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Recherches sur le Développement post-embryonnaire de la Langouste commune (Palinurus vulgaris).

Par

M. E.-L. Bouvier, Professeur au Muséum d'Histoire Naturelle à Paris.

Avec 6 Figures dans le Texte.

C'EST surtout pour étudier le développement post-embryonnaire de la Langouste commune (*Palinurus vulgaris* Latr.) que je me suis rendu au Laboratoire de Plymouth. L'endroit me semblait excellent parce que la Langouste n'est pas rare près des côtes dans les eaux du Devonshire et de la Cornouaille, parce qu'elle est principalement fréquente sur les fonds rocheux au-dessus desquels se dresse le phare d'Eddystone, aussi enfin, parce que le Laboratoire de Plymouth est très bien installé, avec un bateau, l'*Oithona*, qui peut se rendre en mer chaque jour et effectuer les pêches les plus diverses.

Car il fallait pêcher souvent et à toutes profondeurs pour atteindre le but que je m'étais fixé, et ce but n'était rien moins que de découvrir les stades jusqu'alors inconnus du développement de notre Langouste. Depuis les observations de Couch (1857, 25) justifiées par Gerbe (1858, 547) et par Dohrn (1870), mais à tort contestées par Sp. Bate (1868), on sait que le P. vulgaris sort de l'œuf sous une forme larvaire foliacée, hyaline, aplatie dans le sens dorso-ventral, que les anciens zoologistes avaient appelée phyllosome et tenaient pour un genre spécial de Crustacés décapodes. On savait aussi, depuis les recherches de Claus (1863), que le phyllosome acquiert progressivement des appendices à mesure qu'il se développe, qu'il peut atteindre une longueur de 21 mm., et qu'il garde jusque dans sa plus grande taille les caractères généraux qui lui sont propres et qui en font un organisme essentiellement pélagique. Mais quelle est la série des stades présentés par le phyllosome depuis la sortie de l'œuf jusqu'au moment où il acquiert la forme longue, trapue, et rétrécie des Decapodes normaux ? et comment s'effectue le passage à cette forme ? Autant de questions qu'il fallait se poser et que personne encore n'avait pu résoudre. A vrai dire, depuis

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les belles recherches de M. Boas (1881) récemment confirmées par M. Calman (1909), on était en droit de croire que le passage du phyllosome à la forme définitive s'effectue par le moyen d'un "stade natant" désigné jadis par M. Ortmann (1897) sous le nom de puerulus et considéré par cet auteur comme un genre autonome de Palinurien. J'ai moi-même apporté ma contribution (1912) aux travaux de ces auteurs et je connais actuellement le puerulus supposé d'une dizaine d'espèces de Langoustes. Mais ces Langoustes sont toutes exotiques, et d'ailleurs, c'est par une hypothèse rationnelle, mais non à la suite d'une observation directe, que l'on s'accorde à voir dans le puerulus le stade intermédiaire qui conduit du phyllosome à l'état de Langouste parfaite. Il convenait par suite de justifier les suppositions de M. Boas et de chercher à connaître tous les stades évolutifs ainsi que le puerulus de l'espèce localisée dans nos mers. Il fallait aussi chercher l'habitat des puerulus; car ces organismes, au contraire des phyllosomes, sont d'une rareté extrême, et c'est tout au plus si l'on en possède une trentaine. d'exemplaires, pour la totalité du groupe des Palinuriers.

La saison d'été m'a paru plus propre que toute autre à la solution de ces problèmes, car c'est dans la seconde quinzaine de juin et au début de juillet que M. Cunningham (1891–92) captura autour du phare d'Eddystone les premiers stades larvaires du *P. vulgaris*. Mon savant prédécesseur a très bien décrit et figuré ces stades, mais, peu favorisé par le temps, il n'a pu en obtenir que deux, et les pêches faites dans la suite ont été infructueuses, alors qu'elles auraient dû lui procurer la capture des stades plus âgés. C'est dans l'espoir d'obtenir ces stades que je me suis installé à Plymouth du 15 juillet au 1^{er} septembre. Le bref exposé qu'on va lire montrera que le moment était bien choisi ; j'ajouterai, d'ailleurs, que je fus étrangement favorisé par une saison des plus propices.

I. STADES PHYLLOSOMES DE LA LANGOUSTE COMMUNE.

Je vais indiquer tout d'abord les stades phyllosomes obtenus par l'Oithona au cours decet te saison de pêches. L'étude n'en est pas encore achevée et c'est provisoirement que je les classe en série de la manière suivante :

Stade 1 (3 mm. environ). Antennules et antennes presque indivises, de longueur à peu près égale. Le bouclier céphalique atteint à peine la base des maxillipèdes postérieurs (mxp. 3); exopodite des péréiopodes 3 (p. 3) dépourvu de soies, péréiopodes des deux paires suivantes (p. 4, p. 5) à l'état de bourgeons très courts. Abdomen sans appendices visibles et sans articulations bien distinctes en dehors du telson. Ce

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stade a été parfaitement figuré par M. Cunningham dans la première figure de son mémoire ; il est celui que présente le phyllosome à sa sortie de l'œuf.

Stade 2 (4 à 5 mm.). Un court bourgeon représente le fouet interne des antennules ; p.5 et surtout p.4 plus allongés qu'au stade précédent ; des uropodes légèrement échancrés au bout et atteignant au plus le milieu du telson, qui est tronqué en arrière ; la segmentation de l'abdomen encore très vague.

Stade 3 (6 à 8 mm.). La portion pédonculaire des antennules est divisée en deux articles, le fouet interne égale environ un tiers du fouet externe. Le pédoncule des antennes est indivise, et un peu plus court que le fouet, qui est également indivise. Le céphalon recouvre la base de mxp. 3; mxp. 2 avec un bourgeon exopodial. Des soies à l'exopodite de p. 3, p. 4 avec un exopodite nu. Des pléopodes representés par un bourgeon aplati et échancré en arrière; uropodes plus longs qu'au stade 2 et profondément échancrés en deux rames; segmentation de l'abdomen bien distincte, surtout dans les régions épimérales. C'est le dernier stade observé par M. Cunningham, qui l'a bien décrit et fort exactement figuré.

Stade 4 (9 mm.). Le pédoncule antennulaire commence à montrer une division en 3 articles. Il y a déjà quelques soies sur l'exopodite de p. 4; cette patte à peu près aussi longue que l'abdomen. Les pléopodes sont nettement biramés; le telson est arrondi sur son bout distal et légèrement plus long que les uropodes dont l'exopodite présente une très nette échancrure externe.

Stade 5 (10 mm.). Le pédoncule antennulaire est nettement divisé en 3 articles ; les antennes sont un peu plus longues que les antennules. L'exopodite de p. 4 atteint presque le bout de l'endopodite ou, tout au moins, en dépasse le milieu.

Stade 6 (12–13 mm.). Le fouet interne des antennules égale à peu près la moitié du fouet externe ; le fouet antennaire égale une fois et demie la longueur de son pédoncule. L'exopodite de mxp. 2 atteint l'extrémité distale de l'article suivant ; p. 5 arrive à peine à la base des uropodes ; les soies de p. 4 bien développées.

Stade 7 (14–15 mm.). Le fouet antennaire égale près de deux fois la longueur du pédoncule ; mxp. 1 est déjà long ; l'exopodite de mxp. 2 dépasse l'extrémité distale de l'article suivant. Ce stade a été assez bien figuré par Claus (1863, Taf. XXVI, fig. 7) et avec quelques erreurs par J. Couch (1858).

Stade 8. N'a pas encore été trouvé.

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Stade 9 (20–21 mm.). (Fig. 1.) Le fouet interne des antennules égale presque le fouet externe ; les antennes sont à peu près aussi longues que le céphalo-thorax, et leur fouet, où l'on voit déjà des traces de segmentation, égale environ trois fois la longueur du pédoncule. L'exopodite des mâchoires est bien développé. Exopodite de mxp. 1 long et formé de 2 articles, toutes les autres parties de l'appendice (sauf probablement l'épipodite) sont bien indiquées mais réduites ; exopodite de mxp. 2 à peu près aussi long que l'endopodite, mais dépourvu de soies. Appareil branchial formé des mêmes parties que celui de l'adulte, mais les épipodites de mxp. 1 et mxp. 2 font probablement défaut ; le céphalon recouvre la



FIG. 1.—Phyllosome de *P. vulgaris* à l'avant-dernier stade (stade 9) capturé près du phare d'Eddystone. Photographié au Laboratoire d'entomologie du Muséum par M. Boyer. (Cliché communiqué par "Science et Vie".) Grandeur naturelle.

base de p. 1. Les épimères abdominaux sont toujours arrondis, les pléopodes ont un pédoncule très net. Les pédoncules oculaires, grâce à leur tigelle fort longue, atteignent le bout distal des antennules et dépassent le pédoncule des antennes. C'est le dernier stade observé jusqu'ici; Claus en a donné la description et la figure (1863, Taf. XXVI, fig. 8); il a été passablement représenté par Spence Bate (1863, fig. 1).

Stade 10 (20-21 mm.). Ce stade très intéressant était resté inconnu, non seulement dans notre Langouste commune, mais chez tous les Palinuridés. On en trouvera ci-contre la figure (fig. 2). Ce qui le distingue essentiellement, c'est la structure de l'abdomen qui se rapproche déjà beaucoup de celle de la Langouste adulte ; car le telson présente deux



FIG. 2.—Phyllosome de *P. vulgaris* au dernier stade (stade 10) et montrant le puerulus qui commence à s'en dégager. Sous la carapace un peu déformée du phyllosome se voit le bouclier céphalo-thoracique du puerulus, un pédoncule oculaire de ce dernier est sorti du pédoncule phyllosomien, l'autre est encore coiffé de son exuvie; certaines pattes commencent également à se dégager. Dessin de l'auteur d'après un exemplaire capturé dans les parages d'Eddystone. (Le cliché a été communiqué par "Science et Vie".) Gross. 4.

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paires d'épines et les épimères abdominaux se terminent en pointe avec un denticule sur leur bord postérieur. Les longs fouets antennaires présentent des traces de segmentation et quelques soies; les épipodites de mxp. 1 et mxp. 2 sont développés, la formule branchiale est celle de l'adulte et beaucoup de branchies présentent déjà quelques bourgeons. Je n'ai pu obtenir qu'un phyllosome à ce stade; il fut capturé entre deux eaux le 25 août 1913, à 5 milles E.N.E. du phare d'Eddystone.

J'ai examiné les matériaux recueillis au cours de 46 pêches effectuées depuis le 20 juin 1913, jusqu'à la fin d'août. La plupart des pêches faites dans les parages d'Eddystone renfermaient des phyllosomes de *Palinurus vulgaris* et de *Scyllarus arctus*; celles pratiquées en dehors de cette zône ne donnèrent aucun représentant de ces larves. Les pêches du mois de juin ne fournirent que de jeunes phyllosomes de *Palinurus*, mais je dois observer qu'au Laboratoire on avait conservé peu de matériaux de ces pêches; à mesure qu'on avançait en juillet, les phyllosomes âgés devenaient nombreux et sûrement l'évolution peut s'achever durant ce mois, comme on le verra plus loin. D'ailleurs, durant toute la durée du mois d'août, la pêcha rapporta des phyllosomes âgés et des phyllosomes aux premiers stades; on peut donc affirmer que *la Langouste commune*, dans les parages d'Eddystone, *effectue* son développement post-embryonnaire au moins pendant toute la durée de l'été, c'est-à-dire du 21 juin au 21 septembre.

II. STADE NATANT OU PUERULUS.

Caractères du puerulus. Pour des raisons que j'indiquerai plus loin, la capture de l'exemplaire précédent a une importance de premier ordre, au point de vue de la solution des problèmes qui nous occupent; elle doit être mise sur le même rang qu'une seconde dont je vais tout de suite entretenir le lecteur.

Cette seconde capture est celle d'un puerulus qui fut pris le 31 juillet, entre deux eaux, dans les parages compris entre Looe et Eddystone, au-dessus d'un fond de 27-29 brasses. L'exemplaire fut trouvé par M. Gossen parmi les matériaux recueillis au cours de pêches que dirigeait M. Clark, Assistant du Laboratoire. Faut-il dire que j'éprouvai une joie profonde lorsqu'on apporta sur ma table de travail ce puerulus qui avait jusqu'alors échappé à la connaissance des zoologistes ?

L'unique et précieux exemplaire (figs. 3, 4, 5, 6) mesure environ 21 mm. de longueur, ce qui est la taille des grands phyllosomes. Comme tous les puerulus, il est hyalin, avec des téguments coriaces à peu près totalement dépourvus de calcification, et la forme macrourienne normale. Il se

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distingue pourtant des puerulus actuellement connus par son bouclier céphalo-thoracique regulièrement convexe, mais il est possible que cette disposition soit due au renflement des régions branchiales sous l'action de l'eau de mer où l'animal a péri, ou des liquides conservateurs; dans les autres puerulus, en effet, la carapace est très peu convexe dorsalement, et ses régions branchiales forment un angle presque droit avec la région dorsale, disposition qui s'est conservée chez un certain nombre de Palinuridés primitifs (*Puerulus* Ortm.; *Linuparus* Gray). D'ailleurs, notre puerulus est bien au "stade natant" décrit par M. Boas, car ses



Fig. 3.



Fig. 4.

FIG. 3.—Puerulus de *P. vulgaris* capturé dans les parages d'Eddystone. Face dorsale (d'après une photographie de M. Martin Duncan prise au Laboratoire de Plymouth). Grandeur naturelle.

FIG. 4.—Puerulus de la Fig. 3, vu du côté ventral (d'après une photographie de M. Martin Duncan).

pléopodes peuvent se conjuguer par couples dans une même paire, grâce aux rétinacles à crochets qui occupent le bout distal de l'appendice interne situé sur leur rame endopodiale.

L'exemplaire capturé présente déjà de grandes resemblances avec la forme définitive du *Palinurus vulgaris*; les antennules sont du même type brévicorne, c'est-à-dire terminées par deux courts fouets subégaux dont l'externe est beaucoup plus épaissi que l'autre;—les antennes sont très fortes, avec un long et puissant fouet bien articulé et un large



FIG 5.—Puerulus des deux figures précédentes vu du côté dorsal. (Agrandissement photographique obtenu par M. Martin Duncan.)

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pédoncule où les épines sont distribuées à très peu près comme chez la Langouste adulte ;—les pédoncules oculaires sont courts et larges ; le rostre est réduit à une faible pointe médiane comme dans les espèces du genre *Palinurus* ;—les cornes rostrales sont très puissantes et suivies d'une paire d'épines post-rostrales ;—il y a sur la carapace quelques épines qu'on retrouve chez l'adulte (une rangée transverse de quatre épines gastriques, une paire de spinules cardiaques, et, au bord supérieur de chaque région branchiale, une dizaine de spinules disposées en série) les épimères abdominaux sont aigus et, sauf le premier, munis d'une saillie en pointe sur leur bord postérieur ;—on observe une paire de fortes pointes sur le 6^e segment abdominal, à la naissance du telson ; ce dernier présente déjà la paire d'épines proximales et les échancrures latérales épineuses de la Langouste adulte ;—les uropodes sont munis, comme dans cette dernière, d'échancrures externes spinuleuses, les pattes enfin sont courtes, fortes, et dépourvues d'exopodites* bien développés.

Il y a pourtant de profondes différences entre ce puerulus et la forme définitive de la Langouste commune ; outre les caractères généraux propres à tous les puerulus (corps hyalin, téguments coriaces et non calcifiés ; présence de rétinacles sur les appendices internes des pléopodes) il faut signaler surtout l'absence de denticulations aiguës sur les cornes rostrales (fig. 6), le développement de soies assez longues sur les fouets antennaires, l'absence de sillons transverses sur les segments abdominaux et surtout l'armature épineuse de la carapace qui est loin d'être riche et puissante comme dans la Langouste adulte. J'ai montré plus haut que les épines du puerulus se retrouvent à leur place dans la forme définitive ; cela est vrai pour toutes, sauf peut-être pour trois épines, probablement hépatiques, situées de chaque côté en arrière des antennes ; ces épines sont fortes et très caractéristiques de notre puerulus, mais il est difficile de leur trouver des homologues dans les nombreuses épines qui ornent le bouclier céphalo-thoracique de l'adulte.

Le puerulus d'Eddystone se rapproche surtout d'un puerulus caraïbe que j'ai rapporté (1912, 81) au *Palinurus longimanus* Edw.; il présente comme lui un exopodite flagellé sur les maxillipèdes externes et plusieurs paires d'épines sternales; ces dernières, toutefois, sont plus développées dans notre puerulus et d'ailleurs plus nombreuses, car on en trouve une à la base des pattes des quatre paires postérieures tandis que les épines se localisent à la base des trois dernières paires de pattes dans le puerulus caraïbe.

* L'exemplaire avait perdu quelques-unes de ses pattes, mais celles qui restent sont courtes et fortes comme dans les puerulus des autres Palinuridés.



FIG. 6.—Esquisse du même puerulus montrant les ornements en saillie de la face dorsal. Dessin de l'auteur d'après l'exemplaire capturé dans les parages d'Eddystone. (Cliché communiqué par "Science et Vie".)

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Passage du phyllosome au puerulus.—Si le puerulus ressemble beaucoup à la Langouste adulte, il ressemble par contre bien peu au phyllosome : avec ses pattes courtes de Crustacé marcheur, ses exopodites thoraciques réduites à un imperceptible bourgeon dépourvu de soies, ses pédoncules oculaires à tigelle très courte, surtout avec son bouclier céphalo-thoracique trapu et très différent du large et plat bouclier phyllosomien, le puerulus est aussi différent que possible de la forme larvaire des Palinuridés. Provient-il réellement de cette forme et comment s'effectue le passage de l'un à l'autre ? Voilà ce qu'il fallait encore trouver.

Par une bonne fortune singulière et qu'il eût été fou d'espérer, l'Oithona, sous la direction de M. Clark, fît capture d'un phyllosome dans lequel était en voie de se former et de se dégager le puerulus. Ce phyllosome est celui (fig. 2) dont j'ai donné plus haut la description et qui représente, à mon avis, le 10^e stade larvaire de notre Langouste, un stade que les zoologistes n'avaient pas encore observé. Son abdomen ressemble déjà tout à fait à celui du puerulus, mais le spécimen est bien phyllosome par tous ses autres caractères.

Ce phyllosome fut rapporté vivant par M. Clark qui me prévint de suite; mais le délicate organisme avait succombé aux fatigues du voyage et était complétement inerte quand j'arrivai au laboratoire pour l'examiner. La nuit était venue, on le conserva dans l'alcool et j'en fis l'étude le jour suivant. Sa carapace était déformée et ses pédoncules oculaires avaient un aspect bizarre, si bien qu'il me parut être tout d'abord un phyllosome en mauvais état. Mais un examen plus attentif modifia bien vite cette conception trop rapide : l'abdomen avait des caractères tout particuliers propres au puerulus, et sous le bouclier céphalo-thoracique déformé, on apercevait, comme une masse opaque, le bouclier même du puerulus, avec son rostre minuscule, ses cornes frontales, ses fortes épines hépatiques et la plupart des spinules de la carapace (fig. 2). Le pédoncule oculaire droit du puerulus était déjà sorti du pédoncule phyllosomien; le pédoncule oculaire gauche était également formé, indépendant de la tigelle phyllosomienne, pourtant coiffé encore du pédoncule phyllosomien; certaines pattes du puerulus commençaient à se dégager des pattes phyllosomiennes.

En fait, c'était une pièce merveilleuse et singulièrement démonstrative que permettait d'établir sans contestation possible : 1° que le phyllosome capturé représente bien le dernier stade larvaire de notre Langouste ; 2° que cette dernière ne traverse pas, comme d'autres Palinuridés, le curieux stade PHYLLAMPHION décrit et figuré par Reinhardt en 1858; 3° que les conceptions de M. Boas sont parfaitement justes en ce sens que le puerulus est bien directement issu du phyllosome, du moins dans notre Langouste commune.

Par analogie, on devra étendre cette dernière et très importante conclusion à tous les Palinuridés, en remarquant toutefois que certaines formes exotiques traversent un stade *phyllamphion*, assez peu différent d'ailleurs du phyllosome.

Passage du puerulus à la Langouste.—Les observations précédentes nous donnent-elles le droit de conclure que le puerulus d'Eddystone est celui de la Langouste commune et, d'une manière plus générale, que les divers puerulus connus représentent le "stade natant" de divers Palinuridés ? Cela ne me paraît point douteux. Le Palinurus vulgaris représente à lui seul, dans nos mers, la famille des Palinuridés, d'où cette conclusion que tous les phyllosomes palinuriens capturés à Eddystone proviennent bien de cette Langouste. Nous en dirons autant du puerulus, car nous avons vu ce dernier prendre naissance au sein même des grands phyllosomes. Le puerulus d'Eddystone est donc, sans incertitude aucune, le "stade natant" du Palinurus vulgaris.

Il s'en faut que l'on puisse conclure, avec une précision semblable, lorsqu'on s'adresse aux autres formes de la famille, car on n'a jamais observé, dans ces dernières, la série complète des stades phyllosomes et moins encore le passage du phyllosome au puerulus. Mais j'ai largement établi, dans un travail antérieur (1912), que chaque puerulus présente des caractères qui permettent de le rapporter, presque sûrement, à une espèce spéciale de Palinuridés.

III. HABITUDES DES PHYLLOSOMES ET DES PUERULUS.

Toutefois les suppositions les plus logiques ne valent pas une bonne preuve et, en ce qui concerne la Langouste commune, il faudra observer le passage du puerulus à la forme définitive. Ce sera l'objet principal de mes recherches durant la campagne que je dois effectuer prochainement au laboratoire de Plymouth.

La principale difficulté sera d'obtenir des puerulus. On peut se les procurer par deux moyens : soit en élevant des phyllosomes de grande taille, soit en les capturant directement au large.

La première méthode sera sans doute la meilleure et la plus sûre, car l'élevage en aquarium des grands phyllosomes ne semble pas devoir être très difficile. M. Clark a capturé, dans les parages d'Eddystone, un phyllosome à l'avant-dernier stade et l'a rapporté vivant au laboratoire où j'ai pu l'observer pendant les deux jours qui précédèrent mon

départ. Quoique placé dans une simple jarre et dans des conditions peu favorables, la curieuse larve paraissait très active et en fort bon état ; elle se déplaçait à peu près exclusivement au moyen de ses exopodites thoraciques, qui lui servaient aussi à se maintenir dans le milieu et à la diriger ; elle descendait lentement quand ces appendices n'étaient plus en fonction ; les pattes elles-mêmes font peu de mouvements et semblent jouer le rôle de balanciers, l'abdomen et ses pléopodes n'en font aucun. Le jeune animal est rapidement et fortement attiré par la lumière. A cet avant-dernier stade, les phyllosomes sont assez communs vers la fin de juillet et durant le mois d'août ; en les élevant dans un aquarium convenable, on pourra peut-être les conduire jusqu'au dernier stade et de celui-ci au "stade natant" ou puerulus.

La capture des puerulus en pleine mer sera plus difficile. Ces jeunes, en effet, ne doivent pas rester longtemps entre deux eaux, dans le milieu où ils se trouvent en sortant des phyllosomes, et où fut capturé l'exemplaire que j'ai décrit plus haut. Ce sont des nageurs au corps lourd, qui doivent très vite descendre sur le fond* où ils se cachent certainement parmi les rochers, car leurs téguments coriaces et non calcifiés les rendent très vulnérables. Ainsi doit s'expliquer, à mon avis, l'extrême rareté des puerulus dans les collections zoologiques et la diversité d'habitat jusqu'ici connue chez ces animaux : les puerulus étudiés par M. Boas avaient été, "en partie du moins, capturés au large" (1880, 84), et je sais, d'après les notes des pêches faites par la Princesse Alice, que le type du puerulus atlanticus ("stade natant" du Palinurus regius Br. Cap.) fut capturé au trémail par 20 mètres de profondeur, à Ste. Lucie du Cap Vert. D'un autre côté, M. Calman rapporte que le puerulus spiniger, Ortm. ("stade natant" du Palinurus ornatus Fab.) fut trouvé à l'île Christmas "soit au milieu des rochers, soit sur le "pier" dans les crevasses des piles" (1909, 444), et j'ai noté ailleurs (1912, 88) que le puerulus du Panulirus dasypus Latr. fut trouvé par M. le Dr. Jousseaume dans les crevasses du rivage, à Djiboutil.

Qu'ils soient obtenus par élevage ou par capture directe, les puerulus, à cause de leurs habitudes, se prêteront certainement beaucoup mieux que les phyllosomes à la captivité de l'aquarium. On pourra, sans difficulté, j'en suis sûr, les conduire jusqu'à la forme définitive de l'espèce à laquelle ils appartiennent. Cette forme sera sans doute acquise à la première mue, car les puerulus d'une espèce ont tous à peu près la même

^{*} Il en est, sans doute, de même pour les Homards; le bateau du laboratoire a capturé, entre deux eaux, un jeune Homard qui avait acquis tous les caractères definitifs de l'espèce; le jeune venait sûrement de sortir de sa *mysis* qui est pélagique.

taille, et cette taille n'est pas moins grande que celle des plus jeunes Langoustes. En capturant à Djiboutil les puerulus du *Panulirus dasypus*, M. Jousseaume a recueilli plusieurs jeunes de l'espèce, et ces jeunes présentent la même taille et les mêmes variations de taille que les puerulus ; * le Muséum d'histoire naturelle possède un jeune exemplaire de la Langouste commune qui dépasse de 4 mm. seulement le puerulus d'Eddystone, et l'on trouverait sûrement des jeunes ayant la même taille que ce dernier. Quoiqu'il en soit, il n'est pas douteux que du puerulus sortira la Langouste sous sa forme définitive.

J'arrête là cette note préliminaire qui sera complétée et détaillée à la suite de mon prochain séjour au Laboratoire de Plymouth. Si, comme je l'espère, on lui trouve quelque intérêt, je dois en remercier toutes les personnes qui ont provoqué ou facilité mes recherches, c'est-à-dire les membres de la "Marine Biological Association," M. le Professeur Ray Lankester qui me désigna comme "investigator" au choix de cette Société, et, pour leur dévouement au-dessus de tout éloge, M. Allen, Directeur du Laboratoire de Plymouth, M. Clark, assistant, M. M. Gossen et Savage attachés au service, et sans aucune exception le personnel du Laboratoire. Je dois aussi remercier mon excellent confrère, M. F. Martin Duncan, qui travaillait au Laboratoire durant mon séjour à Plymouth et qui a très obligeamment photographié, peu après sa capture, le précieux puerulus recueilli par l'Oithona.

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* Les puerulus capturés par M. le Dr. Jousseaume mesurent de 15 à 19 mm. et les jeunes Langoustes 18 à 20.

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Observations nouvelles sur les trachelifer, larves lucifériformes de Jaxea nocturna.

Par

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Avec 11 Figures dans le texte.

DURANT mon premier séjour au Laboratoire de Biologie maritime de Plymouth, en qualité de "first Ray Lankester Investigator," j'ai eu la bonne fortune de trouver un certain nombre d'exemplaires de la très curieuse forme larvaire découverte en Ecosse, près d'Arran, par G. Brook (1889) qui lui donna le nom de *trachelifer*. Ces exemplaires furent capturés au filet Petersen par l'*Oithona*, bateau du Laboratoire, entre



FIG. 1-Trachelifer au stade mysis imparfaite ; longueur 9 mm.

Looe et Eddystone, le 13 août 1913. Ils appartiennent sans conteste à la forme même décrite par Brook et, comme eux, présentent les traits suivants qui sont fort caractéristiques (Fig. 1) ; un corps étroit, allongé tout à fait identique à celui des Crustacés décapodes du genre *Lucifer*; —des yeux volumineux et courts entre lesquels fait saillir une petite pointe rostrale ;—des mandibules en forme de long crochet recourbé une paire de crochets épiméraux sur le bord postérieur des segments 2 à 6 de l'abdomen ;—enfin un telson élargi en arrière et muni de soies sur son bord postérieur largement échancré. Brook n'a pas eu de peine à montrer que cette larve ne ressemble aux *Lucifer* que par sa forme et qu'elle s'en

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distingue par tous les traits essentiels; mais il ne se crut pas en mesure d'émettre une opinion définitive sur ses affinités, d'autant que ses matériaux se limitaient à des individus relativement jeunes, les plus petits mesurant 6 mm. de longeur, les plus grands 9.

Au surplus, quelques années avant l'observation de Brook, la même larve avait été découverte dans l'Adriatique par Claus qui, sans lui donner un nom spécial, en fit d'abord (1884, 32) connaître deux stades jeunes, l'un de 4 mm. 5, l'autre de 7 mm. 5, puis (1885, 63–64) un stade beaucoup plus avancé (12 à 15 mm.), ce qui lui permit de regarder cette larve comme celle d'un rare Thalassinidé méditerranéen, la Jaxea nocturna, Nardo-Chiereghin (=Calliaxis adriatica Heller).

Depuis, dans un travail fort intéressant au point de vue bibliographique, M. T. Scott (1898, 268–269) rapporte qu'il a capturé le *trachelifer* dans le Golfe de Clyde et a étudié particulièrement un stade avancé dont le longueur atteint 16 mm. 5. La même larve a été retrouvée en abondance par ce zoologiste à Tobermory, détroit de Mull (1901, 481), et par son fils, M. A. Scott (T. Scott, 1901, 481) dans le Barrow Channel, près de Barrowin-Furness, puis plus récemment (1905) dans les mers d'Irlande. Enfin cette larve, au stade le plus jeune, avait été recueillie en Méditerranée et décrite par M. G. Cano, qui en a donné une figuration (1891); d'après A. M. Norman et T. Scott elle aurait également été prise (1906, 13) par M. Robert Gurney au large de Salcombe, c'est-à-dire dans les eaux mêmes de la région de Plymouth.

Je dois ajouter, pour être complet, que M. T. Scott (1900, 405) a reçu des restes de la forme adulte trouvés dans l'estomac du Rouget ou "gurnard" (*Trigla gurnardus* L.) et du *Pleuronectes cynoglossus*, L., dans le Golfe de Clyde ; si bien qu'on doit croire, avec M. Scott, que la forme adulte habite réellement les eaux anglaises.

Là se bornent, à ma connaissance, les observations relatives à la curieuse larve; comme elles sont fragmentaires et éparses, j'ai cru bon de les réunir en les augmentant de celles que j'ai pu faire au laboratoire de Plymouth sur les quelques exemplaires capturés par l'*Oithona*.

Stades larvaires actuellement connus.—A tous les stades actuellement connus, le trachelifer est franchement lucifériforme, ce qui le distingue nettement des *Lucifer* qui n'atteignent leur forme spéciale qu'à l'état de jeune immature, ainsi qu'il résulte des belles observations de M. W.-K. Brooks.*

Longueur 4 mm. (1er stade larvaire, zoé).-Ce stade a été décrit et par-

* W. K. Brooks. "Lucifer: a Study in Morphology" (Philosoph. Transactions, Vol. 173, p. 57-137, 11 Planches, 1883).

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ticulièrement figuré par Claus (1884, 32, Figs. 48–50). Ses appendices buccaux sont développés, avec la mandibule gauche et le paragnathe en long crochet courbé, caractère tout à fait propre à cette larve et qui persiste à tous les stades ; la mandibule droite est normale ; les appendices thoraciques se réduisent aux deux paires de maxillipèdes antérieurs qui sont biramés et fonctionnels, du moins au point de vue de la natation. Le telson est élargi en arrière et très profondément échancré, beaucoup plus que dans les autres stades ; il ne porte qu'un petit nombre de soies.

Longueur 6 mm. (zoé).—Stade étudié et figuré par Brook (1889, 420, Fig. 1). Les pédoncules antennulaires paraissent indivises et le fouet qui les termine est remarquablement court; les antennes présentent une épine basilaire et deux branches subégales dont l'externe porte des soies et n'atteint pas l'extrémité distale des pédoncules antennulaires. Les mandibules conservent les traits du stade précédent; les deux paires de mâchoires sont biramées. La troisième paire de maxillipèdes apparaît sous la forme d'un bourgeon simple, comme d'ailleurs les péréiopodes des deux premières paires. Les autres appendices ne sont pas encore développés et aucune ligne articulaire ne sépare le telson du dernier segment abdominal.

Longueur 7 mm. 5 (zoé).—Stade étudié par Claus (1884, 32). Les trois paires de maxillipèdes sont biramés et fonctionnels ; les péréiopodes sont tous représentés par des bourgeons.

Un stade un peu plus avancé a été décrit par Brook (1889, 420-421) : les péréiopodes antérieurs s'allongent en acquérant un exopodite fonctionnel ; les uropodes apparaissent à la base du telson qui est séparé du 6^e segment abdominal. Les péréiopodes des deux paires postérieures ne seraient pas encore développés ce qui ne concorde guère avec les observations de Claus et semble pour le moins douteux. Ce stade est intermédiare entre la zoé et la mysis.

Longueur 9 mm. environ—(mysis imparfaite). C'est le dernier stade étudié par Brook et celui auquel appartiennent la plupart des exemplaires de l'Oithona; les caractères schizopodiens sont indiqués par la division en exopodite et endopodite des six paires d'appendices thoraciques antérieurs, mais le stade mysis n'est pas encore complètement réalisé, car les exopodites des cinq paires antérieures fonctionnent seuls comme rames natatoires. Il convient de décrire ce stade dont Brook n'a fait qu'une étude incomplète (1889, 421, Fig. 2).

Les antennules (Figs. 1 et 2) sont longuement pédonculées mais les trois articles de leur pédoncule semblent peu distincts ; elles se terminent.

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par deux courts fouets simples, l'un externe assez fort, l'autre interne plus long et plus grêle. Il y a de longues soies sur la face dorsale des pédoncules et à l'extrémité distale du fouet externe. Les *antennes* (Figs. 1 et 2) n'atteignent pas l'extrémité des pédoncules antennulaires; leur second article présente une pointe antéro-externe et porte à son sommet deux longues branches subégales, simples l'une et l'autre : un exopodite ou écaille, longuement sétifère, un endopodite un peu plus long et dépourvu de soies.

Les appendices buccaux sont, comme dans le genre *Lucifer*, situés fort loin des yeux, juste derrière l'étranglement qui sépare du thorax la très longue et fort grêle région céphalique (Fig. 1), ils comprennent des



FIG. 2.—Trachelifer de la Fig. 1: yeux, antennes et antennules vus du côté dorsal. FIG. 3.—Trachelifer de la Fig. 1: une mandibule (md), une maxille (mx¹), et une mâchoire (mx²).

mandibules, des maxilles, et des mâchoires (Fig. 3). Les paragnathes et *mandibules* (md) présentent toujours la forme curieuse signalée par Claus dans les exemplaires du premier stade, à savoir celle d'un crochet longuement recourbé. Je n'y ai pas vu de palpe. L'un des crochets m'a paru simple, l'autre était finement denticulé vers le bout distal. Les *maxilles* (mx¹) sont très normales avec un palpe simple muni au sommet de trois soies et une lacinie bien développée mais pauvrement sétifère ; je n'y ai pas vu de lame exopodiale. Les *mâchoires* (mx²) ont également une structure normale ; leurs lacinies externe et interne sont armées de soies, mais indivises; leur palpe est court, leur exopodite cilié. Je n'ai pu observer la partie postérieure de cette lame exopodiale.

Les appendices thoraciques (Figs. 1, 4, et 5) sont au nombre de huit paires. Les *deux paires antérieures* (Fig. 4, maxillipèdes 1 et 2) se différencient de toutes les autres (Fig. 5) en ce sens que *l'article basilaire de leur exopodite est fusionné complètement avec l'article basal de l'endopodite*,

d'où il résulte que la partie libre de l'exopodite se compose seulement de deux articles et la partie libre de l'endopodite de quatre; le dernier article de l'exopodite se termine par six longues soies bipennées; on



FIG. 4.-Trachelifer de la Fig. 1 : maxillipèdes de la 1re (mxp1) et de la 2c paires (mxp2)

trouve également des soies sur les divers articles de l'endopodite (Fig. 4). Les appendices *des quatre paires suivantes* (Fig. 5, mxp.³, p.¹, p.², p.³) sont biramés comme ceux qui précèdent, *mais sans fusion basale de l'exopodite et de l'endopodite*; si bien que, dans ces appendices, l'exopodite



FIG. 5.—Trachelifer de la Fig. 1 : maxillipède postérieur et les cinq péréiopodes du même côté (p¹ à p⁵).

se compose de trois articles libres. Au surplus, l'exopodite n'est sétifère et fonctionnel que dans les trois paires antérieures (maxillipèdes 3, péréiopodes 1 et 2), il se réduit à l'état de bourgeon dans ceux de la dernière paire (6^e paire thoracique representant les péréiopodes 3) comme d'ailleurs l'endopodite des quatre paires qui nous occupent. J'ajoute

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que ces bourgeons endopodiaux sont simples (Fig. 5), sans articulation apparente, toujours dépourvus de soies, très courts dans les appendices antérieurs, plus allongés en arrière où ils atteignent à peu près les dimensions de l'exopodite. Les appendices *des deux paires postérieures* (péréiopodes 4 et 5) *sont réduits à l'état de bourgeons simples*, privés de soies et non fonctionnels, ceux de la dernière paire étant un peu plus courts que les précédents (Fig. 5, p.⁴, p.⁵).

Ainsi le thorax des larves à ce stade porte six paires d'appendices biramés dont la sixième n'est pas fonctionelle et dont les deux premières se différencient de toutes les autres par la fusion basale de leurs exopodites et endopodites qui sont l'un et l'autre fonctionnels; à partir de la troisième paire, les endopodites se présentent sous la forme de bourgeons non fonctionnels, comme les appendices des deux dernières paires qui, d'ailleurs, ne sont pas biramés.



FIG. 6.—Trachelifer de la Fig. 1 : le 7° segment abdominal avec ses épines postérieures et ses bourgeons pléopodiaux.

FIG. 7.-Trachelifer de la Fig. 1 : dernier segment abdominal, telson et uropode gauche.

Cette description des appendices thoraciques diffère beaucoup de celle qu'a donnée Brook ; car mon regretté prédécesseur n'a signalé ni la bifurcation des péréiopodes, ni la curieuse particularité des deux paires de maxillipèdes antérieures. Et ces deux caractères sont, à coup sûr, les plus importants dans la forme que nous étudions. J'ajoute que Brook mentionne simplement, sans les décrire, les maxilles et les mâchoires.

L'abdomen (Figs. 1, 6, 7) présente les caractères signalés par Brook, avec de longues pointes épimérales (nulles sur le premier segment, particulièrement longues sur le sixième) et un telson très élargi en arrière où il présente 11 ou 12 paires de soies spiniformes (Fig. 7). La caractéristique du stade dont nous faisons l'étude, c'est l'apparition des uropodes (Fig. 7) qui se composent de deux lames sétifières subégales beaucoup plus courtes que le telson. Les pléopodes font défaut ou, dans quelques cas très rares, apparaissent sous la forme d'un très court bourgeon (Fig. 6).

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Longueur 10 à 11 mm. (mysis).—Un exemplaire capturé par l'Oithona diffère des précédents en ce sens que les exopodites des appendices thoraciques de la C^e paire (péréiopodes 3) sont fonctionnels et que l'endopodite des péréiopodes de la paire antérieure commence à se fendre pour produire la pince (Fig. 8). C'est le stade mysis proprement dit.

Longueur 13 mm. (stade mysis à chélipèdes).—Ce stade n'a pas été signalé jusqu'ici; il est représenté dans les récoltes de l'Oithona par un seul individu. Cet exemplaire ressemble tout à fait à ceux qui précédent par la structure du corps, mais il s'en distingue par les caractères suivants, dont certains ont une grande importance.

Les pédoncules antennulaires sont fort nettement triarticulés ; les antennes présentent une épine antéro-inférieure sur chacun de leurs deux

FIG. 8.—Trachelifer au stade mysis, long de 10 mm.: un péréiopode antérieur avec l'endopodite commençant à se transformer en pince.

articles basilaires, leur endopodite se différencie en une hampe basale et un fouet ; ce dernier dépasse notablement les antennules mais n'est pas encore brisé en articles.

Les pléopodes abdominaux se développent sur les segments 2 à 5 sous la forme de bourgeons allongés et bifurqués (Fig. 8). Les rames des uropodes restent subégales, et dépassent notablement le milieu du telson. L'échancrure terminale de celui-ci est limitée en avant par un bord presque rectiligne et sur les côtés par les deux pointes normales, qui sont divergentes et presque droites.

Les appendices buccaux et les yeux ne présentent rien de particulier ; les appendices thoraciques sont en même nombre qu'au stade précédent, de même type, et doués des mêmes fonctions, les appendices de la Ce paire (péréiopodes 3) étant semblables aux précédents en ce sens que leur exopodite est sétifière et fonctionnel (Fig. 9 et p.³, Fig. 11). Il faut signaler à ce stade le développement d'un très court bourgeon exopodial

(Fig. 9 et p.⁴, Fig. 11) à la base des appendices de la paire suivante (péré opodes 4); la présence de cet exopodite rudimentaire montre qu'il faut considérer comme un endopodite les appendices assez réduits et très vaguement articulés qui représentent les deux dernières paires de péréiopodes (Fig. 8 et p.⁴, p.⁵, Fig. 11).

Mais ce qui distingue surtout notre exemplaire et lui donne une signification importante, c'est la structure des appendices de la 4^e paire (Fig. 9 et p.¹, Fig. 11) qui réprésentent, comme on sait la paire antérieure des péréiopodes des Crustacés décapodes ; *dans cette paire, l'endopodite se termine par une pince bien formée* et présente des lignes articulaires assez nettes ; d'ailleurs les deux pinces sont égales et semblables, très



FIG. 9.—Trachelifer au stade mysis à chélipèdes (long. 13 mm.): thorax avec un appendice et partie antérieure de l'abdomen.

développées et à peu près aussi longues que le reste de l'endopodite; leurs doigts ont à peu près la même longueur que le reste de la portion palmaire et laissent entre eux un léger hiatus.

J'ajoute qu'on observe des bourgeons branchiaux sur tous les appendices thoraciques, depuis la deuxième paire jusqu'à la septième (Figs. 10 et 11).

Longueur 15 à 16 mm. (dernier stade mysis). Je n'ai pas eu d'exemplaires à ce stade qui a été étudié par Claus (1885, 63-64, Taf. V., Fig. 45) avec le plus grand soin, du moins en ce qui regarde la région thoracique. C'est un stade mysis, comme les deux précédents.

Ce stade diffère de celui que je viens de décrire par la segmentation très nette des appendices thoraciques, par la réduction plus grande des deux paires postérieures de péréiopodes, et par l'allongement de l'exopodite des péréiopodes 4 qui restent non fonctionnels, enfin et surtout par ses branchies qui sont en même nombre que dans les *Jaxea* et déjà divisées en lamelles branchiales.

Je crois bien qu'il faut rapporter à ce stade l'exemplaire de 16 mm. brièvement décrit et figuré par M. T. Scott (1898, 269, Pl. 12, Figs. 16–20). A vrai dire, M. Scott ne mentionne pas les branchies mais l'examen qu'il fit de son exemplaire fut certainement très rapide, si j'en juge d'après les Figures 19 et 16 du travail, qui sont défectueuses.

Conclusions.-M. Scott rappelle, dans son intéressante note, tous les travaux relatifs à la curieuse larve que nous venons d'étudier. Son



FIG. 10.-Trachelifer de la Fig. 9 : les maxillipèdes des deux premières paires.

travail, à ce point de vue, offre au vif intérêt, et je dois remercier mon excellent collègue M. Calman qui, par l'intermédiaire de M. Allen, a eu l'obligeance de me le faire connaître. Sans cet avis précieux, je me serais borné peut-être à faire une comparaison entre les stades que j'ai décrits et ceux observés par Brook, alors que cet auteur n'a pas reconnu les affinités de sa larve *trachelifer* et qu'il ignorait, non seulement le travail où Claus a pour la première fois signalé cette larve (1884), mais en outre celui où l'éminent zoologiste de Vienne donna une exacte signification de sa découverte (1885). Or, cette dernière étude est de grande importance : Claus a observé, en effet, que la bizarre larve capturée à Trieste présente, en dépit de sa forme, tous les caractères essentiels des larves des Thalassinidés, qu'elle ressemble tout à fait, par ses caractères, aux larves de *Gebia littoralis* Risso supérieurement étudiées par M. G. O. Sars,* qu'elle possède le même nombre de branchies que le *Calliaxis adriatica* et qu'il faut la considérer comme la forme larvaire de ce Thalassinien.

Cette identification ne saurait faire le moindre doute ;† elle peut même être poussée jusqu'au détail, car dans les figures données par M. G. O. Sars, on voit que les exopodites des maxillipèdes des deux paires antérieures se distinguent des autres par la fusion de leur article basal avec le deuxième article de l'endopodite. Nous avons montré plus haut qu'il en est de même dans le *trachelifer*. J'ajoute, comme Claus l'a d'ailleurs observé, que les *trachelifer* au stade mysis avancé sont dépourvus de pléopodes sur le segment abdominal antérieur et que leurs péréiopodes des deux dernières paires restent à l'état de bourgeons non fonctionnels, deux caractères également propres aux mysis de *Gebia*.



FIG. 11.—Trachelifer de la Fig. 9 : maxillipède postérieur et les cinq péréiopodes du même côté.

M. G. O. Sars signale cinq stades larvaires dans le développement de la *Gebia littoralis*; 1°, au premier stade, qui est celui de zoé, les deux paires antérieures de maxillipèdes sont fonctionnelles, et l'on observe les bourgeons, parfois bifurqués, de presque tous les appendices thoraciques suivants, sauf ceux de la dernière paire; 2°, la deuxième forme larvaire tient le milieu entre la zoé et la mysis; tous les appendices thoraciques sont développés et tous, sauf ceux des deux dernières paires, ont une branche endopodiale et une branche exopodiale, mais cette dernière n'est fonctionnelle que dans les quatre paires antérieures (les

 G. O. Sars. "Bidrag til Kundskab on Decapodernes Forvandlinger. I. Nephrops, Calocaris, Gebia" (Arch. for Math. og Naturvid., B. IX, pp. 155-204, Pls. 1-7, 1884).

+ Elle est d'ailleurs acceptée par M. M. Korschelt et Heider qui ont identifié (1892, 471) le *trachelifer* avec la larve de Claus, par M. Scott (1899, 69) et par M. Calman (1909, 301).

M. E.-L. BOUVIER.

trois paires de maxillipèdes et les péréiopodes 1); 3°, la troisième forme larvaire correspond au stade mysis, mais c'est une mysis dépourvue d'exopodites sur les péréiopodes des deux dernières paires, les exopodites des autres appendices thoraciques étant d'ailleurs fonctionnels; il y a des bourgeons de pléopodes, le telson est séparé du 6^e segment abdominal qui porte en arrière des uropodes biramés; 4°, au dernier stade larvaire, la structure est à peu près identique, mais les pinces commencent à présenter une échancrure digitale et les pléopodes sont allongés avec une seule branche. Au stade suivant, la forme *Gebia* est réalisée.

