

1. The migrations of the fishes.
2. The rate of growth of plaice in different localities.
3. The intensity of fishing.

An obvious objection has frequently been made to the validity of results deduced from such experiments, and is this: the operation of marking injures the fish, and the continuous attachment of a label or mark to the body reduces to some extent its vitality, so that it is probable that the results, whether migrations or rate of growth, obtained from the marked fishes do not represent those changes undergone by unmarked fishes. The force of the conclusions depends on the assumption that a marked fish behaves normally, and this is questioned. The objection, which is an *a priori* one, probably has some force, but the general opinion of those who have had experience of fish-marking experiments is that the operation, if carried out carefully, has little or no influence on the health or habits of the fishes dealt with.

The migrations of the marked plaice are naturally the most interesting of the results obtained from these experiments. In stating the more prominent facts observed, one cannot, however, be too cautious. Only the results of one complete year's experiments have so far been tabulated and discussed, and it is most essential that these should be confirmed by the further experiments that have already been made. A plaice is an animal possessed both of volition and intelligence, and its movements in the sea must be expected to be at times of an entirely capricious nature. It is only by the study of results of extensive and repeated experiments that one can hope to eliminate such accidental or capricious migration results, and obtain an expression of the average movements of large numbers of fishes. Bearing this in mind, we may state the results at present apparent. Young plaice—that is, fishes up to 8 inches in length—do not migrate to any marked extent. These fish remain on the shallow-water areas immediately adjacent to the places where the first year of their life has been spent. Any one who observes attentively the shallow pools which have been left by the receding ebb tide on almost any of the extensive sandy flats on the coasts of England will be able to see numbers of small plaice and other flat-fishes there during the months of June or July. At that time these little fishes have just recently completed their metamorphosis from the larval to the post-larval stages, and are little larger than one's thumb-nail. As they grow they gradually move further out into deeper water, but for this first year of their life and the next one they do not travel very far from the shore on which they may first be found. After they have entered on the third year of life, however, their more lengthy migrations begin. These are influenced to a very great extent by the nature of the sea area in which they find themselves. Thus the results obtained by the Danish naturalists* show that the plaice marked and liberated off the coast of Denmark travelled for the most part along the shallow water adjacent to the coast (Chart X) or, when liberated, migrated inwards toward the shore. But other fishes travelled outwards into deep water. There is little doubt that these movements depend to some extent on the season. Off the Danish North Sea coast there is a distinct tendency for plaice to move from deep water towards the shore during April, May, and June, but later in the summer they appear to move off-shore again into deeper water and to spread over a somewhat wide area.

In the case of the English experiments carried out in the southern part of the North Sea, the change of the migration path according to the season is also displayed. In the charts giving synoptic representations of the experiments† this is well shown. South of latitude 53° 30′ in the North Sea, it may be said that plaice for the most part travel to the south during the winter and to the north during the summer. This applies to the larger fishes dealt with. The smaller fishes hardly travel at all. Sometimes, in the case of the larger fishes, the distance travelled is very considerable. Thus one plaice of 13 inches in length, liberated in December, 1903, in the middle of the North Sea, nearly in the latitude of Grimsby, was found about three months later in the English Channel, having travelled in the interval a minimum distance of 175 miles. Other instances are recorded of long migrations made by marked plaice, and generally it may be said that the larger fishes travel further and more rapidly than the smaller ones, and in addition frequent deeper water. But we meet with puzzling exceptions to this general rule. Thus a medium-sized plaice liberated by the Lancashire naturalists in the preserved waters of the south coast of Scotland was found in the same place nearly two years afterwards, having in the interval probably not left the bay in which it was first found.

To deduce the rate of growth from marking experiments is a simple matter. The fish being marked and measured is again measured when

* See charts X–XII, *Meddelelsen Komm. Havundersög.*, Fiskeri, Bd. i. Nr. 2, 1905.

† Garstang and Borley, *Fishery and Hydrographical Investigations in the North Sea, etc., Southern Area* (cd. 2670), 1905.

recaptured, and the difference in length is the growth during the interval. As might be expected, there are considerable differences in the average results so obtained. It now appears, from a discussion of these experiments and others, that no average growth rate can be laid down which applies to all plaice in the British and continental fishery area. Some of these differences are summarized by Garstang.* On the Horn Reef grounds, off the coast of Denmark, the greatest rate of growth indicated by plaice in the course of a single year was about 5 centimetres (about 2 inches). On the other hand, certain plaice caught on these grounds, and on the east coast of England, and then transplanted to the Dogger Bank, showed a much greater increase in length. In the case of some of these plaice, the growth in one year was as much as 14 centimetres (nearly 5 inches). Analogous differences in the rate at which plaice grow are met with in very many of the experiments made.

The intensity of fishing on any fishing ground can be deduced from these marking experiments. If we capture (say) 1000 fishes and mark and liberate them on the ground from which they were taken, then the proportion of these 1000 fishes which are recaptured within one year from the date at which they were liberated is an indication of the degree to which this ground has been exploited by the fishermen in the course of the year. For the 1000 marked fishes may reasonably be assumed to have spread uniformly over the fishing ground in question; and if the fishermen capture (say) 250 of them during the year, there seems no escape from the conclusion that they have also captured 25 per cent of *all* the plaice, of the same range of sizes as the marked fishes, which were originally present on the ground. Of course, such deductions must be made very cautiously and must depend on the consideration of fairly large numbers of fishes. But, remembering this, it is certain that in this method we have a fairly satisfactory means of ascertaining how far fishermen reduce the fish population of a fishing ground, in the course of their ordinary operations. There is only one other way of obtaining this information: by a consideration of the number of eggs of the species of fish considered which are produced on the ground during the spawning season, and this method is very unreliable. Nevertheless, such an estimate, made by Victor Hensen in the case of the West Baltic cod and plaice fisheries in 1895,† agrees very well with the average results of the fish-marking experiments. Naturally the intensity of fishing on the various grounds varies very greatly.‡ On the fishing grounds of the North Sea, Skagerak,

* *Rappts. et Proc.-verb.*, vol. iii., 1905, app. II, p. 14.
† See Jenkins, *Trans. Liverpool Biol. Soc.*, vol. xv. p. 312, 1901.
‡ See Garstang, *Rappts. et Proc.-verb.*, vol. iii. app. II, p. 10, 1905.

and Cattegat it varies from 4 to 56 per cent. We may reasonably conclude, eliminating exceptional circumstances, that the intensity of plaice fishing on the North Sea fishing grounds varies from 10 to 25 per cent. That is to say, that man, for his own use, removes annually from the sea from one-tenth to one-quarter of all the marketable plaice which are annually produced by the natural reproduction and growth of the species.

How significant these results are from the point of view of the regulation of the plaice fishery and its further exploitation and improvement will easily be seen. The question now arises how far this process of exploitation of the (say) plaice population of our seas can go on without progressive impoverishment of the fishing grounds. There must be some limit up to which these fishing grounds can be depleted without undergoing injury; that is, without making them less productive in the future. To discover this limit is the aim of this portion of fishery investigation, and it then remains for the Governments concerned so to legislate that it should not be exceeded. In no way can this knowledge of the extent to which the resources of the sea can be strained be attained than by scientific investigation on the lines indicated and by the careful consideration of reliable commercial statistics. When the International Investigations are completed and thoroughly discussed we may hope for much more knowledge of the conditions of this problem than we at present possess.

Then in the result that plaice are so very variable in growth we have a factor of no less significance for the legislators.

When we find that the growth rate of plaice on a fishing ground is small, we usually find that the number of small plaice present on that ground is unusually large. There is, in fact, this relation between abundance of plaice and their size, that the more numerous the fish are on a certain ground the more slowly they grow. It is a question of the available amount of food for the fishes that we have to consider. Where the number of mouths is small there is all the more food for them and the fishes grow quickly; on the other hand, where the population is large and the stock of food not proportionately large, the fishes are less well nourished and they grow slowly. How significant this question is when the protection of immature plaice (and other fishes) is being considered is very apparent. In the past the protection of immature fishes *per se* has been considered as of undoubted value for the fisheries.* Now we must remember that to "protect" by legislative restrictions the immature fishes of particular fishing grounds

* In spite of the declared opinion of Huxley, who deprecated such legislation if incautiously embarked upon (*Life and Letters of Thomas Henry Huxley*, vol. ii. p. 234, 1900).

may be positively detrimental to the industry generally. The lesson that such investigations of crowded fishing grounds, with large numbers of small plaice growing slowly, teach is the necessity for transplantation. Long ago Petersen pointed this out in the case of the Limfjord plaice fisheries, and the International Investigations point this advice more clearly. Garstang, in a remarkable series of experiments carried on on the effect of transplanting plaice from overcrowded to less frequented grounds, has shown how useful such measures might conceivably be.* It was observed, as we have seen, that plaice on the "small-fish grounds" off the coast of Denmark or off the east coast of England grew slowly in comparison with plaice on the more open and less crowded grounds on the Dogger Bank. A number of plaice were therefore captured on these grounds and taken across to the Dogger, where they were marked and liberated. The growth rates of the fishes on the latter locality could then be compared with the same growth rates on the localities from which the fish were originally taken, and which had been determined by other experiments. About 40 per cent of the fishes transplanted to the Dogger were subsequently recaptured, and these showed a remarkably higher rate of growth than obtained on their original localities. Whereas on the Horn Reef grounds—a good example of a crowded plaice ground—the fish increased in length about 1¾ inch in the course of a year, *the same fishes* on the Dogger added about 5 inches to their length in the same period.

Whether such transplantation operations could be carried out on a really large scale, and would be productive of such results as would justify the expenditure of public money on this work, is a question which is discussed at some length by Mr. Garstang. The practical difficulties attending such work are of course very great, and one can see that considerable organization of methods would be required. Conspicuous commercial success has attended similar operations carried out by the Lancashire and Western Sea Fisheries Committee;† but the practical details of the transplanting operations, which in this case concerned mussels, were of course much more easily dealt with.

The life history of the Cod.‡

With respect to the natural history of the cod, we find that the investigations are still very incomplete. A very considerable amount of material for the study of the life history of this fish has been collected by the Norwegian, Danish, and English research vessels, but

* Garstang, *Fishery and Hydrographical Investigations in the North Sea, etc., Southern Area*, p. 45, 1905.

† See Scott and Baxter, *Report Lancashire Sea Fisheries Laboratory for 1905*.

‡ Hjort and Petersen, *Rappts. et Proc.-verb.*, vol. iii. 1905, app. G.

we are still far from knowing enough to enable us to follow out the habits and wanderings of this important food fish. One may confidently expect, however, that the result of the International Investigations will be to make clear the principal features in the life history of this fish. The following account is based on the work so far published:—

The cod has not the same importance for the fisheries of Britain as for those of Norway. Over the whole North Sea the fish occurs and is caught, but it only forms a part of the general catches of the fishery fleets. In Norway, however, it is *the* fishery, and the cod has for the fisheries naturalists of that country a degree of importance which has justified considerable research. The great cod fishery in Norway is that which is followed in the spring of the year on the coastal banks from Lofoten to Tromso. The line-fishery there for spawning cod, the "Skrei" fishery, sometimes obtains great dimensions. In the spring of the year the adult fish frequent the coastal banks in great shoals. They are found almost exclusively on these grounds. At this time they are spawning, and it is when the fish are most numerous that the pelagic eggs at the surface of the sea are also present in greatest abundance. The Norwegian research vessel, for instance, took as many as 5800 cod on 17,800 hooks in one day, and during the entire spawning season of the same year about one and a half million of cod were caught by the entire fishing fleet. Experimental fishing operations were carried on over a wide area, but the fish were restricted to a comparatively small ground. On the Lofoten fishing grounds the Norwegian naturalists found that the characteristic spawning size of the fish was about 28 inches. In the North Sea the cod spawns when about the same size. On the other hand, very different conditions obtain in the Cattegat. Petersen found considerable numbers of cod spawning there when no larger than about 12 inches.

On most cod grounds investigated the early part of the year to the spring is the period when spawning takes place. In the Lofoten fisheries the spring is the spawning season, and the same is the case in the North Sea. In the Cattegat, spawning takes place earlier in the year. In the Irish Sea cod spawn in the spring. But a remarkable exception to this general behaviour of the cod was first demonstrated by Fulton,* who found when fishing from the Scottish International research steamer *Goldseeker* that cod might spawn in the North Sea in the autumn. In August of 1903 both fertilized and developing cod eggs were found in the townets, and ripe and mature cod were taken in the trawl. The discovery was quite novel. Hitherto an autumn spawning was only known in the case of herring, and the well-known spring and autumn

* *Publications de Circonstance*, No. 8, 1904.

or winter and summer herring spawning has been explained by assuming the existence of two "races" of fish, one spawning in the spring and the other in the autumn. Whether or not such is also the case with the cod must be left for future investigation.

On the Lofoten cod fishing grounds, as in the North Sea, the cod frequents the coastal shallow water when about to spawn. The striking figures given by Hjort in the paper quoted show that the eggs were present in extraordinary abundance on the surface of the sea over these banks. In the waters of the channels between the banks much smaller numbers of eggs were taken out at sea, and generally over the surface of the open Norwegian sea the cod eggs were most scanty, or altogether absent. Just where the spawning fish were present on the bottom, there the resulting eggs were found. The eggs were very slowly distributed over the sea area, so slowly that in the meantime incubation had proceeded and resulted in the hatching of the pelagic fry. Many fishery experiments were made by the Norwegians to determine the range of distribution of the cod fry of different stages and at different seasons, and these results are very interesting. Hjort's Fig. 6 in the paper referred to shows this in a striking manner. The area over which the eggs were distributed extended but little out to sea from the banks. Outside this again, but a little later in the year (June and July), were to be found the young cod, at this period up to about 1 inch in length. Then in August to September the area over which the fry was distributed had greatly increased. Young cod up to about 3½ inches in length were found in the Norwegian sea as far from land as 120 nautical miles. During the interval between spawning in March and April and September, the cod fry had slowly drifted off-shore and to the north. All this time they were pelagic in habit—that is, they were found near the surface of the sea—but when attaining this length they began to seek the bottom. This habit differs greatly from that of the young cod in the North Sea. There the pelagic mode of existence is abandoned, and the little fish seek the bottom when little over 1 inch in length.

Hydrographic conditions in the sea are most probably the causes of these differences in the habits of the cod. The dispersal of the eggs and young fishes is due to surface-drifts and currents. The assumption of the bottom-living habit of the young cod is no doubt also dependent on the temperature, among other conditions. Thus over the greater part of the northern North Sea area young cod are hardly ever found at the sea bottom. There a bottom temperature of 6°–7° C. holds good all the year round. With regard to the distribution of the cod in its first year of life, a great amount of material has been collected by the International exploring steamers, and when this is fully worked out we may expect to possess a very complete knowledge of the manner in which hydrographic conditions influence the distribution of the fish over the North European area.

Statistical Investigations.

If a knowledge of the life histories of the edible fishes is essential for the proper control of the sea-fishing industry, an exhaustive knowledge of the statistics of the fisheries is no less indispensable. Fishery authorities, recognizing the value of statistical knowledge, have almost invariably created organizations for obtaining this information, and one may say that the success of these has been proportional to the experience of the authority. Thus in Scotland, where a strong fishery board has now existed for nearly a century, a system of collecting fishery statistics has slowly been evolved and is probably the most perfect in existence. In England, on the other hand, where the fishery authorities are of much more recent origin, statistical knowledge of the industry is still very imperfect. By the statistics of the fisheries has usually been understood a knowledge of the quantities and values of the marketable fishes sent to the public markets from month to month throughout the year; with also a knowledge of the numbers of fishermen and of the fishing vessels belonging to various classes. Such is the statistical information relating to the sea-fishing industry which is published in the official documents of the authorities. As the industry has developed and the need for legislation become apparent, it has gradually become evident that such information is far from being adequate.

Official fishery statistics have in fact been based almost entirely on the material landed on our shores, without regard to the places and methods where, and by means of which, this material was obtained, and it is very evident that such information affords only an imperfect view of the operations of the fishing vessels. An exhaustive system of statistical information would inform us where the fishing vessels had been fishing from day to day throughout the year; what methods they had employed; what proportion of the time of their voyages had been spent on actual fishing operations; what kinds and quantities of fish they had caught, and on what particular fishing grounds these had been captured. Then we ought also to possess exhaustive knowledge of the *personnel* of the industry, as well as that of the kinds, tonnage, value, etc., of the vessels employed. Such statistics of the fishing industry have not, so far, been furnished by any fishery authority. But even if we did possess them, they would be inadequate for a proper understanding of the conditions of the industry. The figures relating to the quantities of fish captured and landed would be based on the working of certain kinds of fishing apparatus—trawls, lines, drift nets, etc. These are designed to capture only certain kinds and sizes of fishes, and it is these that would be represented in the returns. What the trawl, for instance, captured that was not utilized would not be represented in the statistics. Then the condition of the fishes, as regards spawning or characteristic food, for instance, would not appear. We must remember also that commercial fishing apparatus would not give us any knowledge of the fish population of the sea in general. The capture of anything whatever, except those animals which are to be placed on the market, is not desired, and the fishing nets are constructed with this object. To know the condition of the fishing grounds, we must employ other methods in addition to the study of the commercial products of fishery. That is to say, exploring vessels equipped with other fishing apparatus than those used by the fishing fleets must be employed, and the statistics obtained by these vessels should supplement the commercial figures.

Here we trench on the purely scientific investigations of the fisheries, and, indeed, there is no real dividing line between these two departments of research. They must be followed in conjunction, the one supplementing the other. When the International Investigations were devised this was recognized, and the synthesis of both statistical and purely scientific researches, the two being controlled by the same authority and carried out by the same organization, was elaborated. A large portion of the results of the investigation published so far consists therefore of statistical studies and discussions.

A very good example of the scientific study of fishery statistics is furnished by Henking's paper* dealing with the statistical material of the Deutschen See-Fischerei-Verein. The latter body is a private fishery research society, which, however, enjoys imperial recognition and patronage, and a considerable financial support from German state funds. In the course of the years 1902–5, the See-Fischerei-Verein organized a system of collecting statistics from German steam fishing vessels. Not only does the information given to the society contain the quantities and kinds of fish caught, but it also gives the regions of the North Sea exploited by these vessels. In the year 1904 this system of statistical collection had been completed, so that the See-Fischerei-Verein now obtains the results of the fishing operations of the entire fleet of German fishing steamers.

Henking divides the North Sea into two areas: (1) the northern North Sea area, which comprises the Great Fisher Bank, the Long Forties, and the portion of the North Sea plateau which lies to the

* *Rappts. et Proc.-verb.*, vol. iv., 1905, app. F. See also *Betheiligung Deutschlands an den Internationalen Untersuchungen*, Bd. i.

north of the grounds mentioned, as far to the west as Scotland; and (2) the southern North Sea area, which comprises the banks in the German Bight. Then we have in addition (3) the region of the Skagerak. The catches of the steamers are expressed as average numbers of pounds of fish caught per steamer per day. These average catches are studied from month to month. Curves are also given by Henking which show clearly how the fishing varies from month to month throughout the year. The result of such analyses of the catches is the defining of "Fishery Periods," which are periods of time during which some particular fish is abundant on a certain ground. Such fishery periods are of course familiar things, and one need not give as instances more than the well-known herring fishery periods of the east coast of Britain or the cod fishery periods of the Norwegian Lofoten Banks. A fishery period is caused by the immigration of great numbers of fishes into relatively restricted areas. Then begins the commercial fishery, which ends with the emigration of the fishes from the fishing ground in question. When the regular variations in the amount of fishes brought from the (known) fishing grounds are studied from month to month, it is seen that the existence of such fishery periods applies to almost every kind of edible fish studied. These fluctuations in the abundance of fish on the different grounds from time to time throughout the year are due to real migrations of the fishes; either to their migration to different fishing grounds or to their dispersal through the upper layers of the sea, where they are without the reach of the trawl. "In view of the considerable material which forms the basis of our review, it can hardly be considered that the fluctuations in the curve of the catches is referable to the captains of the boats wishing to avoid the capture of certain species at certain periods of the year; there remains no other possibility, therefore, than that the number of fish in front of the trawl has actually varied."*

Into Henking's details of the migrations of food fishes in the North Sea we cannot of course enter, and the reader is referred to the charts of results. These curves when plotted for different regions of the North Sea and Skagerak show that extensive movements of fishes go on. The hake, for instance, is such a migratory fish. For the first three or four months it is hardly at all taken in the North Sea or Skagerak. Then it appears "in ever-increasing numbers, perhaps with the inflow of Atlantic water." The shoals spread over the northern North Sea and appear in dense masses in the Skagerak in June. In that month the fish is relatively scarce in the southern North Sea. Then later in the year, August to September, when the fish has become less abundant in the Skagerak, it increases in abundance in the northern North Sea

* Henking, *loc. cit.*, p. 18.

area, indicating the emigration southwards of the shoals previously present in the Skagerak.

Such a mass of statistical data provides only a "representative sample" of the fishing carried on over the region investigated by Henking. Even though the study professes to deal with the catches made by all the German fishing steamers, it must be remembered that these form only a portion of the whole fishing fleet exploiting this area. Obviously such a method of studying the operations and results of the fishing vessels can be wholly satisfactory only when *all* the vessels, steam trawlers, liners, and smacks, can be made to furnish returns of their catches, stating the quantities and kinds of fishes caught, the areas of capture, and the duration of the fishing. If we could obtain this information, and have it worked up under the direction of an International Fishery Board, we should then be in possession of knowledge of incalculable value for the regulation of the industry.