Tels sont les quatre stades larvaires indiqués par M. G. O. Sars; on doit les considérer comme des stades essentiels reliés entre eux par des intermédiaires qui se manifestent à la suite de mues. Du moins en est il ainsi dans notre trachelifer :- les trois premières formes décrites plus haut (4 à 7 mm.) dans cette larve sont des zoés à divers stades, les plus simples sans appendices thoraciques autres que les maxillipèdes des deux paires antérieures, les plus avancés ayant les caractères des larves de Gebia au 2º stade, mais en plus les péréiopodes postérieurs et des uropodes biramés :--la forme suivante (9 mm.) est une mysis imparfaite qui n'est pas encore au stade 3 de la Gebia, car les exopodites des péréiopodes y sont à l'état de bourgeons non fonctionnels; il est probable qu'une simple mue suffit pour que ces bourgeons deviennent natatoires, et que la mysis parfaite des Thalassiniens soit réalisée ;--à la mysis typique font suite, dans le trachelifer, trois stades mysidiens successifs (10 à 16 mm.) cù les péréiopodes antérieurs se terminent par des pinces de plus en plus parfaites, où les branchies sont de plus en plus développées, et où les pléopodes acquièrent progressivement leurs deux rames, le premier de ces stades mysidiens à pinces correspond à très peu près au 4^e stade larvaire décrit par Sars dans la Gebia littoralis.

Ainsi, Claus avait amplement raison de regarder la forme larvaire qui nous occupe comme une larve de Thalassinidé, et sans doute aussi avait-il raison de voir dans cette forme curieuse la larve de la Jaxea nocturna; elle ne saurait être rapportée, en effet, aux autres Thalassinidés méditerranéens qui tous ont une forme larvaire plus différente de celle des Gebia; et d'autre part, Claus observe qu'à un stade avancé elle présente les mêmes branchies que la Jaxea nocturna.

Faut-il croire, avec Claus, qu'une mue devra suffire pour conduire de cette larve lucifériforme avancée à l'individu présentant les caractères de l'adulte ? J'ai sous les yeux deux exemplaires de *Calliaxis adriatica* envoyés jadis au Muséum par Heller; ils sont tout à fait d'un type astacien et si différents du *trachelifer* qu'on pourrait mettre en doute la

OBSERVATIONS NOUVELLES SUR LES TRACHELIFER.

possibilité d'un passage direct de l'un à l'autre. Dans les Thalassinidés comme chez les Paguriens et les Macroures marcheurs cuirassés (Palinuridés, Scyllaridés), un stade intermédiaire doit rattacher la forme adulte à la forme mysidienne, un *stade natant* (pour me servir d'une terme fort juste emprunté à M. Boas) où la forme se rapproche déjà beaucoup de celle de l'adulte, et où la natation s'effectue au moyen des pléopodes dont l'appendice interne présente des rétinacles. Le jeune de *Gebia littoralis* figuré par M. G. O. Sars (1884, Taf. V, Fig. 1) est certainement à ce stade intermédiaire, il mesure environ 6 mm.

Le stade natant de la Jaxea nocturna peut-être imaginé un peu plus long et plus grêle, parce que l'adulte diffère de la Gebia littoralis au point de vue de la gracilité du corps ; par une contraction et une condensation analogues à celles qui se produisent dans le phyllosome passant au puerulus, le trachelifer lucifériforme long de 15 à 16 mm. donnera un natant plus court de moitié et présentant déjà la forme des Jaxées adultes. Cette forme, d'ailleurs, sera aisément reconnaissable à ses pinces astaciennes, qui sont déjà fort longues dans les mysis et qui le sont plus encore chez l'adulte. Ainsi le petit organisme sera aisé à reconnaître et on le trouvera sans doute quelque jour dans les pêches pélagiques au filet fin.

C'est une capture que l'on peut faire à Plymouth, dans les parages de Looe—Eddystone cù l'Oithona fit l'heureuse trouvaille des exemplaires étudiés dans le présent opuscule. Là également devra-t-on rechercher la forme adulte, Jaxea nocturna, mais alors au moyen de pêches effectués sur le fond, au chalut plutôt qu'à la drague. Cette dernière recherche sera certainement bien plus difficile que la première, car la Jaxée adulte est un animal rarissime, trouvé seulement à Trieste, puis à Naples où d'après S. Lo Bianco (1898–99, 503) on n'en put prendre qu'un exemplaire au cours de 25 ans.*

Voilà pour les travailleurs du Laboratoire de Plymouth, un sujet de recherches tout indiqué. Grâce au concours de tout le personnel du Laboratoire, surtout au zèle obligeant de M. le Directeur Allen et de M. Clark, on sait aujourd'hui que la *Jaxea nocturna*, déjà connue à Salcombe sous la forme de larve, habite aussi le voisinage immédiat de Plymouth. Il n'y a pas lieu de douter qu'on trouvera quelque jour, dans les mêmes eaux, le stade natant inconnu et l'adulte de cette espèce.

* Cet exemplaire fut capturé non loin de la station zoologique, par 15 mètres de profondeur, sur fond de vase et sable fin.

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Quelques mots sur la variabilité du Pycnogonum littorale, Ström.

Par

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Avec 2 figures dans le texte.

DURANT mon séjour au Laboratoire de Biologie maritime de Plymouth, j'ai eu l'occasion d'examiner un lot très important de *Pycnogonum littorale*, Ström, qui se trouvait dans les collections de l'établissement depuis le 8 juillet 1908. Ce lot ne comprenait pas moins de 3268 individus. Il avait été recueilli au Barbican Pool, vieux port de Plymouth, dans les filets de pêcheurs qui avaient fait leur capture, disaient-ils, à 200 milles O. N. O. des Iles Scilly. Les exemplaires étaient beaucoup plus nombreux, mais le Laboratoire n'avait pas cru devoir en conserver davantage.

Je ne crois pas qu'on ait signalé jusqu'ici une pareille abondance des Pycnogonides de cette sorte ; évidemment l'espèce devait pulluler aux lieux où elle fut prise. C'est le premier point sur lequel il me semble utile d'attirer l'attention.

J'ai voulu profiter de cette pêche miraculeuse pour mettre en lumière quelques autres faits relatifs à l'histoire du dit *Pycnogonum*.

J'ai constaté tout d'abord que l'espèce atteignait, au point où elle fut prise, des dimensions plutôt fortes; les femelles mesuraient en moyenne 13 mm. du bout de la trompe à l'extrémité postérieure de l'abdomen; les mâles 11 mm. au plus. Les mâles sont à peu près de moitié moins nombreux que les femelles: ces dernières étaient représentées dans la collection par 2082 individus; les mâles par 1186. Sur ce nombre 185 seulement étaient porteurs de masses ovigères.

Ces observations peuvent avoir un léger intérêt mais ce n'est point pour les faire que j'ai passé en revue, successivement, tous les exemplaires capturés ; je voulais profiter de la récolte pour étudier les variations du *Pycnogonum littorale* en un même lieu, surtout espérant trouver, dans cette abondante récolte, un individu anormal quant au nombre des pattes. Mon espoir a été complètement déçu : l'espèce est remarquable par la fixité de ses caractères, les seules variations qu'on y observe sont très légères et relatives à l'inflexion plus ou moins grands de la trompe, au pigment des yeux, au développement des tubercules dorsaux.

Tous les exemplaires avaient le nombre normal d'appendices; tous, sauf un seul (Fig. 1), sur lequel je croisutile d'attirer l'attention. Cet exemplaire est une grande femelle très asymétrique présentant quatre pattes du



FIG. 1.-Femelle anormale de Pycnogonum littorale ; vue du côté dorsal et grossie 2 fois.

côté droit et trois du côté gauche : la dernière patte droite (Fig. 2, p.⁴) est dirigée en arrière suivant l'axe du corps avec un très gros tubercule dorsal sur son article basilaire ; l'abdomen (ab.), faiblement dilaté en arrière, est rejeté obliquement du côté gauche entre la patte précédente (p.⁴) et la dernière, ou troisième (p.³) du côté gauche. Cette anomalie bizarre me paraît due à l'ablation accidentelle de la quatrième patte gauche, non pas chez l'adulte, mais chez l'individu très jeune, alors que les pattes de la quatrième paire étaient encore à l'état de frêles bourgeons ; car on ne voit plus traces, dans l'exemplaire, de la patte perdue.* Ainsi

* La disparition de la 4^c patte gauche a eu pour résultat de faire disparaître l'orifice sexuel correspondant; notre exemplaire ne possède qu'un orifice sexuel, celui du côté droit (*og*).

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un espace serait devenu libre en arrière du côté gauche, et aurait été occupé par l'abdomen et la dernière patte droite.

Il résulte des observations précédentes que le nombre des pattes est absolument constant dans notre *Pycnogonum*. Comme ces appendices se développent successivement d'avant en arrière, il semblerait possible qu'anormalement une cinquième paire pût prendre naissance et, plus possible encore, que la quatrième paire ne se produisît pas. Ces deux anomalies pourraient être interprétées comme le premier pas vers des formes nouvelles qui, dans le premier cas, seraient décapodes, et dans le second, simplement hexapodes. Mais elles ne semblent pas pouvoir se produire et, comme on connaît d'ailleurs trois genres de *Pycnogonides*



FIG. 2.-Extrémité postérieure très grossie de la même femelle ; côté dorsal.

à dix pattes (*Decolopoda, Pentanymphon, Pentapycnon*) appartenant aux familles les plus diverses, il semble naturel de considérer la forme décapode comme une forme ancestrale qui, par réduction dans le nombre des pattes, a conduit au type actuel du groupe, je veux dire au type décapode.

Appendices.-Je viens de recevoir du Laboratoire de Plymouth une petite collection de Pycnogonum littorale recueillie par le S.S. Albatross, au large de Bishops (à 200 milles O. par N.), le 8 décembre 1913. Cette collection comprend 44 exemplaires dont 21 \mathcal{E} et 23 \mathcal{P} . Le corps des plus grands mâles (céphalothorax + abdomen) mesure 8 mm., celui des plus petits 7; la taille des femelles varie entre 10 mm. et 8 mm.; dans les femelles de 8 millimètres, l'orifice sexuel apparaît fort distinctement, mais ne semble pas encore fonctionnel. Ainsi, les femelles où le sexe commence à se manifester quelque peu extérieurement égalent au moins la taille des plus grands mâles. Les mâles, pour une moitié, sont chargés de pontes relativement récentes et tous semblent avoir atteint la maturité sexuelle.

[211]

On Some Plymouth Holothurians.

By

J. H. Orton, A.R.C.Sc., B.Sc., Naturalist at the Plymouth Laboratory.

With 13 Figures in the Text.

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PART I.

ON THE SPECIFIC CHARACTERS OF CUCUMARIA NORMANI PACE, AND CUCUMARIA SAXICOLA BRADY AND ROBERT-SON, WITH AN ACCOUNT OF SOME UNDESCRIBED DIF-FERENTIAL CHARACTERS AND AN INVESTIGATION OF THE VARIATION OF THE GONAD IN C. SAXICOLA.

COMPARISON OF THE CHARACTERS OF C. NORMANI AND C. SAXICOLA.

Some of the specific and differential characters of these two species have already been enumerated by Pace (1). Subsequently Norman (2) NEW SERIES.-VOL. X. NO. 2. JUNE, 1914. denied that these two forms were different, so that the literature on them was left in an unsatisfactory state. On investigating these two forms, however, I have obtained sufficient evidence—from the characters of the gonadial tubes, the calcareous collars, and the young of both forms —to verify the observations of Pace and to meet satisfactorily the objections put forward by Norman against them. The differential characters of these two species as given by Pace (loc. cit.) have been verified in an unpublished investigation by Mr. W. De Morgan and by the present writer. These characters, most of which were observed by Pace, are now given revised * in the following table in a comparative manner, so that the differences between these two species can be readily shown :—

TABLE 1.—A comparison and a contrast of the characters of *C. saxicola* Brady and Robertson and *C. normani* Pace.

Cucumaria saxicola B. and R.

[†] Common on the shore, also taken in depths of a few fathoms.

General colour of body a pure milk white, becoming black when exposed to light.

Surface of body smooth.

Body wall delicate, relatively thin, marked only with transverse striæ due to encircling fibres of the superficial muscle layer, with relatively few spicules.

General body spicules devoid of nodulation, lozenge-shaped in one stage of growth, but subsequently developing 2 or even 3 additional foramina on the ends of the spicule and thus losing their lozenge shape. (See 4, Plate LXXII, Fig. 3.)

Cucumaria normani Pace.

† Fairly common on the shore, also taken in depths of a few fathoms.

General colour of body dirty brownish white, becoming black when exposed to light.

Surface of body much wrinkled.

Body wall tough, coriaceous, crowded with spicules.

General body spicules typically lozenge-shaped, perforated with four large foramina, and always bearing on each side about 12 very prominent nodules. (See 3, Plate XI, Fig. 1.)

* Owing to the fact that both species develop black pigment when and where exposed to light, it follows that the differential characters depending upon the degree of pigmentation of the tentacles and anal aperture noted by Pace cannot be relied upon, and have consequently been abandoned.

+ As an example for illustrating the occurrence of these two forms, in one day's collecting on the shore (3rd April, 1911, Wembury Bay) about 80 *C. saxicola* were obtained and only about 6 *C. normani*, including specimens of various sizes. Another day (1st May, 1911) about 40 *C. saxicola* were obtained and only 2 *C. normani*. This disproportion is usual in this district.
Cucumaria saxicola B. and R.

Surface spicules of body irregular in shape, consisting of rods radiating from a central portion, scattered in the skin. (See l.c. above and also Fig. 6, p. 221.)

Podial spicules have foramina typically in a single series. (See Fig. 6, p. 221.)

Gonadial tubes relatively few, varying in number between 10 and about 60, large, and club-shaped. (See Fig. 1, p. 214.)

Calcareous collar relatively delicate. Internadial calcareous pieces deeply bifurcated posteriorly. (See Fig. 4, p. 218.)

Dorsal ambulacra with modified tube-feet. (See Fig. 9, p. 228.)

Spawning period about May.

Cucumaria normani Pace.

Surface spicules campanulate, forming a continuous covering in the skin of the body. (See Figs. 8 and 7, pp. 225 and 222.)

Podial spicules have foramina in two or more parallel rows or with a group of 3 or 4 small foramina at each end of the spicule. (See Fig. 7, p. 222.)

Gonadial tubes very numerous, frequently more than 500, relatively small, and of even cylindrical calibre. (See Fig. 2, p. 214.)

Calcareous collar relatively strong. Internadial calcareous pieces only slightly bifurcated posteriorly. (See Fig. 5, p. 219.)

Dorsal ambulacra with ordinary ambulatory tube-feet.

Spawning period about March.

The differential characters of most importance in the foregoing table are (1) those of the main body spicules, (2) the spicules near the surface of the body, (3) the shape and number of the gonadial tubes, and (4) the shape and relative stoutness of the pieces of the calcareous collar. Pace has already emphasized the first and second of these characters. These have, however, gained additional importance from the recent observation of their correlation with differences in the gonad and calcareous collar. In *C. saxicola* the gonadial tubes are large, club-shaped, and few in number (see Fig. 1, p. 214), while those in *C. normani* are relatively small, of even, cylindrical calibre, and very numerous. (See Fig. 2, for the faithful drawing of which I am indebted to Mrs. Orton, as well as for all the figures by which this paper is illustrated.) The gonad in the male and female in each of these forms is alike in its structure. The eggs of both species are about the same size, i.e. about $\cdot 4$ mm. in diameter, but the sperm has not been examined closely.

VARIATION OF THE GONAD OF CUCUMARIA SAXICOLA.

The variation in the gonad of *Cucumaria saxicola* has been investigated in 50 adult specimens varying in size* from about 6 cm. to about 10 cm. in length. The gonad in adult *C. saxicola* consists of from about 10 to 60 club-shaped tubes (see Fig. 1, p. 214). These tubes vary in length



FIG. 1.—The gonad and gonoduct of *C. saxicola* B. and R. (Drawn *in situ*, $\times \frac{a}{2}$.) The single tube in the lower part of the figure on the right shows the shape of the tubes in this species better than those in the upper figure. This tube was taken from a male gonad, those in the upper figure constitute the whole gonad of a female.

FIG. 2.—The gonad and gonoduct of C. normani Pace. (Drawn in situ from a female * specimen, $\times \frac{3}{2}$.)

from about 1 mm. to about 3.4 cm.: they are narrowest at the attached end, and vary somewhat in the degree to which the distal end is swollen (see Fig. 1), but at this part they are commonly 3 mm. in diameter. In any particular individual the tubes may vary greatly in size. The

^{*} These specimens were all measured when preserved, but as they were mostly well expanded the measurements may be regarded as roughly comparable.

tubes are arranged to the right and left of the mesentery supporting the alimentary canal in a position which is just behind the middle of the length of the animal. In this species the tubes join up at their attached ends to form a very short duct which unites almost immediately with its fellow on the opposite side to form the main gonoduct. The number of tubes on each side of the mesentery was noticed in all the specimens and recorded in columns 4 and 5 in Table 2 (see p. 215). It was found that the same number of tubes occurs only rarely on each side of the mesentery, but that there is generally about the same number : on the whole, however, more were found on the left than on the right side.

TABLE 2.—Illustrating the variation in the distribution and number of gonadial tubes in *Cucumaria saxicola* of different sizes.

Ref. No.	Approximate Length of Specimen.	Sex	•	No. of Gons On Left Side.	dial Tubes. T Right Side. T	otal.
1.	6.0 cm.	ç :	*	9	6+1 R.†	16
2.	6.0 "	5	tubes full of sperm.	6	11	17
3.	6.3 "	5		7	8	15
4.	6.4 ,,	5		6 + 1 R.	12 + 3 R.	22
5.	6.6 ,,	Ŷ		5 + 1 R.	3+1R.	10
6.	6.6 "	5	tubes full of sperm.	12 + 1 R.	8 + 2 R.	23
7.	7.0 ,,	Ŷ	tubes up to 2.6 cm. long.	2 + 1 R.	12 + 1 R.	16
8.	7.0 ,,	5		14	16	30
9.	7.0 ,,	5		16	15 + 2	33
10.	7.0 ,,	5		12	9	21
11.	7.0 ,,	5	tubes full of sperm.	22	17	39
12.	7.0 ,,	5		16	7	23
13.	7.0 ,,	5		17 + 3 sm.	$13 + 3 \text{ sm.}^{\dagger}$	36
14.	7.0 ,,	ç		8	10	18
15.	7.1 ,,	5		14	8	22
16.	7.3 "	Ŷ		4 + 2 R.	3+1 R.	10
17.	7.3 ,,	5		12 + 4 R.	10 + 3 R.	29
18.	7.3 "	Ŷ		9	9+1 R.	19
19.	7.4 ,,	Ŷ		10	7	17
20.	7.4 ,,	Ŷ		10 + 2 R.	7 + 1 R.	20
21.	7.4 ,,	Ŷ		12	12	24
22.	7.5 ,,	5		30 + 1 sm.	30	61
23.	7.5 "	5		18	11	29
24.	7.5 ,,	Ŷ		6	4	10
25.	7.8 "	5		12	8	20

* Eggs in various stages of development were observed in the tubes of all the females.
† R. means a rudimentary; sm. a rather small tube.

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Ref. No.	Approximate Length of Specimen.	Sex.		No. of Gonad On Left Side.	lial Tubes. Right Side.	Total,
26.	7.9 cm.	Ŷ	very large tubes.	6 + 1 R.	6	13
27.	8.0 ,,	Ŷ		8	10	18
28.	8.0 ,,	5		8	9	17
29.	8.0 ,,	5	· modeling and starting in	13	16	29
30.	8.3 "	9		13 + 1 sm.	12 + 1 sm.	27
31.	8.5 ,,	5		6	7	13
32.	8.5 ,,	Ŷ		13	15	28
33.	8.5 ,,	9		13	13	26
34.	8.5 ,,	5		21	28	49
35.	8.5 ,,	9		15	18	33
36.	8.5 ,,	5		29	23	52
37.	8.7 ,,	9		7 + 1 sm.	7 + 1 sm.	16
38.	·8·8 "	9	tubes up to 3.0 cm. long.	13	14	27
39.	8.8 ,,	5		14	15	29
40.	8.8 ,,	9		10	13	23
41.	9.0 ,,	5		11 + 3 sm.	11	25
42.	9.0 ,,	5		12+12 sm.	14+12 sm	. 50
43.	9.0 ,,	9		12	10	22
44.	.9.0. ,,	5		11 + 1 sm.	11	23
45.	9.5 ,,	9.	tubes up to 3.4 cm. long.	16 + 1 R.	15 + 1 R.	33
46.	10.0 ,,	5		16	21	37
47.	10.0 ,,	9		7	12	19
48.	10.0 ,,	Ŷ		8	4	12
49.	10.0 "	Ŷ		12	8	20
50.	10.0 "	5		14	12	26

A glance at the last column of Table 2 shows at once that the variation in number of the gonadial tubes in this species is distributed sporadically among individuals, and that the number does not necessarily increase with the size of the adult animal. Since the number of gonadial tubes is variable, it is of interest to examine the relative frequencies of the occurrence of any particular number. The frequencies of particular numbers, as, for example, of numbers between 10 and 15, and 16 and 20, and so on, have been plotted to give the curve in Fig. 3, p. 217. As, however, the number of individuals examined is small, the curve is less symmetrical than it would probably have been if a thousand specimens could have been examined. The ideal curve indicated by that in Fig. 3 would doubtless have one maximum in the region of 24 and 25, as indicated by the dotted line. Whether, however, the smaller crest of the curve (between 40 and 50) would become more important can only be found out by further investigation. The usual number of gonadial tubes in C. saxicola may therefore be fairly stated as 24 or 25. Curiously enough, about 25 is also the average number of tubes given for the whole of the 50 specimens examined. There is variation, however, in the number of gonadial tubes in this species between 10 and 61, as has already been observed.

It is an interesting fact that the males appear to be more variable in this respect than the females, although the small number of individuals examined necessitates caution in making this suggestion. Of the 50 specimens examined 24 were females and 26 males. The number of gonadial tubes in individual females varied between 10 and 33, whilst in the males the variation lay between 15 and 61. The total number of gonadial tubes in all the females was 477, giving an average of less than 20, while all the males gave a total of 769, giving an average of about 29.5.





Ordinates=frequencies; abscisse=number of gonadial tubes between 10 and 15, 16 and 20, and so on. The continuous line denotes the actual curve obtained, the dotted one an approximation to the form of the curve if a larger number of individuals were examined.

THE GONAD OF CUCUMARIA NORMANI.

The gonad of C. normani consists of a very large number of small cylindrical tubes of almost even bore. These tubes are arranged as in C. saxicola, on each side of the mesentery supporting the alimentary canal. The tubes on both sides open into one longitudinal collecting duct which extends in the mesentery some distance behind and in front of a point about the middle of the length of the body. This duct is

continued anteriorly as the main gonoduct (see Fig. 2, p. 214). The largest individual tubes in a very fine specimen were found to be about 3.0 cm. long, and less than 1 mm. wide.

The number of tubes was counted for the purpose of comparison with those in *C. saxicola* in 6 individuals, of which 3 were males and 3 females. In these specimens, whose lengths were (1) 5·3, (2) 7·2, (3) 8·2, (4) 8·6, (5) 9·0, and (6) 12·5 cms., there were respectively 528, 582, 473, 513, 839,* and 250 tubes. A similar large number of tubes was, however, observed in all the specimens obtainable, namely, 30, of sizes similar to those given in Table 1. A comparison with similar specimens of *C. saxicola* from



FIG. 4.—External view of the calcareous collar of *C. saxicola* drawn from a glycerine preparation after separating the ventral piece from the adjacent right radial piece $(\times \frac{20}{3})$.

Table 2 indicates at once the great difference in this respect between the two species. The number in the specimen drawn for Fig. 2 was not counted. In this figure it may be mentioned that the tubes shown are chiefly those constituting the upper of several similar layers.

It is an interesting fact that the examination of the gonad of even these few specimens of *C. normani* indicates a similar range of variation to that observed in *C. saxicola*, namely, that the males (numbers 1, 2, and 5) possess more gonadial tubes than the females (numbers 3, 4, and 6), that the number of these tubes is not necessarily larger in the larger individuals, and that within the species there is a wide range of variation in the number of the gonadial tubes, which may vary from about 250 to more than 800.

* At least this number were present. Thirty-nine tubes which might have been broken were not added to the total.

The number of gonadial tubes was also counted in a few small specimens of *C. saxicola* and in one small immature specimen of *C. normani*. In specimens of the former of 3.8, 3.1, and 2.8 cms. in length, there were respectively 8, 4, and 6 small tubes, while in the specimens of *C. normani* of 3.3 cms. in length there were 199 tiny tubes.

It is thus evident that there is a marked difference between C. saxicola and C. normani in the characters of the shape and number of the gonadial tubes.



FIG. 5.—External view of the calcareous collar of *C. normani*, drawn from a glycerine preparation after separating the ventral piece from the adjacent right radial piece $(\times \frac{2}{3})$.

CHARACTERS OF THE CALCAREOUS COLLAR OF C. SAXICOLA AND C. NORMANI.

The calcareous collars of both C. saxicola and C. normani consist alike of 5 radial alternating with 5 internadial pieces, and in both forms three of the ventral pieces, one radial and two internadials, are partially fused together. (See Figs. 4 and 5.) There is, however, a general difference in the relative stoutness of the collars in the two species, and some differences in the shapes and mode of connexion of the parts.

The collar of C. saxicola is relatively delicate, that of C. normani relatively stout. In specimens of the two species of about the same size, both the radials and interradials in C. normani are stronger, wider, and longer than in C. saxicola. (See Figs. 4 and 5.) In the latter species the interradials are deeply bifurcated at the posterior end (see Fig. 4), whereas in C. normani these plates are only slightly bifurcated (see Fig. 5), and the radials of C. normani differ from those of C. saxicola in being deeply constricted at the sides near the posterior end. Further, in C. saxicola there is a long narrow calcareous connecting loop between the radials and interradials, whilst in C. normani the similar connecting pieces are short and stout and produced posteriorly to a point. Hence the collar of C. saxicola is doubtless capable of much greater expansion than is that of C. normani. The shapes of these collars can be easily seen in preparations made by first soaking the anterior end of the animal in glycerine and afterwards dissecting away the surrounding tissue and mounting the collar in glycerine or glycerine jelly. This was found to be a better method than treating the collars with potash.

CHARACTERS OF THE SPICULES AND TUBE-FEET IN C. SAXICOLA AND C. NORMANI.

The characters of the spicules in C. saxicola have already been well described by Brady and Robertson (4). These characters have been confirmed by De Morgan (loc. cit.) and the present writer. They have also been found to co-exist with the characters of the gonad and calcareous collar given above for the species.

The spicules of the adult C. normani have also been well described and figured by Norman (2 and 3, Plate XI, Figs. 1, 2, 3, and 4) from his specimen labelled A. Spicules identical with these have been found to be correlated with a gonad consisting of a large number of small tubes and a calcareous collar as described above.

It is therefore only necessary here to point out the main features of difference between the chief kinds of spicules occurring in these two forms. The chief body spicule in *C. saxicola* is plate-like and rhomboidal in outline, having the opposite ends of one axis more or less produced. The central portion of the spicule is perforated by four holes, placed along the long axes and around the centre of the spicule. On the produced axis of the spicule one, two, or even three additional holes may be developed. In some individuals the holes on the shorter of the long axes are usually circular, while those near the centre on the long axis are more or less ellipsoidal in outline and larger than the former: in other individuals, however, the relative sizes of these foramina are reversed (see Brady and Robertson, 4, Plate LXXII, Fig. 3).

The chief body spicule in C. normani is also plate-like but ellipsoidal in outline; it has rarely more than four foramina, and bears on each surface usually 12 rounded bosses or nodules. The foramina are arranged diamond-wise along the long axes of the spicule. There are a great many more spicules in a given area of the body wall in C. normani than in C. saxicola, as may be easily seen in preparations of the skin: it is difficult to obtain exactly comparable specimens, but at a rough computation one would doubtless be well below the actual proportion in stating that they are twenty times more numerous in C. normani than in C. saxicola.

The surface body spicules in *C. saxicola* are well shown in Brady and Robertson's figure (4, Plate LXXII, Fig. 2). They are microscopic, stellate, of varying shape and size, but rarely more than 30 μ . wide, and scattered



FIG. 6.—A single tube-foot of C. saxicola, showing the kind and number of the podial spicules (\times about 30).

sparsely over the body. Usually they consist of a thin central plate from which radiate tiny cylindrical rods about 12 μ . long. On the other hand, the corresponding spicule in *C. normani* is bell-shaped, being slightly rectangular across the mouth of the bell, where on the average they measure about 40 μ . by 36 μ . These spicules are almost uniform in size, forming a continuous covering over the whole of the body and passing on to the bases of the tube-feet. Their compactness may be gathered from Fig. 8, which is a view through a low power of a microscope of a portion of the body wall of a small specimen in which, however, only one of the bell-shaped spicules is fully developed.

The podial spicules in *C. saxicola* are, as Pace has shown (loc. cit.), usually perforated with a single series of holes. These are well shown in Fig. 4, which is a drawing of a whole tube-foot well expanded (taken from specimen 45, Table 1). One of the microscopic surface spicules only is present. In *C. normani*, on the other hand, these spicules are mostly larger, and with two or more series of foramina (see Fig. 5, p. 219).

This figure is a drawing of a tube-foot of a specimen of C. normani 5.3 cm. long, taken from the right ventral ambulacral row—as was that of C.saxicola, shown in Fig. 6, p. 221. A comparison of these two figures, which may be regarded as typical, indicates the differences which occur in the podial spicules of these two forms. Those in C. saxicola are relatively few, mostly straight, with foramina in a single series, although there may be spicules with more than one series. Those in C. normani, on the other hand, are mostly broadly V-shaped, with foramina in two or more series : some spicules, however, are straight, with foramina in single series, as in C. saxicola. There are also a few bell-shaped surface spicules around the base of the tube-foot.

The difference in the relative number of spicules in these two forms



FIG. 7.—A single tube-foot of C. normani, showing the kind and number of the podial spicules (× about 65).[§]

is also well shown in these figures, and this difference is emphasized still more by the fact that not all the spicules in the tube-foot of C. normani could be drawn.

DISCUSSION OF SOME FORMER OBSERVATIONS ON C. SAXICOLA AND C. NORMANI.

The establishment of undoubted specific and differential characters given in the preceding pages—for these two species enables a partial clearing up to be made of the literature referring to these forms. Norman (3) in 1893 described three specimens, A, B, and C, of *Cucumaria* obtained at Polperro in 1865 as *C. montagui*. Subsequently Pace (1) in 1904 showed that one of Norman's specimens, A, was undoubtedly the same

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as the Plymouth species known at that time at Plymouth as C. planci, while the other two, B and C, were similar to the species known at that time at Plymouth as C. pentactes. After discussing the synonymy of Norman's C. montagui, Pace showed (1) that this name is a complex one, whose original form could not be traced, (2) that C. planci Brandt "cannot be applied to the very different species from Plymouth," and (3) that C. pentactes (Linnæus) "is now generally regarded as an indeterminate species." He therefore proposed to abolish all these names, substituting C. normani for the Plymouth C. planci and specimen A of Norman's C. montagui; and C. saxicola Brady and Robertson for the Plymouth C. pentactes, and B and C of Norman's C. montagui, which were shown to be identical with a species described in 1871 by Brady and Robertson as C. saxicola.

The researches here described support Pace's contention that Norman's C. montagui consisted of two species, subsequently named by Pace as C. normani Pace, and C. saxicola Brady and Robertson.

In 1905 Norman (2) wrote a paper maintaining his former views, which at this stage can be stated to be as follows: That he considered the Plymouth C. saxicola as the young of the Plymouth C. normani Pace, and that both were really equivalent to C. montagui Fleming. Norman's main contention in this paper is that the Plymouth C. saxicola are the young of the Plymouth C. normani. He, however, freely states that "When young specimens of C. montagui, say 14 mm. long, should be found having spicules agreeing with those of the adult, my view that B and C are young forms of that species would require to be reconsidered." In further support of his view Norman cited the known facts that spicules found in the young of some forms (for example, C. frondosa) disappear in the adult, and that spicules which in the young of some forms are smooth (for example, C. hyndmanni) become nodulous or thickened in older specimens.

The correlation of differences in the gonad and calcareous collar with the differences in the spicules described above is doubtless sufficient to establish the distinctness of these two species. Fortunately, however, tiny young ones of both species have been obtained, and so enable a comparison of both forms to be made throughout all stages of growth.

Besides these, however, De Morgan also obtained tiny C. normani. In his unpublished MS. he states: "I have examined specimens of both species from about one centimetre to three inches in length, both fresh and preserved in spirit, and find the plates that distinguish C.normani confined to C. normani; and those of C. saxicola to C. saxicola."

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Tiny specimens of *C. normani* were obtained by the writer from a floating raft moored in Cawsand Bay, just outside Plymouth Sound. These specimens measured about 13 and 14 mm.; in fact, just the size Norman wished for. These specimens were examined while living, and sketches made *from the living animal* of all stages of growth of the bell-shaped spicules.

Subsequently a preparation was made of the skin of these animals and a drawing of the spicules made *in situ* for Fig. 8, p. 225. This figure shows the different stages of growth of the bell-shaped spicules and also the degree in which these spicules are crowded in the surface of the skin. The young of *C. saxicola* have been reared by the writer from the egg to a size of about 5 mm., i.e. somewhat smaller than the tiny *C. normani* mentioned above. In these no bell-shaped spicules developed, although the body spicules were well formed. Specimens of all sizes of both species have been obtained from dredgings, forming a parallel series from the tiny ones mentioned above to the adults of sizes whose gonadial tubes and other correlated characters have been described. The evidence for the distinctness of these two forms is thus complete, whatever their ultimate names may be decided to be.

THE GROWTH-STAGES OF THE BELL-SHAPED SPICULES OF C. NORMANI.

The tiny specimens of C. normani mentioned above presented an opportunity of following the development of the bell-shaped surface spicules of this species. These spicules develop in four well-defined stages. In the earliest stage they consist of a microscopic plate forked at both ends (see Fig. 8 for this, as well as for the following stages). At a later period of development each of the forked ends divides dichotomously twice to give two succeeding well-marked stages. At the same time the central portion of the spicule becomes wider and thicker, and the growing arms arch outwards to form a hemisphere. At this stage one branch of each of the last-formed bifurcations grows towards a similar branch derived from the subdivision of the adjacent primitive prong. These branches grow together, but frequently become slightly forked again before fusing to form the rim of the spicule. The whole spicule at this stage becomes thickened, and generally two branches of the third order of division persist as projections at each of the four corners and one in the middle of each side of the rim when the spicule is fully formed. There are, however, sometimes variations from the general course. Occasionally three or five original prongs may develop and a

three- or a five-rayed spicule is produced, at other times further subdivision of the branches of the third order occurs, giving rise to bellshaped spicules slightly different from the usual form ; the normal form is, however, the one described above.



FIG. 8.—The campanulate surface spicules of *C. normani*. Drawn from a piece of the skin (mounted whole) of a specimen 13 mm. long to show a series of stages in the development of these spicules and their compact arrangement.* One fully developed spicule is depicted (× about 300).

THE SYNONYMY OF C. SAXICOLA BRADY AND ROBERTSON AND OF C. NORMANI PACE.

It will be evident from the foregoing accounts that the synonymy of the two species mentioned above may be expected to be and actually is in a highly confused state. This confusion has been rendered still worse by the fact that continental zoologists have regarded *C. montagui* as a good species, whereas it has been shown to be a complex one. Thus according as the one or the other constituent of *C. montagui* has fallen into the hands of these zoologists, the other constituent—on the Continent —has been given another name. There can be little doubt that the two species discussed in this paper do occur on the Continent, but at present

^{*} Drawings were made of some of these stages of development from the fresh living animal as a safeguard against their possible subsequent alteration in preservation. It was found, however, that the spicules in the mounted specimen agreed with the drawings from the living animal.

pass under other names. It is therefore improbable that the literature on these Holothurians will be properly purged until some specialist can take the whole group into consideration and obtain and compare type specimens from the various authors and stations.

A few observations on the literature may, however, be useful. From the establishment of the complex nature of *Cucumaria montagui*, it seems highly probable that the earlier British naturalists were familiar with the constituents of the complex under the names of *Holothuria pentactes* and *H. pentactes* var. *montagui* Fleming. The descriptions of these animals are, as Norman has already pointed out (1905), insufficient to enable us to identify them. These names should therefore be abandoned on this ground if on no other. In 1828 Fleming (5) called *H. pentactes* var. *montagui* definitely *H. montagui*, but, as Pace (1904) pointed out, Fleming unfortunately based his description of this form on specimens which were obtained from the Firth of Forth and which may have belonged to another species. Thus we have no criterion as to what *Cucumaria montagui* really is.

In 1871 Brady and Robertson (4) discovered a species of *Cucumaria* in Westport and Birterbury Bays, Ireland, and gave a good description of the spicules. This species they named *C. saxicola*. In 1882 Barrois (6) found a species of *Cucumaria* at Concarneau on the shore which he called *C. lefevrei*. This species resembles that described by Pace (1904) as *C. normani* closely in the characters of its spicules (as described) and its calcareous collar. It is, indeed, highly probable that these are the same species, but it would be necessary to compare actual specimens of these forms to be certain of their identity. If, however, such were established Pace's name would have to give way to that of Barrois'. It should be pointed out that Barrois' figures do not agree with his description.

In 1889 Hérouard (7), having apparently never seen Brady and Robertson's description of C. saxicola, described a form apparently identical with the latter as Colochirus lacazei n.sp. It is a somewhat amusing fact that this writer was roundly accused shortly afterwards by Marenzeller (8, 1893) of wilfully renaming what he well knew was C. montagui. It is also of interest that Marenzeller—like Pace—states confidently in the same paper that C. montagui is quite and obviously different from C. lefevrei Barrois. Now Marenzeller's C. montagui were sent to him by Norman (2, p. 389), who definitely states they were like his specimens B and C, which have been shown above to be C. saxicola.

About the same time Ludwig and Hamann (9, 1892) state, but with-

out giving a discussion, that C. lacazei Hér. =C. lefevrei Barrois. It is thus a curious fact that two pairs of men, one in England and one on the Continent, should hold independently similar conflicting views on what appears to be the same pair of species.

A little later Koehler (10, 1893), discussing the synonymy of C. montagui Fleming, gives as synonyms among others C. lacazei Hér., Holothuria montagui Fleming, and Cucumaria pentactes Bell, pointing out, however, at the same time that C. montagui differs from C. lefevrei in the shape and number of its genital tubes. He also figures spicules of C. montagui which are identical with those of C. saxicola. Now Koehler also received his specimens of C. montagui from Norman, who admits, as we have seen, that those sent were identical with his specimens B and C, i.e. with C. saxicola.

About this time Bell (11) added his quota to the confusion by giving as synonyms Holothuria montagui Fleming, Cucumaria pentactes Forbes, C. elongata Düb. and Kören. In 1902 Perrier (12) obtained C. elongata from the Gulf of Cadiz, and stated that this species is fundamentally different from C. montagui: he did not indicate, however, what were the characters of his C. montagui. Kemp (13) in 1905 described C. elongata Düb. and Kör. from Ireland and figured its spicules. Subsequently I obtained specimens of this species from various localities in this neighbourhood (see description on p. 229) from which there can be no doubt of the distinctness of this species.

From the foregoing historical account it appears that the complex, Holothuria montagui, of the older naturalists has subsequently been renamed as Cucumaria saxicola Brady and Robertson, C. lefevrei Barrois, Colochirus lacazei Hér., and C. normani Pace, as well as other names. Of these four names one pair, C. saxicola and Colochirus lacazei, seem to be undoubtedly synonymous; from the apparent identity in the characters of the spicules and genital tubes it is highly probable also that the other pair are synonymous. It is important, however, that these latter forms should be compared in actual specimens before making further alterations of names; hence until the whole of the European Cucumarians are revised by a specialist, the name C. normani Pace may be said to stand for that constituent of the old C. montagui whose characters are summed up in the foregoing pages.

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P

CORRELATION IN THE CHARACTERS OF THE GONAD AND AMBULACRA IN THE GENUS CUCUMARIA.

The difference in the character of the gonad in *C. saxicola* and *C. normani* described in the foregoing pages suggested that similar differences might occur in other Cucumarians. On investigating the other



FIG. 9.—View of *Cucumaria saxicola*, showing the five ambulacral rows $(\times \frac{3}{4})$. The view is mainly lateral from the right side, but the posterior end of the animal is turned somewhat dorsalwards to show in this region the three ventral ambulacral rows. These rows are seen to consist of suctorial tube-feet. On the upper right side of the figure are seen the two dorsal ambulacra, the right one of which is continued in profile to the posterior end of the body; both rows are seen to consist merely of ambulatory papillæ, except at the anterior end, where there are a few suctorial tube-feet.

species of this genus occurring in this district, it was found that they fall into two groups, having the following characters :---

GROUP A. Species whose gonad consists of numerous short cylindrical tubes, and whose dorsal as well as ventral ambulacra have well-developed tube-feet.

> In this group fall the species normani, hyndmanni, elongata. (Compare Fig. 10, p. 230.)

GROUP B. Species whose gonad consists of relatively few, large, clubshaped tubes and whose dorsal ambulacra contain mostly ambulatory papillæ, which are less numerous than the tube-feet in the ventral rows, but with a few definite tube-feet at the anterior ends. (See Fig. 9, p. 228.) In this group fall the species saxicola and brunnea.

Now the genus *Colochirus* differs in the literature (9, p. 343) from the genus *Cucumaria* mainly in having ambulatory papillæ in the dorsal ambulacra. It is possible, however, that when the gonad in species of

Colochirus is examined it may be found to be similar to that in C. saxicola and C. brunnea.

With regard to the Group B given above, it is an interesting fact that Norman himself (2, p. 382) states that some of his specimens (which have been shown to belong to *C. saxicola*) would be placed by some naturalists in the sub-genus *Colochirus* merely on account of the characters of the dorsal ambulacra, and also that Hérouard placed what is almost certainly *C. saxicola* in that very genus as *Colochirus lacazei*. It is not improbable, therefore, that when the European *Cucumarians* are revised the whole of the genus *Cucumaria* may be divisible into two groups similar to those given above, and that those specimens having the characters of Group B may have to be designated as species of the genus *Colochirus*.

PART II.

ON THE OCCURRENCE OF CUCUMARIA ELONGATA DÜB. AND KÖR. AND THYONE RAPHANUS DÜB. AND KÖR. IN THE PLYMOUTH DISTRICT.

During the period from March, 1911, to Sept., 1912, numerous specimens of *Cucumaria elongata* Düb. and Kör. were obtained at various stations in the Plymouth district. These specimens were nearly all taken in a dredge with a fine-meshed net, worked from the Laboratory steamer *Oithona*. The depths from which these *Cucumarians* were dredged varied from about 5 to about 30 fathoms, and the nature of the bottom in which they were living was almost invariably muddy, but varying from fine mud in Plymouth Sound and off Rame Head, to muddy gravel in the region about 2 miles south of Wembury Bay, and to fine muddy sand on the Rame-Eddystone Trawling Ground. (See 16 and 17.*) There can be little doubt that *C. elongata* is fairly common in this district on all the muddy grounds, and is probably not uncommon on the fine sand of the outer grounds.

The captures of this species have been made at 15 stations within a small area, so that the distribution can be described with reference to the various grounds already defined in earlier volumes of this Journal (16* and 17) as follows :—

Plymouth Sound. On one occasion (18th May, 1911) 4 specimens

* See these references for a description of the grounds in the Plymouth district. Since those accounts were written in 1899 and 1904 there has been a good deal of mud deposited on the various grounds just outside the Sound from dredgings in the harbour. were taken in one haul of the dredge in the middle of Plymouth Sound, while on the date 23rd March, 1911, one specimen was obtained similarly in the same locality. Many unsuccessful hauls have, however, also been made.

Off Rame Head 6 specimens were taken in the dredge in mud about 1 mile south of the headland. Five of these specimens were taken in one haul of about five minutes' duration.

From the region of the Mewstone "Amphioxus" Ground, between and about the points $1\frac{1}{2}$ to 2 miles south of the Mewstone and Yealm Point, captures of *C. elongata* were made in the dredge on seven different occasions. On the 3rd June, 1912, 12 specimens were obtained in about half a day's work with the fine-meshed dredge. In all, about 20 specimens have been obtained from this ground.



FIG. 10.—Cucumaria elongata well expanded, showing the tentacles and dorsal ambulacra (\times 3/2).

Two specimens have been taken on different occasions on the Rame-Eddystone trawling grounds, both from a position about 5 to $5\frac{1}{2}$ miles S. $\frac{1}{2}$ E. of Rame Head.

The total number of specimens obtained from all the grounds is about 35. They varied in size from about 1.4 cm. long and 2.5 mm. broad to 6.6 cm. long and 9 mm. broad at the broadest part. The specimens when caught were U-shaped, or more or less S-shaped, with a tapering posterior end, and varied in colour from a purplish brown to a browny grey.

NOTES ON CUCUMARIA ELONGATA.

The discovery of this species in the Plymouth district is of some interest with regard to the unravelling of the synonymy of British *Cucumarians*. Bell in 1892 (11, p. 38) gives *C. elongata* Düb. and Kör.

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as a synonym of C. *pentactes*, most of the specimens of which he records from Plymouth.

It has been shown in the foregoing pages that the Plymouth species called *C. pentactes* in 1892 is undoubtedly the same as Brady and Robertson's *C. saxicola*. This species is, however, totally different from *C. elongata* Düb. and Kör., as may indeed be gathered from the description of this animal given by Düben and Kören (14). Kemp (13) has recently given a good description of the external characters and spiculation of *C. elongata* Düb. and Kör. from Ireland. The Plymouth specimens agree well with Kemp's description and with that given by Düben and Kören themselves. There is thus no doubt that *C. elongata* is a good species and quite different from other Plymouth *Cucumarians*.

Some of the specimens obtained have been kept under observation alive for as long as nine months embedded in fine sand. In life the posterior end of the body, "the tail," protrudes above the surface of the



FIG. 11.—Drawing from life of the "tail" of *Thyone raphanus* protruding from the sand $(\times 4)$.

sand presumably for the purpose of respiration. (Comp. Fig. 11.) The body is bent in a U- or S-shaped fashion as was observed in the freshly caught animal. During the whole of the period these animals were kept the tentacles have rarely been seen above the surface of the sand. It is possible, therefore, that the animal feeds mainly by ingesting mud or sand, as it is apparently much too sluggish to search actively for food. The tentacles in this species are very short, as may be gathered from Fig. 10, which is a drawing of a specimen narcotized by menthol. In this figure is well shown the double rows of tube-feet near the middle of the body and the gradual passage into single rows towards both the tapering ends of the body.

It has already been noted that the gonadial tubes of this species are numerous and cylindrical, resembling those of *C. normani* both in shape and approximately in numbers. The retractors of the buccal mass are extremely short and altogether poorly developed.

The gonads of female specimens taken in June and July were found to contain nearly ripe eggs; in July, 1912, a specimen was obtained with active sperm and an unsuccessful artificial fertilization tried. It is highly probable, however, that the species breeds a little later than this time of the year, as specimens taken in early May and September had only immature ova in the gonad.

ON THYONE RAPHANUS DÜB. AND KÖR.

Nine specimens of *Thyone raphanus* Düb. and Kör. were taken at various times between July, 1911, and July, 1912. These specimens were captured, except in one case, in the fine-meshed dredge in muddy sand or in muddy gravel in depths from about 12 to 30 fathoms. Four specimens were taken on one occasion $1\frac{1}{2}$ to 2 miles S. of the Mewstone, and on another one specimen $1\frac{1}{2}$ miles off Yealm Point. Two were obtained in July, 1911, about 3 miles S. of Rame Head, and two in May,



FIG. 12.—*Thyone raphanus.* The body portion was drawn from the living animal and the tentacles afterwards added from a preserved specimen $(\times \frac{9}{2})$.

1912, in a position 5 to $5\frac{1}{2}$ miles S. $\frac{1}{2}$ E. of Rame Head. In the same month one specimen was taken in the trawl on the inner portion of the Rame-Eddystone trawling grounds.

The specimens varied in size from 2.5 cms. long by 7 mms. wide at the widest part to 6.2 cms. long by 1.1 cms. wide, the measurements being taken from the preserved animals. Their general colour was of a creamy white, and when obtained from the dredge they were bent in the form of a U. In none of the specimens examined were ripe sexual products found, hence it is likely that breeding occurs during the winter months. The spicules from the skin, tube-feet, and tentacles agree closely with those given by Düben and Kören (14, Plate V, Figs. 49 to 55). There are, however, some spicules with bosses arranged concentrically around the foramina, but probably the Figures 50, 51, and 54 in the aforementioned plate are an attempt to represent these bosses. The calcareous

ON SOME PLYMOUTH HOLOTHURIANS.

collar is shown in Fig. 13, from which it will be seen that it is very similar to the portion figured by Marenzeller (18): the connecting pieces are not calcified in the smaller forms. The polian vesicle is single and very

FIG. 13.—External view of the calcareous collar of *Thyone raphanus* Düb. and Kor. drawn from a glycerine-jelly preparation after separating the ventral piece from the adjacent right radial piece : the polian vesicle and the stone canal are shown attached to the collar* (\times 9).

long, and longer in the larger than in the smaller specimens; in preserved specimens it may be dilated at the proximal or the distal end, or at both ends.

* The constituent pieces of the collar are somewhat delicate, so that drawings from potash preparations are liable to be inaccurate, inasmuch as the middle portion of the radials is very thin and might easily be abraded to give such a figure as is drawn by Barrois for *T. poucheti* (loc. cit.).

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It is unfortunate that Düben and Kören did not figure the calcareous collar and polian vesicle of the type specimens, for Barrois has described a form which only differs from T. raphanus in having a bifurcated polian vesicle. Neither of these authors, however, found more than one specimen. The Plymouth specimens agree with Barrois' form except in the calcareous collar as figured by Barrois and the presence of tube-feet on the "tail" (cf. 6, Plate I, with Fig. 11, p. 231, and Fig. 13, p. 233), and they agree also with Marenzeller's form except in the polian vesicle as figured by Marenzeller. As, however, Théel (19) had already doubted the distinctness of T. poucheti, it is very probable that all these forms belong to Düben and Kören's species T. raphanus. There is some ground for believing that Barrois' figure of the delicate calcareous collar of his Thyone is not a typical one; and Marenzeller's figure of a bifurcated polian vesicle requires confirming in more specimens. Therefore for the present it has been deemed advisable to refer the Plymouth forms to T. raphanus Düb. and Kör. If, however, the type of the latter species is found to possess constantly a bifurcated polian vesicle, then the forms from this district probably belong to T. poucheti Barrois.

Several individuals of this species were kept under observation alive for some months in the same dish with the C. elongata mentioned above. These specimens maintained their tails above the surface of the sand, as is shown in Fig. 11, in the same way as did the Cucumarian. The tentacles have, however, only been seen expanded above the surface of the sand on two occasions when the water was becoming foul, and it was observed that the body was maintained bent in a U-shaped manner. The tentacles in this species are very short (see Fig. 12), as in C. elongata. This reduction of the tentacles and buccal retractors and the correlated tailed posterior end are also found in the group Malpodiida, which also inhabit muddy situations and have been found to ingest the muddy sand in which they live (15). Doubtless these characters of the tentacles are related to the manner in which all these animals feed, for short stiff tentacles would be much more useful for ingesting mud or fine sand than the long dendritic tentacles such as are found, for example, in some other species of Cucumaria and Thyone. Thus these mud-dwelling Holothurians form one more example of that interesting phenomenon in nature, namely, the occurrence of similar adaptations in different animals for performing the similar functions necessitated by a similar mode of life.

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On Anthura gracilis (Montagu).

By

E. W. Sexton.

With 12 Figures in the Text.

ON August 14th, 1913, a fine male specimen of *Anthura gracilis* was taken by the *Oithona*, in the young-fish trawl working at the surface at night, about six miles west of the Eddystone.

An excellent account of the female and young male has been given by Norman and Stebbing (*Trans. Zool. Soc.*, Vol. XII, p. 122), but, as far as I am aware, the adult male has never been described, and as it differs considerably in appearance from the female, I have figured it here, adding to Norman and Stebbing's description some notes made on the Plymouth specimens.

Female specimens are occasionally found in the dredgings from Plymouth Sound, but males are rarely captured.

Very little is known of the habits of the species. The females are evidently much more sedentary than the males; they are more heavily built, the body stouter, the mouth organs larger, and the first gnathopods much heavier and bigger than in the male (cf. Figs. 9 and 11). Stebbing, in his History of Crustacea, 1893, p. 335, makes an interesting suggestion with regard to these animals and their mode of life. In referring to the Eisothistos vermiformis of Haswell and its habit of living in the tube of a Serpula with its tail at the mouth of the tube, the uropods and telson mimicking in appearance the operculum and branchiæ of the worm, he says: "Probably the British Anthura gracilis may use a similar shelter, since it is undoubtedly dredged up in company with shells and stones on which the tubes of Serpulæ are abundant." An observation recently made by Mr. Crawshay (Mar. Biol. Journ., Vol. IX, No. 3, 1912, p. 351) appears to support this suggestion, at least as far as the female is concerned. In the material trawled at forty-two fathoms he found one specimen of this species, a female, head inwards in a tube of Sabellaria spinulosa. He noted the position of the tail appendages lying nearly flush with the opening of the tube, and added: "Their

appearance was so deceptive to the eye that they might easily be mistaken at a rough glance for the anterior region of the original occupant of the tube." On the other hand, it must be stated that an examination



Anthura gracilis. FIG. 1.-3, dorsal view. Eddystone specimen, × 17.

of several hundred tubes of *Sabellaria spinulosa* dredged in Plymouth Sound did not yield a single *Anthura*. The female specimens collected by the Laboratory have been generally found after the dredgings have been left standing for some time; as the water becomes foul the animals crawl out of the crevices and holes in which they have been hidden.

The males are very active. Mr. Clark, the naturalist on board the *Oithona*, says of the Eddystone specimen that when caught it darted about from side to side with quick jerky movements. This specimen is the largest male yet recorded, measuring 10 mm. from the tip of the rostrum to the tip of the telson. Of the three other males caught at Plymouth, one taken off Drake's Island measured 8 mm.; the other two recorded by Garstang (*Mar. Biol. Journ.*, Vol. II, p. 123) were 4 mm. and 5 mm. long and had 9 and 12 joints respectively in the flagel-



Anthura gracilis. FIG. 2.—Telson, $\mathfrak{P}, \times 42$. Cyathura carinata. FIG. 3.—Telson, $\mathfrak{P}, \times 42$. a, muscle attachment;

a, muscle attachment; b, muscle attachment, inner uropod; st, statocyst.

lum of the upper antenna. A suggestion has been made that the male on reaching sexual maturity has an active but short life. I think the note just referred to helps to solve this question. These two small males had already reached sexual maturity, as shown by the development of the sensory setæ of the upper antennæ (a secondary sexual character appearing at maturity), but that they were not nearly full grown can be seen on comparison with the Eddystone specimen. The number of joints in the flagella increases with age. The Eddystone specimen—10 mm. in length—had 20 joints developed in the flagellum of the upper antenna, thus showing that the period of sexual maturity and activity had extended over a length of time sufficient to allow for several moults and the consequent considerable increase in growth. A very interesting point in this species is the presence of statocysts in both male and female. I am indebted to Dr. Calman for drawing my attention to the question of the existence of these organs in the Anthuridæ; to Dr. A. Thienemann for sending me some of the actual specimens referred to in his paper (*Zool. Anz.*, Vol. XXVI, pp. 406-410); and to Dr. Allen for his kindness in sectioning specimens of both *Cyathura carinata* and *Anthura gracilis*.

The species, of which the statocysts are so fully described by Thienemann, proved to be *Cyathura carinata* (Norman and Stebbing, *Trans. Zool. Soc.*, Vol. XII, p. 124) as suggested by Gurney (*Trans. Norfolk*



Anthura gracilis. FIG. 4.—Horizontal section, upper part of statocyst on the right side, showing duct, × 100. FIG. 5.—Horizontal section, lower part of statocyst on the left side,

showing the crystalline bodies of the statolith, × 435. d, duct; m, muscle; st, statolith; v, vesicle.

Nat. Soc., Vol. VIII, p. 433). I have figured the telson of both species for comparison.

It will be seen that the general structure of the statocysts is exactly the same in both genera, but the details naturally vary a little. It is impossible to see these organs in specimens preserved in the usual way. Dr. Thienemann, in reply to a question as to whether they were to be observed in the living animal, said : "So viel ich weiss, waren die Organe am Lebenden *nicht* zu sehen ; dagegen waren Sie sehr deutlich bei Aufhellung mit Nelkenol, Kreosot oder Zylol." Dr. Thienemann adds the interesting note that in two species of another genus of the *Anthuridæ* examined by him, viz. *Calathura brachiata* Stimps, and *C. norvegica* G. O. Sars, in Bergen Museum, no statocysts were found.

Each statocyst consists of an oval vesicle, lying embedded in the

tissue of the anterior part of the telson, nearer the dorsal surface. A very fine tube or duct communicating with the exterior rises from the upper surface of the vesicle, on the side away from the median line (Fig. 4 d), while at the bottom of the vesicle, towards the median line, the crystalline bodies of the statolith can be seen (Fig. 5 st). A strong muscle is attached to the anterior wall of each statocyst; much stronger in *Anthura* than in *Cyathura*; it appears to be attached at its anterior end to the chitin of the telson. This attachment looks like a coloured oval body, and is as noticeable as the statocyst itself, seen *in situ* (Fig. 2 *a*), but an examination of the sections shows its construction. The two dotted bodies (Fig. 2 *b*) are similar muscle attachments in the inner uropods.

DESCRIPTION.

Body cylindrical, much more stoutly built in the female than in the male, with strongly marked longitudinal keels, three in the female, four in the male. In both sexes there is a dorso-lateral keel on either side, starting in the male just behind the eye, and finishing at the end of the peraeon, while in the female it runs the whole length of the body, from the tips of the lateral angles of the head to the end of the pleon. In both, also, the mid-ventral keel is well developed. The male has, in addition, on the head and peraeon, a smaller but well-defined mid-dorsal keel, most marked on the anterior segments.

Pleon. In the female the first five segments are coalesced and equal in length to the last peraeon-segment, in the male these segments are distinct and equal in length to the two last segments of the peraeon.

Head in the female almost square, with a short rostrum and with the anterior lateral angles also produced and projecting a little further forward than the rostrum. In the male the shape is quite different, the front of the head from the eyes tapering gradually downwards to a strong obtuse rostrum (Fig. 1).

Eyes black, very prominent in the male, and of great size, occupying nearly half the surface of the head and almost meeting dorsally; ommatidia very large, distinct from each other, corneal facets convex, the whole eye resembling a blackberry. In the female the eyes are much smaller, round in shape, and flat, not prominent.

Upper Antennae in the female shorter than the lower antennae. The first joint of the peduncle is equal in length to the second and third taken together; flagellum two-jointed, consisting of one long joint without setae, and a minute terminal joint carrying a cluster of eight to ten setae

of varying lengths, and three long sensory filaments. In the male the long flagellum reaches to the posterior margin of the second peraeon-segment, and consists of twenty joints in the Eddystone specimen (Fig. 1), the first joint short, the second constricted proximally and expanded distally. All the joints except the first are fringed with very long, delicate, outstanding setae, giving a brush-like effect to the antenna. The smaller male from Drake's Island had sixteen joints in the flagellum.

Lower Antennae. The second joint of the peduncle is greatly expanded distally; the third very small; fourth rather longer; the fifth equal in length to the third; flagellum in the female four-jointed, the terminal joint furnished with a thick cluster of long setae. The flagellum in the male is six-jointed, the first joint as long as the others taken together.



Anthura gracilis.

FIG. 6.—Abnormal maxillipeds, δ, Drake's Island specimen, × 75.
 FIG. 7.—Maxilliped, δ, Eddystone specimen, × 75.
 FIG. 8.—Maxilliped, φ, 10.5 mm., × 75.

Mouth organs as described by Norman and Stebbing. They are larger in the female than in the male. The mandibles have a three-jointed palp; the falcate process terminates in three blunt teeth, the thin blade below with five serrations, the serrations more acute in the males examined than in the females.

Maxillipeds. Palp one-jointed (Figs. 7 and 8) tipped with a row of four stiff slightly curved setae. In Fig. 6 the maxillipeds of another male are figured, showing an abnormality in that a second and very distinct joint is developed. The specimen was perfectly normal in all other particulars, but it serves to illustrate the danger of describing species from one or two solitary specimens.

Gnathopod 1. In the male the first and second joints are subequal, both produced distally on the upper side over the succeeding joint; third joint produced on the under side. The fifth joint or hand narrowly pyriform, widest proximally, tapering to the insertion of the finger, rounded above, and turned at a different angle to the rest of the appendage; palm covered on the under surface with long stout setae; finger carrying one small spine and a few setae distally; nail strong, curved.

In the female (Fig. 11) the gnathopod is much larger and stouter than in the male. The first joint is as broad as long, distally expanded; second joint slightly longer, furnished on both margins with a pectinate scale-like armature. This armature is also found on the anterior margins of the fourth, fifth, and sixth joints. The hand as described by Norman and Stebbing is pyriform, upper portion well rounded, palm with a welldeveloped process projecting forward near the base; inset on the under surface near the finger is a cluster of stout setae similar to those of the male.



Anthura gracilis. FIG. 9.—First Gnathopod, upper surface, ♂, Eddystone specimen, × 42.
FIG. 10.—First Gnathopod, under surface, ♂, Eddystone specimen, × 42.
FIG. 11.—First Gnathopod, upper surface, ♀, × 42.

Gnathopod 2 and Peraeopod 1 alike in construction in both sexes. The first joint is longer than the second; third half the length of the first, strongly lobed posteriorly; fourth very small, triangular; fifth as long as the first, nearly parallel-sided, front margin finely pectinate, the microscopic spines arranged in semicircles giving the effect of overlapping pectinate scales down the whole length of the margin; two strong spines inset at the insertion of the finger. Finger long, finely pectinate, carrying one strong spine and some setae at the base of the nail, and two or three small spines proximally. Scattered over all the appendages are many mobile sensory hairs, each hair consisting of a shaft and a fine flagellum. These hairs are most numerous on the palm.

Peraeopods 2, 3, 4, and 5 alike in construction, a little shorter and stouter in the female. The first joint is slightly longer than the second; third and fourth shorter, subequal in length; fifth about the length of the first; finger two-thirds the length of the fifth. The first three joints are constricted proximally, the third lobed posteriorly. In all

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the peraeopods the anterior margins of the fourth and fifth joints are pectinate, the spines in the female being longer and more setiform in character; the finger also bears some small spines: two stout spines are inset together at the anterior distal angle of these joints, and a long plumose sensory hair at the posterior angle of the fourth joint. In the male the third joint of the fifth peraeopod is provided with two long sensory plumose hairs as long as the succeeding joint.

Pleopods 1 in both male and female, with the outer rami greatly expanded, forming a kind of operculum, reaching in the female to the extremity of the fifth segment of the pleon, in the male considerably



Anthura gracilis. FIG. 12.—Second pleopod, J, × 42.

beyond the end of the pleon. The modified second pleopod of the male is figured (Fig. 12).

Telson and uropods as described by Norman and Stebbing, so constructed "as to resemble nearly a cylinder, with one side (the dorsal) cut obliquely away. The telson has the apex truncated, and is of the same length as the inner branch of uropods. Outer branches of uropods nearly meeting at their bases dorsally, broadly lanceolate, curved, rather longer than the first joint of the inner branch."

Colour, yellowish white, with markings of a brownish pigment in the form of cloudy patches. The colour varies considerably, probably with the nature of the ground on which the animal lives, some specimens as the Eddystone one—having only a few small dotted patches on the head and peracon, others again being nearly covered with the brown tint.

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On Leptonereis glauca Clpde., and the Genus Leptonereis Kinberg.

By

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With Plate 1 in the Text.

INTRODUCTORY.

IN February of this year Mr. J. H. Orton collected a number of small nereids on the piles of a wharf at the Great Western Docks at Millbay, Plymouth. These he kindly handed over to me for identification, and, along with other material collected at Plymouth in March, they form the basis of this paper.

These nereids proved to be none other than the little-known *Leptonereis* glauca of Claparède, of which the only specimen hitherto recorded from the shores of this country was found by Major E. V. Elwes at Oddicombe (8, p. 351) some years ago.

Claparède (3, p. 90) described the species from specimens obtained by him at Naples about 1870. He gives a good description and figures, but no particulars as to its numbers or habitat. It was next met with by de St. Joseph, who found it commonly in dredgings at all depths on the coasts of Dinard (6, p. 246) in 1888. This authority described his specimens as a distinct species, naming it *L. vaillanti*. (I shall show later that the two are identical.) He observed also the male and female heteronereids, of which he gave excellent and detailed descriptions, with a number of figures.

Thenceforward, *L. glauca* was not met with so far as has been recorded, until 1909, when Major Elwes found his specimen, a male heteronereid, at Oddicombe.

In 1878, however, Langerhans (5, p. 279) had described under the name of *Leonnates pusillus* another small species of nereid which, as I hope to show, is very closely related to, if not identical with, the one under consideration. This species he found at Madeira, and he observed in an aquarium the change to the heteronereid form in both sexes.

LEPTONEREIS GLAUCA CLPDE. AND GENUS LEPTONEREIS KINBERG. 245

There can be little doubt that *Leptonereis* must occur commonly in many localities on the shores of this country and of the Continent in which its presence is not suspected, either for lack of observers or on account of its small size.

GENUS LEPTONEREIS KINBERG, CHAR. EMEND.

Proboscis furnished only with soft papillæ.

The notopodium and neuropodium rather deeply divided.

In the male heteronereid, the body is divided into three distinct regions, the middle region only being modified for swimming, while the posterior is marked by the appearance of peculiar fused setæ, not present in the nereid-form or in the female heteronereid.

Characters otherwise as in Nereis Lin.

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LEPTONEREIS GLAUCA Claparède, Plate I, Figs. 1-10.

Leptonereis glauca Claparède, 3, p. 90, Pl. 7, Figs. 3-3c.

vaillanti de St. Joseph, 6, p. 246, Pl. 10, Figs. 113–123; Pl. 11, Fig. 124.

vaillanti Elwes, 8, p. 351.

,, vaillanti McIntosh, 8, p. 264, Pl. 86, Figs. 9-9a.

? Leonnates pusillus Langerhans, 5, p. 279.

This little nereid occurs in some numbers on the piles of the wharf at the Great Western Docks. These are exposed at low water, and are covered with compound ascidians, sponges, various cœlenterates and other sedentary organisms, which, together with the muddy sediment which accumulates in such places, form a thick encrustation on the cement piles and wallings near low-water mark. In these congenial surroundings *Leptonereis* dwells. It also occurs in dredgings from Asia Shoal and the Cattewater, in the former of which localities the bottom consists of stones and mud, in the latter of soft mud.

Its small size and the resulting difficulty of distinguishing it from other small nereids, no doubt account for its having been hitherto overlooked. The short cephalic lobe, stout squat palpi, and short tentacles, peristomial and parapodial cirri, and peristomium, serve to distinguish it —once its appearance is known—from *Nereis pelagica*, small examples of which occur in the same localities, but for certainty the parapodia and proboscis must be examined under the microscope.

Several dozens of specimens in all were collected, and a number of these were examined in detail, as a basis for the following description. The length of the individuals ranges from 7 mm. to 35 mm., but the majority are about 25 mm. long.

As to colour, I examined live specimens from all three localities, and these were practically colourless, except for blood-vessels and gut showing through the semi-transparent body-wall. In examination some months later, however, some specimens (preserved in alcohol) show a slight band of brownish granular pigment across the dorsum of each segment, becoming more marked towards the posterior end of the animal. This band of pigment is more or less continuous with glands which occur on the base of the parapods, rather like those of N. dimerilii.*

Specimens of average size have 55 to 60 pairs of parapods; the greatest number noted was 66, the smallest, in a specimen barely 9 mm. long, 35 pairs.

The body is fairly stout, tapering gradually towards the posterior end. There is a tendency towards shortness in all the appendages. The general form will best be realized by a glance at the figures, which are taken from typical specimens (Plate I, Fig. 1).

These worms, when placed in spirit, usually die with the proboscis retracted, but I succeeded in preventing its retraction in about a dozen specimens, obtained during my stay at Plymouth, by means of a pin pressed behind the head while spirit was poured over the creature. (This immensely facilitates the examination of small nereids.) The proboscis is short and stout; the maxillary division is quite smooth, but the basal division possesses on the ventral side a row of 5 to 9 minute, soft, conical papillæ, perfectly colourless, in a transverse, even-spaced row towards the anterior margin. These correspond in position to paragnaths of groups VII, VIII. On the dorsal surface of the basal division a single larger papillæ of similar nature (corresponding to VI) exists on each side. These papillæ are small and very inconspicuous. It is very difficult to distinguish them at all except when seen in profile, or when the light upon them falls at a suitable angle. Fig. 1 shows in profile the two outer papillæ of the ventral row.

Neither Claparède nor de St. Joseph observed any trace of such papillæ in the specimens from Naples and Dinard, but the Plymouth examples agree so completely otherwise with those, that one is inclined to

* Later, in December, 1913, Mr. Orton kindly sent to me at Cambridge a number of living specimens from the Great Western Docks. In the living state these were of a dull orange tint over most of the body, due to the internal organs showing through the transparent body-wall. Towards the anterior end there was a slight dull greenish pigmentation of the skin, strongest on the head and adjacent segments, but hardly noticeable in most specimens. This pigment is shown up more clearly just after fixation when the body has become opaque.

LEPTONEREIS GLAUCA CLPDE. AND GENUS LEPTONEREIS KINBERG. 247

think that the papillæ must have escaped observation in the other cases.

Their presence, of course, rather upsets the characterisation of the genus, which has hitherto been based solely on the total absence of paragnaths or papillæ!

A remarkable feature was exhibited by a number of specimens collected on 20th March. These bore on the proboscis four patches of a jet-black colour, radiating outwards from the bases of the jaws, in the everted proboscis, towards the areas where groups II and IV of the paragnaths would, if present, occur. These black marks appeared to consist of a deposit of opaque pigment beneath the cuticle. Fig. 1 is taken from a typical specimen, and shows the two dorsal patches. Of twelve specimens collected on this date, eight showed these patches strongly developed, while the remainder exhibited no trace of them.

The black marks were still present when the specimens were re-examined after lying for some weeks in alcohol and formol, but by October, 1913, all traces of them had disappeared. Fortunately, however, one specimen had been mounted in balsam at the earlier date, and in this (the specimen figured) the black is perfectly preserved. Further investigation of its nature is desirable. The only other specimens which I examined in a fresh state had the proboscis inverted ; the rest of the material had been lying in spirit for some months.*

The parapodia of Leptonereis have been described in detail by St. Joseph, but I have thought it useful to figure these again, as they are the chief means of identification. (St. Joseph's figures are rather grotesque.[†]) They do not differ from the typical nereis-form of parapod except in that their noto- and neuropodia are more deeply and widely separated than usual. They are approximately similar from end to end of the body. The noto-cirri are rather short, usually slightly overreaching the ligule; a slight increase in relative length of the cirri usually takes place in the posterior half of the body.

The setæ, which have been figured by Claparède, St. Joseph, and McIntosh, have the typical nereid arrangement, thus :----

Notopodial bundle, homogomph spinigers.

Upper neuropodial bundle { homogomph spinigers (above). heterogomph falcigers (below).

Lower neuropodial bundle { heterogomph spinigers (above). heterogomph falcigers (below).

* The everted probosces of more than a dozen of the living specimens received in December, 1913, showed on examination no trace of these black patches.

+ Claparède's single figure of a parapod is also unnatural.

St. Joseph (6, p. 247) notes that from the 13th to the 4th last segment, the spinigers of the notopodial bundle are replaced by others, similar, but with a much longer terminal appendage. This appears to be the case, too, in some at least of the Plymouth specimens, although the change seems to occur posterior to the 13th segment. I have not paid much attention to this point. He also states that homogomph as well as heterogomph spinigers occur in the lower neuropodial bundle. This I have not found to be the case.

Among the material collected by Mr. Orton on 25th February is a male heteronereis, apparently in the fully developed condition, and two other males at earlier stages of development.

St. Joseph (6) has described both the male and female heteronereid forms in detail. Claparède did not meet with either.

The above-mentioned male agrees very well with St. Joseph's description. It is 12.5 mm. long, with 58 pairs of parapodia. The noto-cirri of the first seven pairs of parapodia are much swollen (Fig. 7). The change to the swimming-parapod occurs between the 14th and 15th pairs (St. Joseph found it to occur between the 15th and 16th pairs—the variation is unimportant). In the 43rd to 45th pairs a transition towards the form of the third region occurs, the cirri and lobes becoming shorter and smaller, and the paddle-setæ decreasing in number.

The third region may be reckoned as commencing at the 44th pair, where the peculiar, large, simple setæ, figured by St. Joseph, commence. These are from one to three in number, and continue till the last setigerous segment. They are, I believe, to be regarded simply as derived from normal heterogomph falcigers by the fusion of the appendage with its socket. Ground for this belief is afforded by the analogy of the large bristles which occur in the posterior regions of *Nereis pelagica* and *N. agassizi*. In these the appendages are in some cases completely free, in others totally fused with the shaft.

Several females of the nereis-form, obtained on 20th March, were filled with ova. These are of very large relative size (0.24 mm. diameter).

The synonymy at the head of this section requires some explanation.

St. Joseph in his detailed and excellent account of Leptonereis vaillanti never refers to the possibility of this species being identical with Claparède's. He does not indicate any points of difference between the two species, and indeed, the only mention he makes of L. glauca is to say that the setæ of vaillanti are exactly similar to those figured by Claparède for the Mediterranean form.
Comparison of the descriptions and figures published by these two authors leaves us with the following points of difference :---

(a) The Dinard specimens differ slightly in colour.

(b) Their noto-cirri are shorter.

The general form of the head and its appendages, the proboscis and jaws, the peristomial cirri, the parapodia (except for the noto-cirri), the setæ, the dimensions of the whole animal and number of segments—all are identical in the two.

As to the points of difference, (a) hardly amounts to more than the fact that the Mediterranean specimens were more strongly pigmented than those from Dinard. The Plymouth ones, it appears, are still less so.

Then coming to (b) one may note that the noto-cirri of the Plymouth specimens are almost intermediate between those of St. Joseph's and those of Claparède's. It does not seem that much importance should be attached to this point.

Secondly, I have come to the conclusion that Langerhans' Leonnates pusillus from Madeira is at least very closely related to Claparède's Leptonereis glauca. Langerhans' description and figures leave no doubt that the two species are of the same genus (in view of the presence of papillæ on the proboscis to Leptonereis). In Leonnates pusillus a papilla is present in area II on each side, in addition to those on the basal ring (these are only visible " bei sehr genauem Zusehen "). Also the peristomial segment apparently was distinctly longer than in Leptonereis glauca. Many examples showed a large yellow spot on the cephalic lobe; this, however, was not always present.

In other respects *Leonnates pusillus* is identical with *Leptonereis glauca*. Langerhans kept some specimens in captivity for some time and witnessed the change to the heteronereid form, in both male and female. His observations on these agree essentially with St. Joseph's. The large, brown setæ appeared in the same way in the posterior eleven pairs of parapodia of the male.

Langerhans concludes his description of this species with the suggestion that an examination of fresh material will show that in species such as *Leptonereis glauca* and *L. cebuensis* the proboscis is furnished with papillæ similar to those of *Leonnates pusillus*. After a lapse of thirtyfive years his prediction has been fulfilled.

HISTORY AND SYSTEMATIC POSITION OF THE GENUS.

Kinberg (2, p. 179), in 1865, "created" the family Niconidea to contain those nereids in which the proboscis is devoid of papillæ, whether hard (paragnaths) or soft.

This family contained three genera, distinguished thus :--

-	uniform							Nicon.
Parapodia-	ahanging	gradual	lly					Leptonereis.
	Changing	(abruptly (with 3 changes)						Nicomedes.

In these three genera he enumerated eight species, all new to science, from the east and west coasts of South America, and from Tahiti. None of these species is described in sufficient detail to be recognisable, and only one is figured [(1, Taf. XX, Fig. 7), *Leptonereis lavis*, n.sp., from Guayaquil].

Claparède (3, p. 90) united Kinberg's three genera under the name of *Leptonereis*, which he ranked as a sub-genus of *Nereis*, Linn. s. str. He chose the name *Leptonereis* on account of its convenience as a sub-generic name, and because it was the only one of the three genera which Kinberg had figured.

Claparède did not further characterise *Leptonereis*, but apparently simply accepted Kinberg's definition of the "family" Niconidea, namely, total absence of paragnaths or papillæ from the proboscis. Further he described *Nereis* (*Leptonereis*) glauca, a new species of which he apparently found several specimens in the Gulf of Naples, although in his "Annélides Chétopodes du Golfe de Naples" he gives absolutely no information as to its occurrence or habitat. He also figured the head and anterior segments, proboscis, a parapod, and setæ (most of his figures are good, although a little "artificial" in appearance).

In 1878 Grube described *L. cebuensis* from the Philippine Islands, and in the same year Langerhans published his account of *Leonnates pusillus*. Ten years later St. Joseph brought out his account of the annelids of the coasts of Dinard.

Grube and St. Joseph both followed Claparède in regarding *Leptonereis* as a sub-genus of *Nereis*, but McIntosh ranks it as a separate genus, differing from *Nereis* Lin. in the absence of paragnaths and in the deeply divided rami of the parapodia.

My own view, based on the examination of a large amount of material in all the groups of the genus *Nereis*, and in *Leonnates* and *Leptonereis*, is that the last-named should be ranked as a genus distinct from both LEPTONEREIS GLAUCA CLPDE. AND GENUS LEPTONEREIS KINBERG. 251

the others. These three genera are, however, more closely related to one another than to any of the remaining genera of Nereidæ (i.e. Lycastis, Ceratocephale, Tylorrhynchus, Dendronereis, and Micronereis).

SURVEY OF THE GENUS LEPTONEREIS.

For generic characters (emended) see above, p. 245.

LEPTONEREIS GLAUCA Claparède, 1870.
 L. vaillanti, de St. Joseph, 6.
 Range : English Channel.

 LEPTONEREIS PUSILLUS Langerhans, 1878. Leonnates pusillus Langerhans, 5. Very closely allied to the preceding species, if not identical (see above, p. 249).

Range : Madeira.

3. LEPTONEREIS CEBUENSIS Grube, 1878.

Grube's description of this species is unfortunately not accompanied by any figures.

Range : Philippine Islands.

4. LEPTONEREIS LÆVIS Kinberg, 1865.

This species must remain rather uncertain, as Kinberg's description is very brief. The figures of anterior region and proboscis, a parapodium, and the setæ, are fairly good. The palps and tentacular cirri are longer than in L. glauca.

Range : Guayaquil (Ecuador).

[Kinberg did not figure any of the other seven species which he described under the genera *Nicon* and *Nicomedes*, and his descriptions are so brief as to be of little value for purposes of identification. The only one of these which has been met with again is *Nicon loxechini*, from the Straits of Magellan. In this case Ehlers has employed the name *Nereis loxechini* Kinberg for a species of which a single small specimen was collected by the German Deep-Sea Expedition at St. Paul Island (38° 40' S., 77° 38' E.), in the southern Indian Ocean. Ehlers unfortunately does not figure this specimen, nor does he describe it fully, so that there is considerable doubt as to whether it should be assigned to the genus *Leptonereis*. The *Nereis eugeniæ* Kinberg of Ehlers, although founded on Kinberg's *Nicon eugeniæ*, is a true *Nereis*.]

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EXPLANATION OF PLATE.

Leptonereis glauca Clap. Plymouth, 1913.

- Fig. 1. Anterior region, with proboscis extended, $\times 23$.
- ,, 2. Posterior extremity (from above), $\times 23$.

FIGS. 3–5. Parapodia of immature form.

- Fig. 3. 2nd R., anterior view, $\times 25$.
- ,, 4. 12th L., anterior view, $\times 25$.
- ,, 5. 34th L., anterior view (total 59 pairs), $\times 25$.
- ,, 6. 41st L. (\heartsuit nereid with ova), anterior view (total about 60 pairs), $\times 25.$

FIGS. 7-10. Male Heteronereis.

- Fig. 7. 5th R., posterior view, $\times 35$.
 - , 8. 30th R., anterior view, $\times 47$.
- " 9. 48th R., posterior view (total 58 pairs), ×35.
- ,, 10. Neuropodium from the posterior region, showing one of the large fused setæ half-grown, not as yet projecting from the parapodium (posterior view), ×145.



On the Breeding Habits of *Echinus miliaris*, with a Note on the Feeding Habits of *Patella vulgata*.

By

J. H. Orton, B.Sc., A.R.C.Sc.

With One Figure in the Text.

WHILE on shore-collecting expeditions in this district it was frequently observed that Echinus miliaris has the habit of associating together in pairs, and sometimes in groups of more than two.* The association of these pairs and groups is sometimes so intimate that it is not possible to interpose even the blade of a penknife between the interlocking spines of the urchins. In all cases observed except one, such pairs were placed side by side, but in one particular case the apical region of one individual was almost certainly placed adjacent to the apical portion of the other. In all the collecting expeditions[†]-made at various times of the year between April and August-on which groups were collected, the total number of urchins of all sizes obtained amounts to about 710. Among this number were obtained 84 groups, which amount in all to 189 specimens. In the earlier part of the investigation a group was taken as such if the members were merely fairly close together, but afterwards only those specimens were recorded which were actually touching one another in the manner described above. Out of the total of 84 groups only 27 were actually recorded definitely as touching one another, although some of the other groups may have been touching. Of these 27 closely associated forms all the individuals were ripe except 3 small specimens belonging to two pairs which were recorded as having an immature gonad. The remainder consisted of 19 pairs 39, 2 pairs 92, 1 pair 33, and 3 groups respectively 392; 332, and 3933. These facts in themselves point to the conclusion that in E. miliaris

* In a few cases as many as from 13 to 21 individuals have been found close together under one stone.

† In the search for groups of these urchins I am much indebted to the laboratory fisherman, William Searle, for the zeal and care with which he helped in the collecting.

 \ddagger In this group the φ associated with the male was almost certainly spent, although it was difficult to make certain whether on the other hand it might be immature. Hence it is not grouped with the definite pairs of male and female.

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there is a distinct instinct for association of individuals at the time of sexual maturity, and that the association frequently, but not always, results in pairing of the sexes. In this respect the position in which two of the above pairs of male and female were taken is specially interesting. Both pairs were situated under a large stone whose lower surface was somewhat rectangular, and would measure rather more than two feet on the longer axis. The pairs were on the opposite ends of the lower surface near the edge of the stone on the long axis, and each member of a pair was closely opposed to the other. It would thus appear that these four urchins had definitely mated in pairs.

Of the 57 remaining groups taken, 41 contained all ripe individuals, and combining these 41 groups with those given above, it was found that out of the total of 66 associations of ripe specimens, 41 were $\Im Q$, 9 of various sexes, $8 \ Q \ Q$, $6 \ \Im \ J$, and $2 \ Q \ Q \ Q$. Thus in all the groups of ripe forms there were 40 pairs of opposite sexes and 8+6+2=16 groups exclusively of one sex or the other. Therefore, leaving out the 9 groups containing various sexes, it is seen that the number of pairs, namely 41, is greater than twice the number of the groups which contain one sex or the other. Consequently it is highly probable that the statement that the sexes of *E. miliaris* associate definitely for the purpose of breeding is significant.

In the whole of the groups collected, regardless of ripeness of the gonad in all the members of the group, there were 47 pairs of 3° and 9° , 15 pairs 9° , 6 3° , 8 groups of more than two containing both sexes, 2 groups 9° , 9 1° , 1 3° , and 5 containing one or more immature forms. In the groups recorded as not all ripe there were some specimens quite ripe. Many of the other urchins in these groups, however, would probably have yielded some embryos if their sex cells had been mixed with those from similar forms of the opposite sex, but an attempt based on experience was made to name those forms ripe which would probably have yielded a good proportion of segmenting eggs as a result of fertilization. In this branch of the investigation I am indebted to Mr. H. M. Fuchs for some help in determining the state of the gonad.

A more significant result could doubtless be obtained by an examination of a larger number of pairs of E. *miliaris* obtained about the same time and during the breeding season, but the opportunities for such an investigation are not very common. E. *miliaris* can often be taken in numbers by dredging, and then I have frequently observed that many individuals are taken matted together, and in such a way as to suggest they were actually in that condition before being captured by the dredge. In the same way large hauls of *E. esculentus* and *E. acutus* and relatively* large hauls of *Echinocardium cordatum* can frequently be made on certain grounds in hauls of not more than 10 to 15 minutes, but it is equally uncertain here, as in the case of the dredged *E. miliaris*, that there is any association in pairs; nevertheless it is not improbable that the



FIG. 1.+—A view of Patella showing the food-paths it has eaten in a growth of green algæ, chiefly young Enteromorpha (²/₃ natural size).

The limpet is shown on its "home," from which it has made excursions in various directions and to which it has afterwards returned.

aggregation of such large numbers of individuals might be in part for the purpose of spawning, since such hauls may be taken when all these species are ripe.

Tennent has observed; in Toxopneustes that "when these animals are

* Echinocardium cordatum when living in deep water inhabits fine sand, from which it can only be captured by means of a dredge, and in a 3-foot dredge a short haul may sometimes yield as many as 15 individuals. This species occurs in great numbers in the Salcombe estuary within a very small area, but this aggregation is probably due more to the presence of only a small area of suitable ground than to a desire of the individuals to associate. Nevertheless in this locality these heart-urchins associate closely in groups of twos, threes, and sometimes in larger numbers. The sexes of the members of such groups have not, however, been observed.

+ I am indebted to Mrs. Orton for the drawing for this figure, which has been copied from a sketch made in my collecting book.

‡ D. H. Tennent, Journ. Exp. Zool., Vol. IX, No. 4, p. 659, 1910.

ON THE BREEDING HABITS OF ECHINUS MILIARIS

ready to spawn they gather more or less closely together," and Hertwig* mentions that "egg-deposition may provide sexual stimulation to the males, since when a large number of urchins are placed together in seawater as soon as the females begin to discharge eggs the males spawn." It is not improbable, therefore, that association of the sexes for the purpose of spawning may be common throughout the Echinoids.

NOTE ON THE FEEDING HABITS OF PATELLA.

It is well known that Patella obtains its food by browsing on both the smaller and larger forms of algæ. † Striking evidence of this fact has, however, been obtained and is worth noting. In observing specimens of Patella situated on cement piles above low-water mark, it was noticed that the animals had in many cases eaten away paths in the green algæ, chiefly young Enteromorpha, by which they were surrounded. The paths radiate from the "scar" of the animal, and are marked with fine lines made by the teeth on the radula. These paths are shown in Fig. 1. In several cases the animal had travelled beyond the end of the path formerly eaten before beginning to browse again, and afterwards returned home to its scar. (See Fig. 1.) Such configurations as that shown in the figure are by no means uncommon on the pier walls in this district in situations favourable for the growth of algæ. As the alga grows the food-paths of the limpet may become more marked, and in some cases the spatting of Balanus balanoides along the paths makes them so evident that they are easily seen from some distance away.

* O. Hertwig, Zeit. für Wiss. Zool. Jen., Vol. XXIV, p. 282, 1890.

+ J. R. Ainsworth Davis and H. J. Fleure, Patella L.M.B.C. Memoir, Vol. X, London, 1903.

On the Occurrence of Aphroceras (Leucandra) cliarensis Stephens near Plymouth.

By

Arthur Dendy, D.Sc., F.R.S.

IN July, 1912, a paper was published in the *Proceedings of the Royal Irish Academy* (Vol. XXXI) on the Marine Porifera of Clare Island, by Miss Jane Stephens, in which the authoress gives an excellent account of a new species of Calcareous Sponge, *Leucandra cliarensis*. In April of the same year I happened to be working at the Marine Laboratory at Plymouth, and my friend Mr. Orton brought me several specimens of a very pretty little calcareous sponge just collected by him at Wembury Bay. I was too much occupied with other work to examine these carefully at the time, but simply preserved them in spirit. Recently I have examined them in detail, and find, curiously enough, that they belong to the species described by Miss Stephens from Clare Island on the west coast of Ireland.

It is unnecessary, in view of the description already published by Miss Stephens, to give a detailed account of the sponge in this place. I may, however, point out the salient features by which it is easily recognized. The external appearance is characteristic. The individuals are usually solitary and less than an inch in height. The form of the sponge, however, varies greatly, from quite slender to almost globular. There is usually a single terminal vent. The surface, when viewed under a pocket-lens, exhibits a glistening appearance, with longitudinal striations due to the presence of gigantic oxea in the dermal cortex. This arrangement of the large oxea brings about a close resemblance to species of the genus Ute. The canal system is, however, typically leuconoid, with small, rounded flagellate characters.

The most remarkable and constant specific character appears to be the presence of enormous sabre-shaped apical rays on the gastral quadriradiates, sometimes reaching a length of 0.5 mm., and, of course, projecting into the gastral cavity.

In our recently published paper on "The Classification and Phylogeny

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of the Calcareous Sponges, etc." (*Proc. Zool. Soc. Lond.*, Sept., 1913) Mr. Row and I have placed the species in the genus *Aphroceras* Gray, which is distinguished from Leucandra by the presence of a dermal layer of gigantic longitudinal oxea. This genus cannot, however, be very sharply separated from Leucandra, and in *A. cliarensis* a great many of the large oxea lie obliquely in the deeper parts of the sponge, as in many Leucandras. Nevertheless, there are sufficient of the large oxea in the dermal layer to give the surface of the sponge the longitudinally striated (and not obviously hispid) character of Aphroceras.

The discovery of this interesting species at Plymouth contributes an interesting addition to the marine fauna, not only of the district, but also of Great Britain ; while the fact that it should have turned up there so shortly before the appearance of Miss Stephens' memoir is one of those curious coincidences which so frequently surprise the systematic zoologist.

Note on Two Unrecorded Plumularian Hydroids from the Plymouth Area.

By

James Ritchie, M.A., D.Sc., Royal Scottish Museum, Edinburgh.

CONFUSION has reigned in the works of British authors as to the relationship between *Plumularia catharina*, Johns., and a more simple form, with unbranched stem, found, like the former, on many parts of the coast. Johnston and Hincks, and the majority of their successors, have recorded the simple form, where it was thought worthy of mention, as a "stemless variety" of the former; but examination of the type specimens of *P. catharina* in the British Museum has proved that a fundamental distinction exists between the two forms.* *P. catharina* is a branched species and bears on each side of a hydrotheca *a pair of lateral sarcotheca*; the other is a branchless, bristle-like form, bears on each side of a hydrotheca *a single lateral sarcotheca*, and has been long known as *Antenella* (or *Plumularia*) secundaria (Gmelin).

One of the most common of *Plumularias* in the Plymouth area, in a wide sense, is *P. catharina*, and in a recent paper[†] Mr. Crawshay records the "creeping variety" from many stations in the Outer Western Area of the English Channel, with the remarks that it occurred over the whole area, and that it was perhaps the most frequent of the two varieties, and was certainly the most flourishing in point of growth.

I have had the opportunity, thanks to Mr. Crawshay, of examining a few samples of the simple form, and find that it embraces two distinct species, which are different from *P. catharina*, and have not been recorded from the area. The most common of these is *Antenella secundaria* (Gmelin), distinguished by a simple stem, and by details of hydrotheca structure exceedingly like those of the erroneous figure of *P. catharina* given by Hincks in "British Hydroid Zoophytes," Plate LVI, Fig. 2a. It was found at Duke Rock in August, 1895, and was dredged in the

^{*} See Ritchie, "Note on the Type Specimens of *Plumularia catharina*," etc., *Proc. Roy. Physical Soc.*, Edinburgh, Vol. XIX, 1913, p. 1.

⁺ Crawshay, Journ. Marine Biol. Association, Vol. IX, 1912, pp. 279 and 330.

Outer Western Area of the Channel at Station 37 (S. 41° W. of Eddystone at distance of 17.1 miles) in 1906.

The other species is Antenella siliquosa (Hincks), described by Hincks, from St. Peter's Port, Guernsey, in 1877,* and since recorded from only two areas: from S.W. of Toulon at a depth of 445 metres, and in the neighbourhood of Roscoff on the N.E. corner of France between 60 to 80 metres (Billard, 1907 and 1912). To these localities Plymouth material adds two more records, both in the Outer Western Area of the Channel. A few colonies were obtained from Station 80, S. $16\frac{1}{2}^{\circ}$ W. of Eddystone, 48.9 miles distant, at a depth of 51 fathoms; and a larger clump was dredged during Cruise VII at an undefined position between S. 17° to 27° W. of the Eddystone, at a depth between 49 and 53 fathoms.

The two species may be readily distinguished. Both have simple unbranched stems. A. secundaria closely resembles P. catharina in the details of structure, but has only one sarcotheca flanking each hydrotheca, in place of a pair; A. siliquosa has a wider and larger hydrotheca, but its distinctive feature lies in the lateral sarcothecæ, which occur one on each side of a hydrotheca, and have the even margin of the terminal section interrupted by a large wide embayment, a condition not recorded from any other species of Antenella.

* Ann. Mag. Nat. Hist., ser. 4, Vol. XIX, 1877, p. 148, Pl. 12, Figs. 2-6.

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On Alcyonium pulmonis instar lobatum Ellis.

By

R. Hartmeyer, Berlin.

With one Figure in the Text.

In the year 1755 Ellis described in his "Natural History of the Corallines," as "Alcyonium pulmonis instar lobatum," a "sea production" from Whitstable, which the fishermen there had brought to him under the name of "Sea-Fig." As regards the systematic position of this form, he expresses himself only in so far as to place it with the Alcyonians, a group in which were united at that time, along with true species of Alcyonium, Ascidians, Hydroids, Sponges and even Algæ. As a doubtful synonym of his species Ellis put forward the Pulmo marinus of Rondelet (1555), which however has nothing whatever to do with it and indeed cannot be certainly determined. During the following years, Ellis' work was translated into several languages. A Dutch and a French translation, both dating from the year 1756, are known to me, the former by Tak, the latter by Allamand. There is also a German translation by Krüniz dated 1767.

Before I proceed with the history of this species it appears to me advisable first of all to define it, so as to be able in the further course of the discussion to deal with a fixed systematic conception. The description and the figures which Ellis gives are so characteristic that the "Alcyonium pulmonis instar lobatum" can only be identified as a compound Ascidian. As such the species was recognised, as soon as ever the close relationship of the colony-forming ascidians, which had previously been regarded as Alcyonians, to the simple ascidians was determined, that is to say about the year 1816. It is remarkable however that the form has never since been the subject of a thorough description, although it is mentioned in many textbooks and handbooks, as well as in faunistic papers, during the following 30 or 40 years. In more recent literature the species receives scanty mention, mostly only as a list name or as an uncertain species, whilst it has practically entirely disappeared from the most modern literature.