But a scheme of statistical collection of such nature and magnitude is apparently Utopián only, when we consider the present organization and resources of official fishery authorities. The next best method is that which has been followed by some of the organizations in connexion with the International Fisheries Council. Since it is impossible to obtain figures representing the fishing results of all the North European vessels, we have to be content with results which represent the fishing of large and important fleets having their head-quarters at various fishing centres. If a large number of vessels which fish over a wide area can be induced to furnish the results of their fishing, then we possess a series of data which may be taken to represent the fishing carried on by *all* the fleets. The larger the number of vessels supplying returns, the more reliable, of course, are the conclusions made. Such is the method of studying the fluctuations of the fisheries on the more important fishing grounds which was first suggested by Fulton in his well-known paper in the Report of the Scottish Fishery Board for 1901; and which has been adopted by Redeke for the Dutch North Sea trawlers, by Henking for the German steam fishing vessels; and which may be studied at its best in the Reports on the fishing results of the Aberdeen fishing fleets by D'Arcy Thompson and Fulton.* Since 1901 the Scottish Fishery Board has collected such statistics, and when the International fishery researches began the figures obtained were dealt with by the International Council in connexion with the other investigations.

At the present time nearly all the steam liners, about two-thirds of

* See D'Arcy Thompson, "Aberdeen Trawling Statistics"; Fulton, "Distribution and Seasonal Abundance of Flat-fishes in the North Sea"; *Fishery and Hydrographic Investigations in the North Sea* (cd. 2612), 1905.

the steam trawlers, and a number of the sailing trawlers landing catches at Aberdeen furnish voluntary returns as to the places where they have been fishing, the number of hours fishing, the number of hauls of the trawl and number of lines shot. The quantities of fish landed by these vessels at Aberdeen, with respect to the market grouping in sizes, are obtained by the officers of the Fishery Board. The figures so obtained are collected and discussed by the statistical clerks and others on the staff of the Scottish section of the International organization. No details of individual catches are published, only abstracts, and the statistics themselves are made public long after the actual fishing has taken place. There can be no commercial use made of the information given by the masters of the vessels by their rivals in trade: an important consideration, since the information is voluntary and can be withheld.*

In dealing with the figures of fish captured by the Aberdeen fleets, Fulton refers the catches to the areas in the North Sea in which they were made. For this purpose the North Sea north of parallel 50° N. and E. of meridian 6° W. is divided up into forty-eight squares, each of which corresponds to one degree in latitude and two in longitude. When a vessel returns to port, her master informs the collectors of statistics what course he has steered on his voyage out from port, where he has fished, and the number of hours trawling on each ground or the number of lines shot (if he is a liner). The results of the voyage, when tabulated by the statistical clerks, show for the trawling fleet during January (for instance) the average quantities of each kind of fish taken per 100 hours trawling on each of the numbered areas, or the average quantities of fish taken per 100 lines shot.

By this method a very great mass of information has been accumulated and published by the International organization. Fulton's paper already referred to deals with the flat-fishes taken by the Aberdeen trawlers—turbot, brill, halibut, witch, megrim, lemon-dab, plaice, and dab. The abundance and fluctuations of each of these fishes on the northern North Sea grounds from month to month are studied with reference to particular fishing areas. The fluctuations are represented by tables and charts showing graphically the variations on particular areas throughout the year. Into the details of this most interesting study we cannot, of course, enter; only one or two of the main conclusions can be alluded to here. A result that appears persistently throughout the discussion

* It is therefore erroneous to state (see, for instance, the House of Lords debate, 25th June, 1906) that we have by the publication of these figures handed over information to German fishermen which is made use of to our detriment. Even if these figures could supply such information, one can hardly imagine that the German fishing industry is so well organized that trawl owners or fishing-boat masters study English scientific journals; any more than that English or Scotch owners or masters study, for instance, the German *Mittheilungen des Deutschen See-Fischerei Verein*; or that state fishery intelligence departments exist in either country which study this information and supply it to the fishing industry.

of these statistics is the "complementary fluctuations" among different flat-fishes inhabiting the same ground. In the case of one particular fish the abundance varies, of course, with the season; but the periods of the year at which a fish is most abundant differ for many of the species considered. In one area considered, for instance, megrim were most abundant about May, plaice in April and September, witches in June and July, halibut in April, and lemon-dabs in September. Thus the scarcity of one species was compensated for by the abundance of one or more others, so that on any one fishing ground the general abundance of *all* the flat-fishes was maintained throughout the year at roughly the same level. In the case of nearly every one of the fishes studied the fluctuations from month to month exhibited undoubted regularities. It was nearly always possible to deduce that on each fishing ground there was one month during which each species of fish was present in greatest abundance. This maximum in each case corresponds with the spawning season and indicates an aggregation of the fishes on particular areas for the purposes of reproduction. Following this spawning maximum of abundance, the period of which, of course, varies with each kind of fish, is a period of relative scarcity. Then occurs a secondary maximum some time in the autumn, when the fish is again abundant, though usually not so abundant as in the spring or summer spawning maximum. Then in the winter there is often another period of relative scarcity. These remarks apply to the study of the fishes present on each particular fishing area throughout the year. How the abundance of each kind of fish is distributed throughout all the separate fishing areas may be seen by considering the charts of the fishing grounds published by D'Arcy Thompson in the paper referred to above. These show for each month in the year the average amounts of cod, ling, saithe, hake, haddock, and whiting caught on each area per 100 hours trawling by the Aberdeen trawling fleet. Their charts simplify greatly the study of the statistical data. The variations in fish abundance displayed by them are interesting and well worth study by the reader.

The aim of the master of a fishing vessel is, of course, to get as much fish as possible. Therefore he does not always frequent the same grounds, but fishes from place to place over the North Sea, following the fish shoals, getting varying catches on the various grounds. At one time one kind of fish may predominate, during another month other kinds. Long experience, and many fruitful or fruitless experiments, have taught him where and when to expect good catches. If this practical knowledge of the fishermen could be systematized, sifted from error, and recorded, we should possess a knowledge of the seasonal fluctuations and migrations of the fishes which, supplemented by the knowledge of their life histories slowly acquired by the naturalist, would provide the material for the legislators. Bearing this in mind, the reader will see how valuable would be a knowledge of the places where the fishing fleets have worked from month to month throughout the year, for when considered along with the statistics of the fishes caught by them, this information would show us how the vessels had been following the fish from fishing ground to fishing ground. In Thompson's paper, already referred to, a beginning has been made of the collection of information of this kind. The twelve beautiful charts* of the northern North Sea which are contained in this paper show from month to month the positions of the Aberdeen trawling and lining fleets. These show how the fishing vessels move from place to place, sometimes aggregated on a relatively small area, at other times widely dispersed. It is the migrations of the fishes forming the objects of the fisheries that are the cause of these movements of the fishing fleets, and the latter are, to some extent, a representation of the former.

I will refer to only one more statistical study made by the International organization. The reader will find in volume iii. of *Rapports et Procès-verbaux* a comprehensive survey of the fishery statistics of the various participating countries, which will show him how very deficient our knowledge of the economics of the industry is, and how great is the need for the co-ordination of the statistical bureaux of the North European fishing countries and for improvement in the means of collection. If as one result of the International Investigations a central statistical office could be instituted, which would receive, collate, discuss, and publish the statistics of the North Sea fisheries, a store of knowledge of incalculable value to the fishing industry would gradually be accumulated. When the International Investigations began, the most prominent question, in this country at least, was that involving the effects of capture of small plaice on the so-called eastern grounds of the North Sea. The material for the treatment of this question did not then exist, and its acquisition was one of the aims of the International Fisheries Council. In 1904 the various Governments concerned began systematically to collect statistics of the sizes of plaice landed by their fishing fleets. In volume iv. of the *Rapports et Procès-verbaux* the first results of this work are published, though previously the English Board of Agriculture and Fisheries had instituted such investigations with reference to the Immature Fish Bill then before Parliament.† In the paper‡ referred to is contained a summary of the

* D'Arcy Thompson, *Fishery and Hydrographical Investigations in the North Sea* (cd. 2612), 1905, p. 352.

† See Archer, *Report of the Committee on Sea Fisheries Bill* (H.L.), 1904.

‡ Kyle, "First report on the statistical material received by the Bureau regarding the quantities of small plaice landed in the various countries," *Rappts. et Proc.-verb.*, vol. iv., 1905, app. C.

returns made by England, Holland, Germany, Denmark, and Belgium with regard to the quantities of small plaice landed in these countries. These returns are, of course, very imperfect, but the result giving the proportion of small plaice to the total quantity landed is probably approximately correct. About 2½ per cent of the plaice landed in Holland and about 1 per cent of the plaice landed in England were under 8 inches in length, an estimate which does not greatly encourage the pessimistic view held in various quarters as to the detrimental effect of steam-trawling upon the plaice population of the North Sea.

The connexion between Hydrographic and Biological Phenomena in the Sea.

We have seen that there is a well-marked periodicity in the hydrographic changes taking place in the sea. When the temperature and salinity of the sea water are regularly determined, it is found that the variations are not irregular or casual ones, but are repeated with a certain amount of regularity from year to year. At any one place in the seas of Northern Europe the temperature of the water gradually rises from a minimum some time in the winter or spring, to a maximum in the summer or autumn; and so also with the quantity of salt in the water; this too varies with more or less regularity, though the maxima and minima may not correspond with those of temperature. Then we have also seen that there is an analogous periodicity in the fisheries of the same area. These are not carried on with perfect regularity all the year round. At certain times in the year different fisheries are predominant. For any one fishing area there are seasons in the year which are characterized by the abundance of a certain kind of fish. Herring fisheries, cod fisheries, sole fisheries, and others have their seasons, which are repeated from year to year with a certain uniformity. Leaving aside for a moment the commercial fisheries, we find that the same periodicity of occurrence and abundance also obtains with the microscopic life of the sea. The waters of the sea always contain a certain amount of drifting microscopic life, bacteria, diatoms, protozoa, cœlenterates, and the eggs and larval forms of the larger animals living at the sea bottom or swimming about in the water. If the occurrence and abundance of this *plankton* are studied throughout the year, it will be found that it too is not always the same, neither in nature nor quantity. There is a more or less regular sequence of forms of animal or vegetable life, each of which has its maximum and minimum of abundance. Further, if the reproduction of any animal or plant in the sea is studied, it will be found that the breeding season is periodic, and occurs with very great regularity from year to year at about the same time. All these changing phenomena—the temperature and salinity of the sea water, the occurrence and abundance of different planktonic species, and the reproductive phases of all animals and plants in the sea —occur from year to year with a certain periodicity. The later direction of fisheries research has been to correlate them and to find out how the one phenomenon depends on the other. More precisely, one of the main objects of the International Fishery Investigation has been to determine in what manner hydrographic changes in the sea are connected with the productivity of the various commercial fisheries.