My wish to clear up if possible once for all this form by the examination of typical local examples has now been carried out through

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the kindness of Dr. Allen. I received three colonies sent by him, which had been collected by fishermen at West Mersea, Essex, that is to say in a locality which from a faunistic standpoint can hardly be different from the neighbourhood of Whitstable. Especially valuable to me was however the accompanying information that the name "Sea-Fig" has been retained there down to the present day. We have therefore every right to suppose that these specimens from West Mersea are the same species as the "Alcyonium pulmonis instar lobatum" of Ellis.

An examination of these three colonies has yielded a result which I had previously anticipated : Ellis' species is no other than the wellestablished *Macroclinum pomum* (Sars), which is frequently mentioned in the most recent literature and is everywhere common in the North





Sea. This supposition must have already forced itself upon the mind of anyone acquainted with the species, when reading Ellis' description, a model of its kind, and comparing it with his figures. After the direct proof of the occurrence of *Macroclinum pomum* on the Essex coast no further doubt of the identity of the two forms would seem to be possible.

Of the three colonies before me from West Mersea, the largest has a typical fig-like shape. The anterior end is broadened, the posterior end is tapered and runs out into a quite short, stem-like process, which serves for its attachment. The colony is strongly compressed laterally. Its length is 7.9 cm., its greatest breadth $5\cdot1$ cm., whilst its thickness never exceeds $1\cdot1$ cm. The colour is greenish grey. The systems are not very clearly recognisable, but are undoubtedly present. The whole habitus of the colony with the separate individuals shining through like yellow seeds, is very aptly characterised by the descrip-

tion "Sea-Fig." A second colony is considerably smaller. The length is only 3.4 cm., the breadth 2.7 cm. The posterior end is less strongly tapered, the remaining characters are on the other hand the same. Finally the third colony forms only a small cushion on a sponge.

So much as to the material in hand and the identity of Ellis' form with the *Macroclinum pomum* of recent literature. In order to establish the synonomy and the correct specific name I will now proceed to the history of the species, which is specially complicated by the fact that in the old literature for many decades the species was confused with a sponge, which to-day in sponge-nomenclature bears the name *Ficulina ficus* (Pall.). Ellis and Solander (1786) first pointed out this error, and Esper (1806) also recognised it, but Lamarck (1815) was the first and after him Lamouroux (1816) to distinguish the two species by special binomial names.

Ellis' "Alcyonium pulmonis instar lobatum" reappeared for the first time in the literature in Pallas, in his "Elenchus Zoophytorum" of the year 1766, and indeed as a synonym of Alcyonium ficus. The specific name ficus was here for the first time used in a binomial combination with the generic name Alcyonium, so that Pallas must be regarded as the author of that species which must bear the name ficus. The following extracts from the literature relating to the synonymy of Alcyonium ficus are quoted verbally:—

(1) Alcyonium tuberosum forma ficus. Imper. ital. p. 599 lat. p. 839. Only the Italian edition of the "Historia naturale" of Francesco Imperato dated 1599 has been available to me. A form is there described and figured on p. 734, under the name "Alcyonio tuberoso in forma di fico frutto: Alcyonio quinto di Dioscoride," which is without doubt a sponge and has been identified by the spongiologists as Ficulina ficus. I do not know whether the page reference given in the Italian edition, namely page 599 in Pallas, is due to an error, or whether it refers to some other edition. A date of publication for Pallas is not given. Moreover the same page reference is found in Esper. In the latter's work the quotation from Imperato (Esper writes Imperati) reads: " Alcyonium tuberosum forma Ficus: Halcyoneum quintum Dioscoridis." I will take this opportunity of mentioning that the "Alcyonio quinto di Dioscoride" quoted from Imperato is mentioned in his Materia medica of the year 1478 as " Alcyonii quinta species." A determination of this form is hardly possible.

- (2) Alcyonium tuberosum. J. Bauh. hist. III p. 817. In the "Historia Plantarum universalis" of Joh. Bauhin and Joh. Henr. Cherler dated 1651 there is in v. 3 lib. 39 p. 817 a copy of the figure from Imperato, with the description Alcyonium tuberosum. This reference also must be assigned to the sponge.
- (3) Ficus substantia inter Spongiam et Alcyonium mediæ. Marsil. hist. mar. p. 87 tab. 16 n. 79. This reference is to the "Histoire physique de la Mer" by L. F. Marsilli dated 1725. The passage there reads exactly: "Figue de substance d'Eponge & d'Alcion, nommée par Trionfetti, Alcyonium tuberosum, forma ficus Imperati." The coasts of Barbary are given as locality. This reference also, as may be seen from the figure, t. 16, f. 79, without doubt has to do with a sponge and Ficulina ficus is indicated. A copy of this figure is to be found also in Esper (1806).
 - (4) Alcyonium quintum antiquorum. Mercat. metall. arm. 6. c. 6. p. 102. In his "Metallotheca Vaticana" dated 1717 Mercati describes, under the title "De quinto antiquorum alcyonio," a form which is also a sponge and must be regarded as a synonym of Ficulina ficus. The figure bears the legend "Alcyonium quintum."
 - (5) Pulmo marinus alter Rondeletii. Raj. syn. p. 31. n. 3. In the 3rd Edition of his "Synopsis methodica Stirpium Britannicarum" dated 1724, J. Ray puts forward the Pulmo marinus alter Rondel. as a synonym for Bursa marina.—Rondelet's species cannot be determined. The Bursa marina is on the other hand an Alga. The reference from Ray does not therefore come into consideration either in connection with the sponge or the ascidian. In the first edition of this work dated 1690, which Lendenfeld (1896) quotes, I do not find "Pulmo marinus" mentioned.

Some references, also relating to the sponge, which are lacking in the list of synonyms in Pallas, should now be added. In the first place a reference which is to be found in Bonanni, in his "Musæum Kircherianum" dating from 1709 and reads: "Aliud Alcionum ev Mari Adriatico acceptum visitur, quod Tuberosum vocavit Imperatus." Further the "Alcionio minore in figura di fico frutto" mentioned and figured by Ginanni (1757) in his "Opere postume," v. 1 p. 41 t. 47 f. 98. Finally the "Alcyonium tuberosum Ficus forma Imp." mentioned by Battarra in a new edition of the "Museum Kircherianum" dated 1773, p. 179 (note).

The next author after Pallas is Linnæus. In the 12th and also in the 13th Edition of the "Systema Naturæ" he records an *Alcyonium (Alcionium) Ficus* with the same synonymy as Pallas. This literature reference is thus also a partial synonym of both species. The Dutch translation of Pallas' Elench. Zooph. by Boddært (1768), Houttuyn's edition (1772) of Linnæus' Syst. Nat. ed. 12, St. Müller's German edition (1775) of the same work, and an extract from Müller's

edition by Höslin (1782) give nothing new.

The Alcyonium Ficus, which Berkenhout mentions in the "Outlines of the natural History of Great Britain and Ireland" dated 1769, refers to Ellis' form, and is therefore exclusively a synonym of the Ascidian. The species appears again later in both editions of the "Synopsis of the natural History of Great Britain and Ireland" by the same author dated 1789 and 1795, which constitute the 2nd and 3rd editions of the "Outlines."

To Ellis and Solander belongs the credit of having pointed out for the first time in their "History of Zoophytes," in the year 1786, the specific difference between the sponge and the ascidian. The ascidian originally called "Sea-Fig" by Ellis received the name "Alcyonium Pulmonaria," without however the authors having recognised its ascidian nature. For the determination of the correct specific name this reference is however of decisive significance, for here the Alcyonium ficus was for the first time divided into two species, of which the one (the ascidian) received the new specific name "pulmonaria," whilst the other (the sponge) retained the original specific name "ficus." Ellis and Solander refer to the mistaken union of the two species in the following words:—"This name of Sea-Fig [of Ellis] has occasioned a mistake in some late authors, who have confounded it with the Sea-Fig of Count Marsigli, which is a true sponge."

The following years yield a series of literature references, which either cannot be accurately determined or in which both species are again confounded. To the latter class belong the *Alcyonium Ficus* in the translation of Pallas' Elench. Zooph. by Wilkens and Herbst (1787), the *Alcyonium Ficus* which Meuschen records in the "Museum Geversianum" (1789), the *Alcyonium ficus* of Bruguière in the "Encyclopédie méthodique" (1787), the *Alcyonium Ficus* in Gmelin's edition of the "Systema naturæ" (1791) and in the English edition of this work by Turton (1806).

Not decisively to be indicated are the *Alcyonium Ficus*, which Olivi (1792) recorded from the Gulf of Venice, and the *Alcyonium ficus*, which Cuvier (1798) mentions in his "Tableau élémentaire" without literature reference or locality. The first of these cannot, owing

to the locality where it was found, be referred to the ascidian. Whether both references belong to the sponge must remain undetermined.

To the sponge must be assigned the *Alcyonium Ficus*, which Poiret records in his "Voyage en Barbarie" of the year 1789. To the ascidian on the other hand the *Alcyonium ficus* of Bose mentioned in his "Histoire naturelle des Vers" (1802). In the second edition of that work of the year 1827 Bose has however again combined the two species, since he here, in addition to the reference to Ellis, gives also as a synonym the *A. Ficus* of Lamouroux (1816), which refers to the sponge.

The *Alcyonium ficus*, which Borowski and Herbst figure in their "Naturgeschichte des Thierreichs" (1787) is a copy of Ellis" figure. In the text however no literature is referred to and the locality is given as the Mediterranean. In the synonymy of the ascidian therefore only the reference to the figure can be accepted.

Esper then again separated the two species in his large work on the "Pflanzenthiere." What he describes as *Alcyonium Ficus* is the sponge, whilst the ascidian is left without a binomial designation. In Esper there is also to be found a careful summary of the literature.

In his "British Fauna" of the year 1807 Turton records an Aleyonium Ficas [sic!], which must be ranked as the ascidian.

Then in the years 1815 and 1816 there follow the important works of Lamarck and Lamouroux, which treat of both species under binomial names. Nevertheless the true nature of the two species was still not recognised, and they were both left in the genus *Alcyonium*. For the sponge Lamarck introduced the new but superfluous name *Alcyonium ficiforme*. The Mediterranean was given as locality. For the ascidian on the other hand the name *Alcyonium pulmonaria*, originating from Ellis and Solander, was applied, and as localities the Atlantic Ocean and the Channel were given.

Lamouroux in his "Histoire des Polypiers coralligènes flexibles," dated 1816, also retains for the ascidian the name *Alcyonium Pulmonaria*, whilst for the sponge he uses the correct nomenclature, that is to say the specific name *Alcyonium Ficus*.

By the important work of Savigny of the year 1816, it was conclusively proved that the colony-building Ascidians, which until then had been placed with the alcyonians and polyps, ought to be united to the simple ascidians. Thus Ellis' form took its place definitely amongst the ascidians, and Savigny indeed placed it in the new genus *Aplidium*, which he then founded. He only made a mistake in the choice of the specific name, since he called the species *Aplidium ficus*, instead of employing the name *pulmonaria* given to it by Ellis and Solander. The consequence of this mistake is that the specific name *ficus* has been retained until the present day in the ascidian literature, but has also been used at the same time by writers on sponges. I have already shown that the name *ficus* cannot be maintained for an ascidian, but must fall to the sponge. Savigny does not discuss the sponge further.

Another new name for the ascidian was introduced in the same year by Lamarck in his "Histoire naturelle des Animaux sans Vertèbres." Although he recognises the genus *Aplidium* founded by Savigny, he calls the species *Aplidium sublobatum*. Why he should introduce this new specific name, although he had in the year 1815 designated the species *Alcyonium pulmonaria*, is not very easy to see. Moreover he retains the sponge in the genus *Alcyonium* and keeps the name *A. ficiforme*.

The year 1816 therefore fixes the time from whence onwards the two species finally remain separate. Ellis' form is recognised as ascidian. whilst it is not until many years later that Alcyonium ficus is regarded as a sponge and placed first in the genus Suberites, later in Halichondria, finally in the genus Ficulina, which was established specially for this species. With this definite separation of the two species only the further history of the ascidian will continue to interest us here, but before proceeding, I should like to consider briefly Lendenfeld's paper on the "Clavulina der Adria" published in 1896. A summary of the literature on Ficulina ficus is given in this paper, which contains some errors in the old references previous to the year 1816, which may be here corrected. In the first place there is placed amongst the synonyms the Alcyonium pulmonis instar lobatum of Ellis. I can only suppose that Lendenfeld had no personal acquaintance with Ellis' work, or he would never have regarded the figure which Ellis gives as that of a sponge. As the earliest literature reference Bauhin and Cherler, 1651 (not 1650 !) are quoted. This is not correct. Bauhin and Cherler indeed are based on Imperato and even give an extract from the work of the latter. I have already referred to the reference to Ray (1690), which also contains an error. A further mistake, finally, is that Lendenfeld ascribes the authorship of the name ficus to Linnæus instead of to Pallas.

I now proceed with the history of the ascidian. After Savigny's species had been placed, in the year 1816, in his genus *Aplidium*, as *Aplidium ficus*, the specific name *ficus* was prevalent for 30 years. Only in quite isolated instances the synonymous specific name *sublobatum*, derived from Lamarck, appeared along with it. On the other hand the generic name was changed repeatedly. This is explained by the fact

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that Savigny's genera were to a large extent again united by later authors. Thus our species appears sometimes as *Polyclinum ficus*, sometimes as *Synoicum ficus*, sometimes as *Pulmonellum ficus*, in isolated instances indeed still as *Alcyonium ficus*. It would take us too far to discuss this literature in detail. I must content myself with pointing out here only the most important facts in the history of the species. It will be best first of all to follow, up to recent times, the specific name *ficus*, which predominated in the older literature till about the year 1850.

The older works belonging to the first half of the last century, in which the species is referred to, are without exception in the nature of compilations, and bring nothing new to our knowledge of the species. To this category belong the references by Cuvier (1817), Goldfuss (1820), Fleming (1820, 22), Schinz (1822), Fleming (1824), Lamouroux (1824), Blainville (1824, 25, 27), Fleming (1828), Stark (1828), Rang (1829), Blainville (1829, 30), Cuvier (1830), Voigt (1834), Blainville (1834), Oken (1835), Cuvier (1836), Blainville (1837), Fleming (1837), Dujardin (1837, 40), Gervais (1840), Comte (1840) (under the name Distoma variolatus this author gives a copy of Ellis' figure), Reichenbach (1842), Deshayes (1842), Poeppig (1848), Forbes and Hanley (1848) also do not know the species from their own observation, but quote from Ellis. From the second half of last century the following references, belonging to the same category should be mentioned : Wright (1855), Gosse (1856), H. and A. Adams (1858), M'Andrew (1861), Granger (1886), Herdman (1891), Lameere (1895), Maitland (1897), and finally also Hartmeyer (1909).

The following works contain some remarks on the species, in some cases only records of new localities :---

Alder and Hancock (1848) mention an *Aplidium ficus* from Cullercoats, but leave the identification uncertain. The record of locality had better therefore for the present remain doubtful, although it is not unlikely that the species occurs there.

Cocks (1850) records in his list of the Ascidians of Falmouth an *Aplidium ficus*. The identification cannot be tested. That the species occurs on the south coast of England I consider doubtful, until the contrary is proved. At any rate I have not found it amongst the extensive collection from Plymouth which I have examined. This locality therefore may for the present remain doubtful.

Gervais and P. J. Beneden (1859) give the North Sea as a locality. P. J. Beneden (1860) records the occurrence of *Aplidium ficus* in deep water on the Belgian coast in company with a second species which he calls *Aplidium ficoides*. Details of the anatomy

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are not given however, but it seems possible to decide with certainty from the external characters alone that it refers to our species. *Aplidium ficoides* is probably only a synonym. I have recently had in my hands many colonies which were also collected off the Belgian coast, so that the occurrence of the species there is certain.

Ansted and Latham also record *Aplidium ficus* in a list of the Ascidians of the Channel Islands. This statement cannot be tested. I have myself not seen any example of this species from the Channel Islands, although I have identified a great deal of ascidian material from that locality. It appears however by no means improbable that the species occurs there, probably in deeper water. I come to that conclusion because Giard (1873) also mentions a *Polyclinum ficus* from the neighbouring coast of Granville, which he identifies as Ellis' species. I do not doubt that this *P. ficus* of Giard is the same as our species. Giard thinks it probable that the species lives in deep water and is only occasionally thrown on the shore. That would also explain the fact that the species is mentioned neither by Milne-Edwards nor by Lahille, and consequently we may conclude that it does not occur within the limits of the true littoral zone on the north coast of France.

Pelseneer (1892) mentions the species from Blankenberghe, where it is frequently taken by the fishermen; Bizet (1892) from the coast of Somme. It seems to me however questionable whether in the latter case our species is really concerned, possibly there is a confusion with *Glossoforum sabulosum*. Sharp (1911) mentions the species again from the Channel Islands (Cobo). The same remarks apply to this record as to that of Ansted and Latham. Finally in the posthumous work of Alder and Hancock (1912) published by Hopkinson a numerous collection of references to this species is to be found, in which however references which belong to the sponge are erroneously included. In other respects this work furnishes nothing new.

An Aplidium or Polyclinum ficus is also repeatedly recorded from the Mediterranean. Thus by Martens (1824), Grube (1864), Faber (1883), and Carus (1890); Targioni-Tozzetti (1880) mentions an Aplidium sublobatum. In all these cases there is a mistaken identification, since our species does not occur in the Mediterranean. Probably in most cases the form dealt with is Amaroucium pyramidale (Brug.) (Syn. A. conicum (Olivi)).

It is interesting to follow how in the course of years the specific name *ficus* disappears more and more from the literature. Up to the middle of the last century one misses it in hardly a single general

work on ascidians. In the fifties and sixties also it is still somewhat frequently mentioned. After that the name becomes constantly less frequent and in the most recent times it has as good as completely disappeared from the literature. But although in the older literature the species was recorded so very frequently, no author has given us an anatomical description sufficient to enable us to place the species with certainty in the present system. For in order to recognise the form, as Giard does, as Polyclinum, the proof must first be forthcoming that it actually agrees with the genus Polyclinum in the arrangement of the intestinal loop, the most important generic character of that genus. For such a proof one seeks in vain in the whole literature of the species. The form has remained, one may rather say, problematical as regards its systematic position up to the present day. By the reexamination of typical, local specimens this question is now solved. The identity of the Aleyonium pulmonis instar lobatum of Ellis with the frequently mentioned Macroclinum pomum (Sars) of recent literature has been established.

The latter species was first described by Sars (1851) as Amaroucium pomum, and was placed later by Huitfeldt-Kaas (1896) in the genus Aplidiopsis founded by Lahille, together with a newly described species A. sarsii. Hartmeyer (1903) then recognised the near relationship of these two species to Macroclinum crater, described by Verrill (1871). from the Newfoundland Banks, which was the type of the new genus Macroclinum, Aplidiopsis sarsii was explained as a synonym of M. crater, whilst A. pomum was placed as an independent species in the genus Macroclinum. Bjerkan (1905) afterwards showed that M. crater and M. pomum were also synonyms, and that the species should bear the latter name. This name has been retained until the present day. Now the name pomum has to be replaced by the older name pulmonaria, so that the species must now be called Macroclinum pulmonaria (Ell. Sol.). Naturally the position of the species as type of the genus Macroclinum remains unaffected by this change of name.

In conclusion I add a list of the most important references to Ficulina ficus (Pall.) up to the year 1816, as well as of the whole literature on Macroclinum pulmonaria (Ell. Sol.) as far as it is known to me

FICULINA FICUS (PALL.).

- 1478 "Alcionii quinta species," Dioscorides, Materia medica, lib. 5 cap. 90.
- 1599 "Alcyonio tuberoso in forma di fico, frutto: Alcyonio quinto di Dioscoride," Imperato, Stor. nat., p. 734 f.
- 1651 "Alcyonium tuberosum," Bauhin & Cherler, Hist. Plant. univ., v. 3
 lib. 39 p. 817 f.

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1709 "Alcionum . . ., quod Tuberosum vocavit Imperatus," Bonanni, Mus. Kircher., p. 267.

1717 "Alcyonium quintum" (quintum antiquorum alcyonium), Mercati, Metallotheca Vatic., p. 102 f.

1725 "Figue de substance d'Eponge & d'Alcion, nommée par Trionfetti, Alcyonium tuberosum, forma ficus Imperati," Marsilli, Hist. phys. Mer, p. 87 t. 16 f. 79.

1757 "Alcionio minore in figura di fico frutto," Ginanni, Oper. post., v. 1 p. 41 t. 47 f. 98.

1766 Alcyonium Ficus (part.), Pallas, Elench. Zooph., p. 356.

1767 Alcyonium Ficus (part.), Linné, Syst. Nat., ed. 12 v. 1 II p. 1295.

1767 Alcionium Ficus (part.), Linné, Syst. Nat., ed. 13 v. 1 II p. 1295.

- 1773 "Alcyonium tuberosum Ficus forma Imp.," Battarra in: Bonanni, Mus. Kircher., p. 178, 179 nota.
- 1786 "Sea-Fig," Ellis & Solander, Zooph., p. 206 t. 59 f. 4.
- 1789 Alcyonium Ficus, Poiret, Voy. Barbarie, v. 2 p. 57.
- 1791 Alcyonium Ficus (part.), Gmelin, Syst. Nat., v. 1 VI p. 3813.
- 1792 Alcyonium Ficus, Olivi, Zool. Adriat., p. 240.
- ? 1798 Alcyonium ficus, G. Cuvier, Tabl. élém., p. 682.
- 1806 Alcyonium ficus, Esper, Pflanzenth., pars 3 fasc. 2 (14) p. 63 t. Alc. 20 f. 1-4.
- 1815 Alcyonium ficiforme, Lamarck in : Mém. Mus. Paris, v. 1 p. 75.

1816 Alcyonium ficiforme, Lamarck, Hist. An. s. Vert., v. 2 p. 394.

1816 Alcyonium Ficus, Lamouroux, Hist. Polyp., p. 348.

1896 Ficulina ficus, Lendenfeld in: N. Acta Ac. Leop., v. 69 nr. 1 p. 94.

MACROCLINUM PULMONARIA (ELL. Sol.):

1755 Alcyonium pulmonis instar lobatum, Ellis, Corallin., p. 82 t. 17 f. b, B, C, D. non bin.

1756 Alcyonium pulmonis instar lobatum, Tak, Ellis Koraal-Gewass., p. 89 t. 17 f. b. B. C. D. non bin. [Dutch translation of Ellis, Corallin.]

- 1756 Alcyonium pulmonis instar lobatum, Allamand, Ellis, Corallin., p. 97 t. 17 f. b, B, C, D. non bin. [French translation of Ellis, Corallin.]
- 1766 Alcyonium Ficus (part.), Pallas, Elench. Zooph., p. 356.
- 1767 Alcyonium Ficus (part.), Linné, Syst. Nat., ed. 12 v. 1 II p. 1295.

1767 Alcionium Ficus (part.), Linné, Syst. Nat., ed. 13 v. 1 II p. 1295.

1767 Alcyonium pulmonis instar lobatum, Krüniz, Ellis, Corall-Art., p. 89

t. 17 f. b, B, C, D. non bin. [German translation of Ellis, Corallin.]

1768 Alcyonium ficus (part.), Boddært, Plant-Dier., p. 442 t. 11 f. 3. [Dutch translation of Pallas, Elench. Zooph.].

1769 Alcyonium Ficus, Berkenhout, Outl. Hist. Great Brit., v. 1. p. 210.

1772 Alcyonium Ficus (part.), Houttuyn, Natural. Hist., pars 1 v. 17 p. 398. [Dutch translation of Linné, Syst. Nat., ed. 12.]

1775 Alcyonium ficus (part.), St. Müller, Natursyst. Linné, v. 6 II p. 787. [German translation of Linné, Syst. Nat., ed. 12.]

1782 Alcyonium ficus (part.), Höslin, Linné, Natur-Syst., v. 2 p. 608.

1786 Alcyonium Pulmonaria, Ellis & Solander, Zooph., p. 175.

- 1787 Alcyonium Ficus (part.), Meuschen, Mus Gevers., p. 532.
- 1787 Alcyonium Ficus (part.), Wilkens & J. F. W. Herbst, Pallas Thierpfl., v. 2 p. 121 t. 18 f. 63. [German translation of Pallas, Elench. Zooph.]
- 1787 Alcyonium ficus, J. F. W. Herbst in: Borowski & J. F. W. Herbst, Naturg. Thierr., atl. v. 9 t. 65 f. 1 a, b.
- (non 1787 Alcyonium ficus, J. F. W. Herbst in: Borowski & J. F. W. Herbst, Naturg. Thierr., v. 10 p. 77.)
- 1789 Alcyonium Ficus, Berkenhout, Synops. Hist. Great Brit., ed. 2 v. 1 p. 213.
- 1789 Alcyonium ficus (part.), Bruguière in: Enc. méth., Vers v. 1 p. 26.
- 1791 Alcyonium Ficus (part.), Gmelin, Syst. Nat., v. 1 VI p. 3813.
- 1795 Alcyonium Ficus, Berkenhout, Synops. Hist. Great Brit., ed. 3 v. 1 p. 213.
- 1802 Alcyonium ficus, Bosc, Hist. Vers, v. 3 p. 133.
- 1806 Alcyonium Ficus (part.), Turton, Syst. Nat. Gmelin, v. 4 p. 653. [English edition of Gmelin, Syst. Nat.]
- 1806 Alcyonium Ficus (part.), Esper, Pflanzenth., v. 3 fasc. 2 (14) t. Alc. 20 f. 5-8.
- 1807 Alcyonium Ficas (err.), Turton, Brit. Fauna, v. 1 p. 207.
- 1815 Alcyonium pulmonaria, Lamarck in: Mém. Mus. Paris, v. 1 p. 76.
- 1816 Alcyonium Pulmonaria, Lamouroux, Hist. Polyp., p. 342.
- 1816 Aplidium sublobatum, Lamarck, Hist. An. s. Vert., v. 3 p. 95.
- 1816 Aplidium ficus, Savigny, Mém. An. s. Vert., v. 2 p. 183.
- 1817 Polyclinum ficus, G. Cuvier, Règne an., v. 2 p. 501.
- 1817 Alcyonium ficus, Anonym in: Enc. Brit., ed. 5 v. 10 p. 358.
- 1820 Polyclinum ficus, Goldfuss, Handb. Zool., v. 1 p. 591.
- 1820 Alpidium (err.) ficus, J. Fleming in: Edinb. Enc., v. 14 p. 631.
- 1821 Aplidium ficus, Lamouroux, Expos. Polyp., p. 74.
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¹⁸⁸⁶ Aplidium ficus, Granger in : Hist. nat. France, v. 7 p. 206.

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DISTRIBUTION.

ENGLAND AND SCOTLAND: Moray Firth (Alder 1863)—? Cullercoats (Alder and Hancock 1848)—West Mersea—Sheerness (Berkenhout 1769)
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ENGLISH CHANNEL: (Lamarck 1815)-(Granger 1886).

CHANNEL ISLANDS: Guernsey (Ansted and Latham 1862)—Cobo (Sharp 1911). NORTH COAST OF FRANCE: Granville (Giard 1873)—Somme (Bizet 1892).

BELGIAN COAST: (Beneden 1860)-Blankenberghe (Pelseneer 1882).

NORTH SEA: (Gervais and Beneden 1859)—Heligoland (Hartmeyer 1906)— Dogger Bank (Alder 1865; Hartmeyer 1906)—Great Fisher Bank (Hartmeyer 1906)—56° 1′ N. 4° 49′ E., 38 m.—S.W. Lindesnaes, 57° 2′ N. 4° 3′ E., 64 m.—57° 11′ N. 0° 11′ E., 78 m.—57° 41′ N. 5° 35′ E., 100 m.—57° 20′ N. 8° 2′ E., 57 m. (Bjerkan 1905). *

SCANDINAVIA AND DENMARK : Baadsfjord (E.-Finmark), 65 m. (Bjerkan 1905)

--Gjesver (Bjerkan 1908)-Havösund, 72 m. (Sars 1851)-Tromsö, 54-72 m. (Hartmeyer 1903)-Tromsösund, 40-100 m. (Bjerkan 1908)--Ure, Lofoten, 36 m. (Sars 1851)--Vestfjord near Bodö, 105-160 m.--Trondhjemsfjord : Skarnsund, 150-200 m.; off Tautra, ca. 200 m.; off Rödberg, ca. 300 m. (Hartmeyer 1912); Rödberg (Herdman 1893)--Hessefjord, near Aalesund, 90 m. (Bjerkan 1905) -- Bohuslän -- Beian -- Christiansund (Huitfeldt-Kaas 1896) --Hellebaek (Mus. Berlin) *--Grosser Belt (Mus. Berlin), †

MURMAN COAST : Kola Fjord (Redikorzew and Hartmever 1911).

SPITZBERGEN : Stor Fjord, 77° 8' N. 20° E., 155 m. (Redikorzew 1907).

FARÖE ISLANDS: North point of Nolsö, ca. 180 m. (Hartmeyer 1912)-East of Faröes, 62° 16' N. 6° 6' W., 110 m. (Bjerkan 1905).

ICELAND: S.E. coast of Iceland, 64° 17' N. 14° 44' W., 75 m. (Bjerkan 1905). GREENLAND: S. of Cape Farewell (Hartmeyer 1910).

NORTH EAST AMERICA: Newfoundland (Verrill 1871; Hartmeyer 1903; Van Name 1912)—Virgin Rock, 72 m. (Van Name 1912).

Macroclinum pulmonaria is a decided sub-arctic species, which is distributed right across the North Atlantic from the east coast of North America to the Murman coast. On the American side it has only been found in Newfoundland. In the eastern part of the North Atlantic its most southerly locality is the north coast of France (Granville) and the Channel. It has not yet however certainly been proved to occur on the south coast of England, nor has it been found in the Irish Sea, on the Irish coasts, nor on the west coast of Scotland. On the other hand it is known from various points on the east coasts of

* Also collected at many other places in the North Sea during the quarterly cruises of the *Poseidon* and of the Heligoland fishery research vessels during the years 1902-5.

[†] The Berlin Museum possesses in each case one small colony of this species from Helleback, Gundel leg., and from the Greater Belt, collected during the *Pommerania* expedition. Both localities are new.

Scotland and England. From the Channel it extends along the Belgian coast and through the whole North Sea, where it appears to be very abundant everywhere, enters Danish waters (Greater Belt), and then follows the whole west coast of Sandinavia by Lofoten and Finmark to the Murman coast. Here its most easterly locality is the Kola Fjord. Towards the north it spreads through the Faröe Islands and Iceland to the neighbourhood of Cape Farewell on the one side and the Stor Fjord (Spitzbergen) on the other. Only at these two points does it go within the Arctic Circle, and it seems always to remain in the neighbourhood of the warmer currents. The whole area of distribution extends therefore from west to east from 48° W. to 34° E., from south to north from 48° 50' N. to 77° 8' N., or through 82 degrees of longitude and 29 degrees of latitude.

The species generally prefers deeper water. The vertical distribution lies, as far as the records show, between 38 and 300 metres. A decided littoral form the species is certainly not. In the Channel it appears to occur only in deeper water, and is absent from the coastal zone. In many places it is clearly extraordinarily abundant, as for example in the North Sea, especially in the neighbourhood of the Dogger Bank and the Great Fisher Bank. The species appears to live chiefly on sandy ground.

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On Ciliary Mechanisms in Brachiopods and some Polychætes, with a Comparison of the Ciliary Mechanisms on the Gills of Molluscs, Protochordata, Brachiopods, and Cryptocephalous Polychætes, and an Account of the Endostyle of Crepidula and its Allies.

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With twelve Figures in the Text.

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INTRODUCTION.

THE results of the writer's investigations on the ciliary mechanisms on the gills of Mollusca and Amphioxus (1 and 2) gave rise to the suggestion that similar mechanisms might probably also occur in Brachiopods, for it is a well-known fact that Brachiopods—like some Molluscs and Amphioxus—feed on the smaller organisms which are to be found floating in the sea. Owing to the kindness of Dr. H. C. Williamson, of Aberdeen, I have been able to examine living Crania which were obtained by dredging in Loch Fyne, and living Terebratula have also been obtained from Naples. An investigation of the living gill-filaments—or lophophoral cirri, as they are frequently termed in this group—showed that the ciliary mechanisms on these filaments are essentially the same as those occurring on the gill-filaments of Amphioxus, Lamellibranchs, some Gastropods, and most Ascidians. As it was found that existing accounts of the mode of feeding in Brachiopods are vague and incomplete the following description of the process has been written.

The nutritive currents in Brachiopods were the subject of an investigation by J. Hérouard (3) as early as 1877. This writer conceived the ingenious plan of investigating these currents by constructing artificial lophophores of lead piping perforated in places corresponding to the point of attachment of the filaments. It was assumed that a representation of the action of the tentacles would be obtained by squirting water under pressure through the holes in the artificial lophophore. Unfortunately, examination of the living filaments shows at once that this assumption is wrong, and that the experiments consequently were valueless. The gills of Brachiopods have, however, been investigated more recently by Shipley, who described the gill-filaments of Argiope as having cilia on three of their four sides, and figures these cilia as being all similar (see 4, Plate 39, Fig. 13). Later, Shipley (5) states that in Brachiopods "the cilia which clothe the tentacles (i.e. gill-filaments or cirri) keep up a constant flow of water into the mantle cavity. This stream not only serves to aerate the blood of the animals-a process which probably takes place through the thin inner lining of the mantle -but it also brings with it a number of diatoms and other minute organisms which serve as food. These particles become entangled in the tentacles, and are ultimately lodged in the groove at their base, and passing along this by the action of the cilia they find their way into the wide mouth, into which the groove deepens in the posterior median line." It will thus be seen that the manner in which the chief foodcurrent is produced and the differentiation of gill-cilia noted in the following pages have not been described. Moreover, it will be shown here that there exist in various parts of the body other ciliary mechanisms than those on the gill, which play an important part in the process of feeding.

CILIARY MECHANISMS PRODUCING THE MAIN FOOD AND RESPIRATORY CURRENT IN BRACHIOPODS.

Brachiopods—like Amphioxus, some Molluscs, and other animals obtain their food by maintaining a continuous current of water through a cavity enclosed by portions of the body, and capturing the organisms
brought along with the current by means of a suitable organ, namely the lophophore, placed between the ingoing and the outgoing currents.

The main food and respiratory stream in Crania enters the mantle cavity at *both* sides and is expelled in the middle of the front of the shell opposite the hinge (see Fig. 1). It will be remembered that the lophophore in Brachiopods is distributed symmetrically on each side of the antero-frontal axis of the shell. The effect of this disposition is—as will be shown later—to divide the mantle cavity in a physiological sense*



FIG. 1.—View of Crania attached to a stone in the act of feeding. Drawn from the living animal and chiefly from the right side (× 10). An ingoing current is drawn into the lower portion of the mantle cavity on each side in the antero-lateral region. The outgoing current leaves the region of the shell in the front middle line. The double row of the protruded gill-filaments is well shown.

into two compartments, each containing a half of the lophophore on each side of the mouth. Consequently two inhalent streams are necessary and enter the mantle cavity, as shown in Figs. 1 and 2. The exhalent streams are, however, combined in Crania, Lingula, and probably most recent Brachiopods in the middle line in the front region of the shell.

These main food-currents in Brachiopods are produced chiefly by the lashings of definite rows of cilia situated along the sides of the filaments of the lophophore (see Figs. 3 and 7, pp. 287, 292). Groups of other cilia, however, on other parts of the lophophore and on the mantle

* The mantle cavity is in many genera partially divided also morphologically by septa, viz. Waldheimia, Stringocephalus. (See also p. 295.)

assist in producing these food-streams. The action of the mantle cilia indicates fairly well the course of the food and respiratory streams through the mantle cavity, and the directions in which the cilia on the lower mantle lash are indicated by the arrows in Fig. 2. From the figure it will be seen that the cilia lash from both lateral regions of the shell towards the front middle region. Besides assisting in producing the main current these cilia also reject from the mantle cavity the heavier undesirable particles brought into the shell in the main stream. On the



FIG. 2.—View of the ventral value of Crania, showing the ciliary currents on the mantle (\times rather more than 3).

This view serves almost equally well for the ciliary currents on the dorsal mantle.

The dotted arrows indicate the direction in which the mantle cilia lash, and the large continuous arrows the regions where the greatest volume of the ingoing current enters the mantle cavity.

mantle lining the upper valve the cilia lash on the whole in similar directions to those on the lower one; there are, however, these differences, the cilia on either side of those in the front middle region lash more and more away from the middle the nearer they are situated to the anterior edge of the mantle. Thus two vortices tend to be formed in the right and left upper portions of the mantle cavity. On the dorsal mantle cilia also lash from between the anterior and posterior occlusor muscles on each side towards the posterior sinus of the mantle cavity which constitutes the space bounded by the posterior occlusors and the "hinge." Into this sinus opens the anus. An outgoing current from this part of the mantle cavity passes between the anterior occlusors to join the main outgoing stream (see Fig. 2). Thus the currents set up by the mantle cilia on each side of the mantle cavity divide into two streams, the major one passing towards the middle of the cavity and out at the front of the shell in the middle line, and a minor one passing between the occlusor muscles into the posterior sinus, from which the outgoing stream passes between the anterior occlusors to join the major outgoing stream. It will be shown later that the currents set up by the mantle cilia are in the main coincident with those produced by the current-producing cilia on the gill-filaments and certain cilia on the lophophore.



FIG. 3.—Lateral views of living gill-filaments of Crania (× about 56).

- A. *View of portion of a filament of the ventral series (the letter is placed near the distal end of the filament segment).
- B. View of portion of a filament of the dorsal series (the letter is placed near the proximal end of the filament segment).
- C. Arrow indicating the direction in which the lateral cilia, l.c., lash.

l.c. Lateral cilia which produce the main current.

D. Arrow indicating the direction in which the frontal cilia, f.c., lash.

f.c. Frontal cilia which collect and transport food-particles.

CILIARY MECHANISMS ON THE GILL-FILAMENTS AND LOPHOPHORE.

The examination of living gill-filaments of Crania and Terebratula under a high power of a microscope revealed the presence of two sets of cilia† which correspond in function and position to those on the filaments of Amphioxus, many Molluscs, and most Ascidians. These sets of cilia are well shown in the transverse sections of the filaments

* This view would serve equally well for the tips of both kinds of filaments.

[†] Blochmann (10) has already figured the differentiation of cilia on the filaments of Crania, without, however, making any observations on their function.

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shown in Fig. 7, p. 292, and in the lateral view of a living filament shown in Fig. 3. From these figures it is seen that the cilia are differentiated into three rows, one extending along that face of the filament which faces the incoming current, and two extending either along the sides of the filaments or along the edges of the filaments at the sides of the former row. Those rows of cilia on the face of the filament facing the incoming current may be called frontal cilia in comparison with the similar cilia



FIG. 4.—Diagram of the currents present in the mantle cavity of a Brachiopod as represented by Crania.

The diagram represents a section taken on one side of the median anteroposterior axis through the shell and the whorls of the lophophore. One anterior and one posterior occlusor muscle are shown.

The larger arrows indicate the course of the main current through the mantle cavity. The large arrow whose head ends above the letter A indicates the course of the ingoing current and the one beginning below B that of the outgoing current. The three arrows between and to the right of A and B indicate the course of the current through the gill-filaments on the lophophore. The dotted arrows on either side of A indicate the region where the heavier food-particles fall out of the main stream on to the mantle and are expelled by the mantle cilia as indicated by the long dotted arrow placed parallel to the lower mantle. The direction in which the cilia lash on the dorsal mantle is shown by the dotted arrow alongside it. The small dotted arrows on the lophophore and gill-filaments show the course of the food-collecting streams.

A. Inhalent chamber of one side.

B. Exhalent chamber of one side.

described in Molluscs and Amphioxus (see 1 and 2), while the rows of cilia on the sides of the filaments may be similarly called lateral cilia. Thus the faces of the filaments may be termed respectively frontal, lateral, and ab-frontal, the latter being the face opposite the frontal. The lateral cilia (well shown in Figs. 3 and 7 l.c.) are the chief producers of the main food and respiratory current in Brachiopods. They lash across the length of the filament, as shown in Fig. 3, from the lower portion of the mantle cavity to the upper. The origin of the lophophore

from the body is such that the plane of the first and longest turn of the lophophore on each side subtends the antero-lateral angle of the shell.



FIG. 5.—View of a portion of the lophophore, including the buccal groove and the base of five gill-filaments of Crania. Three of the filaments are ventral and two dorsal ones.

(For the sake of convenience the lophophore is magnified less than the gillfilaments. Drawn from the living object.)

The dotted arrows indicate the direction in which the cilia on the body of the lophophore lash, the arrows on the filaments the direction in which the foodcollecting, the frontal cilia lash, and the thin-lined arrows below the buccal lip the direction in which the cilia lash in the buccal groove.

- A. Ridge on the lophophore away from which the cilia on both sides lash.
- B. Arrows indicating the direction in which the lateral, i.e. current-producing cilia, lash.

B.l. Buccal lip overlying buccal groove.

B.gr. Buccal groove along which are carried the particles from the lophophore.

l.c. Lateral cilia.

f.c. Frontal cilia.

v.f. Filament of ventral series.

a.f. (d.f.) Filament of dorsal series.

Consequently the main current is drawn into the shell at the anterolateral angles, since the lateral cilia lash on the whole in a direction at right angles to the plane of the lophophore. C

When Crania is feeding the gill-filaments are extended in the plane of the lophophore and extruded beyond the opening of the shell, as shown in Fig. 1; they are also usually kept close to the upper valve. This disposition of the filaments permits a selection of the finer foodparticles, for the heavier particles in the ingoing current drop out of the stream at the entrance to the mantle cavity and are rejected by the cilia on the lower mantle as shown in Fig. 2. The main current, however, passes between the filaments on the first turn of the lophophore and onwards through the filaments of the succeeding turns of the spiral lophophore-which are superposed one above the other (see Fig. 4, p. 288)to be passed out of the mantle cavity finally in the anterior middle portion as has been seen. Thus in traversing the mantle cavity the food-stream passes successively through a number of sieves which are formed by the tiers of filaments on the lophophoral spiral. This arrangement is probably very effective in sieving off the food-particles, although at first sight the somewhat straggling appearance of the filaments does not give this impression. The efficiency of the sieving action of the filaments, moreover, is further enhanced by the fact that the filaments are arranged in two distinct alternating rows at the edge of the lophophore (see Fig. 5, p. 289), one row being slightly behind the other, as shown in Fig. 7, which is a transverse section of a group of filaments taken near their origin from the lophophore.* As a result of this disposition the lateral rows of cilia near the base of the upper filaments lash directly on to the frontal face of the lower ones, that is, directly on to the frontal cilia, which are the principal agents in catching food-particles.

An additional minor factor in producing the main food and respiratory stream are the cilia on the body of the lophophore, which have also been figured by Blochmann. These cilia also assist partially in collecting food-particles and their action may best be gathered from Fig. 5, p. 289 and a diagram of a transverse section of the lophophore (see Fig. 6, p. 291). The cilia on the frontal surface of the lophophore are differentiated into two sets separated by a ridge running along the middle of the spiral, but slightly towards the outer, i.e. filamentar side. The cilia on the filamentar side of this ridge are very powerful and lash towards the filaments, those on the other side lash away from the ridge in a direction mainly transverse to the length of the lophophore, but also slightly oblique, towards the proximal end, as shown in Fig. 5, p. 289. The

* The arrangement of the filaments on the lophophore is probably universal in Brachiopods, as it has been observed by Van Bemmelen in Terebratula (6) and Blochmann (10) in Crania, Discina, and Lingula. Oehlert (14) also makes the general statement that they are arranged in two rows in Brachiopods. cilia on the ab-frontal face are similar to those on the frontal face (see Fig. 6, below). Thus there are two broad zones of cilia on the filamentar side of both faces of the lophophore lashing towards the filaments and so assisting in producing the food-current, and two zones lashing towards the inner edge of the lophophore, along which particles are carried around the inside of the spiral to its base. At the bases of the two arms of the lophophore the particles carried along the inner edge of the lophophore the particles carried along the inner edge of the lophophore the particles carried along the inner edge of the lophophore are passed on to the lower mantle, whence they are expelled from the mantle cavity.



- FIG. 6.—Semi-diagrammatic transverse section of the lophophore of Crania to show the difference in the action of the cilia on its various parts as indicated by the adjoining arrows.
 - A. Arrow indicating the direction in which the current-producing cilia lash on the portion of the gill-filament E.
 - B. Arrow indicating the direction in which the frontal cilia on the gillfilament lash.
 - B.gr. Buccal groove along which food is carried to the mouth.
 - B.1. Buccal lip.
 - C. Inner edge of lophophore along which particles are carried to its base.
 - D. Region from either side of which the cilia lash in opposite directions, resembling a watershed.
 - E. Base of a gill-filament arising from the lophophore.
 - m. Mucus globules.

It will now be seen that there are three factors concerned in the production of the main food and respiratory stream in Crania—and probably in most, if not all, Brachiopods—namely, the rows of lateral cilia on the gill-filaments, which are the most important factor, the cilia on the filamentar sides of the body of the lophophore, and the cilia on the mantle lobes.

Food-collection in Brachiopods is effected chiefly by the frontal cilia on the gill-filaments, and partially by the cilia on the frontal face of the outer side of the body of the lophophore. The cilia on the frontal face

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of the filaments collect food-particles and lash them towards the base of the filaments into the food groove (see Fig. 5, p. 289). In the same way the frontal cilia on that part of the lophophore adjacent to the food groove entrap food-particles and lash them along the face of the lophophore either on to the base of the filaments or towards the powerful cilia at the edge of the buccal lip (see Fig. 5). These cilia quickly push the particles under the lip into the food groove. The food-particles, on entering the food groove, are then carried along towards the mouth, as has been stated by Shipley, being rapidly transported thence by very



FIG. 7.—View of transverse section of five ventral and four dorsal gill-filaments of Crania taken near the lophophore, showing the alternation of the filaments in these two series.

(The outlines of the sections were drawn with the camera lucida, and the remainder filled in slightly diagrammatically (\times about 192.)

The arrows indicate the directions in which the lateral cilia lash, and it will be seen that those of the smaller ventral filaments lash directly on to the frontal surface of the larger dorsal filaments.

- l.c. Lateral cilia which lash across the length of the filament, as indicated by the arrows, to produce the main current.
- f.c. Frontal cilia, which lash along the length of the filament and collect and transport food particles.
- m. Globules of mucus seen in all the sections on various parts of the frontal and lateral sides of the filamentar epithelium.

g.s. The gill-filament supports.

strong cilia. In the process of food-collection the secretion and transportation of mucus plays an important part, for the mucus when spread out in thin layers forms an efficient method of capturing and retaining captured food-particles, and is also easily transported in this form by cilia. Mucus serving this purpose is secreted by the frontal epithelium on the gill-filaments and especially by that of the dorsal filaments, where the secreting cells occur chiefly in the trough of the filamentar groove (see Fig. 7, above, and also Van Bemmelen, 6, Taf. 8, Fig. 6, in a section of a gill-filament of *Rhynchonella psittacea*). Blochmann (10) has described aggregations of mucus cells between the bases of the filaments, that is, in the buccal groove, and also others scattered over the epithelium of the lophophore. The secretions of these latter cells assist in a similar way to that from the filaments in the capture and transportation of food-particles.