In all cases plankton observations have been carried on simultaneously with the hydrographic work. The plankton investigations consist of periodical fishing of the sea over wide areas, and both at the surface and at deeper levels, with fine-meshed silk nets, so designed as to catch all but the very smallest organisms in the water. As a rule, these plankton observations have been so carried out as to secure only samples of the kinds of species in the sea, but in some of the countries quantitative observations have been made; that is, the "townets" are designed to filter a known quantity of water, so that if the numbers of individuals of each species caught are determined, it can be estimated how many organisms of each species were present in a certain bulk of sea water; for instance, in a column of water one square metre in section and extending from the bottom of the sea up to the surface. These quantitative plankton observations are the most laborious which have been included in the International programme, and the results obtained so far are not yet fully worked out and discussed. In the ordinary plankton investigations, only the kinds and relative abundance of the various organisms present have been determined. These qualitative plankton observations have two main objects: (1) to ascertain the sequence of occurrence and abundance of planktonic organisms. Among these are, of course, the eggs and young stages of fishes, and the determination of the occurrence and abundance of these from place to place, or time to time, has obviously the utmost importance in the study of the life histories of the fishes. Then (2) the plankton observations are also of use in confirming the results of the hydrographic researches. The main object of the latter is to ascertain the movements of bodies of water of different origins, by a consideration of their temperatures and salinities. But oceanic streams and currents have also characteristic plankton organisms, and the recognition of the latter is of material value in the determination of the origin of the current.

In any part of the sea of our coasts there is a regular sequence in the occurrence of the organisms of the plankton. It would be quite impossible to give this in detail for the various regions investigated by the International steamers. Speaking quite generally, we should find such a general scheme as the following: At the beginning of the year there is little variety in the composition of the plankton, and it is relatively scanty in amount. But towards March and April it becomes astonishingly rich and abundant. Diatoms are present in great quantity, and we have the eggs and larvæ of the fishes which are then spawning. A little later on the larvæ of hosts of invertebrate animals appear, and towards the summer these and the fish eggs and larvæ begin to decrease. About this time also the diatoms occur in least abundance. Cœlenterates, medusæ, siphonophores, medusoid forms of hydrozoa, and protozoa such as *Noctiluca* and *Ceratium* occur in great abundance. Then in the autumn there is again a luxuriance of diatoms, these organisms attaining their second yearly maximum of abundance, which, however, is usually less than the spring maximum. As winter approaches, the plankton again becomes less varied and abundant.

Then we have "swarms" of organisms appearing in the plankton. Over restricted areas of sea one kind of organism may be present almost exclusively, and this swarm may drift over a large extent of sea. Many such instances are recorded in the International publications. Even if the usual varied plankton is found, we may be able to trace the (passive) migration of certain characteristic constituents from place to place. An excellent example of this is to be found in the distribution of the jellyfish *Muggiæa* in the waters of the English Channel and Irish Sea in 1904. The plankton observations made by the Marine Biological Association in that year* show that a shoal of these animals coming up from the Bay of Biscay reached the English Channel about April. Dividing, one part of this shoal entered the Channel, and by the beginning of September had travelled as far east as Portland, after which month it gradually retreated to the west. The other part of the shoal rounded Land's End, and by the end of September had gone as far north as Cardigan Bay and South Arklow. About this time a southerly drift of water from the Irish Sea had begun to divide the shoal, and part was driven to the south and west coasts of Ireland. By the end of November the shoal had reached far up the west coast of Ireland, and was observed in Galway Bay.

Now the distribution of this shoal of animals depended on three things: (1) the true drift of Atlantic water towards our shores, (2) the superficial drift of the water due to winds, and (3) the reproduction of the animals. Probably the large hydrographic phenomena which we have already considered had not much to do with the migration of the shoal. But in another plankton study carried out by the International vessels† we have a clearer instance of the conveyance of the plankton

* See Gough, *Publications de Circonstance*, No. 29, 1905.

† See Damas, "Notes biologiques sur les Copepodes de la mer norvegienne," *Publications de Circonstance.*

by the great oceanic streams. In the Norwegian sea occur enormous numbers of the copepod crustacean *Calanus finmarchicus*. This animal has its home in the colder sub-Arctic regions, and does not, like so many other planktonic organisms, reach the Norwegian sea from the Atlantic. In the spring of the year the adults are brought to the south by the current which flows to the south-east of Jan Mayen and Iceland —the East Icelandic Polar stream. Reaching the region of the Faeroe-Iceland channel, spawning takes place, and the young are then carried to the north along the coasts of Norway by the Atlantic north-flowing stream. In these waters the young calani, living among immense quantities of diatoms, peridinians, and other forms of plankton life, grow and form the great shoals of *Calanus finmarchicus* which characterize these waters. It is the salt water of the Atlantic stream which, to some extent at least, favours the spread of this crustacean.

The precise manner in which changes in temperature and salinity affect the abundance of planktonic organisms is, of course, very obscure. In many cases the connexion is doubtless an indirect one. We know that in the sea the larger animals prey upon the smaller, and that the ultimate food organisms are the diatoms (and other organisms with a similar method of nutrition). That is to say, every living animal in the sea depends, in the long run, on the diatoms, which form the "pastures of the sea." A cod, for instance, may feed on dabs and hermit crabs (it may feed on anything, but we take these as favourite foods). Now the dab will feed on shellfish, and the hermit crab on (say) small fishes or worms. The shellfish will feed on diatoms (among other things), and the small fish and worms perhaps on microcrustacea, and the latter on diatoms. Every chain of food animals in this sense terminates in the diatoms. If then it can be shown that these organisms are closely affected by hydrographic changes in the sea, we make a distinct step in proving the dependence of many biological phenomena on hydrographic ones. Now we are still far from possessing all the data necessary for proving this connexion, but I may refer to a most stimulating paper by Brandt,* which goes a long way in providing the information required. In the periodical cruises of the German International research vessel *Poseidon* samples of sea water were collected, and these were subsequently examined by the German chemists working under the International organization for the quantities of ultimate food-stuffs contained in them. The ultimate food-stuffs are nitrogen compounds (ammonia, nitrites, and nitrates), silicic acid, phosphates, and some other substances. It is upon these that diatoms (and consequently all other life in the sea) depend. The amount of nitrogen, in the above form, in the sea is very small (not more than about 0·2

* Brandt, *Rappts. et Proc.-verb.*, vol. iii. app. D, 1905.

parts in one million parts of sea water). It is small because it is continually being utilized as food by the diatoms; otherwise, being continually added to the sea by the decomposition of dead animals and plants, and by drainage from the land, the former would gradually become poisoned by it. The German analyses have shown that this small proportion of fixed nitrogen is not constant. Silica (which is required for the skeletons of the diatoms) and phosphates (which are similarly required for other organisms) are also present in correspondingly small and variable amounts.

Now it is of extreme interest to find that the amount of these ultimate food substances present in the sea is greatest just before the time when the maximum abundance of diatoms occurs, and is least about the time of the minimum. This applies more particularly to the German determinations of silica, but no doubt is also true of the nitrogen compounds. In the winter these food-stuffs have been greatly stored up. Then in the spring, under the influence of the rise in temperature of the sea and the increased intensity of the sunlight, an immense diatom reproduction takes place. The result of this is again to reduce the proportion of the food-stuffs, and as a consequence we have the summer minimum of diatom abundance. Further accumulation of the food-stuffs during this period of relative sterility leads to the autumn diatom maximum. Probably denitrifying bacteria play a not inconsiderable *rôle* in producing these variable proportions of nitrates present in the sea. It is known that bacteria exist in the sea which have the power of reducing nitrates to nitrites, the latter to ammonia, and ammonia to free nitrogen. In the latter form nitrogen is, of course, unavailable as food for diatoms. Now it has been shown that these denitrifying bacteria are more active at a high than at a low temperature. In the summer, then, they act on the fixed nitrogen present in the sea and render this unavailable as food for diatoms. In the colder season they are less active, and fixed nitrogen accumulates. It is a surprising thing that the plankton is less abundant in warmer tropical seas, in spite of a higher temperature and better light, than in colder sub-Arctic waters. The explanation lies probably in the more intense action of denitrifying bacteria in those warm waters, whereby the food-stuffs for the plankton are reduced.

Such considerations suggest the close connexion between the lowly organized plankton organisms and hydrographic phenomena. But can the same connexion be shown to exist between changes in temperature and salinity of sea water, and the changes in the abundance of such highly organized animals as our food-fishes? These connexions are more difficult to establish. The changing abundance of fishes on the fishing grounds is expressed in our imperfect statistical systems, and these in the past have lent themselves badly to investigations of this kind. The official returns of fish landed were almost entirely useless, and it was necessary for the fishery research organizations to so organize returns of fish caught as to show the connexions we speak of. Such investigations as those of Fulton and Henking were alone suitable.

Nevertheless, the dependence of fish migrations on hydrographic changes in the sea was always *a priori* probable. For a fish in the sea the water is just such a medium as the atmosphere is for a migratory bird; and if we recognize that climatic changes were the main factors in determining the breeding seasons and migrations of birds, it was surely probable that changes in temperature, etc., in the sea affected the breeding seasons and migrations of fishes. We know how very intimately the period of incubation of a fish egg is determined by the temperature of the water in which it develops; and how the spawning periods themselves are variable with the temperature of the sea. It was just as reasonable to assume that fish migrations were also influenced by temperature at least. The International investigations are slowly accumulating instances of these connexions. Some such connexions were established before the beginning of these researches, but others are coming to light. Long ago Möbius and Heincke divided the fishes visiting the Baltic into "north fishes" and "south fishes." The north fishes have their homes in the Norwegian sea and the waters surrounding Iceland and Faeroe. The south fishes come from the temperate Atlantic. Möbius and Heincke noticed that the north fishes only visited the Cattegat during the first part of the year, and the south fishes during the latter part. Afterwards, when the hydrographic periodicity of the waters of the Skagerak, Cattegat, and Baltic was demonstrated, these migrations were correlated with the ebb and flow of the Atlantic stream. We have seen that during the latter part of the year warm Atlantic water accumulates in the depths of the Skagerak and sets up a warm undercurrent into the Baltic, which is at a maximum about the end of the year. The south fishes appear and travel with this undercurrent, which sets up changes in the fishery biology of the Baltic. Thus in the German fishery cruises of December, 1903, plaice and other flat-fishes, many of them spawning, were found in the southern Baltic in this warm undercurrent. On the other hand, flat-fishes were hardly at all found in this part of the Baltic in June and July, at which time the bottom was covered by the water of the cold undercurrent from the Skagerak, which enters the Cattegat in spring. The hake is a typical south fish, and we have seen that its capture in the North Sea is very inconstant and indicates a definite migration. In the latter area it arrives towards the end of summer with the incoming Atlantic stream; then it is relatively abundant. In the winter it disappears again.

Again, in the Barentz Sea the fisheries depend on the Atlantic flooding. This was shown by the Russian Fishery Commission in 1902. Two kinds of water enter this area. In the winter water from the Atlantic stream enters it, rounding North Cape. With the entrance of this occurs a "vast immigration of food fishes," which have the character of south fishes, and fishing is then productive. In the spring this Atlantic stream subsides and Arctic water takes its place. The fisheries then cease, but still at this time the Atlantic stream is flowing past North Cape, and cod are still caught in quantity.