THE CILIATION OF THE GILL-FILAMENTS OF BRACHIOPODS.

The cilia on the gill-filaments of Brachiopods are arranged in three rows along the length of the filament, as has already been described. There are, however, as Oehlert has observed, two kinds of filaments. a larger and a smaller, as is shown in Fig. 7, p. 292. The smaller ones constitute the ventral series (that is, the series facing the incoming current) on the lophophore and alternate with the larger ones in the dorsal series (see Fig. 5, p. 289). These two kinds also differ in the arrangement of the rows of cilia. On the smaller ones the lateral cilia are situated on the sides of the filaments and near the ab-frontal face, while in the larger filaments they occur similarly on the sides, but near the frontal face, except towards the tips of the filaments, where these current-producing cilia graduate towards the ab-frontal face (see Fig. 3, p. 287). The disposition of the rows of cilia is well shown in Fig. 7, p. 292, which represents transverse sections of the two kinds of filaments taken near their origin from the lophophore. In the smaller sections the filaments are shown to be nearly cylindrical and the greater part of the convex face occupied by the frontal, that is, food-collecting cilia. The larger cilia on the sides of the filaments are the lateral or current-producing cilia. Both these rows of cilia arise from columnar cells which have long elliptical nuclei. On the contrary the non-ciliated ab-frontal epithelium is composed of squarish to flattened cells with more or less spherical nuclei, and indeed it would appear that the character of an epithelium on any gill-filament forms a very good guide as to whether or not that epithelium is ciliated; if the cells in a portion of an epithelium are columnar and the nuclei elongated they probably bear cilia, whereas if the cells are squarish to squamous they are probably not ciliated. Such an interpretation of portions of an epithelium on gill-filaments may be useful in cases where it is difficult to obtain well-preserved material. for as is well known it is difficult to determine what part of an epithelium is ciliated unless such material can be obtained. One good illustration of this fact is afforded by the well-drawn figure of a transverse section of a gill-filament of Rhynchonella given by Van Bemmelen (6, Plate 8, Fig. 6). In this figure no cilia are shown at all, although the characters of the epithelium are seen to be almost identical with that of the smaller sections in Fig. 7, p. 292. A somewhat diagrammatic transverse section

of a filament of Argiope is figured by Shipley (4), who depicts uniform cilia on three of the four sides of the filament. Examination of the living filaments* and sections of specially preserved material, however, would doubtless show that a differentiation of cilia occurs here as on the filaments of Crania, Rhynchonella, Terebratula, and other forms. Blochmann, however, has given beautiful figures of transverse sections of the gillfilaments of Crania, in which the differentiation of the lateral and frontal cilia is very well shown in a section of a filament of the dorsal series, but less well in that of a ventral filament. This writer also gives rougher figures of Discina and Lingula, without, however, figuring the cilia, but he remarks that the filaments of these two forms are essentially similar in their characters to those of Crania. Hence there can be no doubt that the gill-filaments of all Brachiopods have cilia disposed and differentiated in the same way as in Crania.

SUMMARY OF CURRENT-PRODUCING MECHANISMS AND THE MODE OF FEEDING IN BRACHIOPODS.

The main current through the mantle cavity in Brachiopods is produced chiefly by the lateral cilia on the gill-filaments and partially by cilia on the mantle and on the body of the lophophore. The disposition of the lophophore and the filaments on the lophophore is such that two ingoing currents of water are established at the sides of the mantle cavity. On each side the current passes between the filaments of the first turn of the lophophore and outwards through the filaments of the second and succeeding turns of the lophophoral spiral into the median dorsal region of the mantle cavity. At this point the currents from each side meet and pass out of the mantle cavity at the middle of the anterior region of the shell.

The food-particles brought into the mantle cavity in the main stream are caught by the frontal cilia on the gill-filaments, and by those on the outer frontal portion of the lophophore, and transported by these cilia into the buccal groove. In the buccal groove the food-particles are lashed rapidly along to the mouth by the strong cilia on the buccal lip and fused bases of the filaments. It seems probable that the food-stream in Brachiopods is effectively sieved by the gill-filaments, since besides collecting food-particles the ventral ones lash directly on to the food-collecting face of the lower filaments which alternate with them : moreover, part of the food-stream is repeatedly sieved in most forms by the filaments on the superposed whorls of the lophophore.

* Subsequent examination of living Argiope from Naples has shown this statement to be correct.

In Crania a selection of the finer food-particles is effected in the following manner: the ingoing currents are drawn into the dorsal portion of the mantle cavity, hence when the dorsal valve is uppermost—as frequently happens—the heavier particles drop on to the ventral mantle, whose cilia discharges them either outside the mantle cavity or carries them to the edge of the mantle, whence they are shot away by the animal suddenly clapping together the valves of the shell. Modifications in the manner of rejecting unsuitable food-particles probably occur in other Brachiopods in much the same way as has been observed in Lamellibranchs (1, pp. 457 to 463).

AN EXPLANATION OF SOME MORPHOLOGICAL CHARACTERS IN FOSSIL AND RECENT BRACHIOPODS.

In the foregoing description it has been shown that in certain Brachiopods, as, for example, Crania, there is a physiological subdivision of the main part of the mantle cavity into right and left portions, and it would seem highly probable that in all Brachiopods there is a similar subdivision of the mantle spaces, since the disposition of the lophophore is fundamentally similar in them all. Unfortunately few observations have been made on the nutritive currents of Brachiopods, but those of Morse on Lingula (7, p. 157) are of interest. Morse found that Lingula lives embedded in sand, and that "while partially buried in the sand the anterior border of the pallial membranes contract in such a way as to leave three large oval openings, one in the centre and one on each side. The bristles, which are quite long in this region of the animal, arrange themselves in such a way as to continue these openings into funnels and entangle the mucus which escapes from the animal; these funnels have firm walls. A continual current is seen passing down the side funnels and escaping by the central one."* These observations have been confirmed by François (8) in so far as he figures the trilobed apertures of the burrows of this animal (see also Camb. Nat. Hist., Vol. 3, Fig. 321). Thus there can be little doubt that the mantle cavity is subdivided in Lingula in the same way as in Crania.

In these respects it is a highly interesting fact that many Brachiopods both recent and fossil have a trilobed shell whose apertures correspond to the inlets for ingoing currents and the outlet for the outgoing current (see Fig. 8 C, p. 296), but it is probably still more interesting and remarkable that in some forms, as in *Conchidium Knighti*, the mantle cavity is

* The italics are mine.

practically subdivided into right and left portions by a median septum, and that in others, as in *Terebratula janitor*, the shell is actually divided into two wings (see Fig. 8 A and B, below). In all Brachiopods there would thus appear to be little doubt of the physiological independence of the right and left halves of the mantle cavity. Hence variations in the direction of formation of antero-posterior median septa, as shown in Stringocephalus, Conchidium, and many other genera, of trilobation of the shell, as shown in many Rhynchonellidæ, and bilobation of the shell, as shown in *Orthis biloba*, *Terebratula diphya*, and other forms, do not interfere with the functions of the two portions of the lophophore, and it is con-



- FIG. 8.—Views of types of Brachiopod shells showing morphological division of the mantle cavity into right and left portions, and trilobation of the shell.
 - A. Shell of *Terebratula (Pygope) janitor* (after Oehlert) in which the mantle cavity is almost entirely divided into two separate compartments.
 - B. View of interior of shell of *Conchidium Knighti* (after Davidson) showing internal partial subdivision of the mantle cavity by the septa which are shaded.
 - C. Frontal view of the shell of *Rhynchonella cynocephala* (after Oehlert), showing the anterior median portion of the shell produced into a sort of siphon in the region in which in other Brachiopods (for example, Crania and Lingula) is expelled the outgoing current.

ceivable that these variations may be advantageous to certain forms under certain conditions.

The disposition of the lophophore in the Spiriferidæ indicates that the main ingoing current entered the mantle cavity in the front middle portion and was expelled in two outgoing currents at the postero-lateral angles of the shell, a condition exactly the reverse of that obtaining in Crania, where the ingoing current is twofold and the outgoing current single. Thus the production of the shell—frequently occurring in this group—into postero-lateral angles, somewhat like those occurring in modern Pectens, may have served as a sort of siphon for carrying away the exhalent streams.

COMPARISON OF THE CILIARY MECHANISMS ON THE GILLS OF GASTROPODS, LAMELLIBRANCHS, AMPHIOXUS, AND BRACHIOPODS.

The ciliary mechanisms concerned in producing the main food and respiratory current in Gastropods, Lamellibranchs, Amphioxus, Ascidians, and Brachiopods have now been shown to be essentially similar in all these groups (see preceding pages and Orton, 1* and 2, and Herdman, 9). The main current is produced in all groups alike chiefly or entirely by the rows of cilia, the lateral cilia situated at the sides of the gill-filaments (see Fig. 9, p. 299) : for the term "gill-filament" may be used as well for the gill-bars of Amphioxus or Ascidians and the lophophoral cirri of Brachiopods as for the elements of the ctenidium of Gastropods and Lamellibranchs. These rows of lateral cilia lash across the length of the gill-filaments in all cases and set up a current towards and at right angles to the gill. The current thus produced brings into the mantle cavity-or the branchial sac in the case of the Protochordatafood-particles, which serve for the nourishment of the animal, and also brings the means for oxydation of the tissues, while the expulsion of the current from within the cavities of the animals serves to carry away the waste products resulting from the various activities of the organisms.

The food-particles carried in the main current into the spaces of all these animals are arrested on the gill which is necessarily interposed between the ingoing and outgoing currents, and acts like a sieve. The actual collection of food-particles varies somewhat in the different groups. Food-collection is effected chiefly, however, in all the groups by means of rows of cilia on those faces of the filaments facing the oncoming current, that is, on the frontal faces. In some Lamellibranchs which are curiously distributed throughout the group, as Nucula, Solenomya, Anomia, Mytilus, Cardium, Ostrea, Tapes—there are additional food-collecting cilia on the latero-frontal edges of the gill-filaments. These latero-frontal cilia are true straining cilia, and lash across the length of the filament at right angles to the oncoming current and away from the inter-filamentar spaces. In this way they pass particles on to the frontal cilia, and indeed are so numerous in these animals as to give

* In a paper written in 1910 Bourne (11) states of the lateral cilia of the Gastropod *Incisura (Scissurella) lytteltonensis* that he does not think "that their function is to hold the filaments together, but simply to create currents over the surfaces of the filaments." I hasten to give this reference because I only became aware of it after my paper on the ciliary mechanisms in Gastropods was published. From the researches described in that paper it is now seen that there is an element of truth in the suggestion made by Bourne.

the appearance of flexible combs working along the sides of the filaments. The frontal cilia in all forms lash the food-particles into a food-groove, whence the particles are carried to the mouth or œsophagus. It is an interesting fact that the frontal cilia are in all cases short, as compared with the length of the lateral or the latero-frontal cilia, and it is probable that short cilia would be much more effective than long ones in transporting food-particles and masses of particles embedded in mucus, and would, moreover, be more easily controlled and less liable to become intermixed and so interfere with their fellows.

Food-collection is also assisted in some Gastropods as in Crepidula, and some Lamellibranchs as in Nucula, by rows of cilia on the ab-frontal faces of the filaments, but probably the function of these rows of cilia in assisting in producing the main current is more important than that of food-collecting. In Amphioxus and Ascidians cilia on the epithelium of the atrial cavity help in a small way in producing the main stream.

The distribution of the cilia on the gill-filaments of Gastropods, Lamellibranchs, Amphioxus, and Brachiopods is shown in the transverse sections depicted in Fig. 9, p. 299. From these figures the essential similarity of all the filaments is at once apparent. The position of the lateral cilia is, however, somewhat different in the types of filament represented by those of Crepidula and Crania. In those filaments the lateral cilia occupy a position much nearer the ab-frontal surface of the filament. It is probably significant that in both Crepidula and Crania the gill-filaments are free and without any extensive interlocking arrangements such as exist in Lamellibranchs, or such a consolidation as occurs in Amphioxus and Ascidians. It is very probable therefore that the receding of the lateral cilia from the frontal surface in these forms is an effort to compensate for the lack of compactness in the gill, by exposing a larger food-collecting, that is, frontal surface.

A glance again at Fig. 9 shows that in all these filaments internal supports (g.s.) are developed similarly, but with some differences in order to maintain the gills sufficiently rigid in the form of either an open basketwork or grid-iron sieve.

In an earlier paper (2) it has been suggested that the function of the gill in Crepidula, most Lamellibranchs and Amphioxus is merely that of a water-pump and a food-sieve, and that the respiratory function is not performed to any appreciable extent on the gill in these forms. In Brachiopods, Shipley (4, p. 501) has arrived at the same conclusion with regard to the function of the lophophore, of which he states : "I have been unable to detect any blood corpuscles in the tentacles, and I believe



Protochordata

Brachiopoda

FIG. 9.—Transverse sections of the gill-filaments of members of Gastropods, Lamellibranchs, Protochordata, and Brachiopods, illustrating the essential similarity of the ciliation of the filaments in all these groups. (Variously magnified.)

I.c. Lateral cilia which produce the main food and respiratory current in all the groups.

f.c. Frontal cilia which are the main food-collecting cilia in all the groups.

Latero-frontal cilia, which are special food-catching cilia present only in some Lamellibranchs, as Nucula, Anomia, Mytilus, Cardium, and others; they lash in the direction shown by the adjoining arrows.

ab.f.c.

l.f.c.

Ab-frontal cilia present and well developed in Gastropods and some Lamellibranchs, but less well developed in Amphioxus and Ascidians; absent in Brachiopods. These cilia assist both in food-collection and in producing the main current.

g.s.

Internal supports for the gill-filaments and present in all the groups, but additional support by calcareous spicules is given in some Brachiopods, as in *Terebratula vitrea*, shown in the Brachiopod section B.

In the above types of gill-filaments Gastropods are represented by a transverse section of a filament of *Crepidula fornicata*; Lamellibranchs by two sections representing the two types of ciliation in this group. Type A is of *Glycimeris glycimeris*, and would serve equally well for Pecten, Arca, and others. Type B is of *Mytilus edulis*, and represents Nucula, Solenomya, Anomia, Cardium, Ostrea, Anodon, and many others. Protochordata are represented by a section of a secondary gillfilament of *Amphioxus lanceolatus*, but sections of Ascidian and Enteropneustan (as represented by Ptychodera) gill-filaments are essentially similar to that of Amphioxus in their ciliation.

The two kinds of filaments present in Brachiopods are represented by the Brachiopod sections A and B. The section A is of a ventral filament of *Crania anomala*, and B is of a dorsal filament of *Terebratula vitrea*. The latter section is slightly idealized in that the supporting spicules present within the chitinous gill-support are represented in the drawing although dissolved out of the actual section by the fixative.

the sole function of the lophophore is to set up a stream by means of its cilia, and so to bring diatoms and other articles of food to the mouth, and that it has no respiratory function whatever. Indeed, it is difficult to imagine how an interchange of gas could take place through the thick, dense layer of supporting substance."

There would appear to be little doubt that Shipley is correct, hence in practically all the members of the above-mentioned groups the gill probably functions merely as a water-pump and a food-sieve. In Crepidula, most Lamellibranchs and Brachiopods respiration doubtless occurs mainly in the mantle; while in Amphioxus a gaseous exchange is probably effected chiefly in the cœlomic spaces adjacent to the atrium. In Ascidians respiration is doubtless effected in the branchial sac.

In all these gills there can be no doubt that mucus formation plays a very important part in the process of food-collection. It has been shown in an earlier paper (2) that in Amphioxus and Ascidians the mucus formed in the endostylar groove of these animals is thrown on to and transported along the gill-filaments in thin sheets to serve for entrapping food-particles. In Lamellibranchs and Crepidula it has been suggested that the corresponding mucus formation takes place in the frontal epithelium of the gill-filaments, and indeed swollen cells, which are almost certainly mucus cells, have already been figured in the epithelium of the filaments of Mytilus (see I, Fig. 17, *passim*). Similar globules occur also in the filaments of Glycimeris, Crania (see Fig. 9, p. 299), Terebratula and Rhynchonella (see 6). It is hoped to make this important problem the subject of a special investigation.

The writer's work, however, on the endostyle of Amphioxus suggested the probable function of a previously enigmatical glandular organ situated along the base of the gill-filaments of Crepidula. An examination of the living animal confirmed the suggestion that this organ is indeed an *endostyle*, as may be gathered from the description of it in the section on p. 303.

It is an interesting fact that the spines (clavulæ) composing the fascioles of the heart-urchins, Echinocardium and Spatangus, have been found to have the cilia disposed in definite rows along their sides in a manner very similar to that in which the lateral cilia are distributed on the gill-filaments of all the above-mentioned groups. These rows of cilia on the spines do, as a matter of fact, very closely resemble the lateral cilia of gill-filaments in that they lash in a definite direction and with the same wave-like motion characteristic of those current-producing cilia ; they are also situated on opposite sides of the spines, and are indeed current-producing cilia analogous to those of Gastropods, Lamellibranchs, Ascidians, Amphioxus, and Brachiopods.

The function of these spines is being investigated further, and figures will be given to show their resemblance to gill-filaments. MacBride, however, is doubtless correct in stating (*Camb. Nat. Hist.*, Vol. I, p. 550) that : "Between the two posterior petals (in *Echinocardium cordatum*) there is a hoop-shaped band of very small black spines. These spines are ciliated, and draw a current of fresh sea-water over the respiratory tube-feet. Beneath the periproct there is a similar band called the 'sub-anal fasciole'; this probably produces a current of water which sweeps away the material ejected from the anus."

THE CILIARY MECHANISMS ON THE GILLS OF CRYPTO-CEPHALOUS POLYCHÆTES AND ON THE LOPHOPHORE OF PHORONIS.

An examination has also been made of the cephalic gills of various Cryptocephalous Polychætes. It has been found that these gills are used for the purpose of feeding, and that the ciliary mechanisms concerned in the feeding process in—for example—Spirorbis, Pomatoceros, Hydroides, Branchiomma, Sabella, and Filograna are identical with those on the gills of Lamellibranchs, some Gastropods, Amphioxus and Brachiopods, that is to say, there are well-differentiated current-producing lateral cilia and food-collecting and food-transporting frontal cilia on the pinnules of the tentacles. Food is very rapidly collected in these Polychætes and transported along the pinnules to the axes of the tentacles and thence to the mouth. Further particulars and figures with regard to these animals will, however, be given later.

The lophophoral cirri of Phoronis have also been investigated, but up to the present it has only been possible to examine the living animal cursorily. Nevertheless this short examination revealed the facts that in this animal also the cirri—or gill-filaments—are differentiated into lateral and frontal rows, and that a good current of water is drawn towards the mouth within the space enclosed by the lophophoral cirri. The functions of the lateral and frontal cilia in Phoronis, however, do not appear to be identical with those of the similar cilia in Brachiopods and the other groups mentioned above, but a more complete examination of the living animal will be made later with a view to investigating fully the ciliary mechanisms concerned in process of feeding in this animal.



FIG. 10.—View of the mantle cavity and gill of Crepidula, showing the endostyle at the base of the gill. (The animal has been taken out of its shell and the mantle turned over to the left.)

The dotted arrows on the endostyle, En, indicate the directions in which mucus is lashed from the endostyle on to the base of the gill-filaments.

- EN. Endostyle from which mucus and food-particles are lashed on to the gill-filaments.
- c.gr. Ciliated groove along the left side of the endostyle carrying mucus forwards to the food-pouch, as indicated by the complete arrows.

f.p. Food-pouch in which the heavier food-particles become lodged.

f.ch.

- . Food-channel on the right side of the body extending along the visceral mass and the "neck" region of the animal towards the mouth. In this channel is collected the main mass of collected food-particles which are carried in the direction indicated by the arrows.
- f. Foot.
- v.m. Visceral mass.

g.f. Gill-filaments.

THE ENDOSTYLE OF CREPIDULA AND CALYPTRÆA.

At the base of the gill-filaments of Crepidula and Calyptræa there is a group—or rather there are two groups—of large glandular ciliated cells which secrete a mucoid substance (see Figs. 10 and 12, p. 304). Examination



FIG. 11.—View of the endostyle and the bases of four gill-filaments of *Crepidula fornicata* highly magnified. (Drawn from the living object.)

The dotted arrows on the endostyle, EN, and the complete ones on the bases of the gill-filaments indicate the direction in which mucus is passed from the endostyle on to the bases of the gills. The dotted arrows on the mantle on the floor of the inhalent chamber, m, show the direction in which the cilia in this region lash. Similarly the forward stream in the ciliated groove, c.gr., on the left of the endostyle is indicated by the overlying dotted arrows.

EN. The endostyle consisting of two rows of gland cells between and to the left of which are rows of specially differentiated ciliated cells.

c.gr. Ciliated groove on the left of the endostyle.

g.f. The bases of the gill-filaments.

f.c. Frontal cilia of gill-filaments.

m. The mantle covering the floor of the inhalent chamber.

of the living gill and the surrounding parts shows that the cilia of these glandular cells lash the secreted mucus on to the bases of the gill-filaments, whence it is passed along the face of the gill to be used for the purpose of entrapping food-particles (see Figs. 10 and 11, above), as has already been described in this Journal (1, pp. 448, 455). I thought formerly that this mucus was secreted by the epithelium of the gill-filaments (loc.cit.), but there is no doubt now that the greater part is secreted by the glandular cells at the base of the filaments, although it is not unlikely that a certain amount



FIG. 12.*—Transverse section of the endostyle of Crepidula (\times about 105).

- A. Arrow indicating the direction in which the mucus from the endostyle is passed on to the base of the gill-filaments.
- EN. Two rows of groups of gland cells in the endostyle, between and to the left of which is a group of ciliated cells with apical nuclei.
- g.f. Gill-filament.
- f.c. Frontal epithelium and frontal cilia on gill-filament.
- l.c. Lateral cilia on gill-filament.
- g.s. Gill-filament support.
- c.gr. Ciliated groove to the left side of the endostyle.
- m. Epithelium of mantle the cilia on which lash towards the main foodchannel on the right side of the body as indicated by the arrow placed alongside.
- I.ch. Inhalent chamber.
- E.ch. Enhalent chamber into which the main current is passed from the inhalent chamber as indicated by the arrow crossing the gill-filament.

of mucus may be secreted by the epithelium of the gill-filaments. These groups of grandular cells may be properly termed an *endostyle*, since they

* I am indebted to Mrs. Orton for the drawing for this figure as well as those for figures 1, 2, and 8, and also for assistance with all the other drawings except that for Fig. 3; and also to Mr. E. Ford for kindly lettering Figs. 3, 4, 6, 7, 9 to 12.

have the same function as the similar groups of glandular cells in a similar position in Amphioxus and Ascidians. The cilia on the endostyle of Crepidula and Calyptræa lash mucus and food-particles on to the gill as has already been stated, but there is also a ciliated groove on the left side of the endostyle which lashes some mucus and captured food-particles forwards (see Fig. 10). This forward stream of mucus contributes largely to the forward stream in the mantle cavity which has already been described (1, p. 448), and whose function is chiefly that of entrapping the coarser food-particles at the entrance to the inhalent chamber. By means of the mucus which is thus carried along this ciliated channel a large proportion of the larger and often innutritious particles become lodged in the food-pouch in the middle of the front portion of the mantle, and are either rejected or eaten by the animal, as has already been observed (1, p. 448). In this way and to this extent these animals are able to select their food.

The character of the endostyle of Crepidula may be gathered from the views shown in Figs. 10 and 11, and the transverse section shown in Fig. 12. From the transverse section it is seen that there are two rows of long glandular cells with basal nuclei, and between and to the left of these rows is a line of curious ciliated cells with an apical or distal nucleus. On either side of the endostyle, the epithelium consists of columnar ciliated cells, which become more cubical as they recede from the endostyle. The epithelium on the right side (seen on the left in the section) passes into that of the floor of the mantle cavity. In the latter region the cilia lash away from the endostyle towards the right side of the mantle cavity, and while thus assisting in producing the main current, at the same time help in collecting food-particles into the food-groove on the right side of the floor of the mantle cavity (see Fig. 10, p. 302). The characters of the endostyle and the ciliation of the mantle are the same in Calyptræa as in Crepidula. In Capulus these characters are also the same in the living animal, but sections of the endostyle have not yet been examined.

The remarkable likeness of the endostyle of Crepidula and its allies to that of Amphioxus and Ascidians becomes still more evident when it is compared—as it should be—to a half, the right half, of that of Amphioxus and Ascidians : for it is to be remembered that there is only one half of a ctenidium and only one series of filaments present in Crepidula, whereas both a right and left series of "filaments" exist in Amphioxus and Ascidians. When, therefore, the endostyle of Crepidula is compared with the right half of that of Amphioxus and Ascidians it will be seen that in both there are two rows of similar long glandular cells with basal nuclei, separated by a row of ciliated cells with apical nuclei. The function of the intermediate row of ciliated cells in Amphioxus has been shown to be that of passing on to the gill the mucus formed by the gland cells (see 2, Fig. 3, and p. 25), and the function of the corresponding cells in the endostyle of Crepidula is the same.

It has now been shown (1) that the endostyles in Amphioxus, Ascidians, and Crepidula, and its allies* show a remarkable resemblance, and also that the ciliation and internal supports of the gill-filaments in Gastropods, Lamellibranchs, Amphioxus, Ascidians, and Brachiopods are essentially the same. Consequently it is clear that the homological + value of any of those characters cannot be great since they are present in widely divergent groups, and indeed would appear to be merely similar adaptations to a similar method of feeding. Therefore it follows that organs present in different animals, but having the same functions, are never necessarily homologous, since practically identical organs are here shown to occur with the same function in groups which are undoubtedly only remotely related. These groups are indeed so remotely related that the characters of the ciliation and internal supports of the gill-filaments, on the one hand, and the endostyle in Crepidula and in the above-mentioned Protochordates, t on the other hand, must have arisen independently in each case to meet similar requirements. Such plasticity in organisms is indeed remarkable, and its demonstration necessarily increases the difficulties in the already difficult problem of determining what organs in different animals really are genetically related. For instance, the presence of an endostyle in Crepidula confounds all the arguments that we can advance at present in support of the theory that the parabranchial ridges of the Enteroprensta are homologous with the endostyle of Amphioxus (see Willey, 15). These organs may possibly be homologous, but we have no means of determining with any certainty that they really are; and a similar uncertainty must exist in other similar cases.

* It is not improbable that an endostyle may be present also in many other aquatic Gastropods.

[†] The term Homology is used with the meaning Lankester gives to the term Homogenv (see 16).

‡ It is not contended that the endostyle has arisen independently in Amphioxus and Ascidians, for the well-known reason that development in the latter group indicates a not extremely remote relationship of that group with Amphioxus.

COMPARISON OF THE ADAPTATIONS IN BRACHIOPODS AND LAMELLIBRANCHS TO THE PROCESS OF FEEDING.

The general resemblance of the shell and mantle lobe in Brachiopods and Lamellibranchs, as well as the general similarity of their feeding organs, renders a comparison of the adaptations in these groups to the process of feeding a matter of some interest. It has been shown in an earlier work (1, p. 463) that it is highly probable that Lamellibranchs have evolved in the direction of perfecting the gill as a feeding organ. In all Brachiopods, so far as is at present known, the feeding organ, the lophophore with its gill-filaments, is in a condition comparable with that of the lower Lamellibranchs, namely, the Protobranchia and the more lowly Filibranchia. No process of fusion of the filaments appears to have taken place in any Brachiopod similar to that generally recognised as having occurred in Lamellibranchs. Since in the latter group this process of fusion appears to have been one of the main factors governing the evolution of that group, the absence of such a process of fusion in Brachiopods may very probably be one of the factors which has resulted in the present decadent condition of that group. Along with the absence of fusion of the gill-filaments in Brachiopods are correlated the absence of fusion of the mantle lobes and the formation of siphons, both of which characters are in many cases of prime importance in the feeding process. Doubtless other disadvantages under which Brachiopods suffer-in comparison with Lamellibranchs in general-are the absence of a locomotory organ in the adult stage represented by the foot in Lamellibranchs, and the sedentary life necessitated in Brachiopods by their structure. These two factors debar Brachiopods from the liberty Lamellibranchs mostly have of moving about, and so being able to place themselves to some extent in a suitable environment. Thus, therefore, probably the sum of these disadvantages may account in some measure for the decadence of the group of Brachiopods, as compared with the flourishing condition of Lamellibranchs at the present day.

It has been shown that the mantle cavity in Brachiopods is physiologically and sometimes morphologically divided into two compartments. This condition is absent in Lamellibranchs, where the mantle cavity in all forms is physiologically entire. It is true that in all Lamellibranchs the mantle cavity is divided either temporarily or permanently into inhalent and exhalent chambers by the gill (see 1), but a corresponding temporary division occurs in *both* compartments of the Brachiopod shell when the animal is feeding. The nearest approach in Brachiopods to the

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siphonate forms in Lamellibranchs is probably represented by members of those genera in which the postero-lateral angles of the shell are very much drawn out, as in *Productus giganteus*, *Spirifer verneuilli*, and species of Leptæna and Platystrophia, and in other forms common in the Rhynchonellidæ, in which the front middle part of the shell is differentiated from the rest in such a way as to resemble a siphon (see Fig. 8, C, p. 296). In all these forms it is highly probable that the shell modifications are correlated with localization of the food-currents. Lingula, however, has been shown by Morse (7) to dispose the mantle setæ in such a way that they form a sort of temporary siphon for the ingoing and the outgoing currents, and this method of forming siphons may occur in other Brachiopods.

From the description of the Brachiopod lophophore given in the preceding pages there can remain no doubt that that organ is analogous to the gill of Lamellibranchs, as has indeed already been observed by Lankester (12). The resemblance in appearance of the lophophore to the palp of a Lamellibranch such as Nucula is indeed close, but that the resemblance is superficial will have been seen from the foregoing account of its function. Hence, if the organs can be compared at all Morse is undoubtedly wrong in comparing the lophophore as he does (13) with the Lamellibranch palp. Thus it is seen that on the whole the parallel developments of organs in the Brachiopods and Lamellibranchs are much fewer than might have been expected from the similarity in their mode of feeding, and the differences which do exist may probably be very largely due to the absence in Brachiopods of that consolidation of the gill-filaments which appears to have played such an important part in the evolution of the Lamellibranchs.

SUMMARY.

Brachiopods feed in the same way as some Gastropods, as, for example, Crepidula, most Lamellibranchs, Amphioxus, and Ascidians, that is, by establishing a current of water through certain spaces bounded by the body, and sieving off the food-particles contained in that current by means of the lophophore and its cirri.

The cilia on the gill-filaments (cirri) are differentiated in Brachiopods into *lateral* and *frontal* cilia, in essentially the same way and with the same functions as in some Gastropods, most Lamellibranchs, Amphioxus, Balanoglossus, and some Ascidians.

The main current through the mantle cavity in Brachiopods is pro-

duced chiefly by rows of *lateral cilia* on the cirri, or gill-filaments, but cilia on the body of the lophophore and on the mantle assist in maintaining this current, which in Crania enters the mantle cavity in the antero-lateral regions of the shell at each side and is expelled in the middle front part of the shell. The mantle cavity in Brachiopods is divided physiologically into two compartments corresponding to the bilateral symmetry of the lophophoral spirals. In some Brachiopods the mantle cavity is also divided morphologically into two compartments, either by medium antero-posterior septa or by actual bifurcation of the whole shell.

Food-collection is effected in Brachiopods mainly by the frontal cilia on the gill-filaments, but tracts of cilia on the filamentar side of the lophophore assist in capturing food-particles. The captured food from both these sources is passed into the well-known food-groove on the lophophore and thence to the mouth.

For the capture of food-particles mucus is secreted on the frontal epithelium of the gill-filaments, at the bases of the gill-filaments, and on the body of the lophophore. A selection of the finer food-particles is effected in Brachiopods to some extent in the lower parts (inhalent chambers) of the mantle cavity ; the heavier undesirable particles being collected on the mantle lobe from which they are expelled from the precincts of the animal.

Some of the characters of the shells of many fossil and recent Brachiopods can be partially explained from the fact of the physiological subdivision of the mantle cavity.

The cephalic gills of Cryptocephalous Polychætes have current-producing lateral cilia and frontal food-collecting cilia essentially similar to those of Brachiopods, Lamellibranchs, and the other groups mentioned above. In Phoronis there is also a similar differentiation of cilia on the lophophoral cilia, but so far as this animal has been examined the functions do not appear to be quite the same as in the other groups examined.

Thus the ciliary mechanisms on the gills of many Gastropods, most Lamellibranchs, Amphioxus, Ascidians, Brachiopods, and the Cryptocephalous Polychætes are essentially similar, and in the three groups to which these animals belong the same mechanism—and similar gill-filament supports—have arisen independently to meet similar or the same requirements, and thus afford an interesting example of parallel evolution.

An endostyle is present at the base of the gill in Crepidula, Calyptræa, and probably also in Capulus. This endostyle of Crepidula shows a remarkable resemblance to that of Amphioxus and Ascidians and serves the same purpose, that is, it secretes mucus which is passed on to the gills for the entrapping and the transportation of food-particles. On the right side of the endostyle of Crepidula is a ciliated groove, which carries mucus and some food-particles forwards to serve for catching and expelling the heavier food-particles which enter the front portion of the inhalent chamber.

The independent origin of essentially the same ciliary mechanisms in Molluscs, Protochordata, Brachiopods and some Polychætes, and of a similar glandular organ, the endostyle in Crepidula and Amphioxus and Ascidians, are facts which add greatly to the difficulty of determining with any certainty what are homologous organs in different animals. It also follows that similar organs occurring in different animals and having the same function are never necessarily homologous.

The adaptation in Brachiopods and Lamellibranchs to the process of feeding are compared, and the suggestion is made that the present decadent condition of the former group is due to the absence of that consolidation of the gill and correlated modification of the mantle which appear to have conduced to the present relatively flourishing condition of the Lamellibranchs.

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Preliminary Account of a Contribution to an Evaluation of the Sea.

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INTRODUCTION.

An investigation of the rate of growth in Marine Invertebrates was begun in 1911, and a large amount of material the age of which is known has now been collected from various sources. The particular objects of this research are : (1) to establish the age of common marine invertebrates, (2) to determine the minimum age at which these forms begin to breed, (3) to examine the rate of growth at different seasons of the year and under different conditions, (4) to investigate the fecundity of different forms so far as possible, and (5) to collect the scattered literature on these subjects.

The investigations have been carried on mainly by immersing various objects in the sea at a known time and subsequently observing and collect-

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ing the various kinds of animals growing on them. Other experiments, however, are being carried out with some success with the object of entrapping young or larval free-living animals and observing their rate of growth. The sexual condition of the collected animals has been noticed particularly, and evidence of the maturity of the sexual products obtained either by isolating the animals or by trying artificial fertilisations. As a result of these investigations a good deal of information about members of most of the groups of invertebrate animals has been obtained, and the following statements may be regarded as a sample of the results.

RATE OF GROWTH IN SOME CELENTERATA.

Among the Cœlenterata it has been found that various species of Obelia and Clytia Johnstoni give off medusæ when not more than a month old. Similarly, Bougainvillea ramosa yielded medusæ at once when collected at an age of not more than six weeks and a few days. In all these cases, however, the observations do not cover the whole life-cycle as do the following. The commonest species of Tubularia-almost certainly T. larynz-has been found to give off actinulæ larvæ at an age of not more than six weeks, and in one experiment this species had moderately developed gonophores at an age of not more than 26 days. As these Tubularia actinulæ have been found to settle and grow into little polyps within a few days, it follows that this species may pass through its life-cycle within about six weeks and probably actually within four or five under favourable conditions. In the same way Plumularia and Gonothyræa have been found to give off planulæ at an age of not more than three months; thus, as these planulæ may probably settle almost immediately, these hydroids may complete their life-cycle within at least three months, and in both cases in a period probably less than that stated by some few weeks. Hence there can be little doubt that these hydroids pass through several generations-probably three and possibly morein a year. A species of Syncoryne yielded medusæ at a maximum age of ten weeks, but doubtless the actual age was much less than this.

In all these cases, however, there can be little doubt that the rate of growth—probably apart from the question of food-supply—varies at different times of the year. So far as the investigations have been examined, it would appear that in this group most of the species mentioned above appear to have a maximum rate of growth in the months of August and September.

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The most interesting record of the rate of growth obtained so far in Actinians is that of *Sagartia viduata*, which has been found to attain to full size at a maximum age of 14 to 15 months.

RATE OF GROWTH IN SOME PORIFERA AND THE LIFE-HISTORY OF SYCON, GRANTIA, AND LEUCOSOLENIA.

Among Porifera a fairly complete investigation of the life-history and rate of growth of Sycon coronatum, Grantia compressa, and a species of Leucosolenia has been made. These sponges have been found to be annuals, as they have generally been believed to be. But the interesting fact has been ascertained that there are two breeding seasons, especially well marked in S. coronatum and Leucosolenia, one in summer and one in late autumn. Data have, moreover, been obtained supporting the view that the same specimens may breed twice in their life-history. namely, once in late autumn and again in the following summer. Thus, therefore, it would seem that temperature is the main factor governing reproduction in these animals, since continuous rapid growth takes place in the winter, as will be seen from the following observations. Some very fine specimens of S. coronatum of known age have been obtained. One exceptionally fine specimen attained a length of more than 28 cms. with an average width of about 2.2 cms. in not more than 10 months 19 days, and growing during the period from July to May. Another specimen 24.8 cms. long grew between June and January in a period not longer than 7 months and 20 days. In another case several specimens measuring between 14 and 16 cms. long grew between May and January in a period not longer than 8 months and one day. It is an interesting fact that none of these specimens yielded embryos when they were isolated in dishes of sea-water, whereas tiny specimens from 3 to about 5 cms. taken in September and October gave off a good number of embryos. These tiny specimens have been obtained from several independent experiments started in early and late spring and in the summer, hence they are the sponges derived from the embryos liberated at the summer breeding period, namely, about the latter end of May or early June. The approximate age of these specimens is therefore about four months; in one case the actual age of such specimens was not more than 15 weeks. It is highly probable, moreover, that these autumn breeding forms continue to grow through the winter and again give off embryos in the following summer, when they die down. However this may be, there can be no doubt that there are at least two broods of

embryos produced in a year, and from the fact that specimens only 1.5 cms. long have been found to contain fully developed free embryos in the inner flagellated chambers in the autumn I think it very probable that this species might in favourable seasons yield three generations within a year, rushing through two of them in late autumn.

Similar breeding phenomena to those described in S. coronatum are presented by G. compressa and Leucosolenia. Tiny specimens of G. compressa 1.3 cms. long taken in October at an age not greater than 7 months and of an actual age of less than 4 or 5 months have been found to be crammed full of embryos, while large specimens 8 cms. long with an average width of 3.5 cms. taken in March and April have been found to contain only immature ova. In the following June, however, specimens similar to the latter have yielded crowds of embryos. Corresponding results to these have been obtained with Leucosolenia. Thus the summer and winter breeding periods appear to be general in our calcareous sponges. The life-cycle of Grantia has been carefully followed round the year, and it was observed that in one situation where this sponge was extremely common of a large size in June they gradually disintegrated during July, so that by August it was impossible to find any but the tiniest specimens, which were doubtless the first comers of the new summer crop. The same difficulty in finding any but small specimens was also met with on other grounds in the district where these sponges can generally be obtained at any other time of the year.

The summer crop continues to grow during the autumn, and by about December may attain to an area in side view, i.e. on one flat side, of about 10 sq. cms. By the following March specimens may be found with an area of from 25 to 30 sq. cms.,* and at the end of a year's growth in the following June specimens of average size may attain to an area of at least 30 sq. cms.* in side view, or in other words, the whole "bodywall" would have an area of more than 60 sq. cms. After delivering their summer embryos these specimens, as we have already seen, die down and a fresh crop arises.

Of siliceous sponges few records of much value have so far been obtained, but a colony of *Halichondria panicea* grew on a flat surface between June and the following January to an area of about 45 sq. cms. and of about the usual thickness of this sponge.

* More exact measurements will be given later.

RATE OF GROWTH IN SOME PLATYHELMINTHES.

Among the Platyhelmia strong indications have been obtained that Cycloporus, Leptoplana, and their allies pass through a generation within a few months, but no certain evidence has been obtained with regard to these animals. The results will be more fully discussed later.

RATE OF GROWTH IN SOME ANNELIDA.

A good deal of information has been obtained of various members of the Annelid group, and especially of the sedentary Polychætes. Pomatoceros triqueter and Hydroides norvegica grow to nearly full size in about 4 months, and at this age the former has yielded in many cases practically 100 per cent of embryos on being artificially fertilized, while a specimen of Hydroides of the same age shed ripe eggs, but unfortunately no male of the same age was available for a fertilization. The common species of Filograna has been obtained, carrying ripe eggs and trochospheres at an age probably less than four months, having grown through the summer. About the same time another experiment yielded specimens with fully developed eggs at an age not greater than 10 weeks and 4 days. Later in the year full-sized specimens with buds had an age not greater than 4 weeks and 2 days. There can be little doubt, therefore, that in this species there is an alternation of generations, the summer forms producing eggs and sperm and the autumn and winter ones producing buds.

Polymnia, Dasychone, and many others have been found to attain a good size in much less than a year. Ripe *Serpula vermicularis* not more than about 10 months old yielded an excellent result on being fertilized. Dinophilus has been reared through at least one generation in the Laboratory within a period of 7 weeks, and Ophryotrocha to a medium size in 8 weeks, but with more attention doubtless the rate of growth in these two forms might easily be found to be twice as great. Chætopterus at an age less than 13 months grew a tube 14 cms. long and had developing ova in its gonad, and *Sabella pavonina* a tube 12.6 cms. long in less than 31 weeks, and at this age contained well-developed but not quite mature ova. Similar results have been obtained with many free-living Polychætes, but these will be discussed later.

RATE OF GROWTH IN SOME POLYZOA.

One interesting result has been obtained among the Polyzoa. By continued experiments and observations *Buqula flabellata** was found

* Including Bugula calathus, Norman, for the purpose of the present paper.

to grow to a good-sized colony and give off larvæ within a period of not more than 8 weeks. From the observations made there is no doubt that this species passes through several generations during the summer and autumn, and indications were given that the most rapid growth occurs during August and September. In one case more than 100 zooids were counted in a colony not more than a fortnight old. Another species of Bugula has been found to grow colonies 4 cms. high and 2.5 cms. wide in 15 weeks. Very large colonies of a Bowerbankia species of an age not more than 9 months gave off a great number of larvæ, and in another experiment a colony 4.5 cms. high and 2.5 cms. wide was obtained at an age not greater than 15 weeks. Scrupocellaria reptans formed goodsized colonies in less than 7 months; Membranipora membranacea grew to a circular colony 6 cms. in diameter within 12 weeks, Lepralia pallasiana circular colonies 1.1 cms. in diameter within 8 weeks, and 3.1 cms. in diameter within 23 weeks. Cellularia neritina grows into huge colonies in the inner basin at the Great Western Docks in a year.

RATE OF GROWTH IN SOME CRUSTACEA.

A few observations have been made on members of the Crustacea, mostly of the sedentary forms.

Balanus balanoides attains to full size in a year and gives off large numbers of nauplii at this age, but there does not appear to be more than one breeding season, namely, in the late winter months. Other species of Balanus, however, have been found to grow to a large size in less than a year. Especially interesting results have been obtained in this group by examining the bottoms of ships in dry dock and obtaining information from the captain of the ship as to when the ship was last scraped and painted. From the information obtained in this way it has been found from independent data that Conchoderma virgata grows to a good size and gives off nauplii within from 4 to 5 summer months, and Lepas anatifera and L. hilli within the same period. Conchoderma aurita grows to a large size, namely, 7 cms. long, within 5 months, but was not found with embryos or nauplii when examined. This rapid growth of Cirripedes is well known to some captains of sailing vessels, who are constantly sailing the high seas in relatively slow-moving boats, for there is apparently a limit to the speed of the boat on which Lepas and Conchoderma will grow. The vessel on which the specimens mentioned above were obtained had travelled mostly at 6 to 8 knots I was told, hence the limit of speed for their growth must be something greater than this.

In this group a special experiment has been tried with success, with the object of entrapping young forms in a wire basket of a small mesh inside which, as the animals grow, they become imprisoned. Food is obtained by the animals from the natural growth on the wire basket and the surrounding parts. The wire basket was placed in a large floating wooden raft in Cawsand Bay adjacent to Plymouth Sound. From this cage put out in the sea on the 28th May, 1913, and taken in on 26th February, 1914, were obtained Palamon servatus measuring on the average about 5.6 cms. long from the tip of the rostrum to the end of the tail, and two Portunus puber, one a male with a carapace width of 3.5 cms. and one female whose carapace measured 3.3 cms. wide. As the greatest width of the mesh of the wire cage at the close of the experiment was 14.5 mms., by 9 mms., it follows that the specimens of Portunus were in all probability samples of the young for the season of 1913, since the breeding season of this species of Portunus falls in about the spring of the year. (See "Plymouth Marine Invertebrate Fauna," p. 257, J.M.B.A., N.S., Vol. VII, No. 2, 1904.) It is highly probable that the specimens of Palæmon serratus entrapped in the cage were also examples of last year's crop of this species, and as specimens about the size they attained occur in berry there would appear to be little doubt that this species becomes mature and bears young within a year. Some specimens are being kept alive in the tanks with a view to watching their subsequent growth.

An experiment conducted on similar lines on the Essex coast (see pp. 320 and 322) with a wire cage, the *greatest* width of any mesh of which at the end of the experiment was less than 2 cms., yielded four specimens of *Carcinus mænas*, three males and one female. The width of the carapace of the three males was respectively 3.6, 3.4, and 3.2 cms., and that of the female 3.1 cms. This experiment extended over a period of 15 weeks between the 18th June and the 3rd October. Hence there can be little doubt that the common crab also attains to maturity within a year. Further experiments will be made with cages of wire having a smaller mesh in the hope of following the rate of growth more fully in these and other species of Crustacea.

RATE OF GROWTH IN SOME MOLLUSCA.

In the Mollusca group the age at which several species begin to breed has been determined. The common mussel, *Mytilus edulis*, has been found to spawn naturally at an age of one year. From eggs spawned in this way a fertilization made by adding sperm from a male of the same age yielded 100 per cent of fertilized eggs. At this age the commonest sizes are from 3.5 to rather more than 4 cms. A good deal of material of this species has been obtained continuously during a period of two years, so that it will be possible to work out the rate of growth in this important mollusc fairly thoroughly. From several independent experiments it has been found that M. edulis may grow in this district to a size of from 3.5to 4 cms. within the period between April and November, i.e. in about 30 weeks. During the winter it would appear that relatively little growth takes place. By the following April, however, specimens may attain to the size of upwards to 5 cms., and at the end of the summer following that in which the animals were spawned, i.e. at an age of about 18 months, the average length of specimens is about 5 cms. with a corresponding increase in width and depth, while one specimen of this age attained a length of 6.8 cms. and a width of 3.4 cms. The variations in size at different ages will be given later. An interesting comparison has been made between mussels 3.5 cms. long and about 10 months old and thick-shelled mussels from 1.3 to 1.6 cms. long from the exposed shore at Whitsand Bay. The latter were quite ripe and gave good fertilizations, whereas at the same time the former were not ripe. Thus it would seem that the Whitsand Bay specimens really were dwarfed individuals of an age of at least two years.