The bottom of the North Sea is a submarine plateau, which towards the north slopes down to the depths of the Norwegian sea. On this northern slope Atlantic water may be found at all times of the year, but at varying depths, according as the incoming stream waxes and wanes. On the bottom is cold Arctic water, and separating this from the overlying Atlantic water is a mixed layer, which contains relatively large quantities of fish, such as the ling and halibut. The Swedish fishermen set long lines on the portion of this slope towards Shetland. In the summer the mixed layer of water is nearer to the surface than in the winter, when the Atlantic stream is gathering volume. Just as this mixed-water stratum is nearer or further from the surface, so the fishermen move about so as to find it. In summer, when it is near the surface, they set their lines near Shetland in about 75–100 fathoms. In autumn, when the growing Atlantic stream forces down the significant water layer further from the surface, they are obliged to go further north, that is, down the North Sea slope, in order to find it. The lines are then set at depths of 150–200 fathoms.

The connexion of the herring migrations with the hydrographic changes is now quite certain, though much research is still necessary. There is no doubt that the great summer herring fishery of the east coasts of Britain hangs, in some way, on the periodic flooding of the North Sea with Atlantic waters. The case of the winter herring fishery off the coasts of Sweden is, however, a clearer case of the connexion of hydrographic and fishery phenomena. The winter herring is a north fish, and does not inhabit Atlantic water, but rather the mixed "Bank water" of lower salinity. In the great herring years it has been found that the Atlantic water lay at considerable depths beneath the surface, and that on this warm dense water was a layer of Bank water which covered the coastal shoals and entered the fjords. In this layer the herring was always found. In December, 1896, there was an unusual flooding of the Skagerak with Atlantic water. The level of this had reached so high that only a thin layer of Bank water remained. In this year the winter herring fishery was a failure.

Much has been done by the International researches to establish the connexion of the cod fisheries with the hydrographic changes. In the winter of 1902–3 the Atlantic stream in the Norwegian sea attained its maximum much later than usual. That is, the stream had a greater volume than usual in this winter, and much more warm Atlantic water entered the northern ocean than in previous years. Many climatic phenomena accompanied this greater accumulation of warm water: the ice border everywhere receded to the north and east. Barometric depressions and cyclonic storms were more numerous than usual, and the weather was wild and stormy. Biological phenomena were also occasioned; Atlantic plankton was found as far north as 70° N., even among the drifting ice floes near Jan Mayen. The spawning period of the cod was greatly postponed, and the Lofoten cod fishery (which depends on spawning fish) was delayed for two months, and was a partial failure. The winter herring fisheries at Bergen and in the Skagerak also failed.

Quite recently too Schmidt has made some interesting observations on the cod fisheries off the coasts of Iceland. The island is surrounded by cold Arctic water, but on the south the Atlantic stream approaches it and flows, as the Irminger Current, along the north-west coasts. The cod spawns at the south of Iceland in the border region of the warm Atlantic stream and the cold littoral water, and the eggs are only found where the temperature of the water is over 5° C. Having spawned, the cod go west and north-west, following the Atlantic stream, and in the summer there is a general movement of cod, herring, and fish fry along the north and east coasts of Iceland; the fisheries take the same course, always in the border region of the Atlantic and Arctic waters.

More instances of hydrographic-biological phenomena might be quoted from the International publications, but we have noticed the more striking cases. The question why this connexion exists must be left for future investigation, and will certainly only be solved by very laborious researches. One wonders that the minute differences of salinity such as exist in the sea, and the comparatively small temperature differences, should affect so notably the migrations of fishes. It is perhaps a possible explanation that it is the food of the fishes that is affected in some such manner as we have discussed in relation to the varying abundance of diatoms in the plankton, but it is also probable that the metabolic processes of the fishes themselves are affected by even these small variations in the watery medium in which they live. After all, climatic differences affecting ourselves are sometimes very subtle, and when expressed by the readings of meteorological instruments are just as small as those which we have been considering.

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OF THE

Marine Biological Association of the United Kingdom.

THE ASSOCIATION was founded at a Meeting called for the purpose in March, 1884, and held in the Rooms of the Royal Society of London.

The late Professor HUXLEY, at that time President of the Royal Society, took the chair, and amongst the speakers in support of the project were the late Duke of ARGYLL, the late Sir LYON PLAYFAIR, Lord AVEBURY, Sir JOHN HOOKER, the late Dr. CARPENTER, Dr. GÜNTHER, the late Lord DALHOUSIE, the late Professor MOSELEY, the late Mr. ROMANES, and Professor LANKESTER.

The Association owes its existence and its present satisfactory condition to a combination of scientific naturalists, and of gentlemen who, from philanthropic or practical reasons, are specially interested in the great sea fisheries of the United Kingdom. It is universally admitted that our knowledge of the habits and conditions of life of sea fishes is very small, and insufficient to enable either the practical fisherman or the Legislature to take measures calculated to ensure to the country the greatest return from the "harvest of the sea." Naturalists are, on the other hand, anxious to push further our knowledge of marine life and its conditions. Hence the Association has erected at Plymouth a thoroughly efficient Laboratory, where naturalists may study the history of marine animals and plants in general, and where, in particular, researches on food-fishes and molluscs may be carried out with the best appliances.

The Laboratory and its fittings were completed in June, 1888, at a cost of some £12,000. Since that time investigations, practical and scientific, have been constantly pursued at Plymouth. Practical investigations upon matters connected with sea-fishing are carried on under the direction of the Council; in addition, naturalists from England and from abroad have come to the Laboratory, to carry on their own independent researches, and have made valuable additions to zoological and botanical science, at the expense of a small rent for the use of a working table in the Laboratory and other appliances. The number of naturalists who can be employed by the Association in special investigations on fishery questions, and definitely retained for the purpose of carrying on those researches throughout the year, must depend on the funds subscribed by private individuals and public bodies for the purpose. The first charges on the revenue of the Association are the working of the sea-water circulation in the tanks, stocking the tanks with fish and feeding the latter, the payment of servants and fishermen, the hire and maintenance of fishing-boats, and the salary of the Resident Director and Staff. At the commencement of this number will be found the names of the gentlemen on the staff.

In the summer of 1902 the Association was commissioned by His Majesty's Government to carry out in the southern British area the scheme of International Fishery Investigations adopted by the Conference of European Powers which met at Christiania in 1901. In connection with this work a laboratory has been opened at Lowestoft.

The purpose of the Association is to aid at the same time both science and industry. It is national in character and constitution, and its affairs are conducted by a representative Council, by an Honorary Secretary and an Honorary Treasurer, without any charge upon its funds, so that the whole of the subscriptions and donations received are devoted absolutely to the support of the Laboratory and the prosecution of researches by aid of its appliances. The reader is referred to page 4 of the Cover for information as to membership of the Association.

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All correspondence should be addressed to the Director, The Laboratory, Plymouth.

GENERAL INDEX.

INDEX

TO

PLYMOUTH MARINE INVERTEBRATE FAUNA

pp. 155–298.

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A.

M.

N.

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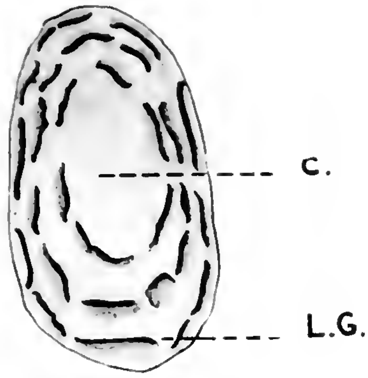

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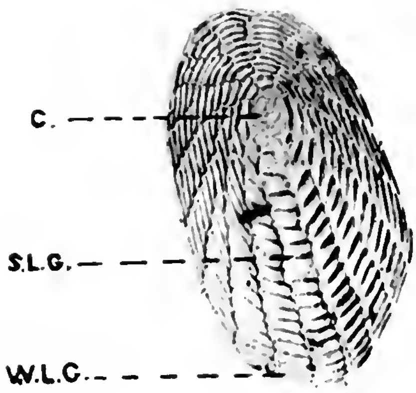

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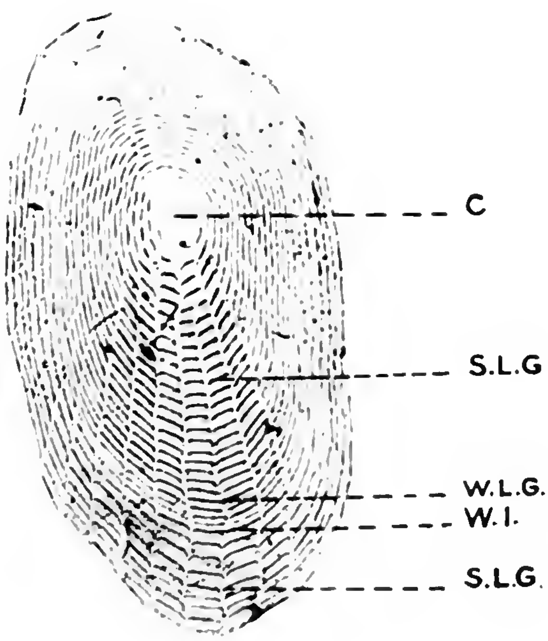

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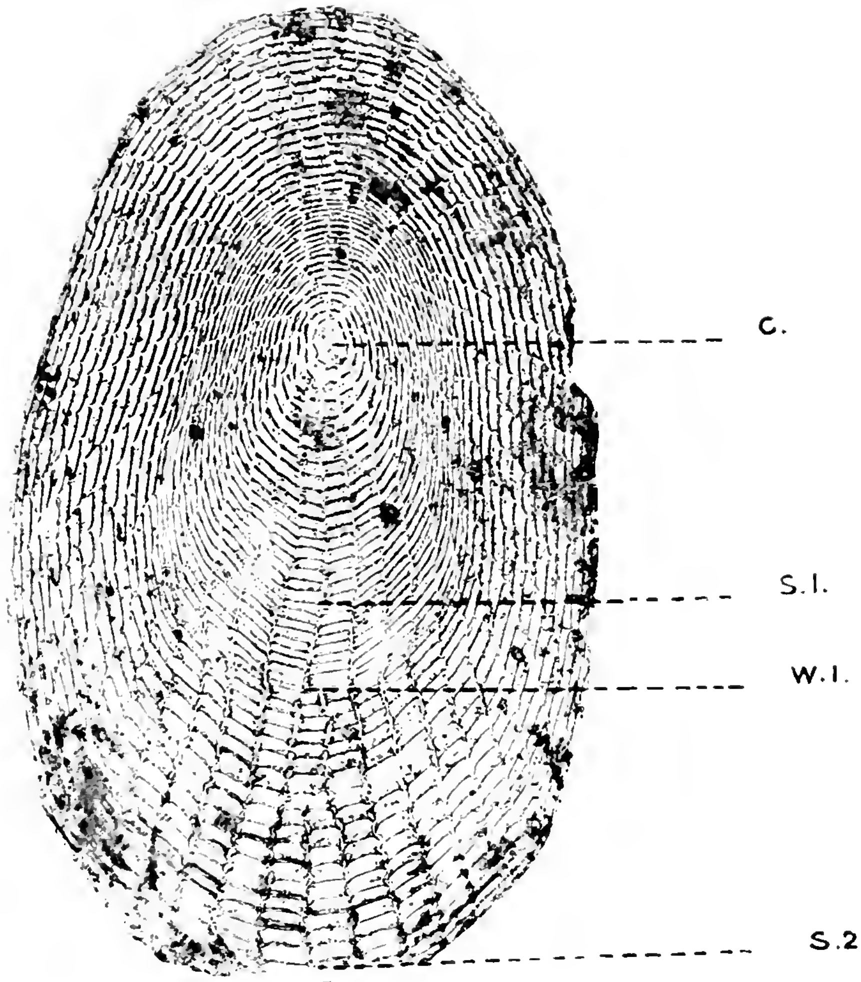

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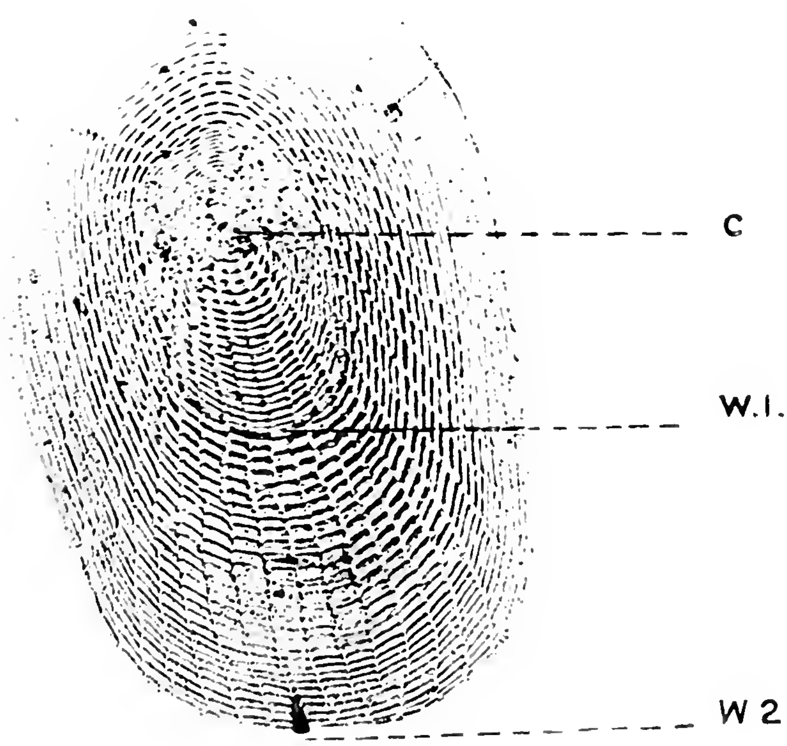

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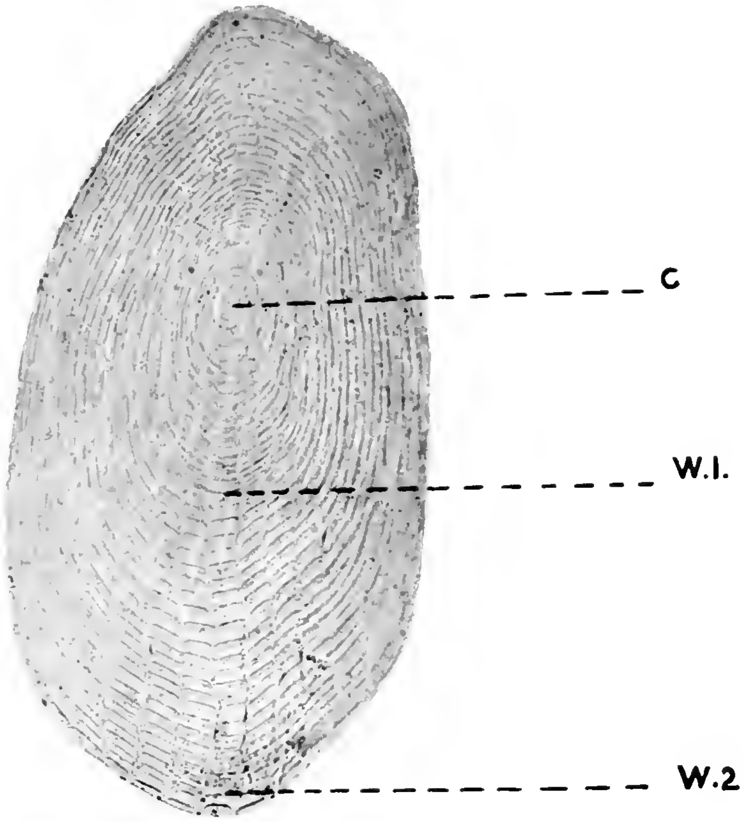

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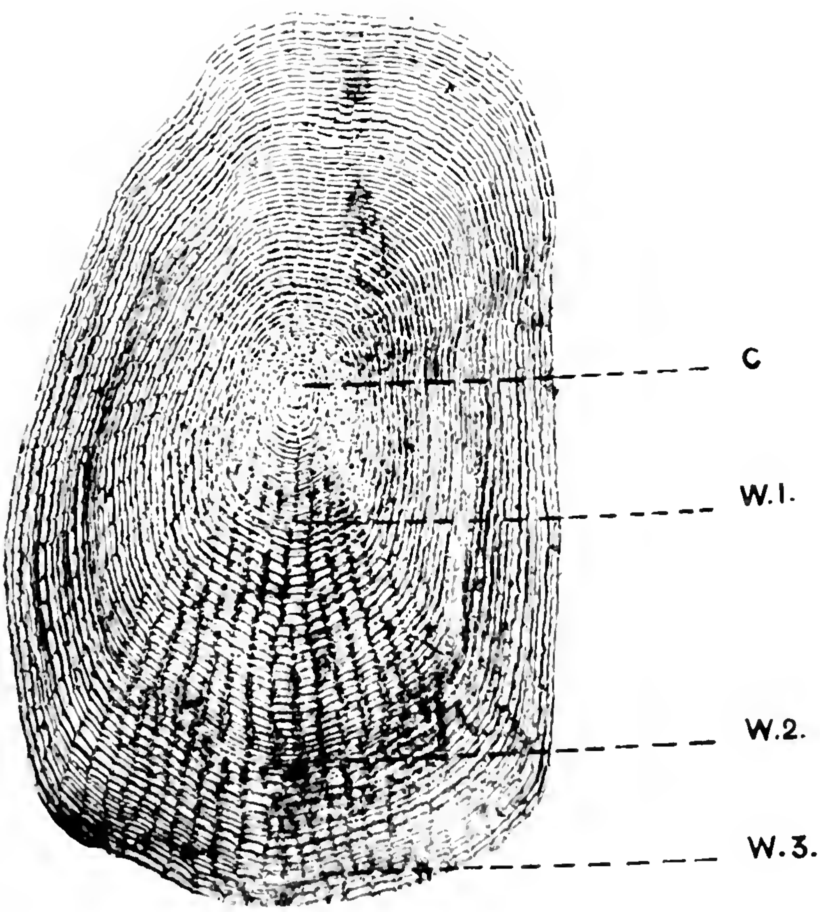

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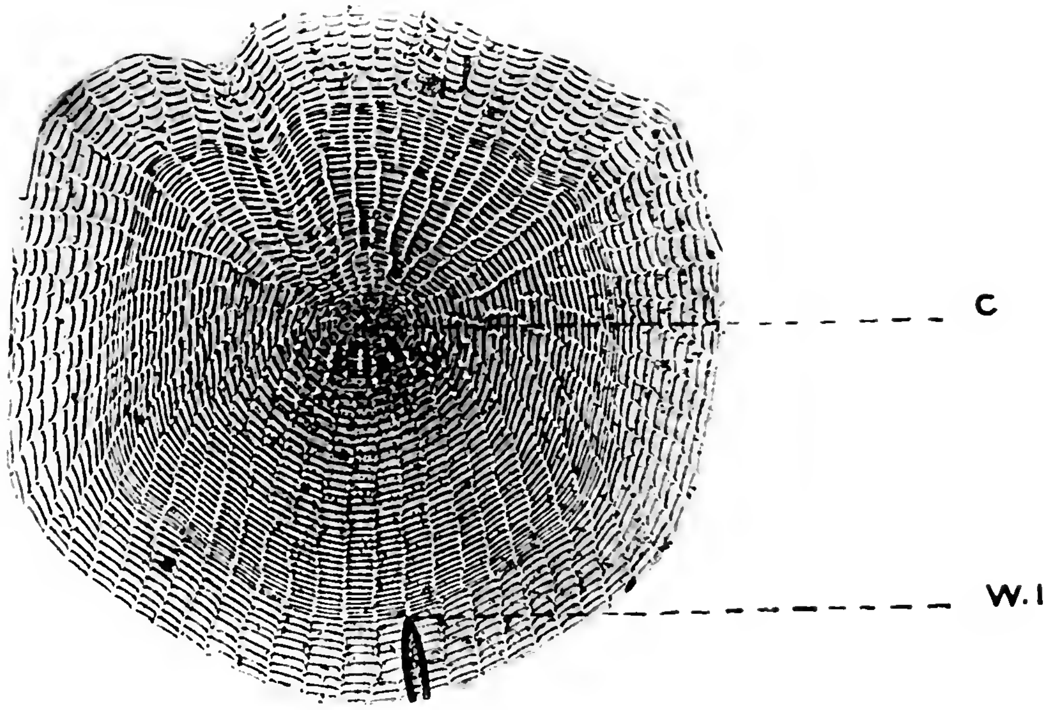

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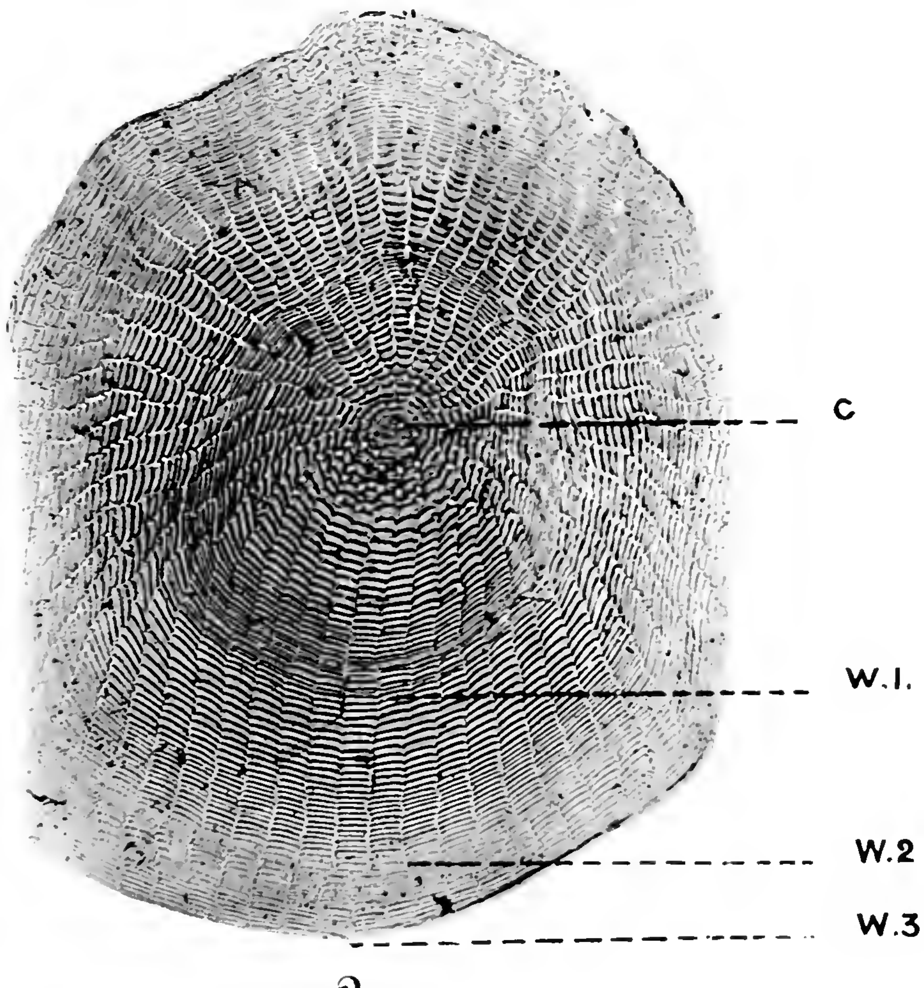