Continuous observations have also been made on the rate of growth in a few individuals of the common limpet, Patella vulgata. It has been found that specimens may attain a size of 4 cms. in less than 15 months, and at this age are ripe. An artificial fertilization made from these specimens gave ultimately a fair percentage of trochospheres. During 31 weeks between the 27th January and the 2nd September, 1913, two specimens grew on a flat surface, respectively, from (a) $2 \cdot 1$ cms. long by 1.6 cms. wide to 4.1 cms. long by 3.3 cms. wide, and (b) 3.8 cms. long by 3.2 cms. wide to 5.3 cms. long to 4.5 cms. wide. Thus the smaller specimen increased 2 cms. in length and the other 1.5 cms. in length. The age of the latter specimen when 5.3 cms. long was not more than two years. Another specimen grew between April 4th and September 2nd in the same year from 2.25 cms. long by 1.7 cms. wide to 3.3 cms. long by 2.85 cms. wide, thus increasing in length 1 cm. within 20 weeks. Thus the rate of growth of P. vulgata in this district is much greateras indeed might be expected-than that found by Russell* in Scotland. These observations are, however, being continued, and the results in

* E. S. Russell, "The Growth of the Shell of Patella vulgata," Proc. Zool. Soc., 1909, p. 235, I.

relation to those obtained by Russell will be discussed later when more data are available.

Anomia aculeata has in several independent experiments been found to attain to an average size for this species and to give larvæ on being fertilized at an age of less than four months. Specimens of this age have been taken at various times of the year with the same result, hence this species undoubtedly passes through two and probably three generations within a year. Next to the common mussel this is probably the commonest mollusc on our shores.

The boring molluse, *Teredo navalis*, has been tound to grow to a length of 19.8 cms. in 31 weeks, and made borings in soft wood 28 cms. long with an average width of about 1 cm. It was also found that the gill was alive in specimens obtained a fortnight after the wood in which they were living was taken out of the sea. Thus these animals would be able to live easily during the period during which most vessels would be in dry dock for scraping and painting, hence, as is well known but not always fully realized, it is highly important that wooden vessels should be constantly cleaned to prevent the attacks of this destructive molluse.

THE RATE OF GROWTH OF CREPIDULA FORNICATA.

By means of a grant from the Royal Society a number of special experiments were carried out during the year of 1913 off the Essex coast with the object of determining the rate of growth in Crepidula. For this purpose a floating raft containing shells and tiles was moored at the mouth of the River Blackwater in the expectation of catching the spat. In putting out the raft and taking it in again in the autumn the Directors of the Tollesbury and West Mersea Oyster Company very kindly placed at my service the valuable help of their fishermen and their boats, and I wish here to express my thanks to them for the facilities they gave me in carrying out the experiment. The design of the experiment succeeded, and Crepidula spat was obtained on the raft and on the material placed in the raft, but unfortunately this success was marred by the fact that the raft had probably been touching the bottom of the river a few days when I went to examine it. It is therefore possible but not probable that some of the spat obtained on the raft may have crept on to it. Hence it is hoped to try the experiment again this year. From the position of some of the spat on the raft and on the tiles in it there was no doubt that they had been settled there some time, and therefore before the raft touched the bottom, and as the specimens obtained were all of sizes similar to the smallest sizes obtainable on the grounds in the
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district, and, further, since the size of the spat is what might be expected from the following experiment and other observations, there can be little doubt that they had settled on the raft and had grown in position, and are therefore examples of the spat for that season. The spat obtained varied in length from 4.5 mms. to 14 mms., and altogether 15 specimens were obtained. Their average length was 8.1 mms. and their average breadth 6.4 mms. Since they had grown during the time the raft was in the sea, namely, from June 16th to October 2nd, their greatest possible age is 15 weeks.

At the same time as the experiment described above was begun another experiment suggested by Mr. J. Bean, of West Mersea, was started for the purpose of observing the rate of growth in the sea of young specimens which were considered almost certainly a year old. For this experiment Mr. Bean very kindly gave me the use of two of his oyster trays-which are shallow wooden trays with one side covered with perforated zinc and the other with small-meshed wire-netting-and also provided new wooden posts, which are driven into the mud to carry the trays. The trays were filled with shells and tiles secured to one side of the tray and a number of young Crepidula were put on to the shells. A few older specimens were marked and the shells on which they were sitting secured to the tray. The total number of young specimens put in the tray was 131, and their average length 10.7 mms. They varied in size from 5 to 15 mms., but the commonest sizes were about 9 to 12 mms. These young ones were put in the trays on June 18th and examined again on the 3rd of the following October. When examined at the latter date a number of them were found dead in the bottom of the tray and only 28 could be found alive. These remaining specimens varied in length from 1.4 cms. to 2.65 cms., and their average length was 2.1 cms., but 17 of them were more than 2 cms. long. It is quite clear, however, that within the period of the experiment, namely, 15 summer weeks, Crepidulas about 1 cm. long grow to a length of two centimetres. Hence the spat obtained in the former experiment may be regarded as a fair sample of the spat for the season of 1913. Thus during the summer Crepidula spat grows to a size of about a centimetre and appears to grow little during the winter, as indeed was found by examining batches of the tiniest specimens procurable on the grounds in the autumn and in the following late winter. During the next summer the young slipper-limpets may grow to a length of about an inch. This experiment is being continued and it is hoped to follow the rate of growth further. Of the few larger marked Crepidula put in this tray only two specimens showed an increase in size. One specimen grew from a length of 25 mms. and a width of 17 mms. to a length of 29 mms. and a width of 20.5 mms.; the other one grew from a length of 28 mms. and a width of 13 mms. to a length of 33.5 mms. and a width of 26 mms. It is thus seen that *C. fornicata* may grow to a length of at least 3 cms. within $2\frac{1}{2}$ years, but it is desirable that the rate of growth should be observed in a larger number of individuals than was possible under the conditions of these experiments.

THE AGE OF SEX-CHANGE IN CREPIDULA FORNICATA.

In the tray experiment just described it was found that some of the small Crepidula had formed chains of two individuals, and in one case two specimens had put themselves in chain with one of the larger marked Crepidula to form a chain of three. When measuring these slipperlimpets their sex condition was also recorded and the singular fact established that while the individuals in chain were quite vigorous males, those which were leading a solitary life were changing from males into females. This phenomenon had indeed been suspected from the extensive examinations which have been made from time to time during the last few years on batches of Crepidula. The condition of these small Crepidulas may be gathered from the following records in which the abbreviations used in an earlier paper* are again adopted. The solitary specimens were recorded as follows : 8 specimens & p.sm. ; 3 & p.tr. ; one p.r.ut.r.: 2 ut.sm.p.tr.; 4 or 5 \mathcal{J} . In the chains formed by the small specimens (one year old forms) the sexes were recorded as follows: (1) $A \heartsuit p.r., B \checkmark;$ (2) $A \heartsuit ut.r.? p.r., B \circlearrowright$. The chains formed by the small specimens with the larger marked specimens, which in all cases are the A's in the chain, were recorded as follows : A I sex not recorded, B 3, $C \mathcal{Z}$; A II \mathfrak{Q} p.tr., $B \mathcal{Z}$; A IV \mathfrak{Q} p.tr., $B \mathcal{Z}$. Thus in all cases where the young Crepidula had formed chains they retained their characters as males, whilst 14 out of 19 that remained solitary had begun to change their sex. Thus the absence of association with their fellows in chains undoubtedly results in a more rapid change from the male condition to the female condition than in the cases where the Crepidulas are able to form chains. Sex-change in Crepidula therefore may take place in the second year of the life of isolated individuals.

p.sm.=penis small; p.tr.= trace of penis; p.r.= penis rudimentary.

^{*} J. H. Orton, "On the Occurrence of Protandric Hermaphroditism in Crepidula fornicata," Proc. Roy. Soc. B., Vol. 81, 1909.

The meaning of the abbreviations used above is as follows :----

ut.sm.=uterus small; ut.r.=uterus rudimentary.

THE RATE OF GROWTH OF OYSTER SPAT IN THE FIRST SUMMER.

Besides the two experiments described above two other independent ones were carried out, but without success, for the purpose of catching Crepidula spat. These experiments, however, were successful in catching a large amount of oyster spat and other marine invertebrates, and in one case a few spat of the common cockle, *Cardium edule*, which are of much interest, were obtained. Measurements of the oyster spat have been made and a growth curve will be given to show the variation in size in spat of all ages up to 10 and 15 weeks. The limits of size of the 10-weeks' spat—as determined by the area of one valve—are from about 2 sq. mms. to 175 sq. mms., and the commonest size appears to be about 75 sq. mms. The largest specimens of 15-week spat have an area of about 250 sq. mms., i.e. about a square inch. Samples of these oysters are still being kept under observation with the object of observing their subsequent rate of growth and the age at which they begin to spawn.

The spat of the *C. edule* mentioned above varied in their greatest breadth between 2.4 mms. and 8.4 mms. and their greatest age is 15 weeks. Other observations on this mollusc, however, are being carried out with the object of following more fully the rate of growth, and particulars will be given later.

A large collection of various molluses has also been made with a view to investigating their age from the periodicity of the main lines of growth. Some success has already been obtained with *Patella vulgata*, *C. fornicata*, *C. edule*, and the fresh-water mussel, *Anodonta cygnea*, in all of which the periodicity of growth is well marked. In all these cases, however, it is important to establish the rate of growth during the first season, and, as has already been noted above, valuable information in this respect has been obtained for Crepidula, Patella, Mytilus, Cardium, and Ostrea.

THE LIFE-HISTORY OF GALVINA PICTA.

Some remarkable facts relating to the life-history of the Nudibranch Molluscs have been obtained, and the following case may be taken as an example. The raft moored in Cawsand Bay—mentioned above—was visited six weeks after it was put out in the sea. It was found to be covered with a large scattered growth of the hydroid Obelia geniculata, on which the adult Nudibranchs, Galvina picta, G. exigua, Tergipes despectus, G. farrani, and young Facelina drummondi and Doto coronata were feeding.

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G. picta was the dominant Nudibranch, and 53 specimens were brought in and measured. Their average length from tip of head to end of tail was 11 mms., and they varied in length from 7 to 17 mms. Masses of spawn of both G. picta and exigua were present on the hydroids, and from these masses free-swimming veligers were being given off. Thus these Nudibranchs had undoubtedly peopled the raft as veligers, rushed through their development at the expense of the hydroid, and were giving off veligers again to populate hydroids elsewhere within a period not longer than 6 weeks and 2 days. Such a rapid growth is very probably a necessity for hydroidfeeding organisms, since the hydroids themselves attain maturity very quickly. In this respect it is also of great importance to the race that some Nudibranchs are protandric hermaphrodites,* for by this means a few individuals are able to multiply rapidly where food is abundant, and thus the race by means of its free-swimming larvæ is frequently able to utilize an abundant food-supply wherever such is available.

THE LIFE-HISTORY OF CIONA, CLAVELLINA, AND ASCIDIELLA.

In the group of Tunicata the rate of growth in many species has been thoroughly worked out. Ciona intestinalis, Ascidiella aspersa, Molgula ampulloides ? have all been found to be ripe and yield embryos on being artificially fertilized at an age of not more than 31 months, and in some cases have themselves extruded fertilized eggs. Better fertilizations of these forms are, however, obtained from specimens about $4\frac{1}{4}$ months old. At an age of less than 15 weeks Ascidia conchilega from the Essex coast also gave 100 per cent of tadpoles on being artificially fertilized. Large numbers of successful artificial fertilizations were made in this group in running down the minimum age at which tadpoles can be obtained, and it was generally noticed that crossfertilizations gave better results than self-fertilizations. All these species, however, grow at a much greater rate in the summer and autumn than at any other time of the year, and in the months of August and September Clavellina lepadiformis and Leptoclinum (Diplosoma) gelatinosum grew from the tadpole to a tadpole-bearing adult within 8 weeks. In one remarkable case L. gelatinosum was found to have raced through the whole life-cycle from the tadpole to an adult form giving off tadpoles at an age not greater than 3 weeks and 5 days. And indeed about this time of the year, August, this compound Ascidian is to be found overgrowing almost everything, both about and below low-water mark.

* As has been found by the writer in researches in this group.

CONTRIBUTION TO AN EVALUATION OF THE SEA.

The life-history of C. intestinalis is very similar to that of the Sycons described above. It has been definitely established that the species dies down about October, at about which time very fine specimens upwards to a foot long can be obtained. This fact has, however, been known at this laboratory for several years. By the end of October it is difficult to find Ciona of even medium size, but very small specimens are not uncommon. Breeding commences again after the winter season about April, and from April to October specimens may attain to a length of 15 cms., while those which have wintered and are practically a year old at this time have been found to attain a length of 30 cms. It is thus evident that Ciona is an annual, but passes through at least two generations in a year, and in favourable seasons may yield three, rushing through two generations in the autumn, as in the case of the Sycons. Thus these observations support the statement made by Anton Dohrn that Ciona at Naples passes through three generations in a year. (See footnote, p. 326.) The life-history of C. lepadiformis has been found to be very similar to that of C. intestinalis. It appears in this district about the end of April-apparently growing from dormant stolons -and grows to huge colonies during the summer, and at the same time passes through at least two generations. At about October these colonies die down and nothing is to be seen of them during the winter until about the following April.

A. aspersa has a somewhat similar life-history, but does not die down as completely in the autumn as Ciona. Between April and September this species has been found to grow to a length of 9 cms., very nearly the maximum size. *M. ampulloides*? has also a very similar life-history to that of Ascidiella, and gives quite good fertilizations at an age of 3 months, and this sub-spherical Ascidian may attain at this age a diameter of 2.5 cms., a size not far from the maximum for this species.*

RATE OF GROWTH IN SOME OTHER TUNICATES.

Botryllus violaceus gives off larvæ at an age not greater than 3 months and grows to large colonies during the summer. Thus in the case of all these Ascidians there are at least two crops of larvæ produced in a year, and in some of them, as in Leptoclinum, Clavellina, and Botryllus, there may be three or more crops in favourable seasons.

* Development in this species is remarkably rapid; the fertilized egg developing into a metamorphosing larva in less than 24 hours.

It is interesting that the maximum rate of growth in this group occurs at about the same time of the year as that found in the Sycons, some Polyzoa, some Molluscs, and some Hydroids. This period of maximum rate of growth occurs about August and September, and it is hoped that when the whole of the material collected has been worked out that it will be possible to estimate more accurately the rate of growth for different times of the year in all the groups.

RATE OF GROWTH IN SACCORHIZA BULBOSA.

A few marine algae have been collected in the course of the experiments, and so far the most interesting growth obtained is that of *Saccorhiza* (*Laminaria*) bulbosa, which between April and October, a period of 7 months, was found to grow a lamina 3 to 5 feet long and a subspherical base about 5 inches in diameter.

SUMMARY.

From the foregoing preliminary account it will have been seen that the rate of growth and the period of the life-cycle in marine invertebrates are in many cases much more rapid than has hitherto been suspected. Many forms which have been generally considered annuals with one breeding period, such as the Sycons and other Porifera, some Polyzoa, some Ascidians, some Molluscs and some Annelids, have been shown to pass through two generations, and in many cases there are strong probabilities that they may pass through more than two generations in a year. Even among the Hydroids the rate of growth is probably greater than has generally been suspected.

The results obtained will be discussed in relation to those obtained elsewhere, when the whole of the scattered literature on this subject has been gathered together. So far, however, very few reliable observations have been found on the rate of growth in marine invertebrates, as indeed Weismann* has already noticed, and I should be very glad to receive any references to work of this kind that readers may have come across.

* A. Weismann, *Essays upon Heredity*, Vol. 1, p. 57. Edited by E. B. Poulton, S. Schönland, and A. E. Shipley. Oxford, 1891

General Report on the Larval and Post-Larval Teleosteans in Plymouth Waters.

By

R. S. Clark, M.A., B.Sc.,

Naturalist to the Association, Plymouth Laboratory. With 11 Figures in the Text.

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Mullidæ											346
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Carangidæ											348
Scombridæ											349
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Pleuronect	idæ										355
Gobiidæ					-						372
Cottidæ											375
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INTRODUCTION.

THE material on which the present report is based was collected by the *Oithona* from 1906 to 1909 inclusive, and during the latter half of 1913. Attention was directed particularly to the capture and determination of the post-larval fishes. The investigations during the first four years were carried out by Mr. A. E. Hefford, and his notes have been fully relied upon for the identification of the species. For the collecting and working out of the 1913 material I am directly and wholly responsible.

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The young-fish trawl was used throughout for the capture of the specimens, and hauls were taken at depths ranging from the surface to the bottom. This method of securing the young pelagic stages has proved so successful in the Danish researches that it has been followed at Plymouth, with equally good results.

All the nets used were constructed on the system of the Petersen young-fish trawl, and three qualities of material were used. These were coarse sacking ("Stramin"), with mesh $\frac{1}{16}$ " square; cheesecloth, with mesh $\frac{1}{32}$ " square; and mosquito netting. In order to withstand the strain of pulling on board, the last type was strengthened by an outer herring-net. It was noticeable that every sample taken with the first two types contained a mass of stringy substance, indicating considerable wear and tear of the net. As a result, these nets became weakened and quickly broken up, especially near the cod end.

Table 1 gives a record of the number of hauls with the locality, date, and depth at which these were taken. To distinguish between the hauls taken by Mr. Hefford and those by myself, I have used the letters H and A respectively, which appear after the number of the haul. Letters corresponding to the chart areas are also represented.

Tables 2–24 contain records of the number and size of the individuals of each species investigated, and these are usually accompanied by short notes on the more important biological features of the particular groups, but it has been necessary to give a detailed description of a few forms which appear to be either entirely new, or at most, little known.

Table 25 summarizes the captures of the species the individuals of which were too numerous for separate tabulation.

The region investigated and shown on the accompanying chart has been subdivided into areas with latitude of 5' and longitude of 10'. An approximation to the positions of the hauls can thus be arrived at by reference to Table 1. Small crossed circles have been used to indicate the position of the hauls for the years 1906–1909 and plain circles for 1913.

The credit of the work for the results from 1906–1909 must be given to Mr. A. E. Hefford, while I have received much helpful advice from Dr. Allen, Mr. C. Tate Regan, Dr. Kyle and Mr. E. T. Browne. In the preparation of this report I have had the assistance of my colleague Mr. E. Ford, to whom I am also greatly indebted for the excellent series of drawings which are reproduced in the text and for the lettering in the chart. Further, Mr. Gossen has been a valuable help in the collecting and sorting out of the material.



To face p. 329.

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TABLE I. LIST OF STATIONS.

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Explanation of abbreviations. S.=surface. M.=midwater. B.=bottom. M.H.=midnight haul.

	No. of Haul.	Date.	Depth of Capture.	Duration of Haul in min.	Locality.	Total Depth in fms.	Chart Area,
	L H	10.v.06	B.	_	Cawsand Bay	<10	T.U.
	II. H	22.v.06	S.	15	Mewstone E, by N, 1 N., Rame Hd, N.W. by N.	24	W
	III. H		M	30	E about l mile	15	W
	IV H	"	B	30	E by N 1 N Bame Hd N N W	25	T
	V H	"	B.	00	Caureand Bay	-10	TI
	VI H	20 7 06	B.	95	Rame Hd NF 1N Edductone SSW	20	1.U. S
	VI. II	30.0.00	D. G	20	Whiteand Par Dame Hd S 1 E half a mile	-10	ю. Т
	VII. H	"	D. D	20	wintsand day, name Hd . S . $\frac{1}{2}$ L . nam a mile	<10	1.
	VIII. H	20	D.	30	Manatana Dava D 1	<10	1.
	IX. H	20.01.06	N.	30	Mewstone Buoy E. I mile	15	W.
	X. H	"	M.	30	,, ,, ,, , , , , ,	15	W.
	XI. H	,,	в.	15	· · · · · · · ·	15	W.
	XII. H	,,	S.	15	Mewstone E.N.E. 4 miles, Rame Hd. N. by W	27	<u>T</u> .
	XIII. H	"	м.	_	»» »» »» »» »» »» »» »» »» »» »» »» »»	27	т.
	XIV. H	,,	В.	15	,, ,, ,, ,, ,, ,, ,,	27	т.
	XV. H	28.vi.06	S.	15	»» » » » » » » »	27	Т.
	XVI. H	,,	м.	15	,, ,, ,, ,, ,	27	т.
	XVII. H	,,	В.	15	··· ·· ·· ·	27	т.
	XVIII. H		M.	20	Cawsand Bay	<10	T.U.
	XIX. H	20.vii.06	S.		Mewstone Buov E. 1 mile	15	W.
	XX. H		В.		Rame Hd. N. by W., Mewstone Buoy N.E. by E. 4 miles .	28	S.X.
	XXI. H	27.vii.06	_	20	ENE 4 miles	28	T
	XXII. H	milliou		20	Mewstone Buoy E 1 mile	15	W
	XXIII H	10 iv 06	в		Mewstone E by N 4 miles	94	T
	XXIV H	10.14.00	M		E by N. Bamo Hd. N. 1 E	97	T.
	XXV H	11 1 06	B.		Whiteand Bar	00 10	T. II
	VVVI U	17 in 06	D. D		Momentana ENE A milea Dama Hd N 1 W	07	I .U.
-	VVVII II	17.11.00	D.	_	E la N 5 alle Demo Hd N	21	1.
÷		91 : 00	D.		, E. Dy N. 9 miles, Rame Hd. N	20	1.
Δ	AVIII. H	21.1X.00	Б.	20	Eddystone S.E. by S. $\frac{1}{4}$ S. 1 mile	31	p.
	AAIA, H	. "	-	-	$,,$ S.S.E. $2\frac{1}{2}$ miles $.$ $.$ $.$ $.$ $.$ $.$	31	D.
	XXX. H	4.x.06	в.	25	Mewstone E. $\frac{1}{2}$ N. 2 miles	21	w.
	XXXI. H	25.111.07	S.	30	Eddystone S.W. by S. $1\frac{1}{2}$ miles	29	S.
2	XXXII. H	,,	М.	20	$,, S.W. by S. \frac{1}{4}S $	29	S.
X	XXIII. H	11.iv.07	м.		Mewstone E. by N. $\frac{1}{2}$ N., Rame Hd. N.N.W. 2 miles .	23	т.
X	XXIV. H	,,	В.	-	", ", ", $2\frac{1}{2}$ miles .	24	т.
-	XXXV H	6 vi 07	B		E 1 N Penlee N by W	23	W

LARVAL AND POST-LARVAL TELEOSTEANS.

TABLE I. LIST OF STATIONS .- Continued.

Explanation of abbreviations. S.=surface. M.=midwater. B.=bottom. M.H.=midnight haul.

No. of	-		Depth of	Duration of Haul		Total Depth	Chart
Haul.		Date.	Capture.	in min.	Locality.	in fms.	Area.
XXXVI.	Η	6.vi.07	В.		Cawsand Bay	< 10	T.U.
XXXVII.	Η	1.vii.07	S.	—	Mewstone N.E. by E., Rame Hd. N.W. by N. 3 miles .	23	W.
XXXVIII.	H	,,	В.	_	,, ,, ,, ,, ,, ,	23	W.
XXXIX.	H	10.vii.07	В.	20	Rame Hd. N. by E. $\frac{1}{2}$ E., Eddystone S.W. by S.	24	Т.
XL.	H	19.vii.07	В.	20	Mewstone E. $\frac{3}{4}$ N., Penlee Pt. N. $\frac{1}{2}$ W. 3 miles	24	W.
XLI.	H	26.v.08	?	20	Rame Hd. N.E. $2\frac{1}{4}$ miles	27	Т.
XLII.	H	28.v.08	?	_	Rame-Eddystone	20 - 30	S.T.
XLIII.	H		?	20	,, ,,	20 - 30	S.T.
XLIV.	H		?			20 - 30	S.T.
XLV.	H	1.vi.08	S.	20	Rame Hd. N. by E. 3 mile	24	т.
XLVI.	H		М.	_		20	Т.
XLVII.	H	,,	B.			20	Т.
XLVIII.	H	,,	S.		Eddystone S.S.E. 14 miles	31	S.
XLIX.	H	"	M.	_		32	S.
L	H	"	B.	_		31	S.
LL	H	4.vi.08	B.	_	Cawsand Bay	<10	T.U.
LII	H	3	9			<10	TU
LIII	H	"	ŝ		Mewstone Buoy	~10	w.
LIV	H	"	M			~10	w
L.V.	H	5 vi 08	S		Cawsand Bay	~10	TI
T VT	H	0.11.00	B.			>10	T II
T VII	TT	10	D.		Mewstone Buoy N by E 3 mile	20	W.
T WITT	II	10.11.00	р. В		1000000000000000000000000000000000000	20	W.
	II.	19: 00	D. G		Pama Hd N 1 E 21 miles	24	W.
	п	12.01.08	D. D	-	Name nu. N. $\frac{1}{2}$ E. $2\frac{1}{2}$ miles	27	1. T
LA.	п	15 00	D. D	- /	Momentana E. 21 milas	21	1. T
LAI.	H	15.vi.08	B,	_	Mewstone E. $2\frac{1}{2}$ miles	22	1.
LAII.	H	19.v1.08	D.	-	Cawsand Bay	<10	T.U.
LXIII.	H	,,	B.	-	, , , , , , , , , , , , , , , , , , ,	< 10	T.U.
LXIV.	H	,,	S.	-	Rame Hd. N. by E. 4 miles	27	8.
LXV.	H	"	M.	-	,, ,, ,, , , , , , ,	27	S.
LXVI.	H	,,	В.			27	S.
LXVII.	H	"	S.	-	Whitsand Bay	10 - 20	M.T.
LXVIII.	H	, ,,	В,	-	,, ,,	10 - 20	М.Т.
LXIX.	H	23.vi.08	S.	-	Stoke Pt. N.E. $3\frac{1}{2}$ miles	25	Х.
LXX.	H		M.		yy yy yy · · · · · ·	25	X.

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LXXI.	н	23.vi.08	В.	_	Stoke Pt. N.E. 31 miles .						25	X.
LXXII.	H		В.	_	Cawsand Bay						<10	T.U.
LXXIII.	H	25.vi.08	В.	-	Looe Is. W.S.W. 14 miles .						15	М.
LXXIV.	Ħ	30.vi.08	?	_	Rame Hd. N.E. 21 miles .						27	Т.
LXXV.	H		B.	-	Cawsand Bay						<10	T.U.
LXXVI	H	2 vii 08	M	_	Mewstone E, by S, 3 mile						12	W.
LXXVII	H		B	_	incomposite in 159 for 4 mino						12	W.
LXXVIII	H	15 vii 08	?		Cawsand Bay						<10	TI
LXXIX	H	10.11.00	?		Mewstone E by N 1 [§] miles						ca. 18	W
LXXX	H	"	?		menseene 11. by 11. 14 miles .	•		•			ca. 18	w
TXXXI	н	20 vii 08	M	_	Eddystone S by W 21 miles	•	•	·	•		30	S
LYXXII	п	20.01.00	2		Eddystolic 5, by W. 22 lilles	·		•			30	S
TYYYIII	п	91 mii 08	M		Mewstone Buoy N by W 1 mile	•	•	·	•		20	W
LYXXIII.	п	20 mii 08	9		Eddystone N by E 1 E 2 miles	•		•	•		35	B.
LAAAIV,	п	30.011.08	P	_	Equivatione IV. by E. $\frac{1}{2}$ E. 2 milles		•	•	•	•	25	D.
TYYYUT	п	e	9	_	Monstone NE 4 miles	•	•	•		•	97	TV.
LAAAVI.	II. II.	0.011.08	G	_	Producton N.N.E. 1 mile	•	•	•	·	•	-10	A.
LAAAVII,	П. TT	10.011.08	р. а	-	Monstone N.F. 2 miles	•	•	•	•	•	<10	VV.
LAAAVIII,	H	17.011.08	D. D	-	Mewstone N.E. 5 miles .	•	•	•	•	•	20	WV.
LAAAIA.	H	"	D. D	-	", ", ", ", ", ", ", ", ", ", ", ", ", "	•	•	•	•	•	20	W.
AC.	H	00 " 00	в.	-	Cawsand Bay	•	•	•	•	•	<10	T.U.
XUI.	H	20.011.08	N.	-	Mewstone N. 3 miles	•	• •	•	•	•	25	W.
XCII.	H		в.		· · · ·	•	•	•	•	•	25	W.
XCIII.	H	26.viii.08	-	-	Cawsand Bay	•		•	•	•	<10	T.U.
XCIV.	H	,,,	M.		,, ,,		•	•	•	•	<10	T.U.
XCV.	H	28.iv.09	S.	-	,, ,,	•	•	•	•	•	<10	T.U.
· XCVI.	Η	,, .	В.	-	,, ,,	•			•		< 10	T.U.
XCVII.	Н	3.v.09	?	-	,, ,,		•	•	•	•	< 10	T.U.
XCVIII.	H	7.v.09	?	-	Bovisand Bay	•			•	•	< 10	W.
XCIX.	Н	13.v.09	М.	-	Eddystone S.S.W. 2 miles .						29	S.
С.	н	24.v.09	S.	-	Whitsand Bay	•					10 - 20	M.T.
CI.	H	""	В.	-	,, ,,						10 - 20	М.Т.
CII.	H	2.vi.09	S.	-	Rame Hd. N. 2 miles						26	т.
CIII.	H	"	M.		,, ,,						26	Т.
CIV.	H	"	В.	-	,, ,,						26	т.
CV.	Н	10.vi.09	S.	-	Whitsand Bay						10 - 20	M.T.
CVI.	H	,,	В.	-	,, ,,						10 - 20	M.T.
CVII.	H	22.vi.09	S.	-	Cawsand Bay						<10	T.U.
CVIII.	H	,,	В.	-	,, ,, ,, ,,						< 10	T.U.
CIX.	H	25.vi.09	S.	-	,, ,,						< 10	T.U.
CX.	H		В.		., .,						< 10	T.U.
CXI.	H	29.vi.09	S.		Eddystone N.W. by W. 1 mile						31	S.

LARVAL AND POST-LARVAL TELEOSTEANS.

TABLE I. LIST OF STATIONS .- Continued.

Explanation of abbreviations. S.=surface. M.=midwater. B.=bottom. M.H.=midnight haul.

No.	of		Depth of	Duration of Haul	Tot Dep	al th Chart
Har	ul.	Date.	Capture.	in min.	Locality. in fr	ns. Area.
CXII.	H	29.vi.09	м.	—	Eddystone N.W. by W. 1 mile	S.
CXIII.	Η	,,	В.	_	,, ,, ,, , , , , , , 31	S.
CXIV.	H	6.vii.09	S.	-	Cawsand Bay	T.U.
CXV.	H	,,	В.	-		T.U.
CXVI.	H	8.vii.09	_		Outside Breakwater	W.
CXVII.	H	13.vii.09	S.		Eddystone S.E. 11 miles	S.
CXVIII.	Η		М.	-		S.
CXIX.	H	16.vii.09	S.		Mewstone E. by N. 13 miles	18 W.
CXX.	H	20.vii.09	S.	_	Eddystone N.W. 14 miles M.H	S.
· CXXI.	H		?		. M.H	S.
CXXII.	H		?			S.
CXXIII.	H	6.viii.09	S.		Mewstone N.E. 4 miles	X.
CXXIV.	H		М.			X.
CXXV.	H		В.			X.
CXXVI.	H	11.viii.09	S.		Breakwater N.E. 1 mile	W
CXXVII.	H	19.viii.09	S.	-	Cawsand Bay	TI
CXXVIII.	H		M.		<10	TU
CXXIX.	H	26.viii.09	?	_	Eddystone S 1 W 11 miles	S
· CXXX.	H		B.	_		S.
CXXXI.	H	27.viii.09	M.		Bame Hd E N E 3 miles 26	T
CXXXII.	H	30 viji 09	M		SE by E I mile	т. Т
I.	A	6.vi.13	S	20	Off Pentawan Beach Mayagissay Bay	K.
II.	A	0111110	B	20	<pre>controlledual Beach, Mevagissey Day : <10 </pre>	K.
TIT.	A	11 vi 13	M	20	Loop Is N Barne Hd NE by E	N.
IV	A	11.11.10	S	20		N.
V	A	12 vi 13	M	20	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	M.
VT	A	13 vi 13	M	20	Cowcard Bay	TTT
VIT	Δ	10.11.10	S.	20	Off Paples Dt	T.U.
VIII	A	. ,,	M.	20	Between Deplee Dt and Dame Hd	1. T
TY	A	"	D.	20	Whiteand Day E	
V	A	16 19	D. D	20	Paterson Deales and Demo IId	0 1.U.
VI	A	10.11.15	D. D	20	Eddeeteen NW 9-cite	1. D
VII	A	10 19	D.	20	Ladystone N.W. 2 miles ,	E.
VIII.	A	10.11.15	D.	20	Eddenters GER Land MIL	o M.
VIV.	A	"	M.	20	Eugystone S.E. by S. M.H	N.
ALV.	A	""	в.	20	,, ,, M.H	7 N.

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XV.	A	18.vi.13	М.	20	Off Rame Hd	10 - 20	т.
XVI.	A	19.vi.13	M.	20	Rame Hd. N.W. 1 W. 2 miles	17	Т.
XVII.	A		M.	20	Mewstone N.E. by E. 1 mile	20	W.
XVIII.	A	,,	?	20	Cawsand Bay	< 10	T.U.
XIX.	A	20.vi.13	M.	20	Between Mewstone and Stoke Pt	10 - 20	W.
XX.	A		S.	20	Eddystone ³ mile W	29	S.
XXI	A	24.vi.13	S.	20	Rame E, by N, 61 miles	26	М.
XXII.	A	27.vi.13	M.	20	Rame E. $\frac{1}{2}$ N. 5 miles	27	M
XXIII.	A	30.vi.13	B.	20	Looe Eddystone	20-30	М.
XXIV.	A	3.vii.13	M.	20	Bame E.	20-30	М.
XXV.	A	7.vii.13	B.	20	Whitsand Bay E.	10-20	T.U.
XXVI.	A	8.vii.13	M.	20	Bigbury Bay	10 - 20	Υ.
XXVII.	A	10.vii.13	S.	20	Cawsand Bay	<10	T.U.
XXVIII	A	11.vii.13	M.	20	Looe Eddystone	20-30	М.
XXIX.	A	*********	S.	20		20-30	M.
XXX.	A	14.vii.13	M.	20	Whitsand Bay	10-20	M.T.
XXXI.	A		S.	20		10 - 20	M.T.
XXXII.	Ā	15.vii.13	B.	20	Off Polperro	ca. 20	М.
XXXIII.	Ā		S.	20	Off Looe	<10	L.M.
XXXIV.	A	16.vii.13	M.	20	Rame E. 5 miles	27	М.
XXXV.	A	17.vii.13	S.	20	White Patch to New Ground Buoy, Plymouth Sound	<10	V.
XXXVI.	A	18.vii.13	M.	20	Rame Hd. N. by W. & W. 2 miles	23	Т.
XXXVII	A	24.vii.13	B.	20	Eddystone E.S.E.	ca. 30	S.
XXXVIII	A	24.vii.13	M.	20		ca. 30	S.
XXXIX	A	25.vii.13	S.	30	Rame N E, by N 1 mile	25	Т.
XL.	A	28.vii.13	M.	20	Cawsand Bay	<10	Т.
XLI.	A		M.	20	Outside Breakwater	<10	W.
XLII.	A	,,	M.	20	Jennycliff Bay	<10	v.
XLIII.	A	,,	S.	20		<10	V.
XLIV.	A	29.vii.13	S.	20	Eddystone S. by W. & mile	ca. 29	S.
XLV.	A		B.	20	. S.E. mile	ca. 25	S.
XLVI.	A		Μ.	20		31	S.
XLVII.	A	30.vii.13	S.	20	Jennycliff Bay	<10	V.
XLVIII.	A		В.	20		< 10	V.
XLIX.	A	31.vii.13	В.	20	Rame E. 7 miles	27	M.
L.	A		М.	20	6 miles	27	M.
LI.	A		M.	20		27	M.
LII.	A		S.	20	. 4 miles	26	Т.
LIII.	A	1.viii.13	S.	20	Eddystone N. 2 miles M.H	36	R.
LIV.	A	2.viii.13	S.	20	" N. 3 miles M.H	ca. 35	R.
LV.	A		S.	20	. N. 51 miles M.H	38	R.

TABLE	I.	LIST	OF	STATIONS.—Continued.	
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Explanation of abbreviations. S.=surface: M.=midwater. B.=bottom. M.H.=midnight haul.

No. of			Depth of	Duration of Haul		Total Depth	Chart
Haul.		Date.	Capture.	in min.	Locality.	in. fms.	Area.
LVI.	A	2.viii.13	М.	20	Eddystone N. 6 miles M.H	38	Q.R.
LVII.	A		M.	20	, N.E. 6 miles M.H	37	R.
LVIII.	A		S.	20	., N.N.E. 6 miles M.H	38	Q.
LIX.	A	6.viii.13		20	Lynher River above H.M.S. Defiance	<10	Ū.
LX.	A	7.viii.13	S.	20	Eddystone N. 1 mile	33	R.
LXL	A		M.	20	N. 31 miles	36	R.
LXII	A	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	B	20	N 6 miles	38	OR
LXIII	A	,,	M	20	N 5 miles	38	P
T VIV	A	11 viji 12	M	20	N 2 milos	24	D.
LAIV.	A	11, 111, 10	B.	20	N 2 miles	94	D.
T VVI	A	,,	D.	20	WE has N 21 and 1 and	04	R. D
LAVI.	A	,,	IVI.	20	$,, \qquad N.E. by N. 3\frac{1}{2} miles $	38	R.
LAVII.	A	,,	D.	20	$,, N.E. 3 \pm miles \cdot \cdot$	38	R.
LXVIII.	A	,,	M.	20	", S.S.W. $2\frac{1}{2}$ miles	29	S.
LXIX.	A	,,	В.	20	" S.W. by S. 3 miles	.28	S.
LXX.	A	,,	м.	20	Between Rame Hd. and Penlee Pt	< 10	т.
LXXI.	A	13.viii.13	S.	20	Off Downderry towing W. M.H	< 10	L.
LXXII.	A	,,	S.	20	Bell Buoy, Looe M.H	< 10	L.
LXXIII.	A	,,	S.	20	Looe N. 2 miles M.H	13	М.
LXXIV.	A	.,	M.	20	" N. 4 miles M.H	25	M.
LXXV.	A		S.	20	" N. 6 miles M.H	27	М.
LXXVI.	A	14.viii.13	S.	20	Eddystone E. 6 miles M.H.	35	0.
LXXVII	A	18.viii.13	Μ.	20	W. by N. 2 ¹ miles	32	S
LXXVIII	A		B.	20	3 miles	33	S
LXXIX	A	,,	B	20	4 miles	35	x.
LYXY	A	"	M	20	New Grounds Plymouth Sound	~10	V.
LYVYI	Δ	19 viji 13	B.	40	Righury Bay	10.20	v.
TVVVII	A	10.011.10	M.	20	Eddystone W by S 0 miles	20	I. W
TVVVIII	A	"	D.	20	Eddystone W. by 5. 5 miles	24	WV.
LAAAIII.	A	01	D.	20	19 59 59 57 · · · · ·	24	w.
LAAAIV.	A	21.VIII.13	M.	20	Rame E. $3\frac{1}{2}$ miles	25	Т.
LXXXV.	A	"	В.	20	" E. by S. 3 miles	22	Т.
LXXXVI.	A	,,	S.	20	" E.S.E. 3 miles	19	т.
LXXXVII.	A	,,	М.	20	" S.E. by E. 3 miles	14	Т.
LXXXVIII.	A	22.viii.13	м.	20	Cawsand Bay	< 10	T.U.
LXXXIX.	A	,,	В.	20	,, ,,	< 10	T.U.
XC.	A	,,	В.	20	Off Little Penlee	< 10	T.

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XCI.	A	25.viii.13	S.	20	Eddystone N. 5 miles M.H	
XCII.	A		Μ.	20	N. by E. 5 miles M.H	
XCIII.	A		М.	20	N.N.E. 5 miles M.H	
XCIV.	A	,,	M.	20		
XCV	A	,,	M.	20	"N.E. 5 miles M.H	
XCVI	Δ	,,	B	20	" NE by E 5 miles M.H. \cdot \cdot \cdot \cdot 38 O	
XCVII.	A	"	B.	20	ENESTING MH 36 O	
VOVIII,	A	,,	D. M	20	36 O	
NOTY	A	00	MI.	20	" NW 2 milor 31 B	
AUIA.	A	20.VIII.13	IVI.	20	W W S = 2	
C.	A	27.vm.13	M.	20	$", W.S.W. 5 miles \dots 1 20 X$	•
CI.	A	,,,	M.	20	", W. by S. $4\frac{1}{2}$ miles \cdot	v
CII.	A	"	М.	20	", W. by S. 4 miles	А.
CIII.	A	29.viii.13	м.	20	, N.E. by N. $3\frac{1}{2}$ miles	
CIV.	A	,,	В.	20	$,, N.E. 4\frac{1}{2}$ miles \cdot	
CV.	A	,,	M.	20	Eddystone N.E. 5 miles	
CVI.	A		В.	20	, N.E. 6 miles $.$ $.$ $.$ $.$ $.$ $.$ $.$ $.$ $.$ $.$	
CVII.	A	1.ix.13	M.	20	Rame E. 31 miles	
CVIII.	A		M.	20	$4\frac{3}{2}$ miles	.T.
CIX.	A	,,	В.	20	$5\frac{1}{4}$ miles	
CX	A	,,	B	20	$6\frac{1}{2}$ miles	
CXI	A	3 iv 13	M	20	Eddystone N NW 2 miles M H	
CVII.	A	0.11.10	S	20	Budystone Hilter and MH 32 R	
OVIII.	A	"	D.	20	"," "," "," "," "," "," "," "," "," ","	
CXIII.	A	F : 19	D.	20	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	
CALV.	A	0.1X.13	D. M	20	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	
CXV.	A	"	MI.	20	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	·
CXVI.	A	,,	M.	20	, , 10 miles 40	•
CXVII.	A	19	M.	20	"," ", $10\frac{1}{2}$ miles	•
CXVIII.	A	"	м.	20	$,, ,, 4$ miles $\ldots \ldots \ldots 37$ R	•
CXIX.	A	,,	М.	20	$,, ,, 3\frac{1}{2}$ miles \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot 37 K	•
CXX.	A	8.ix.13	м.	20	Rame N. by W. 2 miles	
CXXI.	A	"	В.	20	,, ,, ,,	
CXXII.	A	,,	В.	20	Eddystone S.W. 4 miles	
CXXIII.	A		M.	20	S.W. by S. 21 miles $$ 29 S.	
CXXIV.	A		В.	20		
CXXV.	A	9.ix.13	Μ.	20	Rame Hd. E.N.E. 11 miles	
CXXVI	A	United	B.	20	$E_{\rm bv} N_{\rm s} 3$ miles	
CXXVII	A	"	M	20	E 4 miles 26 T	
UAAVII.	A	,,	M	20	F 6 miles 27 M	
CYVIV.	A	,,	S	20	Loop N 4 miles	
OVVVV	A	10 : 19	M.	20	Off Downdown /10 I.	
CXXX.	A	10.1X.13	MI	20		
CXXXI.	A	11.1X.13	M.	20	Eddystone S.W. 5 miles	

		-					
No. of Haul.		Date.	Depth of Capture,	Duration of Haul in min.	Locality.	Total Depth	Chart
CXXXII.	А	11 ix 13	B.	20	Eddystone S W 31 miles	98	S
CXXXIII	A	11,14,10	M	20	2 miles	20	d.
CXXXIV	A	**	M.	20	SSW 11 miles	29	ю. а
CXXXV	A	19 1 19	M.	20	Pamo Hd E has N 9 miles	00	ю. П
OXXXVII	A	12,11,10	MI.	20	Name nu. E. by N. 2 miles	27	T .
OVVVVIII	A	"	MI.	20	$,, \qquad N.E. 4 miles \qquad . \qquad $	28	5.
VAAAVII.	A	""	M.	20	Eddystone S. by W. $3\frac{1}{2}$ miles	29	S.
AAAVIII.	A	"	M.	20	,, S. 2 miles	32	S.
UAAAIA.	A		M.	20	,, N. by W. 2 miles $.$ $.$ $.$ $.$ $.$ $.$	ca. 34	R.
CXL.	A	15.1x.13	M.	20	$,, S.W. 3\frac{1}{2}$ miles	28	S.
CXLI.	A	,,,	В.	20	,, W. by S. $3\frac{1}{2}$ miles	30	S.
CXLII.	A	,,	В,	60	" S.W. 2 miles	29	S.
CXLIII.	A	,,	М.	20	,, ,, ,,	29	S.
CXLIV.	A	,,	M.(bel	ow)20	,, ,, ,,	29	S.
· CXLV.	A	,,	м.	20	,, S.W. by W. 2 miles	29	S.
CXLVI.	A	16.ix.13	М.	20	Bigbury Bay, Borough Is. E. by S. 2 miles	17	Υ.
CXLVII.	A	,,	В.	20	. E. 1 ¹ / ₂ miles	15	Y.
CXLVIII.	A		В.	20		15	Y.
CXLIX.	A		М.	20	Bolt Tail S.S.E. 1 mile	<10	Z
CL.	A	19.ix.13	. B.	20	Rame Hd. N.N.W. 31 miles	25	W
CLI.	A		M.	20	Eddystone S.W. by S. 21 miles	29	S
CLII.	A	"	M.	20	SW 11 miles	20	g.
CLIII	A	"	M.	20	SSW 11 miles	30	g.
CLIV	A	,,	B	20	S 11 miles	21	d.
CLV.	A	20 iv 13	B	20	S W 1 mile	00 00	ю. с
CL.VI	Δ	20.12.10	M	20	WSW 1 mile	08. 49	D.
CLVII.	A	99 iv 12	B.	20	Pama Hd E 1 mile	24	D.
CLVIII.	A	44.1.4.10	M.	20	Polnomo N 4 miles	14	1.
CITY III.	A	"	D.	20		20	M.
OLIA.	A	"	D. D	20	$,, $ IN.IN. W. $4\frac{1}{2}$ miles $.$ $.$ $.$ $.$ $.$ $.$	27	M.
OLA.	A	"	D.	20	Looe Is. N. 4 miles	ca. 27	м.
CLAI.	A		M.	20	Looe N. 4 miles	25	М.
CLXII.	A	24.1x.13	M.	20	Between Mewstone Buoy and Stoke Pt	ca. 10	W.
CLXIII.	A	,,	M.(bel	ow)20	, , ,, and Shagstone	< 10	W.
CLXIV.	A	,,	М.	40	Jennycliff Bay	< 10	V.
CLXV.	A	,, .	В.	20	,, ,,	< 10	V.
CLXVI.	Α.	25.ix.13	В.	20	Between Mewstone Buoy and Stoke Pt	ca. 10	W.

TABLE I. LIST OF STATIONS.-Continued.

Explanation of abbreviations. S.=surface. M.=midwater. B.=bottom. M.H.=midnight haul.