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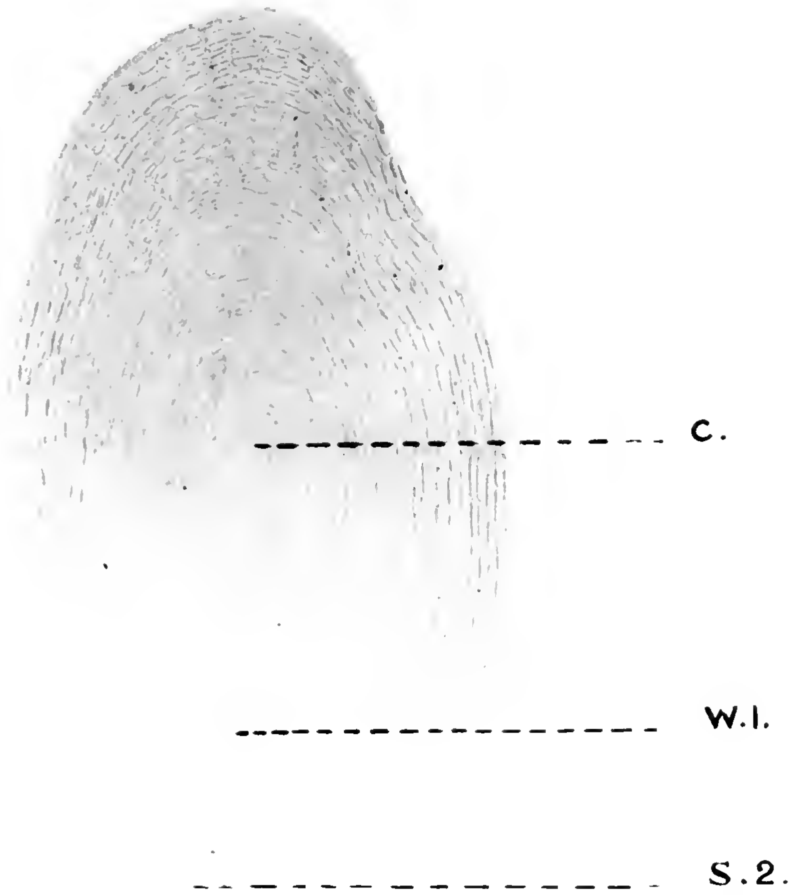

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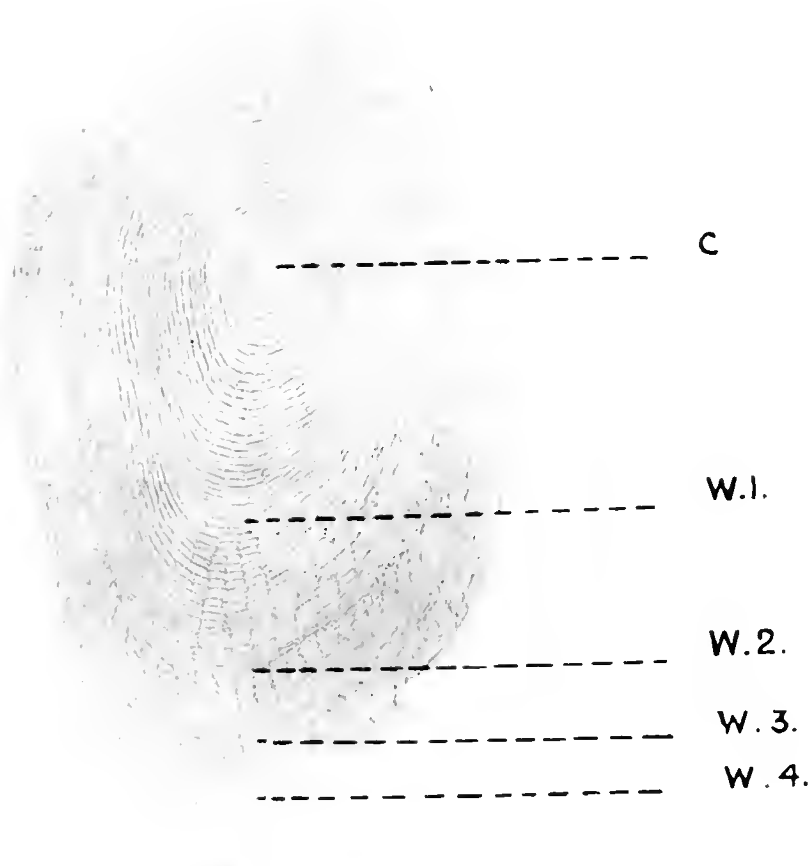

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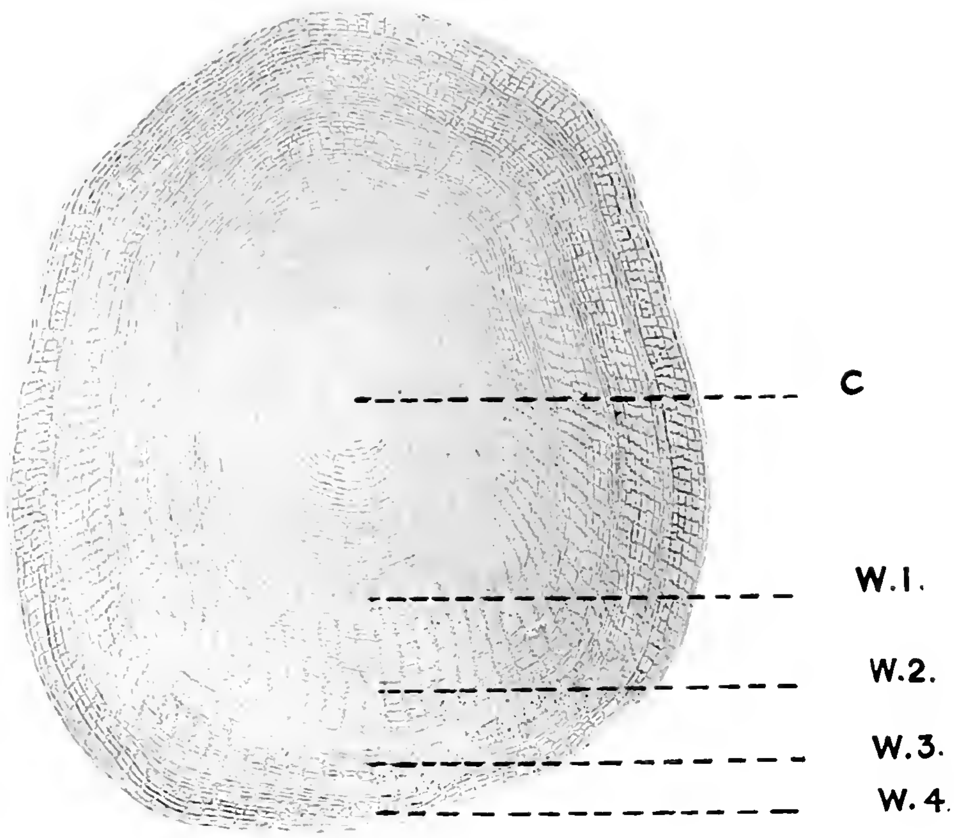

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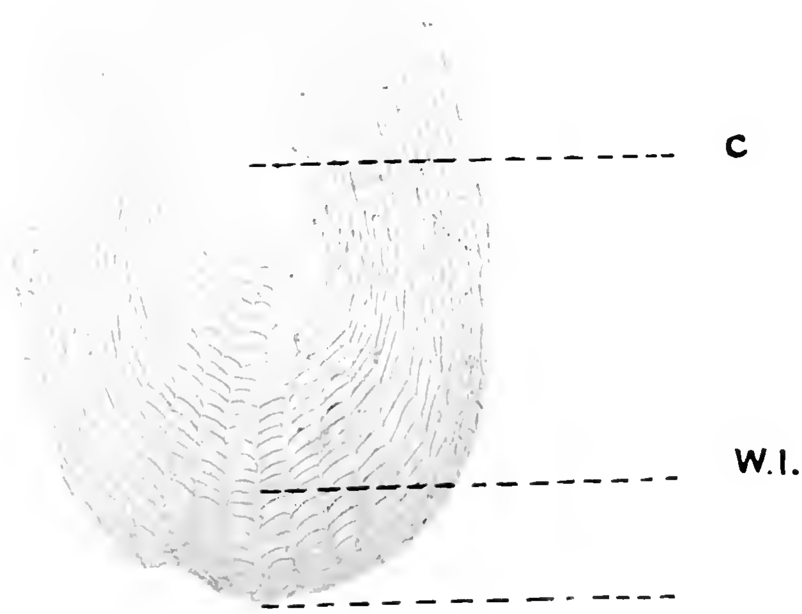

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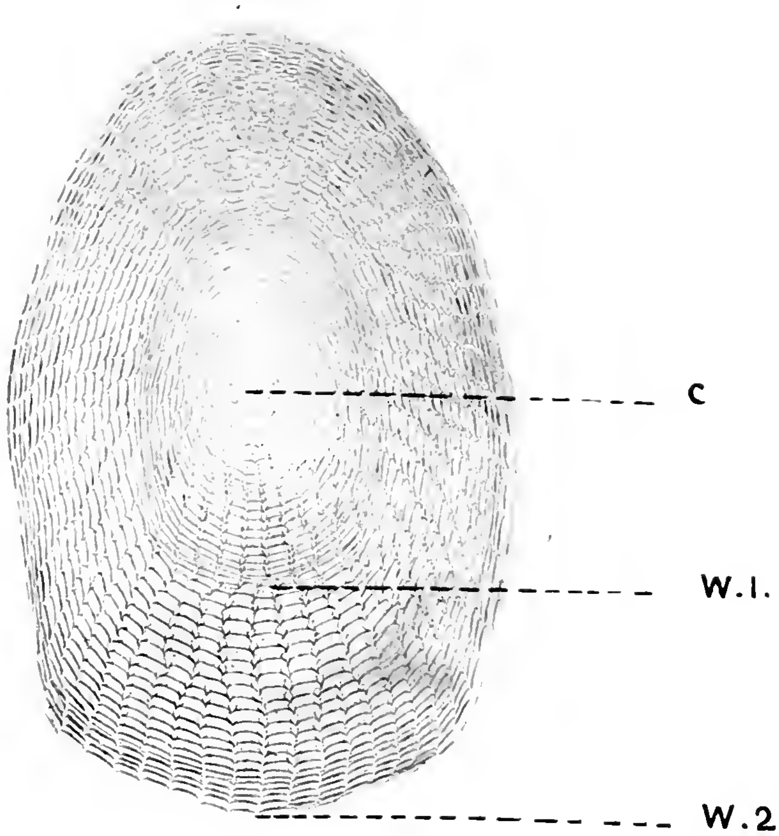

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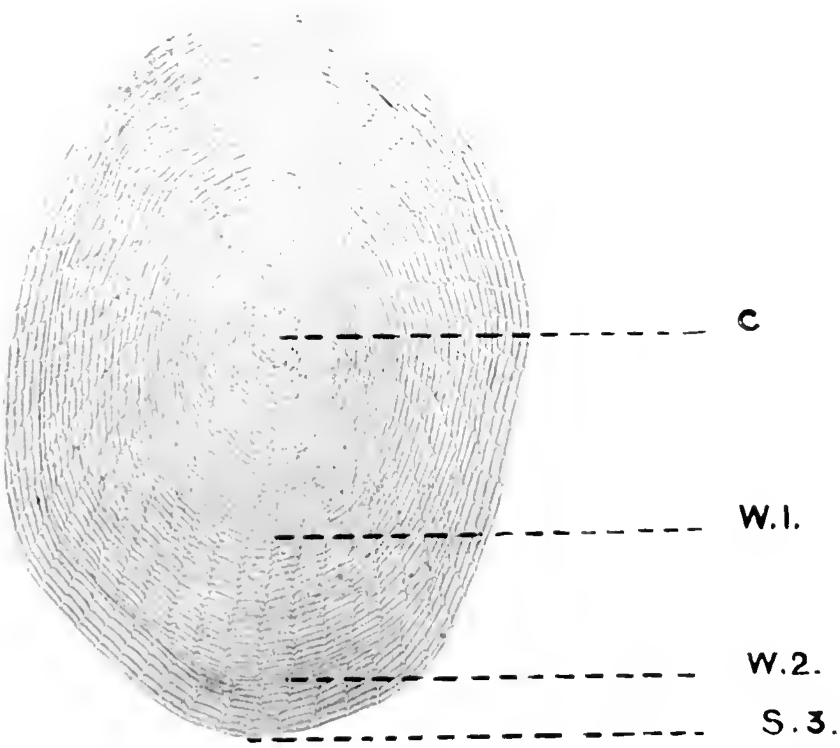

2

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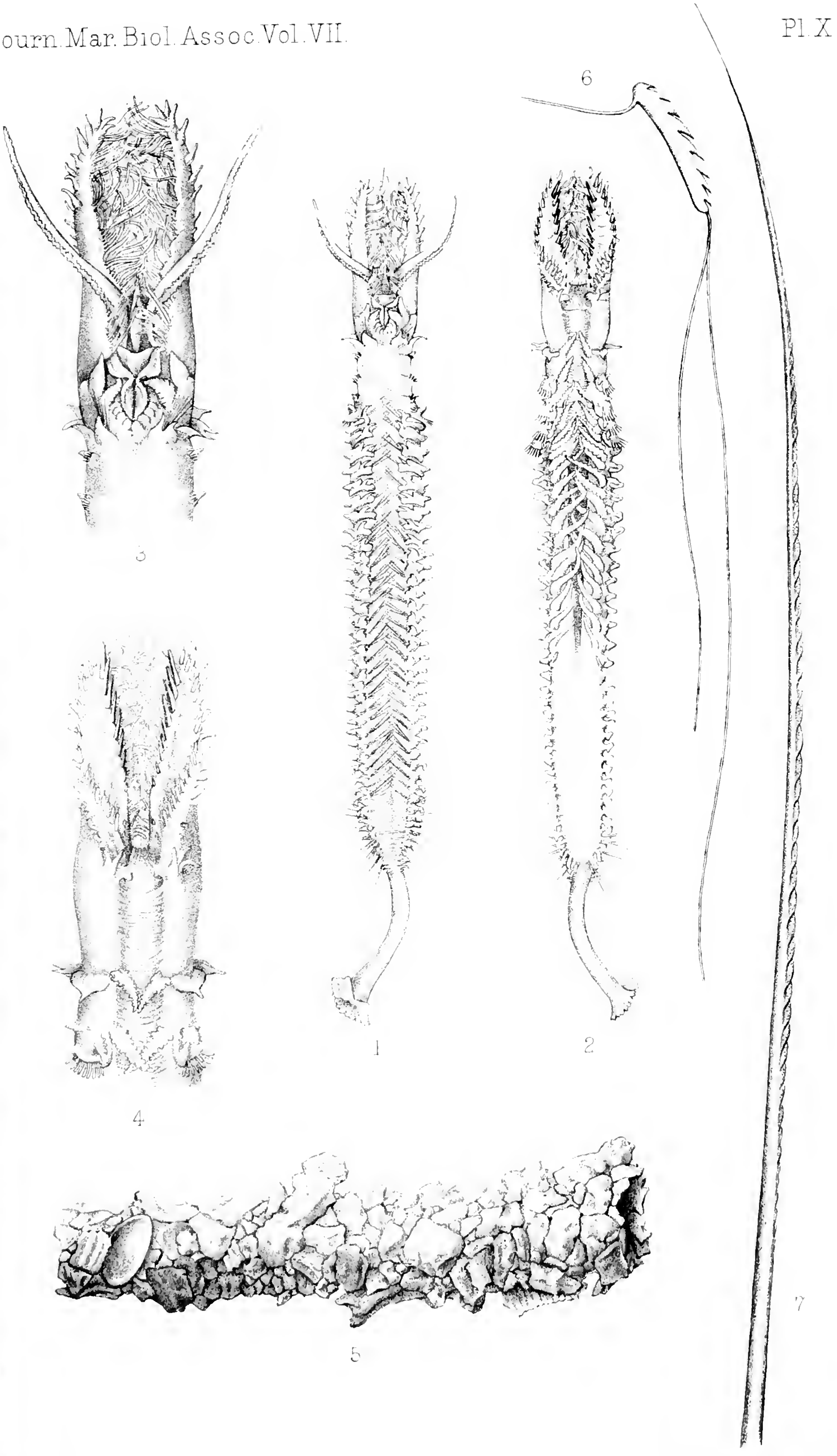

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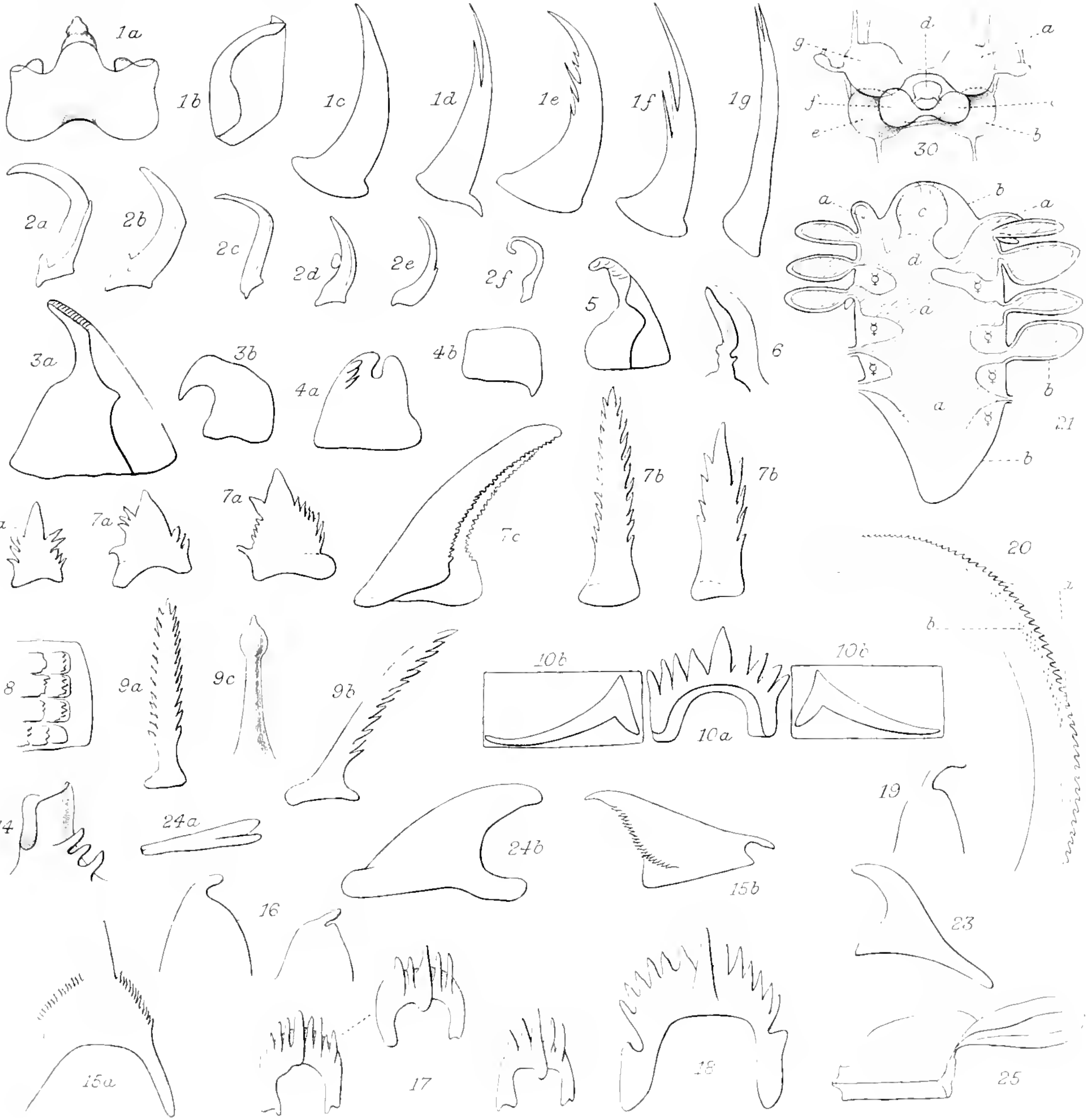

West, Newman

Figs 1 10 14 21. 23 25, 30


12
11
13
vent.
aor
rpo
vo
pc
22
26
28
27
29