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OT VITT	A	95 in 13	м	20	Between Mewstone Buoy and Sto	ke Pt.					ca. 10	W.
OLAVII.	A	20.13.10	Q.	20	Booncoll III not the ave						ca. 10	W.
CLAVIII.	A	"	N.	20	Eddystone WSW 3 miles .						30	S.
CLXIX.	A	"	M.	20	21 miles						31	S.
CLXX.	A		D.	20	Dama E 5 milos	•					27	М.
CLXXI.	A	26.1x.13	IVI.	40	Kame E. 5 miles	•	•	•			27	M.
CLXXII.	A	,,	м.	20	$,, D_2 \text{ miles.} \cdot \cdot$	•	•	•	•		27	M
CLXXIII.	A	,,	В.	20	""", "	•	•	•	•			M
CLXXIV.	A	,	В.	40	", 6 miles	•	•	•	•	•	97	M
CLXXV.	A	,,	M.	20	,, ,, , · · ·	•		•	•	•	07	MT
CLXXVI.	A		В.	20	$,, 4\frac{1}{2}$ miles			•	•	•	21	MI. I.
CLXXVII.	A		S.	20	,, 4 miles				•	•	20	1.
CLXXVIII	A	29.ix.13	M.	20	Eddystone S.S.W. 2 miles .					•	29	D.
CLYXIX	A		В.	20	., S. by E. 2 miles .						32	5.
CI VVV	Δ	30 iv 13	M.	20	Mewstone Buov ³ / ₄ mile N.						ca, 18	W.
OI VVVI	A	00.14.10	B	20							ca. 18	W.
OLAAAI.	A	"	M.	20	Bame Hd. E. by N. 2 miles .						ca. 27	т.
ULAAAII.	A	"	M.	20	ENE 2 miles						ca. 26	т.
CLXXXIII.	A	1	D.	20	Whitsand Bay W						10 - 20	L.M.
CLXXXIV.	A	1,X,13	D. M	20	wintesand Day w.						10 - 20	L.M.
CLXXXV.	A	,,	M.	20	Dame IId NW Imile		•				14	Т.
CLXXXVI.	A	"	в.	20	Name Hd. N.W. 4 mile.		•	•			10	W.
CLXXXVII.	A	10.x.13	B.	20	Mewstone E. 4 mile	•	•	•	•	•	11	W.
LXXXVIII.	A	13.x.13	.В.	20	mile	•	•	•	•	•	27	Т
CLXXXIX.	A	14.x.13	В,	20	Rame Hd. E. by N. 3 miles .		•	•	•	•	97	T.
CXC.	A	,,	M.	20	$,, 3\frac{1}{2}$ miles.	•	•	•	•		00 93	T.
CXCI.	A	.,	М.	20	" E. by S. 4 miles .	•	• •	•	•	•	08. 20	M.
CXCII.	A	24.x.13	м.	20	Rame E. 6 miles			•	•	•	21	MI.
CXCIII.	A		В.	20	" E. by N. 6 miles				•	•	20	MI.
CXCIV	A		М.	20	$, E.N.E. 6\frac{1}{2}$ miles .			•		•	ca. 28	IN.
CXCV.	A	27.x.13	В.	40	Cawsand Bay						<10	1.0.
CYCVI	Δ	arrier to	B.	20	Mewstone S.E. by E. 2 miles.						ca. 12	w.
CYCVII.	A	7 vi 13	B	20	Rame Hd. N. 1 mile						24	T.
OVOVIII.	A	1.41.10	M	20	N.N.E. $2\frac{1}{2}$ miles .						27	т.
CAUVIII.	A	19 19	B	20	South of Breakwater						< 10	W.
CAUIA.	A	10.11.10	D. B	20	Penlee NW by W 2 miles .						ca. 15	W.
CC.	A	,,	D. D	20	Botwoon Ponlee and Bame Hd.						< 10	т.
CCI.	A	• • • • •	B.	20	Brookween remee and Ramo Ind.						<10	т.
CCII.	A	"	M.	20	Eddastone SW 5 miles						27	т.
CCIII.	A	26.xi.13	В.	20	GW by S 2 miles	•					29	S.
CCIV.	A	,,	В.	20	" S.W. by S. 5 miles	•		•			31	S.
CCV.	A	"	М.	20	,, S. I mile , .	•	•	•	•	•	01	

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LARVAL AND POST-LARVAL TELEOSTEANS.

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CLUPEIDÆ.

The Clupeoids, which are recorded in Table XXV, have not been fully determined specifically, though the material contains examples of three species, *Clupea harengus* L., *C. sprattus* L. and *C. pilchardus* Walb. A survey of Table 2 shows a maximum frequency in numbers during May and June, and the records for these two months are chiefly those of the Sprat, though Herring and Pilchard are also represented. The increase in numbers during September and October, after a decrease in July and August, was due largely to the capture of larval Pilchards, which were easily identified by the presence of an oil globule and segmented yolk. The occurrence of the eggs and early stages of *C. pilchardus* during a considerable part of the year raises the important question (which will be discussed in a later contribution) as to the periods of spawning for this species.

SYNGNATHIDÆ.

TABLE III.

RECORD OF NUMBER AND SIZE OF INDIVIDUALS.

No.	of			S	acus.	S. ro	stellatus.	N. æ	quoreus.
Hau	Haul. Date.		Depth.	No.	Size mm.	No.	Size mm.	No.	Size mm,
IV.	H	22.v.06	В.	3	13 - 15	-	-	-	-
XVI.	H	28.vi.06	М.	-	-	1	17	-	-
XXV.	Η	11.ix.06	В.	-	-	4	24 - 65	-	-
XXX.	H	4.x.06	В.		—	1	27	-	-
LXVIII.	H	19.vi.08	В,	1	12		_	-	-
LXXVII.	H	2.vii.08	В.	1	19	-		_	_
LXXX.	H	15.vii.08	В.	1	22	_	-	_	_
XCIV.	H	26.viii.08	М.	2	23	-	-	-	-
CXIV.	H	6.vii.09	S.	1	18.5		_	-	-
CXXVII.	H	19.vii.09	S.	-	-	1	23	-	-
Χ.	A	16.vi.13	В.	-	_	1	20	-	-
XLI.	A	28.vii.13	М.	-	-	1	14.5	-	-
XLII.	A	.,	М.	-	-	1	25.5	-	
XLIII.	A		S.	_	-	1	26	-	-
XLIV.	A	29.vii.13	_	-	_	-	-	1	9
XLVI.	A		Μ.	-		1	14		-
XLVIII.	A	30.vii.13	В.	-	-	2	$21 - 29 \cdot 5$		
LIV.	A	2.viii.13	S.	1	56	_		_	_
LXXXI.	A	19.viii.13	В.	_	_	1	33	-	-
LXXXVIII.	A	22.viii.13	Μ.	-	-	3	17 - 20	_	-
LXXXIX.	A	.,	В.	_	-	4	17.5 - 22.5	_	-
XC.	A		B.	_	-	17	$18 - 33 \cdot 5$	-	-
XCI.	A	25.viii.13	S.	1	43	-	_	-	-
CVIII.	A	1.ix.13	М.	-	-	-	_	1	14.5
CXXI.	A	8.ix.13	B.	1	21		-	-	-
CXXII.	A		В.	-	_		-	1	22
CLX.	A	22.ix.13	В.	_	-	1	36.5	-	-
CLXV.	A	24.ix.13	В.	-	-	3	16 - 42	_	-
CLXXXIV.	A	1.x.13	В.	-		1	14	-	_
CLXXXIX.	A	14.x.13	В.	-	-			1	11
CXCVIII.	A	7.xi.13	М.	_	-	1	27	1	15

NEW SERIES.																				
-VOL.							TABLI	E II.	Mon	THLY	Summary	OF C	LUPEOIDS.							LA
X. NO.							Explana	tion of	Abbrevia (tions	$\begin{cases} \infty &= S \\ M. &= M \\ SIZE &= I \end{cases}$	everal Iany. Jength	thousands.							RVAL A
2. JU		M. No.	ARCH. Size.	A No.	PRIL. Size.	No. ^N	IAY. Size.	Jt No.	JNE. Size.	No.	JULY. Size,	At No.	ugust. Size.	Sept No.	EMBER. Size.	Oc' No.	FOBER. Size.	Nov No.	EMBER. Size.	ND PO
NE,	1906	-	-	-	-	œ	9-47	112	9 - 22	53	10.5 - 24	-		2	4.5 - 18	1	7	-	-	ST-
1914	1907	24	$3 \cdot 5 - 20$	20	$5 - 14 \cdot 5$	-	-	3	9-12	1	16	-	-	-	-	-	-	-	-	LARV
•	1908	-	-	-		55	4-21	м.	6 - 24	71	7-27	3	20	-	-	-	-	_	-	7AL
	1909	-	-	7	7-15	14	12 - 27	117	10 - 41	127	$7 \cdot 5 - 22 \cdot 5$	11	$10 - 22 \cdot 5$	-	-	-	_	-	• _	TEI
	1913	-	-	-	-	-		856	$8 - 32 \cdot 5$	59	10-25	90	$9 \cdot 5 - 36$	264	$3 \cdot 4 - 24$	486	3.5 - 24	93	$5 \cdot 5 - 21$	EOS
	Total	24	3.5 - 20	27	5 - 15	œ	4-47	м.	$6 - 32 \cdot 5$	311	7-27	104	8.7-36	266	$3 \cdot 4 - 24$	487	$3 \cdot 5 - 24$	93	$5 \cdot 5 - 21$	TEA
				Tł	ne measure	ments 1	ecorded in	a Table	s 2 to 25	were t	taken from	specin	nens preser	ved in	5% Form	alin.				NS.

The measurements recorded in Tables 2 to 25 were taken from specimens preserved in 5% Formalin.

м

R. S. CLARK.

SYNGNATHIDÆ.

Syngnathus acus L. S. rostellatus Nilss. Nerophis æquoreus L.

Larval and post-larval pipe-fishes occurred sparingly in the youngfish trawl material. They represent types of three species, of which the commonest is *Syngnathus rostellatus* Nilss. Most of the specimens were taken in bottom hauls close inshore, with a higher frequency from the mouth of the Sound inwards. A few were taken offshore, notably two older stages of *S. acus*, in surface hauls at midnight from 3 to 5 miles south of the Eddystone rocks.

AMMODYTIDÆ.

Ammodytes sp.

According to the records in Table 25, the frequency of the sand-eel larvæ and post-larvæ is greatest between the thirty and forty fathom lines, decreases slightly between the twenty and thirty, and is practically limited to a few records under twenty fathoms.

The summary (Table 4) shows a gradual increase in numbers until August, and a decrease in September, after which no individuals were captured. There is thus a comparatively dense spawning period in the middle months of the year, which seems to correspond to the period assigned to *A. lanceolatus*. Ehrenbaum considers the lesser sand-eel (*A. tobianus*) an earlier spawner. The period of maximum hatching for this species in the North Sea lies between January and March.

Both species are represented in the collection, but I have been unable to separate out the two forms as they show no obvious specific characters which would ensure accuracy in identification.

GADIDÆ.

Gadus pollachius L. G. merlangus L. G. minutus O. F. Müller. G. luscus L.

These four species of Gadoids have been brought together in Table 5. It will be seen that the maximum number of individuals lies in May and June, and that these are mostly whiting (G. merlangus). The pollack is an early spawner, but this may not account altogether for the scarcity of post-larval forms, especially when one considers the tolerable abundance of older stages in the littoral areas in summer. The records of G. minutus and G. luscus are important, and may help to throw some light on the spawning periods of these two closely allied species. G. luscus larvæ were taken in September, October, and November, 1913. Investigations were carried on at intervals during December of the same year, and during January and February, 1914, and eggs of this

	MA	RCH.	A	PRIL.	М	AY.	Jτ	UNE.	Ju	LY.	Au	GUST.	SEPT	EMBER.	Ост	OBER.
1906	No.	Size.	No.	Size.	No. 20	Size. 6–29	No. 40	Size. 6·5–18	No. 17	Size. 7-23	No. 	Size.	No. 1	Size. 15	No. —	Size.
1907	1	8.5	6	6.5 - 12.5	_		-		12	13 - 22	-	-	-	-	-	-
1908	-	-	-	-	-	-	84	6-23	100	5-20	26	5 - 19	-	-	-	-
1909	-		1	12	-	-	16	10-32	57	7-29	18	5 - 22	-	-	-	-
1913	-	-	'	-		-	51	14-104	144	6-28	462	4.5 - 25	13	$5 \cdot 5 - 24$	-	-
Total	1	8.5	7	$6 \cdot 5 - 12 \cdot 5$	20	6-29	191	6-104	330	5-29	506	4.5 - 25	14	$5 \cdot 5 - 24$	_	-

TABLE IV.

MONTHLY SUMMARY OF AMMODYTES SP.

species were still abundant in the tow-nets, while larvæ were occasionally taken. Ova of G. minutus were not observed during this period, but it is possible that they may have been represented in the later February catches. There is evidence from the table that the bib spawns in February, March, and April, if not later.

In the four species of Gadus, frequency is high for the early pelagic stages beyond the twenty-fathom line, but gradually diminishes in intensity in the same area as the individuals get older.

TABLE V.

RECORD OF GADUS SP.

No. of Haul.	f	Date.	Depth.	G. p. No.	ollachius. Size.	G. n No.	ierlangus, Size.	G. No.	luscus. Size.	G. n No.	ninutus. Size.
IT	H	22 v 06	S	2	5-10	11	5-17	_	_	_	_
TIT	H	22.0.00	M.	ĩ	10-15	158	5-15	9	5-10	3	5-15
TV	H	"	B.	1	10-10	324	4-15	7	5-10	1	5
V.	H	"	B.			16	5-17		0 10	9	8-11
VI.	п	20 - 06	D. D	1	7.5	20	1.0		_	26	1 0
WIT.	п	50.0.00	D. g	T	1.0	29	7.5 10	-		20	4-5
WIII.	п	,,	D.	-	-	0	1.0-10	-	-	_	_
VIII.	п	20	D,	-	-	1	9	-	-		
IA.	п	20.01.06	D.	-	-	1	9	-	-	-	-
A.	H	"	M.	-	-	1	10.0	-	-		10 - 15
AI.	뵤	,,	B.	-	-	2	- 10	-	-	3	12.9-17
XIII.	H	,,	М.	-		7	5-10	-	-	-	-
XIV.	H		В.		-	4	5-9		-	-	-
XV.	H	28.vi.06	S.	-	-	1	11	-	-	-	/
XVII.	Н	59	В,	-	-	14	6-11	-	-	-	-
XVIII.	H	,,	М.	-	-	2	7.5 - 10	-			-
XIX.	H	20.vii.06	?	-	-	5	7.5 - 8	-	-	-	-
XX.	H	.,	?	-	-	6	$6 - 12 \cdot 5$	-	-	-	-
XXXI.	Η	25.iii.07	S.	4	$4 \cdot 5 - 5 \cdot 5$	-	-	-	-	3	$4 \cdot 5 - 6 \cdot 5$
XXXII.	H	,,	Μ.	19	3-5	2	3-4			11	5 - 7
XXXIII.	Η	11.iv.07	M.	15	$4 - 7 \cdot 5$	20	4-8	1	7.5	-	-
XXXIV.	H		B.	22	$3 \cdot 5 - 6 \cdot 5$	19	3.5 - 7.5	1	5.5	-	-
XXXV.	H	6.vi.07	В.		-	72	5.5 - 40		-	2	10 - 15
XXXVI.	H		В.		-	18	10 - 40	1	9		-
XLII.	H	28.v.08	S.	_		_	_	_	_	1	4
XLIII.	H		М.	_	_	25	6-11	_	-	7	6-8
XLIV.	H	,,	B.	_		14	7-11	_	_	27	7-13
XLV.	H	1.vi.08	S.	_	_	-	-	_	_		_
XLVI.	H	1	M		_	3	4_0	-	_		-
XLVII	H	"	B	_		0	5-14.5	_		_	_
VL.VIII	H	"	S.			1	19				
XLIX	H	"	M.	_		1	12				
T.	н	"	B.			7	6 11			2	6_0
TT.	п.	1 + 08	D.	-/	-	0	5	-	11	9	0-9
T II	ш	4. 11.00	D.	-	_	2	24	1	7.0	-	-
TV	TT	5 00	D.	-	-	0	5 15	T	1.0	-	_
T VT	ш	0.11.00	D.	-	-	10	0-10	-	0.7	-	-
T WITT	п	10	D. D	-	-	12	0.0-14	1	9.9		-
	II	10.01.08	B.	-	-	23	0-14	-	-	-	-
LIA.	п	12.01.08	D.			-	- 11	_			17.00
LA.	H	1	B.	-		22	0-11	T	11	3	17-28
LAI.	H	15.vi.08	В.	-	-	21	6-9	-		36	30-48
LXII.	H	19.vi.08	S.	-	-	4	5-15	-	-	-	-
LXIV.	H	"	М.	-	-	-	-	-	-	-	-
LXV	H		B	-		0	1 16.5			_	

TABLE V.-Continued

RECORD OF GADUS SP.

No. of	2			G. pc	llachius.	G. m	erlangus.	G.	luscus.	G. n	ninutus.
Haul.		Date.	Depth.	No.	Size.	No.	Size.	No.	Size.	No.	Size.
LXVI.	Η	19.vi.08	В.	-	-	20	5-11	2	7-8	13	14-18
LXVIII.	H	,,	В.	-	-	5	9 - 12.5	-	-		-
LXX.	H	23.vi.08	М.	_	-	4	10 - 12	-	-	-	-
LXXI.	H		В.	-		?	8-13	-		3	17-18
LXXII.	H		В.	-	-	1	7.3	-	-	-	_
LXXIII.	H	25.vi.08	B.	_		2	11-14		-	-	
LXXIV.	H	30.vi.08	B.		_	6	5-8	_	_	_	_
LXXV.	H		B.	_	-	_	_	1	4	_	_
LXXX	H	15 vii 09	B.	_	_	1	15	_	_	_	_
XCV	H	28 iv 08	S	_	_	4	5-10		_		
XCVI.	H	20.11.00	B.	1		E G	7-10	1	6	2	15-18
XCVII	н	3 17 00	2.			11	5_15	1	0		10-10
XCIX	II	12 - 00	M	_	-	90	6.5 11	-	_	14	7 19
AUIA.	II	24 00	MI.	-		20	0.0-11			14	1-14
C.	п	24.V.09	D.	-	00	11	0-0-0	-	-	-	-
UI.	п	0	D.	1	22	11	1.9-10	-	-	5	_
UII.	H	2.vi.09	D.	-	-	4	0-12	1	1	-	-
CIII.	H	"	M.	-	_	11	6-12	-	_	-	-
CIV.	H	"	В.	1	23	26	7-13	1	6	1	10
CV.	H	10.vi.09	S.	1	28	2	9 - 13	-	-	-	-
CVI.	H	,,	В.	13	23 - 42	5	$6 \cdot 5 - 14$	-	-	-	-
CVIII.	H	22.vi.09	В.	-	-	4	8-12	-	-	_	-
CIX.	Η	25.vi.09	S.	4	22	14	8 - 15	-	-	-	-
CX.	H	.,	В.	_	-	3	7-7.5	-	-	-	-
CXIII.	H	29.vi.09	B.	_	_	4	7.5 - 8	-	_	3	8-13.5
CXV.	H	6.vii.09	В.	1	6	-	-	-		_	-
CXVI.	H	8.vii.09	?	_	_	_		-	-	1	54
CXVIII.	H	13.vii.09	M.	-	-	_		-	-	1	49
CXXI.	H	20.vii.09	M.		_	1	9	_	_	î	26
CXXII	H		B	_	_	î	12.5	_	-	_	
CXXIV	H	6 viii 09	M	_	_	î	62	_	_	_	_
T	A	6 vi 13	S	_		9	5.6-7.5	_		_	
TTT.	Δ	0.11.10	B.			4	00-10		-	5	5-7
V	A	19 19	M.			1	8.05	1		U	0-1
V. VI	A	12. 11.10	M.	_	-	20	6 10	-		_	_
VI. WIT	A	10.11.10	DI.	-	_	29	7 10.4			_	_
VII.	A	"	10. M	-	-	00	7 10.05	-	-	-	_
VIII.	A	"	M.	-		02	7-12-20	-	-	-	-
IA.	A	10 " 10	D.	-	-	20	7.3-14	-	-	-	_
X.	A	16.vi.13	B.	-	-	5	7-10.8	-	-	-	-
XII.	A	18.vi.13	S.	-	-	2	8-8.2	-	-	-	
XIII.	A	"	M.	-	-	-	-	-	-	3	11.69
XIV.	A	,	В.	-	-	3	9.5 - 12	-	-	-	-
XVI.	A	19.vi.13	М.	-	-	1	12.39	-	-	-	-
XX.	A	20.vi.13	S.	-	-	1	7	-	-	-	-
XXI.	A	24.vi.13	S.	-	-	6	$7 - 12 \cdot 6$	-	-	-	-
XXII.	A	27.vi.13	М.	-	-	3	$6 \cdot 9 - 9 \cdot 5$	-	-	-	-
XXV.	A	7.vii.13	В.	-	-	1	10	-	-	-	-
XXXIX.	A	25.vii.13	S.	-	-	3	$27 - 52 \cdot 5$	-	-	-	-
XLII.	A	28.vii.13	М.	-	-	1	50	-	-	-	-
CXXIII.	A	8.ix.13	М.	-	-	-	_	1	8		-
CLVII.	A	22.ix.13	В.	-	-	-	-	1	8	-	-
CLXXI.	A	26.ix.13	M.	-	-	-	-	1	6.23	-	_
CLXXVI.	A		В.	-	-		-	1	5.76	_	_
CLXXVIII	A	29.ix 13	M	-	_	-	_	î	4	_	
CLXXXVIII	A	13 x 13	B	_	_	_	_	i	4.69	_	_
CLXXXIX	A	14 x 13	B	_	_	-	-	î	3.35	_	_
CXCII	Δ	94 x 12	M.					2	4-4.0		
CXCIV	A	2T.A.10	M.					ĩ	4.80		
CCV.	A	96 - 19	M.	_		_		1	24	_	
UUV.		40.AL15	WI.	-				1	0.4	-	

GADIDÆ.

Molva molva L.

Twenty post-larvæ of the common ling were taken in May and June. These ranged from 5 mm. to 13.09 mm. With the exception of five specimens taken in Cawsand Bay, all occurred beyond the twentyfathom contour line, and the majority of these between twenty and thirty fathoms, at no great distance from the shore, and off the entrance to the Sound. All the stages are similar to those described and figured by Schmidt in "Medd. fra Komm. for Havund. Serie Fiskeri," Bind II, 1906.

These records suggest a similar, though perhaps less extended, spawning period to that for the North Sea, which Ehrenbaum gives as March to May, with a maximum in April.

TABLE VI.

RECORD OF MOLVA MOLVA L.

No. of	Haul,	Date.	Depth.	No.	Size.
IV.	H	22.v.06	В.	1	5
V.	H		В.	1	9
XVII.	H	28.vi.06	В.	2	10-15
XLIII.	H	28.v.08	М.	3	?
LV.	H	5.vi.08	S.	1	7.5
LVI.	H		B.	1	7
LX.	Η	12.vi.08	В.	1	8
LXI.	H	15.vi.08	В.	2	?
LXV.	H	19.vi.08	М.	1	9.5
LXXIV.	H	30.vi.08	В.	1	5
LXXV.	H	30.vi.09	В.	1	8
CIII.	H	2.vi.09	М.	1	13
III.	A	11.vi.13	М.	1	6
XVI.	A	19.vi.13	М.	2	8.75-10.
XXII.	A	27.vi.13	М.	1	13.09

GADIDÆ.

Raniceps raninus L.

The records of the lesser forkbeard are confined to 8 specimens obtained from 13th August to 8th September, 1913. A spawning period from July to August is thus indicated. For the North Sea, Ehrenbaum* has given from middle of June to middle of August.

All were taken between the twenty and forty fathom contour lines. The occurrence of these early stages is interesting, when it is considered that the adult forkbeard is distinctly rare in the neighbourhood. Two

* Nordisches Plankton, Vol. II. Eier und Larven von Fischen. 1905.

LARVAL AND POST-LARVAL TELEOSTEANS.

early post-larvæ of 4.5 mm. bridge the gap between Ehrenbaum's 3 mm. larva and Schmidt's* 5 mm. early post-larva. The general outline of the fish (with the rounded profile of the head) resembles Schmidt's 5 mm. specimen very closely. Pigment is slightly more pronounced, especially over the abdominal surface, where large stellate chromatophores of a rusty-brown colour are more closely packed on the dorsal part of this region. Chromatophores also appear on the suborbital region.

TABLE VII.

RECORD OF RANICEPS RANINUS L

No. of Ha	ul.	Date.	Depth.	No.	Size.
LXXIV.	A	13.viii.13	M.	3	4.5 - 9
LXXIX.	A	18.viii.13	В.	1	17
XCV.	A	25.viii.13	М.	1	17
CII.	A	27.viii.13	М.	1	18.5
CXXII.	A	8.ix.13	В.	1	4.5
CXXVII.	A	9.ix.13	М.	1	5.5

GADIDÆ.

Onos mustela L. O. tricirratus Bl. O. cimbrius L.

I can only identify with certainty one post-larva 3.75 mm. in length as O. cimbrius. It was secured at the surface in haul 58 A, on 2nd August, 1913, 6 miles S.S.W. of the Eddystone rocks. It has the single typical post-anal bar and the long black ventrals as described by Ehrenbaum,† and lies between his Fig. f and Fig. g. Only two adult specimens have come under my notice. One, 22.5 cm., was taken in a commercial beam-trawl on the outer Eddystone Grounds in November, 1912; the other, 15 cm., in a mosquito-net attached to the shackle of the otter-board, 31 miles W.S.W. of Rame Head on 2nd September, 1913. These have the first ray of the first dorsal fin extremely elongated.

Early post-larvæ of O. tricirratus were not observed, and only the later stages, with the three barbels developed, could be identified with accuracy.

O. mustela occurred from March to September with an intensity in June. The characters of these young stages are by no means obvious, and it is just possible that a few may belong really to O. tricirratus. The real difficulty in identifying the rocklings at Plymouth will be overcome when the early stages of O. tricirratus are worked out more fully.

* Medd, fra Komm, for Havund. Serie Fiskeri. Bind, II, Nr. 8. 1907.
† Nord. Plank. Vol. II, p. 280.

TABLE VIII.

RECORD OF ONOS SP.

No. of H		Dete	Dentil	0. I	nustela.	0. tri	cirratus.
NO. OI H	TT	Date.	Deptn.	NO.	Size.	NO.	Size.
IV.	H	22. V.06	В.	1	Ð	-	-
AII.	H	20.01.06	D.	1	4	-	
AIII.	H	" 读"	M.	1	10	1	30
XIV.	H	"	В.	1	4	-	-
XV1.	H	28.vi.06	М.	2	$2 \cdot 7 - 6$	-	-
XX.	H	20.vii.06	?	1	5	-	-
XXXIV.	H	11.iv.07	В.	1	5.5	-	-
XXXIX.	H	10.vii.07	В.	-	-	1	32
XLV.	H	1.vi.08	S.	4	8.7 - 10.5	-	-
XLVI.	H	, ,,	M.	1	7	-	-
XLVIII.	H	,,	S.	1	6.8	-	
LV.	H	5.vi.08	S.	1	4.5	-	-
LVIII.	H	10.vi.08	В.	2	$5 \cdot 5 - 6$	-	-
LIX.	H	12.vi.08	S.	5	6-8	-	-
LX.	H	.,	В.	1	6		-
LXXIV.	H	30.vi.08	В.	3	3-4	-	-
LXXXII.	H	20.vii.08	M.	1	5.2		
CV.	H	10.vi.09	S.	2	3.3-3.4	-	
CXVI.	H	8.vii.09	?	1	8.5	-	_
CXVIII.	H	13.vii.09	М.	1	7.5		_
CXXII.	H	20.vii.09	?	1	6.5	_	
IV.	A	11.vi.13	S.	1	7	_	_
XIII.	A	18.vi.13	М.	-		1	19
XIV.	A		В.	_	-	1	25
XVII.	A	19.vi.13	M.	2	4.2-4.4	_	_
XIX.	A	20.vi.13	M.	1	6.8	-	
XX.	A		S.	_	_	1	36.5
XXIII.	A	30.vi.13	B.	1	5.39	_	_
XXV	A	7 vii 13	B	î	19		_
XXXII	A	15 vii 13	S	î	4.9	-	
XXXIX	A	25 vii 13	S	î	31	_	
LIII	A	1 viji 13	S.	-	01	9	95_95 5
L.VIT	A	2 viji 13	M			2	17-93
LXIII	Δ	7 wiji 13	M	1	4.80	4	11-20
LXIV	A	11 wiii 12	M.	1	+ 00	1	98
LXXVIII	A	18 mii 12	B.			. 1	27.5
CYVIV	A	0 5 12	g.	1	0	T	01.0
VAAIA.	11	J.1A.10	N.	T	0	-	

MULLIDÆ.

Mullus surmuletus L.

Records of post-larval red mullet were extremely few, and confined to June, July, and August. This indicates a spawning period from May to July, which corresponds to the known period of spawning for this species. There is unequal representation during the five years, but, owing to the scarcity of young forms recorded, no actual deduction can be made as to the yearly fluctuations of the adults. Their numbers seem to be clearly diminishing in the neighbourhood.

LARVAL AND POST-LARVAL TELEOSTEANS.

TABLE IX.

RECORD OF MULLUS SURMULETUS L.

No, of H	laul.	Date.	Depth.	No.	Size
XVII.	H	28.vi.06	В.	2	$5 - 6 \cdot 5$
XIX.	H	20.vii.06	?	1	6
XX.	H	,,	?	2	$5 - 5 \cdot 5$
XXI.	H	27.vii.06	?	11	$4 \cdot 5 - 5 \cdot 5$
XXII.	H	,,	?	2	$5 \cdot 5 - 7$
CXIII.	H	29.vi.09	В.	2	7
CXVII.	H	13.vii.09	. S.	1	7
CXX.	H	20.vii.09	S.	5	5 - 6
CXXI.	H	,,	?	6	$5 \cdot 5 - 7 \cdot 5$
CXXII.	H	,,	?	4	6-7.7
CXXIV.	H	6.viii.09	М.	4	$4 \cdot 5 - 6 \cdot 5$
CXXV.	H	,,	В.	3	5 - 6
LVII.	Α	2.viii.13	м.	2	4.69

LABRIDÆ.

Labrus bergylta Asc. Ctenolabrus rupestris L.

I have referred the pelagic young stages to the above two species which are recorded in Table 25. *Ctenolabrus rupestris* L. is quite a distinct form and easily recognized by the help of Ehrenbaum's descriptions and figures in "Nordisches Plankton," Vol. I. Holt gives the spawning period from April to July, and this agrees with the occurrence of the species during the present investigations. The maximum frequency is in July; distribution is general in the area investigated.

The records of L. bergylta Asc. show a similar spawning period with an extension to August. The maximum is in June and July. It is possible that a few individuals of L. mixtus may be included in the list, but as the present state of our knowledge with regard to these two forms is extremely limited, the latter has meantime been excluded. The material seems to suggest two forms, one with a clear caudal peduncle region, the other with a slight continuation of the black stellate chromatophores along the ventral margin as indicated in Hefford's newly hatched larva of L. mixtus.* These two forms, however, show gradations of pigment.

* Journ. M.B.A. N.S., Vol. IX, No. 1. 1910.

CARANGIDÆ.

Caranx trachurus L.

		IADLE	А.		
Rec	ORD	OF CARANX	TRACHURUS	L.	
No. of Ha	aul.	Date.	Depth,	No.	Size.
XXV.	H	10.ix.06	В.	1	13
LXXIX.	H	30.vii.08	S.	1	ca. 2.7
CXVIII.	H	13.vii.08	М.	1	ca. 4
CXXI.	H	20.vii.09	М.	2	$4 \cdot 5 - 5 \cdot 5$
CXXIV.	H	6.viii.09	М.	1	ca. 3
CXXV.	Η	,,	В.	1	6
CXXX.	H	26.viii.09	В.	1	7.7
XXXIX.	A	25.vii.13	S.	1	5.95
XLVI.	A	29.vii.13	М.	1	16.5
LVII.	A	2.viii.13	М	1	10
LVIII.	A		S.	1	16.5
LX.	A	7.viii.13	S.	1	18.5
LXIV.	A	11.viii.13	М.	1	4.489
LXXIX.	A	18.viii.13	В.	1	5.36
LXXXVII.	A	21.viii.13	М.	1	48
XCV.	A	25.viii.13	М.	3	5-6
XCVI.	A		В.	1	6
XCVIII.	A		М.	1	4.5
XCIX.	A	26.viii.13	М.	2	$5 \cdot 5 - 6 \cdot 5$
С.	A	27.viii.13	М.	1	$5 \cdot 226$
CII.	A	.,	М.	1	6
CV.	A	29.viii.13	М.	6	$19 - 26 \cdot 5$
CVII.	A	1.ix.13	М.	1	
CVIII.	A	,,	М.	1	7
CXVII.	A	5.ix.13	М.	50	ca. 63
CXXIII.	A	8.ix.13	М.	3	27 - 33
CXXIX.	A	9.ix.13	S.	1	73
CXXXII.	A	11.ix.13	В.	1	80
CXXXV.	A	12.ix.13	М.	1	50
CXXXVIII.	A	.,	М.	2	46-65
CXLI.	A	15.ix.13	B.	2	66-75
CLVI.	A	20.ix.13	М.	1	4.5
CLXXI.	A	26.ix.13	М.	1	8.576
CLXXII.	A	26.ix.13	М.	1	8
CLXXIV.	A		В.	1	9.5
CLXXXII.	A	30.ix.13.	М.	1	6.5

Caranx trachurus L.

The spawning period of the scad has been given as May and June for the English Channel, but an extension at least to August is warranted by the present records, which indicate June to August. The frequency increases from the twenty-fathom contour line outwards. Young stages with fully developed adult characters were taken in September, generally in midwater or quite close to the surface, at lengths varying from 50 to 80 mm. Several individuals from haul 117 between 60 and 70 mm. in length were kept alive on board the *Oithona*, and transferred to the aquarium tanks. They fed ravenously on small pieces of worms and squid. Measured on 9th February, 1914, six months exactly after transference to the aquarium tanks, they gave measurements ranging from 105 to 130 mm. They had thus almost doubled their length in half a year. Their age may be taken as 9 months, if June be considered the spawning month.

LARVAL AND POST-LARVAL TELEOSTEANS.

SCOMBRIDÆ.

Scomber scomber L.

Post-larval mackerel were exceedingly few. One hundred and eighteen specimens from 4 to 13 mm. in length were taken during the period of investigation. These occurred during June and July, so that spawning in the neighbourhood must have begun in May in each year. The frequency in numbers is seen to decrease inshore, and to increase from the twentyfathom line outwards. Previous captures of the same stages (and these are by no means numerous) have been recorded chiefly at considerable distances from land. It is thus highly probable, from the scarcity of individuals in the samples, that the early stages occur in greater numbers much farther out than the area investigated. Subsequent stages have been observed at Plymouth at lengths of about 100 mm. One specimen of 200 mm. was caught in a commercial beam-trawl west of the Eddystone rocks on 11th February, 1914. Scales were developed, which were obviously in their first year's growth, but on considering the length of the fish, the age must be about 1 year 9 months, if, according to Ehrenbaum, scales begin to develop during the second year.

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LA	DL	Ľ	AI	

RECORD OF SCOMBER SCOMBER L.

Terre	JORD	OF SCOMPER	BCOBIDER	14.	
No. of H	aul.	Date.	Depth.	No.	Size.
Х.	H	20.vi.06	М.	7	$5 \cdot 5 - 7 \cdot 3$
XI.	H	,,	В.	1	6
XII.	H	,,	S.	2	$7 - 7 \cdot 5$
XIII.	H	,,	М.	4	$6 - 7 \cdot 5$
XIV.	H	,,	В.	4	ca. 7
XV.	H	28.vi.06	S.	- 6	7-11
XVI.	H	28.vi.06	М.	3	7-7.7
XVII.	H	"	В.	14	7 - 10.5
XIX.	H	20.vii.06	S.	1	7
XX.	H	27.vii.06	?	2	$4 - 7 \cdot 3$
XXII.	H	,,	?	3	4-11
LII.	H	10.vi.08	S.	1	7.5
LIX.	H	12.vi.08	S.	6	6-8
LX.	H	,,	В.	1	6
LXI.	H	15.vi.08	В.	2	7-7.5
LXIII.	H	19.vi.08	В,	1	7
LXIV.	H	,,	S.	4	7.5 - 10
LXV.	H	,,	М.	7	8-9
LXVI.	H	,,	В.	2	ca. 7
LXIX.	H	23.vi.08	S.	2	8-9
LXX.	H	"	М.	13	4.5 - 12
LXXI.	H	,,	В.	9	7-10
CI.	H	29.vi.09	S.	3	$9 \cdot 5 - 11.5$
CXVII.	H	13.vii.09	S.	1	ca. 7
CXX.	H	20.vii.09	S.	8	7-9
CXXI.	H	,,	?	3	$6 \cdot 5 - 7 \cdot 5$
CXXII.	H	,,	?	3	$6 \cdot 5 - 10$
III.	A	11.vi.13	М.	2	$4 \cdot 9 - 5 \cdot 04$
XVI.	A	19.vi.13	М.	1	11.5
XXIV.	A	16.vii.13	М.	1	13
XXIX.	A	25.vii.13	S.	1	9.45

X

ZEIDÆ. TABLE XII.

R	ECORD	OF ZEUS FA	BER L		
No. of H	aul.	Date.	Depth.	No. of Spec.	Size in mm.
LIII.	A	1.viii.13	S.	1	7.5
XCII.	A	25.viii.13	М.	1	5.5
. C.	A	27.viii.13	М.	2	9 - 11.5
CI	A		М.	2 1	1.5-13.
CII.	A	,,	М.	1	8
CIII.	A	29.viii.13	М.	1	16
CIV.	A		В.	1	6
CVIII.	A	1.ix.13	М.	2	8-19
CXI.	A	3.ix.13	М.	1	6
CXIII.	A		S.	1	15.5
CXVIII.	A	5.ix.13	М.	1	4.5
CXXV.	A	9.ix.13	М.	1	23
CXXXI.	A	11.ix.13	М.	2	11.5-13
XXXII.	A	,,	В.	1	11.5
XXXV.	A	12.ix.13	М.	1	17.5
LXXVI.	A	26.ix.13	B.	1.	7

Zeus faber L.

Our knowledge of the early post-larval stages of the John Dory seems to be restricted to the excellent descriptions of Schmidt in "Medd. fra Komm. for Havund. Serie Fiskeri," Bind II, No. 9, 1908. - These post-larvæ ranged from $7\frac{3}{4}$ mm. to 19 mm. in length, and were taken in the English Channel "almost all within the 100-metre curve" from the end of August to the middle of September. My own observations confirm and supplement those of the Thor. The series which I have recorded ranges from 4.5 to 23 mm., and all were captured within the twenty and forty fathom contour lines, from the beginning of August to the end of September. Six of these from 4.5 to 7.5 mm, represent younger stages than Schmidt's earliest post-larva of $7\frac{3}{4}$ mm., and I have described and figured two of these, one of 4.5 mm. and one of 6 mm. The remaining fourteen, from 8 to 23 mm., agree in every respect so closely with Schmidt's series that nothing by way of description need be added here.

FIG. 1. LENGTH 4.5 mm.

The maximum height is 2.04 mm., and the length from snout to caudal fin 3.06 mm. The highest point of the body lies directly over the posterior margin of the orbit, and in front of the first dorsal fin. The resemblance in shape to a parallelogram noted by Schmidt for his $7\frac{3}{4}$ mm. post-larva is roughly defined. The angle of the snout is very nearly 90°. The contour of the eye is not quite complete, but, so far as can be judged, its diameter is about equal to the length of the snout. The notochord is straight and extends about $\frac{2}{3}$ along the caudal fin, whose rays are only partially developed. The unpaired fins are still

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LARVAL AND POST-LARVAL TELEOSTEANS.

joined to the caudal by a continuance of their fin membranes. The rays of the first dorsal are indistinctly marked. Dorsal and anal interspines are clearly developed, but the fin rays are merely indicated. The ventrals are six-rayed, third largest and sixth shortest. They reach to the middle of the anal fin.



FIG. 1.—Zeus faber. Length 4.5 mm. Oithona Station, CXVIII. A. 5th Sept., 1913. Total depth 37 fms. Midwater haul. Del. E. Ford.

The whole surface of the body is covered with large black stellate chromatophores on a greenish background. These are intermingled with smaller chromatophores. The head is not so densely pigmented, and the interspaces between the chromatophores are larger. The ventral fins are densely pigmented with numerous large closely set chromatophores, giving the fins almost a black appearance. The pigment on the first dorsal fin is also evenly distributed, at least on the anterior half. No pigment occurs on the second dorsal, anal, and caudal fins.

FIG. 2. LENGTH 6 mm.

The maximum height is 3.004 mm. and the distance to the caudal 4.78 mm. (to end of body pigment). The highest point of the body is just in front of the first dorsal fin. The angle of the snout is slightly obtuse, and its length about equal to the diameter of the eye, the contour of which is still incompletely defined. The notochord is still straight or perhaps with a very slight upward tendency, caused by the hypural rays of the caudal being more developed. The unpaired fins are now separated from the caudal-fin membrane, and their rays are clearly, though not fully, defined.

The body pigment has spread on to the base of the dorsal and anal

interspinous regions. Over the whole surface of the body there is a mixture of large and small stellate chromatophores, and smaller black dots. The unpaired fins are still unpigmented. The anterior half of the first dorsal fin has an aggregate of black chromatophores. The snout region has the least amount of pigment.

The spawning of the dory, according to Cunningham,* takes place during June and July. Hefford† obtained ripe ovarian eggs on 31st August, while Holt‡ observed spent dories in June off the west coast of



FIG. 2.—Zeus faber. Length 6 mm. Oithona Station, CXI. A. 3rd Sept., 1913. Total depth 32 fms. Midwater haul. Del. E. Ford.

Ireland. The post-larvæ recorded in the above table suggest a spawning period extending from July to the beginning of September, though it is probable from previous records that spawning may also occur in June.

Cunningham* worked out the rate of growth of the dory, and gave lengths of about 130 mm. at the end of the first year, and about 280 mm. at the end of two years. The usual length of the dory landed at the Plymouth Barbican is from 15 to 18 inches, which, as Cunningham remarks, "is probably not reached in less than three years." On examining the rings of growth on the opercular and hyomandibular bones (especially on the cerato-hyal), according to Heincke's method,§ I find the results agree with those of Cunningham, though not many specimens were examined. The material was secured by the *Oithona* in the Agassiz and otter trawls.

O Group. I Group. II Group. <150 mm. .. ca. 150-ca. 250 mm. .. ca. 250-ca. 350 mm.

* Jour. M.B.A. N.S., 2. 1891-2. ‡ Rep. Roy. Dublin Soc. 1892.

† Journ. M.B.A. N.S., 9. 1910. § Intern. Meeres. Jahresbericht, 4-5.

CAPROIDÆ.

TABLE XIII.

	RECO	ORD OF CAPROS	APER 1	4.		
No. of Haul.		Date,	Depth.	No. of Spec.	Size in mm.	
XCIII.	A	25.viii.13	М.	1	5.5	
XCVI.	A	,,	В.	1	5.76	
XCVIII.	A	,,	М.	1	3.7	
XCIX.	A	26.viii.13	М.	1	4.69	
CXVIII.	A	5.ix.13	Μ.	2	$3 \cdot 4 - 4$	
CXXIII.	A	8.ix.13	М.	1	3.5	
CLII.	A	19.ix.13	M.	3	$3 \cdot 3 - 5 \cdot 5$	
CLXXIV.	A	26.ix.13	В.	1	6	

Capros aper L.

The capture of eleven specimens, 3.3 to 6 mm. in length, of the Cuckoo (as it is known locally in the adult state) between the twenty and forty fathom contour lines within a short radius of the Eddystone rocks, from



FIG. 3.—Capros aper. Length ca. 4 mm. Oithona Station, CXVIII. A. 5th Sept., 1913. Total depth 37 fms. Midwater haul.

Del. E. Ford.

the end of August to the end of September, helps to add considerably to our knowledge of the early developmental stages of this species. So far as I am aware, only the eggs and resulting larvæ are known through the researches of Cunningham* and Holt, † and one post-larva $15\frac{1}{4}$ mm. in length described by Schmidt. † Thus, between Holt's 2.86 mm. larva and Schmidt's $15\frac{1}{4}$ mm. post-larva nothing is known. My specimens are all early post-larvæ, but, unfortunately, they are too badly damaged to give a complete descriptive series. However, I have described and figured one of 4 mm. and one of ca. 5 mm. Zeus faber, the most nearly allied form, differs so markedly in its post-larval characteristics that there can be no confusing its early stages with those of *C. aper.*

* Journ. M.B.A. N.S., Vol. I. 1889-90.

† Annales du Musée d'Histoire Nat. de Marseille, Tome V, 2.

‡ Medd. fra Komm. for Havund. Serie Fisk., Bind II.

In the latter species, orange-red pigment is already developed in specimens of 4 mm. (on the abdominal region), while a distinct structural feature of Capros post-larvæ is the large number of small spines which cover practically the whole surface of the fish, and appear more markedly round the marginal outline. Two specimens were cleared and mounted. Each had about 22 vertebræ.

FIG. 3. LENGTH 4 mm.

The maximum height, measured along a vertical just in front of the first dorsal and anal fins, is 1.7 mm., and the distance from tip of shout to



FIG. 4.—Capros aper. Length 6 mm. Oithona Station, CLII. A. 19th Sept., 1913. Total depth 29 fms. Midwater haul. Del. E. Ford.

base of caudal fin is 3.2 mm. The longitudinal axis runs through the middle of the eye. The angle of the snout is very nearly 90° —if anything less: its length is about equal to the longitudinal diameter of the eye, the contour of which is still incomplete. The rhomboidal form of the fish is well marked. Small tooth-like spines are prominent on the snout, chin, and profile of the head. The second dorsal and anal fin rays are just beginning. Hypurals are developed on the caudal. The first dorsal has the spiny rays moderately developed. As yet, the dorsal and anal fins are both joined by a membrane to the caudal. The notochord is straight. Dorsal and anal interspines are developed. The ventral fins are well developed, and reach back almost to the beginning of the anal-fin region. Number of vertebræ ca. 22.

LARVAL AND POST-LARVAL TELEOSTEANS.

Orange-red pigment, over which occur splashes of bright red, is present on the anterior dorsal half of the abdominal region, while yellow pigment occurs on the rest of the body and very faintly in small patches on the head. A dense aggregate of dark pigment marks off the posterior margin of the abdominal region, beginning just above the longitudinal axis and extending as a line of dark chromatophores to the origin of the anal fin. Large brownishblack stellate chromatophores are spread over the dorsal half of the head and body, leaving a clear space in front of the base of the caudal fin. These large chromatophores are continued across the body post-anally, along the lower part of the abdomen and the ventral margin to the tip of the snout. A few black dots are scattered over the red pigment of the abdominal region. The orbital region, especially the suborbital, is practically devoid of pigment. No pigment is visible on the second dorsal, caudal, and anal fins, while a few dark chromatophores appear on the first dorsal and ventral fins.

FIG. 4. LENGTH 6 mm.

The maximum height is contained a little more than twice in the total length : length to caudal fin about $1\frac{1}{6}$ times. The snout is slightly concave above and below as in the adult ; its length is about equal to the diameter of the eye. The marginal row of spines in front of the first dorsal fin is very prominent. Similar rows are present on the præmaxillary region and along the spiny ray of the ventral fin. The second dorsal and anal fins are separated from the caudal. Their rays are not fully developed posteriorly. The spines of the first dorsal fin are strong and well developed ; nine can be counted. The tip of the notochord is turned upwards and the caudal rays well advanced. The dorsal membrane of the caudal is still fairly large.

The general arrangement and colour of the pigment is much the same as in the previous specimen, though the reddish patch has extended forward on to the orbital region. The colour is generally redder, owing to the presence of a larger number of bright red splashes.

PLEURONECTIDÆ.

Pleuronectes limanda L. (common dab). P. flesus L. (flounder). P. microcephalus Donov. (merry-sole).

Records of post-larval *P. platessa* are absent from the tables, though the eggs were observed fairly frequently during December, 1913, and January and February, 1914. They appeared in the tow-nets in the latter part of December, 1913, and continued to be observed during NEW SERIES.-VOL. X. NO. 2. JUNE, 1914.
January and February of this year, though less frequently in February. The maximum was in January. The diameters of the eggs varied from 1.809 to 2.07 mm. One newly hatched larva measured about 6.9 mm. These eggs were nearly all secured in inshore areas in Bigbury Bay and off the entrance to the Sound in quite shallow water.

Post-larval dabs are distributed generally over the area investigated, though they occur in greater numbers between the twenty and thirty fathom lines. The flounder shows a higher frequency in inshore areas, while post-larvæ of the merry-sole increase in intensity with the distance from land. The maximum frequency for post-larvæ of the dab lies in May, of the flounder in April and May, and of the merry-sole in June.

A specimen of P. microcephalus of 11 mm. shows no sign of metamorphosis, whilst in one of 12.5 mm. metamorphosis has commenced (cf. Kyle,* p. 48, footnote).

PLEURONECTIDÆ.

Sub-fam. BOTHINÆ.

Arnoglossus sp.

An examination of several hundred adult specimens taken in the *Oithona's* otter trawl in 1913 proves conclusively, with the help of Kyle's work,* the existence of three main species of the genus *Arno-glossus* in the neighbourhood of Plymouth. Kyle relied on four principal features for his segregation of the species, which he classified as :--

- (1) Structural Characters.
- (2) Dimensional
- (3) Numerical
- (4) Post-larval Characteristics.

..

These are sufficiently clear and comprehensive to make the identification of the three species at Plymouth comparatively easy. *A. laterna* Walb. and *A. imperialis* Raf. (*A. lophotes* Günther) occur most abundantly, while *A. thori* Kyle is comparatively rare.

The character of the first few dorsal rays, the length of the head, diameter of eye, and length of ventrals seem quite good enough to separate the three species already noted.

The larval and post-larval material will be reported on more fully in a later communication. There are considerably over a thousand specimens, which represent nearly all the stages up to the metamorphosed condition. A survey of Table 25 shows a maximum frequency in August and September, which, with the records for the earlier months, suggests a prolonged

* Rept. Danish Ocean. Exped., 1908-10. No. 2 (1913).

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PLEURONECTIDÆ.

TABLE XIV.

RECORD OF PLEURONECTES SP.

States of the		1 3 3 3 3 3 4 3 4 4		P. 1	limanda.	. P.	flesus.	P. mici	rocephalus.
No. of Ha	ul.	Date.	Depth.	No.	Size.	No,	Size.	No.	Size.
I.	H	10.v.06	В.	3	$14 \cdot 5 - 15$	-	-	-	-
II.	H	22.v.06	S.	-	—	6	7-9	-	-
III.	Η	22.v.06	М.	1	10	7	7 - 9	-	-
IV.	Η	22.v.06	В.	6	6-9	16	$7 - 8 \cdot 5$	6	8
V.	H		В.	4	10 - 12	6	$5 \cdot 5 - 9$	-	-
VI.	H	30.v.06	В.	26	$6 \cdot 5 - 10$	-	-		-
VIII.	H		В.	-	_	24	8-11.5		-
XI	H	20 vi 06	B	1	13.5			-	-
XIII.	H	20.11.00	M	6	6-10.5	-	_	-	
VIV	н	,,	B	_	-	_		3	12-14
VIII	TT	90 00	B.	5	7.5			1	8.5
VVVI	TT	25.01.00	D.	U		7	2.5.9	î	6
AAAI.	II	20.111.07	D.	-		4	5 5-0	T	0
AAAII.	H		M.			1.~	1 7	-	
XXXIII.	Н	11.iv.07	M.	8	0-7	15	4-1	-	-
XXXIV.	Н	,,	В.	3	9	20	4.9-9	_	-
XXXV.	H	6.vi.07	В.	-	-	-	-	2	6-9
XXXVII.	H	,,	S.	-	-	-	-	1	10.5
XLII.	H	28.v.08	?	1	12	-	-	-	—
XLIV.	H	,,	?	16	7.5 - 13	-		11	9 - 13
XLVII.	H	1.vi.08	В.	1	10.4	-	_	-	-
XLIX.	H		M.	2	12.5 - 13	-	-	-	-
L	H		В.	1	13	_	_	3	ca. 8
2 T.TT	H	4 vi 08	2	_	_	2	8-10	-	_
T.TIT	H	1.11.00	s	_	_	_	_	2	7.5 - 11
T TV	TT	"	M			1	8	_	
TT	TT	5 00	. S			-	-	1	7
LIV.	п тт	0.11.00	D.	1	19				
	H IT	10 " 00	D. D	T	10	_		1	Q
LA.	H	12.vi.08	D. D	-	_	-		C I	7 16
LXVI.	H	19.v1.08	В.		-	-		0	7-10
LXIX.	H	23.v1.08	N.	-	-	-	_	1	0 7
LXX.	Н	,,	M.	-	-	-	-	1	8.1
LXXI.	Η	"	В.	-	_	-		z	7-8
LXXIV.	Η	30.vi.08	В.	1	8	-	-	5	6-8
LXXV.	H	••	В,	-	-	-	-	9	5-8
XCV.	H	28.iv.09	S.	-	-	3	7 - 8	-	
XCVI.	H		В.	-	-	28	8-9	-	
XCVII.	H	3.v.09	?	-	_	2	10	_	-
XCVIII.	H	7.v.09	?	_	-	4	9 - 10	-	
XCIX	H	13.v.09	M.	12	8-12	-		_	_
C	H	$24 \ge 09$	S	_	_	1	8	_	-
CIV	H	2 vi 09	B	3	8-12	_		_	_
CIV.	н	25 vi 09	S	_	_	1	9	-	-
OVVII	TT	12 mii 00	S.			_	_	1	7
UAVII.	11	6 mi 19	g.			2	7-0.31	_	_
1.	A	0.11.15	D.		6	0	1-0 01	9	6.96-7
11.	A	11	D.	4	0	- 9	7	õ	0.00 1
111.	A	11.VI.13	MI.	_	1 50	0		. 14	7.5.11
<u>V</u> .	A	12.vi.13	M.	1	1.98	-		14	7 9.5
VI.	A	13.vi.13	M.	-		-		4	1-0.0
IX.	A	"	В.	-		5	1.4-8.54	± -	
Х.	A	16.vi.13	М.	4	7-10.15	1	8.75	3	1.1-9.17
XIII.	A	18.vi.13	Μ.	2	10.5 - 11.5	5 -	-	_	_
XV.	A	,,	М.	2	11.06-11.3	34 -	-	1	9.5
XXIII.	A	30.vi.13	В.	1	5.39	_	-	1	6
XXIV.	A	3.vii.13	М.	-	-	-	-	2	9.5 - 10
XXXVII	A	24.vii.13	В.	-				1	12.5
XLIII	A	28.vii.13	S.	3	39 - 42	-	-	-	
the set of				_					

spawning period for the three species. Kyle has noted an indefinitely prolonged spawning period for A. thori and for A. laterna, and has suggested a similar period for A. imperialis, although he states that the main spawning period for this last species lies in spring. The occurrence of a large number of larval and early post-larval forms of A. imperialis, in August and September, 1913, appears to confirm the view of an extended spawning period.

The frequency of the three species is highest off-shore between the twenty and forty fathom lines, and decidedly low within the twenty-fathom line—the captures inside this limit being confined to four specimens, 6 to 16 mm. in length, from hauls 70 A and 73 A.

It is interesting to note the occurrence in the collection of the pale North Sea and English Channel post-larval form of *A. laterna*, and the dark Bay of Biscay form of the same species. These two varieties of post-larvæ have been fully described by Kyle, who has suggested a higher number of vertebræ for the more southern form.

Sub-fam. RHOMBINÆ.

Rhombus maximus Will. R. lævis Rond.

The few records of these two species indicate an earlier spawning for the brill. Seven of the eight individuals recorded were taken beyond the twenty-fathom line. Permanent bottom stages of the turbot were secured with a push-net in Whitsand Bay on October 1st, 1913. These measured from 25–38 mm. $(1'' to 1\frac{1}{2}'')$ in length, and had fully assumed the adult condition. On the same date, brill of 130–140 mm. $(5'' to 5\frac{1}{2}'')$ in length were secured in the otter trawl in 3 to 5 fathoms in the same locality. These were probably a little over a year old.

TABLE XV.

RECORD OF RHOMBUS SP.

				R. ma	R. lævis.			
No. of Haul,		Date.	Depth.	No.	Size.	N).	Size.
XXXIX.	A	25.vii.13	S.		-		ĺ.	5.25
LXXXI.	A	19.viii.13	В.	-	-		L	6.5
CV.	A	29.viii.13	M.	-	-		L	5.5
CXVIII.	A	5.ix.13	М.	-	_		2	$3 \cdot 5 - 4 \cdot 2$
CXXXVIII.	A	12.ix.13	M.	1	7		-	-
CXL.	A	15.ix.13	M.	1	7.3	_	-	-
CXLII.	A .	15.ix.13	В.	1	7	-	-	-

Sub-fam. RHOMBINÆ.

Scophthalmus norvegicus Gthr. S. unimaculatus Bnp. Zeugopterus punctatus Bl.

Scophthalmus norvegicus Gthr.

This is the commonest topknot of the district. The records of the pelagic stages in Table 25 indicate an indefinitely prolonged spawning period from March or April to July. The maximum for the post-larvæ lies in June, so that the densest spawning month is most probably May. Frequency is highest between the twenty and thirty fathom lines, and lowest beyond the thirty-fathom line.

TABLE XVI.

RECORD OF SCOPHTHALMUS UNIMACULATUS BNP.

No. of Ha	ul.	Date.	Depth.	No.	Size.
XI.	A	16.vi.13	В.	1	7.5
XXIII.	A	30.vi.13	В.	1	7.98
XXXII.	A	15.vii.13	В.	1	11

The adult one-spotted topknots are of exceedingly rare occurrence at Plymouth, so that the capture of these three post-larvæ is all the more interesting. They were all secured beyond the twenty-fathom line, from 16th June to 15th July, and were identified with the help of Petersen's descriptions and figures of specimens, ranging from 6.7 to 8 mm. in length.

The oldest stage has a length of 11 mm., and it is still perfectly symmetrical. The concavity of the snout is well marked, and the dorsal fin is almost on a level with the posterior margin of the orbit. The diameter of the eye is contained about three times in the snout length. Ventrals are developed, though still small. The caudal fin is rounded and almost fully developed and about seventeen rays can be counted. The two pairs of otocyst spines are quite conspicuous, though not so prominent as in Z. punctatus.

Small dendritic chromatophores are scattered over the head and body, much as in *S. norvegicus*, though practically absent from the orbital region, and less dense on the interspinous region. There is a suggestion of the pigment on the unpaired fins beginning to concentrate into bars.

RECORD	OF	ZEUGOPTERUS	PUNCTATUS	BL	OCH.
No. of H	laul	Date.	Depth.	No.	Size.
· IV.	H	22.v.06	В,	1	6
. V.	H		В.	1	7
VIII.	H	30.v.06	В.	6	ca. 11
XIV.	H	20.vi.06	В.	1	9
XXXIII.	H	11.iv.07	М.	12	5 - 6
XXXIV.	H	,,	В.	3	3-5
XXXV.	H	6.vi.07	В.	2	6-9
XLIV.	Η	18.v.08	В.	2	$7 - 7 \cdot 5$
LXVI.	H	19.vi.08	B.	1	9
XCV.	H	28.iv.09	S.	1	4
CIII.	H	2.vi.09	М.	1	7.5
CX.	H	10.vi.09	М.	1	9
I.	A	6.vi.13	S.	10	$6 \cdot 5 - 8.5$
III.	A	11.vi.13	М.	2	ca. 5.5
VI.	A	13.vi.13	М.	1	6.3
XI.	A	16.vi.13	В.	1	11.69
XV.	A	18.vi.13	Μ.	2	$8 - 8 \cdot 5$

TABLE XVII.

Zeugopterus punctatus Bl.

Post-larvæ occurred from April to June, with their maximum in June. The spawning period probably extends from March to May for the Plymouth area. Hefford gives middle of February to May. Their distribution is general, though there is a much higher frequency under ten fathoms and between the twenty and thirty fathom lines.

Sub-fam. Soleinæ.

TABLE XVIII.

RECORD OF SOLEA.

				S. v	ulgaris.	S. va	riegata.	S.	lutea.	S. las	caris.
No. of Ha	aul.	Date.	Depth.	No.	Size.	No.	Size.	No.	Size.	No.	Size.
	-	10 00	n		10.5		mm.		mm,		mm.
1.	Н	10.v.06	В.	1	10.5	-	_	-	-	-	-
IV.	H	22.v.06	В.	2	4	72	6	-		-	-
VI.	H	30.v.06	В.		-	6	6	-	-	-	-
VIII.	H	,,	В.	1	9	-	-	-	-	-	
XIII.	H	20.vi.06	Μ.	-	-	2	$4 \cdot 2$	-	-	-	-
XIV.	H		B.		-	1	6	_	-	-	
XVII.	H	28.vi.06	В.	-	_	5	4-8	-	-		
XLIV.	H	28.v.08	В.		-	1	5.5	-	-		-
LIII.	Η	4.vi.08	S.		-	2	$3 \cdot 5 - 5 \cdot 5$	-	-		-
LVIII.	H	10.vi.08	В.	-		3	$3 - 5 \cdot 5$	-	-	-	-
LIX.	H	12.vi.08	S.	-		2	4-5	-	_	-	-
LX.	H	,,	В.	-	-	5	4-7			-	-
LXI.	H	15.vi.08	В.		-	2	5 - 6	-	-		-
LXV.	H	19.vi.08	M.	-	-	14	$3 \cdot 2 - 7$	-	-	_	-
LXVI.	H	,,	В.	-	-	5	7 - 8	—	-	-	-
LXVII.	H		S.	-	-	1	4	-	-	-	-
LXIX.	H	23.vi.08	S.	-	-	16	4-6	-	-	-	—
LXX.	H		М.	-	-	49	4.5 - 9	-	-	-	-
LXXI.	H		В.	-	-	8	5-7	-	-	-	-
LXXVI.	H	2.vii.08	М.		-	-	_	1	4	_	-
LXXIX.	H	15.vii.08	В.	_	-	1	10	3	$4 \cdot 8 - 6$	-	-
XCII.	H	20.viii.08	В.	-	-	-	_	1	6	-	
XCVII	H	3 v 09	. 9	4	4.9-5	_	_	_	_	_	-

			R	ECOR	D OF S	SOLEA.					
				S. vi	ulgaris.	S. van	riegata.	S.	lutea.	S. las	caris.
No. of Ha	ul.	Date.	Depth.	NO.	Size.	NO.	Size	NO.	mm.	NO.	mm.
CI	н	24.v.09	B.	1	7.5	_	_		-		_
CIII.	H	2.vi.09	M.	1	5	-	_		-		-
CIV.	Ħ		B.	1	6	-	-	-	-	-	-
CXVII.	H	13.vii.09	S.	_	-	1	4.5	-	-	-	-
CXXII.	H	20.vii.09	В.	_	_	2	$5 \cdot 3 - 10$	-	-	-	_
CXXIV.	H	6.viii.09	M.	_	_	1	5	_		-	-
CXXV.	H		В.	_	_	2	6-7	-	-	_	-
CXXXI	H	27.viii.09	M.	-	-	2	ca. 4	-	-	-	-
I.	A	6.vi.13	S.	_	-	_	_	1	4.55	-	-
II.	A		B.	1	6.86	_	_	3	$3 \cdot 7 - 5 \cdot 8$	_	
TIT.	Ā	11.vi.13	M.		-	24	$3 \cdot 9 - 6 \cdot 5$	-	-	_	-
V.	A	12.vi.13	M.		_	2	$5 \cdot 1 - 6 \cdot 1$	2	3.85 - 4.9	-	_
VI.	A	13.vi.13	М.	1	8.75	-	-	1	6.51		-
XII.	A	18.vi.13	S.	-	-	1	8	-		-	-
XIV.	Ā		В.			2	6.95 - 11	-	_		_
XV.	A		М.	-	-	1	7.49	-	-		
XVI.	A	19.vi.13	M.	-		-	_	2	$5 - 7 \cdot 35$	-	-
XVII.	A		М.	_			_	2	$4 \cdot 2$		
XX.	A	20.vi.13	S.		-	3	$5 - 6 \cdot 3$	-	-	-	-
XXII.	A	27.vi.13	М.	_	-	4	$4 \cdot 13 - 7$	1	4.5	-	-
XXIII.	A	30.vi.13	В.	-	-	3	$5 \cdot 25 - 7$	-	-	-	-
XXXIX.	A	25.vii.13	S.	_			· _	_	-	1	5.025
XCVI.	A	25.viii.13	В.		-	2	8-8.5	-	-	-	-
XCVIII.	A		М.		-		-	-	-	3	$6 - 9 \cdot 5$
C.	A	27.viii.13	М.	_		-	-		-	1	8
CII.	A		М.	_		-	-		-	1	10.5
CIV.	A	29.viii.13	В.		-		-	-	-	1	damaged
CX.	A	1.ix.13	В.		_		-	-	-	1	8.5
CXX.	A	8.ix.13	М.	-	-		-	-	-	1	8.7
CXXIII.	A		М.	-	-	-	-	-	-	1	4.5
CXXV.	A	9.ix.13	М.		-	-	-	-	-	1	11
CXXX.	A	10.ix.13	М.	-	-	-	-	-	-	1	4.69
CLV.	A	20.ix.13	В.	-		-	_	-	-	1	7.5
CLIX.	A	22.ix.13	В.	-	-	-	-		-	1	11.25
CLXI.	. A		М.		-	-	-	-	-	1	4
CLXIII.	. A	24.ix.13	M.	-	-	_		-	-	2	7 - 10.5
CLXIX.	. A	25.ix.13	Μ.	-	-		-	-	-	1	5.5
CLXXI	. A	26.ix.13	М.	-	-	_	-			1	5.786
CLXXII	. A	,,	М.		-		-	-		1	7.75
CLXXIII	. A	"	В.	-			-			1	11.5
TYYYI	Δ	30 iv 13	M	-						3	7.5-11.

TABLE XVIII.-Continued.

Solea vulgaris Quensel. S. variegata Don. S. lutea Risso. S. lascaris Risso.

Four species of soles are found in the neighbourhood, and all are represented in the post-larval material from the early post-larva up to the metamorphosing stage.

These are : S. vulgaris Quens. Common sole.

S. variegata Don. Thickback.

S. lutea Risso. Solenette.

S. lascaris Risso. Sand-sole.

With a post-larval series of each, specific determination has been

comparatively easy. Of the four species, S. variegata (thickback) occurs most frequently. The maximum number of post-larvæ was in June. They were taken in diminishing numbers on to August. This coincides with the period recorded by Petersen for the capture of his post-larval specimens-May to July. Records of S. lutea are confined to July and August, but the number of individuals is extremely small. S. lascaris occurred in increasing numbers from July to September, after which month they disappeared from the pelagic hauls. S. vulgaris post-larvæ were taken in May and June, but were extremely few, and by no means representative of the number of individuals in the neighbourhood. S. vulgaris and S. lutea show a higher frequency inshore at depths of about ten fathoms or less, while S. variegata and S. lascaris have a distinctly low frequency for this area. The maximum for these two species lies between the twenty and thirty fathom lines. Both were taken beyond the thirty-fathom line, and it is possible, at least for S. variegata, that the frequency may increase with the distance from land. Our knowledge of the life-history and developmental stages of S. vulgaris and S. lutea is fairly complete. Kyle has remarked on the greater breadth of similar forms of S. lutea from the more southern waters to those from the North Sea. My specimens of S. lutea show a distinct gradation from the one to the other. The greatest breadth (without the dorsal fin) ranges from about 25% to slightly over 40% of the total length.

S. variegata Don.

Post-larval S. variegata are known chiefly from the researches of Petersen,* whose specimens were captured mostly over depths from 1000 to 4000 metres, though he recorded captures from 53 and 113 metres. The series ranged from 7 to $18\cdot3$ mm. in length. At the latter length, metamorphosis was a long way off completion. It seems peculiar that my specimens are equally well advanced in development, but at a much smaller size. My post-larvæ of almost 4 mm. are closely identical with Petersen's 7 mm. post-larvæ, and just as far advanced in development. At 11 mm. in my material metamorphosis has already reached almost half-way. There is at a length of 11 mm., the largest post-larva in my collection, a distinctive difference in pigmentation from Petersen's metamorphosed specimen. The pigment is not confined to the fins, interspines, and margin of the abdomen and head, but also scattered universally over the whole of the body, not as tiny black dots, but as fairly stout stellate chromatophores of moderate size.

* Medd. fra Komm. f. Havund. Serie Fisk. Bind III, Nr. 1. 1909.

As Kyle^{*} has remarked on his single specimen of 7 mm., the depth of body is considerable. This is also a characteristic feature in nearly all my specimens, and contrasts with the much narrower body of Petersen's post-larvæ. There is the further difference to be considered in the localities of the two captures. The area of maximum intensity of this species in the region investigated at Plymouth lies between the twenty and thirty fathom lines, at no great distance from land, whereas Petersen secured his specimens at considerable distances offshore, and over much greater depths.

The numerical characters of my specimens certainly agree with those of S. variegata. D 71-72,

A 56–57.

Vertebræ 9 (10)+29 (30) (31).

Petersen gave for his post-larvæ D 71-76,

A 46–60

Vertebræ 9 (10)+29 (30) (31) (32).

Kyle's single specimen of 7 mm. had 10+30 vertebræ.

Structural and post-larval characteristics are much the same in my specimens as in Petersen's, except for those few characters noted above. There is no trace of an air bladder nor of barred pigment. Holt and Byrne have noted this barred pigmentation for the transition stage, and Mr. Byrne has kindly supplied me with a note on a specimen 16 mm. long (without caudal) having the general appearance of the adult. It was taken 50 miles W.N.W. of Cleggan Head, at a depth of about 120 fathoms. The youngest specimen with the adult appearance which I have observed at Plymouth measured 45 mm. Further investigation is required, especially in the later metamorphosing stages, to arrive at a fuller knowledge of this species.

S. lascaris Risso. (Sand-sole.)

Our knowledge of the post-larval development of the sand-sole is extremely limited. It is confined practically to two specimens, one of 8 mm., described by Kyle in "Rep. of the Danish Oceanographical Expeditions, 1908–10, No.2"; the other of 11 mm., described by Cunningham as a metamorphosing stage of *S. vulgaris* or *S. lascaris* in *Journal* M.B.A., 1897–99. Ehrenbaum was the first to attribute this latter specimen definitely to *S. lascaris*, and, from the material at my disposal, there is no doubt about his identification being correct.

* Report Dan. Ocean. Exped., 1908-10. No. 2. 1913.

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Several adult *S. lascaris* have been trawled from time to time, principally in Whitsand Bay, and I have thought it worth while to give a record of their numerical characters. Nine of these specimens were cut up and the vertebræ counted. In the other eleven individuals the fin formula alone has been recorded.

NUMERICAL CHARACTERS OF ADULTS.

1		80	65	46
2		90	76	48
3		85	70	46
4		87	69	46
5		87	71	47
6		86	70	46
7		81	66	47
8		83	67	48
9		88	72	46
10		80	67	-
11		86	70	-
12		86	69	-
13		91	73	-
14		84	69	-
15		82	71	-
16		85	69	_
17		85	71	-
18		87	73	-
19		91	73	-
20	1	82	68	-

Summary for 20 specimens :---

	D 80–91	A 65–76	Vertebræ 46–48
Kyle gives	D 79–89	A 61–70	Vertebræ 47–48

Vertebræ ca. 47

There is thus an extension to Kyle's summary, which works out as follows :---

D 79–96 A 61–76 Vertebræ 46–48

This large amount of variation seems to be a characteristic feature in the genus Solea.

From previous records of the eggs of this species, and from the occurrence of the post-larval forms, spawning seems to take place during June, July, and August. Hefford recorded the capture of one egg in March, the resulting larva of which he described and figured.* Holt⁺

* Journ. M.B.A. Vol. IX. 1910.

† Sci. Trans. Roy. Soc. Dublin. Vol. IV, S. 2. 1891.

obtained the newly hatched larva at a length of 4.1 mm., but its appearance was entirely different from Hefford's specimen. The distinguishing feature was a well-marked pre-cephalic expansion of the dorsal fin membrane. It was taken much later in the year, and thus more in agreement with the known spawning period than Hefford's larva. My earliest postlarvæ have all got this peculiar "hooded" structure, though much less pronounced. There is distinct evidence in my specimens of shrinkage in this region, so that there seems to be grounds for believing that this pre-cephalic structure was indeed larger in the larval state. I am inclined to consider Hefford's larva, though not without great reservation, as belonging to another species, possibly S. variegata. The pigmentation, shape of head, depth of body, more backward position of the anus, and length of the specimen seem to agree more nearly with the characters of S. variegata. I have described and figured post-larval stages from 5.025 to 11.25 mm. The rate of growth seems rather unequal, and considerable variation is apparent. The metamorphosed specimen of 11.25 mm., though far from having completed its post-larval growth, represents perhaps the minimum length for such an advanced stage, as in specimens of 11.5 mm., the left eye has not even reached the dorsal margin.

S. lascaris Risso.

FIG. 5. LENGTH 5.025 mm.

Length 5.025 mm., of which 3.4 mm. are post-anal. The preanal length is about $2\frac{1}{2}$ times in the total, so that the anus is well in front of the middle of the body. The snout is slightly longer than the diameter of the eye. The lower jaw projects beyond the upper. The greatest depth, which is measured over the middle of the abdominal region, is slightly under three times in the total length. The development of the fin rays is suggested posteriorly by the arrangement of the dorsal and anal pigment. Hypural rays are developed. The vertebræ have not advanced sufficiently to be counted. The snout is compressed and notched where it receives the dorsal fin membrane. The membrane curves back half-way over the nasal region and parallel to it, and then rises almost vertically, giving the larva a "hooded" appearance. This feature is quite distinctive of S. lascaris, and reminds one of Holt's newly hatched (4.1 mm.) larva of the same species with its "abnormal" development of this region. The midbrain is prominent; it overlies the orbit and its anterior outline is almost parallel to the anterior dorsal fin margin. The eyes are perfectly symmetrical. There is a distinct suggestion of an air bladder in a curved line of dark pigment lying on the middle of the dorsal margin of the abdominal region. As yet, there is no appearance of interspines. The notochord is straight or nearly so. The pectorals are fairly large, and equally developed.

The pigmentation is striking, and quite distinctive. The head, body, and abdomen are covered with large, exceedingly delicate stellate chromatophores, which assume a faint bronze tint in formalin. These are largest on the abdominal region. A few dark stellate chromatophores are present on the dorsal surface of the brain region. On the dorsal fin membrane, and similarly on the anal, there is a large aggregation of these chromatophores posteriorly, which assume a pronounced bar formation. On the dorsal fin also are two large much darker chromatophores, which stand out clearly from the rest of the pigment—one is situated



FIG. 5.- Solea lascaris. Length 5 025 mm. Oithona Station, XXXIX. A. 25th July, 1913. Total depth 25 fms. Surface haul. Del. E. Ford.

over the beginning of the notochord, the other about half-way along the fin. A few delicate chromatophores are present on the anterior expansion of the dorsal fin membrane, and near the large mid-dorsal chromatophore. The caudal is sparsely pigmented. Several chromatophores are scattered over the anal fin in front of the posterior bar, while a row of small dark chromatophores extends along the margin of the abdomen to the tip of the snout. The dark curve of the air bladder has already been mentioned. There are extensions in front towards the eye, and behind as far as the downward curve of the intestine. An interrupted line of pigment runs from behind the eye, on a level with its dorsal margin, for a considerable distance along the notochord.

FIG. 6. LENGTH 6 mm.

The preanal length is considerably less than half the total length. The snout is slightly larger than the diameter of the eye. The fin formula cannot be counted, at least dorsally, though the anal fin rays are much

farther advanced. The vertebræ number about 9+38=47. The lower jaw still projects. The snout is decidedly more vertical and almost continuous in outline with the dorsal fin margin, except for a small indentation marking the origin of the dorsal fin. The dorsal fin protuberance is almost parallel with the margin of the mid brain, the anterior border of which is in advance of the orbit. The eyes are symmetrical. Interspines have developed. The first dorsal interspine lies directly over the middle of the medullary region. The air bladder is now well defined and is comparatively large—its length being almost equal to that of the snout. The notochord is still straight.

The pigment is much more pronounced, though similar in arrangement



FIG. 6.—Solea lascaris. Length ca. 6 mm. Oithona Station, XCVIII. A. 25th Aug., 1913. Total depth 36 fms. Midwater haul. FIG. 6a.—Chromatophores enlarged.

Del. E Ford.

to that in the previous specimen. Chromatophores are developed on the snout and on the brain region, which latter is distinctly marked by a line of dark pigment, stretching from the fore brain, over the mid brain, hind brain and medulla, and ending with the beginning of the notochord. The notochordal line of pigment is less interrupted, and reaches almost to the caudal. This line of pigment marks out the ventral aspect of the spinal chord. An interrupted line of pigment runs along the base of the anal interspines, becoming more distinct in the region of the posterior bar of pigment.

FIG. 7. LENGTH 7.75 mm.

The preanal length is 3.42 mm. The snout (measured from the tip of the upper jaw to the anterior margin of the eye) is about equal to the

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diameter of the eye. The dorsal and anal fin rays have advanced considerably and stretch half-way across the fin membranes, though not sufficiently clear on the distal portions of the fins to be counted with accuracy. Vertebræ number approximately 9+37. The notch in front of the origin of the dorsal fin is much more conspicuous. It overlies the region of the mid brain. The interspines have extended forwards. The tip of the notochord is bent upwards, and the caudal rays are developed : twelve rays can be counted.

A few stellate chromatophores have collected round the two large separate dorsal fin chromatophores at positions corresponding to the future pigment bars. The first anal bar is also suggested by an aggregation of similar chromatophores at the beginning of the anal fin.



FIG. 7.—Solea lascaris. Length 7.75 mm. Oithona Station, CLXXII. A. 26th Sept., 1913. Total depth 27 fms. Midwater haul. Del. E. Ford.

FIG. 8. LENGTH 8.7 mm.

Length 8.7 mm., of which 5.69 mm. are post-anal. The anus is thus well in front of the middle line. Length of snout ca. 5 mm. (measured from tip of upper jaw); diameter of eye ca. 4 mm. The greatest depth is slightly more than the preanal length. Length of air bladder about equal to snout length.

> Fin formula D ca. 89. A ca. 73. Vertebræ 9+ca. 38=ca. 47.

The snout is more rounded and swollen anteriorly, and extends backwards to the origin of the dorsal fin membrane, which projects as a small knob in front and above the mid brain, the anterior margin of which is in line with that of the orbit. The dorsal interspines have advanced to a level with a vertical line through the middle of

the eye, and are well developed. The lower jaw still projects a little, and the mouth has a downward curve. The eyes are symmetrical. The tip of the notochord is bent upwards, and the caudal rays are almost fully developed.

The general appearance of pigment is very much the same as in the last specimen. There are now three distinct barred regions in the dorsal fin and two in the anal. The median dorsal bar lies exactly opposite the anterior anal bar, while the posterior dorsal bar seems to be continued across the body on to the anal fin. The two large separate dorsal fin chromatophores have disappeared, and their place is occupied with the median and anterior aggregates of chromatophores. Distinct dashes



FIG. 8.—Solea lascaris. Length 8.7 mm. Oithona Station, CXX. A. 8th Sept., 1913. Total depth 25 fms. Midwater haul.

FIG. 8a.—Chromatophores enlarged, Del. E. Ford,

of black pigment are present along the bases of the interspines dorsoventrally, but fewer in number and of larger size dorsally. Black dots occur on the chin, along the abdominal margin and on the anal fin, but these are obviously the centres of extremely delicate stellate chromatophores. The caudal fin is weakly pigmented—a few chromatophores occurring near the base and along the lower rays. The specimen is equally pigmented on both sides.

FIG. 9. LENGTH 9.5 mm.

The snout is larger than the diameter of the eye by about $\frac{1}{5}$. The greatest depth is slightly more than the preanal length.

Fin formula D ca. 89.

A ca. 71.

Vertebræ 9+ca. 38=ca. 47.

The concavity of the snout and dorsal fin membrane is clearly Vshaped. The mid brain has receded and on a level with the last third of the orbit. The eyes are still symmetrical. The lower jaw is practically

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on a level with the upper, but the chin projects, while the curve of the mouth is even more pronounced than in the previous specimen. The dorsal interspines have reached beyond the mid brain, and in line with a vertical through the middle of the orbit.

The pigment is much as in the previous specimen, with the barred areas forming a distinct feature. The spinal chord is marked out above and below by a continuous row of small dashes, while across the base of the caudal fin the chromatophores appear to be arranged into another small transverse bar.



FIG. 9.—Solva lascaris. Length 9.5 mm. Oithona Station, XCVIII. A. 25th Aug., 1913. Total depth 36 fms. Midwater haul. Del. E. Ford.

Length 10.0 mm. The preval and post-anal lengths show the same proportion as in the previous specimens. The snout is also longer than the diameter of the eye.

> Fin formula D 89. A 71. Vertebræ 9+38=47.

The concavity of the snout is still well marked, though not quite so markedly V-shaped. The left eye has begun to migrate. The interspines have advanced beyond the vertical from the anterior margin of the left orbit, which is slightly in front of the right. The brain has receded, and the anterior margin of the mid brain overlies the middle of the right eye.

There is practically no difference in pigmentation from the last specimen.

FIG. 10. LENGTH 11 mm.

Metamorphosis has gone a stage farther. The left eye is almost clear of the right, but has not yet reached the dorsal surface. The snout is more or less "hooked," with the lower arm of the V-shaped concavity

almost horizontal, round which the left eye will undoubtedly travel. The abdomen is beginning to get enclosed.



FIG. 10.—Solea lascaris. Length 11 mm. Oithona Station, CXXV. A. 9th Sept., 1913. Total depth 25 fms. Midwater haul. Del. E. Ford.

Large exceedingly delicate stellate chromatophores are diffusely scattered over the head, body, and abdomen. The dorsal and anal fins retain the darker barred aggregates, while a similar bar is present on



FIG. 11.—Solea lascaris. Length 11.25 mm. Oithona Station, CLIX. A. 22nd Sept., 1913. Total depth 27 fms. Bottom haul, Del. E. Ford.

the base of the caudal fin, the posterior half of which is devoid of pigment.

FIG. 11. LENGTH 11.25 mm,

Length 11.25 mm., of which 8.5 mm. are post-anal. The preanal length has considerably lessened. The left eye is almost wholly in NEW SERIES.—VOL. X. NO. 2. JUNE, 1914. 2 A

advance of the right, which is contained about twice in the snout length (reckoned from tip of snout to margin of right eye).

Fin formula D ca. 96. A ca. 76.

Vertebræ 9+37 (38)=46 (47).

The upper lip on the right side is curved as in the adult. Teeth are not developed on the right side, though present in the lower jaw on the future blind side. Both eyes are on the right side, and the dorsal fin has grown forward on to the middle of the snout so that the concavity has been overgrown. The abdominal region is entirely enclosed. The ventrals are equally developed, and reach almost to the first anal ray. There is still no trace of the large fringed nostril on the blind side. The air bladder is rather large.

The pigmentation agrees closely with the preceding stages. Both sides are equally pigmented, so that the permanent bottom stage has not quite been reached. The small dark chromatophores which are present on the abdominal margin of the previous stages have now collected into a dense aggregate over the anus. Stellate chromatophores are universally distributed, and extremely delicate, having a rusty-brown appearance. The three dorsal and two anal bars are still quite distinct, while the smaller bar across the base of the caudal has practically disappeared.

This stage is much farther advanced than Cunningham's 11 mm. postlarva. There are six more dorsal rays; the abdomen is enclosed and ventrals are developed. The rough saw-like margins of the dorsal and anal fins are quite typical, and the rays in my specimen reach the tip of each tooth.

GOBIIDÆ.

Gobius minutus Pall. G. microps Kr. G. scorpioides Coll. Crystallogobius nilssoni Düb. and Kör. Aphya pellucida Nardo.

Table 25 gives a record of the gobies, without any definite specific arrangement. These are chiefly G. minutus, though G. microps, which appears to be quite a distinct form, is also well represented.

G. scorpioides Collett.

One specimen, 11 mm. in length, was taken in a midwater haul (192 A) on 24th October, 1913, 6 miles west of Rame Head, over a depth of 26 fathoms. Previous records of this small goby have been remarkably few, and, as Holt and Byrne have remarked, there is little chance of its being taken unless by special methods. Two adult specimens were

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taken by Crawshay* in the outer western area of the English Channel, 31 and 33 mm. in length, at a depth of about 50 fathoms.

The pigmentation of the single specimen recorded differs considerably from that of the full-grown adult. Two conspicuous pale bands are represented. One lies across the caudal peduncle, as in the adult; the other occupies a position directly behind the head in the region of the pectoral and first dorsal fins. A faint yellow tinge is present on the caudal and pectoral fins, while alternate dark and light bands are present on the dorsal fins. Pigment is very sparing on the ventrals, being limited to a few dark splashes at the base and on the middle of the larger rays.

Crystallogobius nilssoni Düb. and Kören.

Adult Crystallogobius are frequently met with in the neighbourhood, being especially numerous on the Eddystone Grounds. Sexual dimorphism is a distinct characteristic. The males have considerably more pigment than the females, while the body is deeper and more compressed laterally than in the female, which has a much more slender body and more pointed head. The first dorsal fin is present only in the male, and contains two long rays. The second ray is the longer, and is joined to the body by a wide membrane.

In June, adult males were found in attendance on the eggs, which were attached to the inside of empty tubes of *Chaetopterus variopedatus*. These were trawled on the Eddystone Grounds, chiefly in the area south and west of the Eddystone rocks. A similar habitat was noted by Grieg,[†] who observed the eggs of this species inside tubes of *C. sarsi*.

The records of this species confirm Holt's observations on the pelagic habit of this transparent goby. The young stages have not been sufficiently cleared up to give a definite idea of the distribution and lifehistory of the species.

ECORD OF C	RYSTAL	LOGOBIUS	NILSSONI	DUB.	AND KOR.
No. of	Haul.	Date.	Depth.	No.	Size.
VII.	н	30.v.06	Ŝ.	. 6	24.30
XI.	H	20.vi.06	В.	. 86	21.5 - 36.5
XXVIII.	H	21.ix.06	В.	1	22
LXI.	H	15.vi.08	В.	6	22-36
CXXIV.	H	6.viii.09	М.	.1	29
CXXV.	H	,, .	В.	3	29-30
XI.	A	16.vi.13	В.	1	24
XIII.	A	18.vi.13	М.	31	23-28
XIV.	A		В.	14	$20 - 30 \cdot 5$
CXIII.	A	3.ix.13	S.	1	28
CXCII.	A .	24.x.13	М.	102	$14 - 26 \cdot 5$
CXCIII.	A		В.	93	$14 - 21 \cdot 5$
CXCIV.	A .	,,	М.	. 17	13 - 25

TABLE XIX.

* Journ. M.B.A. N.S., Vol. IX. 1910-13.

† Bergens Museums Aarbog. 1898.

GOBIIDÆ.

Aphya pellucida Nardo.

The post-larval stages of this species are very much like those of Crystallogobius, from which they have been separated with difficulty. The fin formula has been counted in most of the specimens, and has given D 11-12, A 11-12. In a few of the older post-larvæ the rays of the first dorsal were just visible.

Post-larvæ occurred from June to September with a maximum in July and August. Spawning would thus be at its height in June and July. Post-larvæ of A. *pellucida* are seen to be widely distributed over the area investigated, though frequency is highest within the ten-fathom line.

TABLE XX.

RECORD OF APHYA PELLUCIDA NARDO.

No. of H	laul.	Date.	Depth.	No.	Size.
II.	A	6.vi.13	B.	53	7.7 - 10.5
III.	A	11.vi.13	М.	4	6.02 - 11.4
v.	A	12.vi.13	М.	4	$6 \cdot 3 - 8$
IX.	A	13.vi.13	В.	1	8.4
XXVI.	A	8.vii.13	_	4	$8 \cdot 5 - 10$
XXVII.	A	10.vii.13	S	1	9
XXVIII.	A	11.vii.13	M.	8	8-11
XXIX.	A		S.	1	11
XXXI.	A	14.vii.13	S.	2	8.3-8.68
XXXII.	A	15.vii.13	B.	3	8.5-11.5
XXXIV.	A	16.vii.13	M.	1	6
XXXV	A	17. vii 13	S	21	6-14.5
XXXVI.	A	18.vii.13	M.	5	6-9.5
XXXVII	A	24 vii 13	B	7	5.5-12
XXXVIII	A		M	ġ	6.5-12
XI.	A	28 vii 13	M	12	10.5-11
XLI	Δ	20.011.10	M	61	8-16
XLII.	A	"	M	11	6.5_19.5
VIIII	A	"	S.	5	damagad
XLIV	A	90 mii 19	S.	1	8.5
XLVI	Δ	20.011.10	M.	39	7.5-10.5
XLVII	Δ	30 mii 13	S.	1	11
XLVIII.	Δ	50.011.15	B.	11	4.5_10.5
VIIV.	A	91 mii 19	D. D	11	7 7.5
TITT	A	1 mii 19	D.	17	1.5 19
TIV	A	9	D.	- 17	4.5 16
LIV.	A	2.011.15	D. G	00	9 16.5
TVT	A	"	D.	44	5-10.0
T WIT	A	"	MI.	20	0.0-10
T WIII.	A	"	M.	10	12.9-10
LVIII.	A		D.	10	8-17
LA.	A	7.VIII.15	D.	1	. 8.9
LAI.	A	"	MI.	170	4-4.0
LAII.	A	,,	B.	13	5-7
LAIII.	A	11 " 10	MI.	.5	3.14-8
LAIV.	A	11.vm.13	M.	3	ca. 6
LXV.	A	10 "	B.	2	3.68-12 5
LXXI.	A	13.viii.13	S.	128	4-14
LXXII.	A	**	S.	158	$4 \cdot 5 - 15$
LXXIII,	A	"	S.	49	$4 \cdot 5 - 12 \cdot 5$

TABLE XX.-Continued.

RECORD OF APHYA PELLUCIDA NARDO.

No. of H	aul.	Date.	Depth.	No.	Size.
LXXIV.	A	13. viii. 13	М.	154	3 - 14
LXXV.	A		S.	8	5 - 15
LXXVI.	A	14.viii.13	S.	14	4.5 - 12
LXXIX.	A	18.viii.13	В.	3	8.5-11
LXXXIX.	A	22.viii.13	В.	2	9 - 14.5
XC.	A		В.	27	4.5 - 14
XCII.	A	25.viii.13	М.	2	$8 - 14 \cdot 5$
XCV.	A		М.	2	5.5 - 9
XCVI.	A	.,	В.	2	$8 \cdot 5 - 10$
XCVII.	A		В.	4	$5 \cdot 5 - 12$
XCIX.	A	26.viii.13	М.	2	ca. 8
CI.	A	27.viii.13	M.	4	7.5 - 9.5
CII.	A	.,	М.	1	11
CXI.	A	3.ix.13	М.	8	8-15
CLVI.	A	20.ix.13	М.	3	ca. 8
CLX.	A	22.ix.13	В.	1	15.5
CLXV.	A	24.ix.13	В.	1	19
CLXX.	A	25.ix.13	В.	1	6.03
CLXXIV.	A	26.ix.13	В.	1	7
CLXXIX.	A	29.ix.13	B.	3	8.10
CLXXXIV.	A	1.x.13	В.	1	19.5

COTTIDÆ.

Cottus bubalis Euphr.

Spawning begins in January. Eggs were taken attached to stones between tide-marks on Drake's Island. Post-larvæ occurred from March to June, with their maximum in the last month.

TABLE XXI.

RECORD OF COTTUS BUBALIS.

No. of Hau	ıl.	Date.	Depth.	No.	Size.
II. 1	H 22	2.v.06	S.	2	6-10
III. I	H		M.	3	4.5 - 8
VIII. 1	H 30).v.06	В.	1	7.5
XI. I	H 20).vi.06	В.	3	ca. 8
XIV. 1	E		В.	2	6.5
XVII. 1	H 28	8.vi.06	В.	1	5
XXXI.]	H 25	5.iii.07	S.	6	7.10
XXXII. 1	E	,,	М.	1	7.5
XXXIII. 1	H 11	.iv.07	M.	4	4.5 - 9
XXXIV.]	E		В.	4	$5 \cdot 5 - 11 \cdot 5$
XXXV. 1	H 6.	vi.07	B.	6	6-8
XLIV. 1	H 28	8.v.08	?	2	5 - 7
LVIII. 1	H 10).vi.08	В.	2	$5 \cdot 5 - 6$
LXVI.]	H 19).vi.08	B.	1	8
LXVII. 1	H		S.	4	ca. 5
LXVIII. 1	E		В.	2	ca. 4
XXIV.]	H 30).vi.08	?	1	4
XCV. 1	H 28	8.iv.09	S.	7	3-6
XCVI. 1	H		В.	1	5
XCVII. 1	H 3.	v.09	. ?	1	4
XCIX. 1	H 1:	3.v.09	M.	3	7-8
CIV. 1	H 2.	vi.09	В.	1	6
CIX. I	H 20	5.vi.09	S.	2	7.5-8

CYCLOPTERIDÆ.

Cyclopterus lumpus L. Cyclogaster montagui Donov. Cyclopterus lumpus L.

Only one specimen of the lumpsucker is recorded. It was taken in the Zostera bed of Cawsand Bay in a midwater haul on 24th September, 1913. The total length was 18 mm.

Cyclogaster montagui Donov.

Post-larvæ of this species occurred most frequently in June, at lengths ranging from 3 to 7.07 mm. The capture of two specimens 5.6 and 6.7 mm. in length in August and September, in bottom hauls, seems to suggest a long post-larval life. In these, the sucker was well developed in front of the abdomen, as in Ehrenbaum's Fig. C, "Nordisches Plankton," Vol. I.

TABLE XXII.

RECORD OF CYCLOGASTER MONTAGUI.

			U	y ciogas	ber monua	gw
No. of H	aul.	Date.	Depth.	No.	Size.	-
VI.	H	30.v.06	В.	4	$4 \cdot 5 - 6$	
VII.	H	,,	S.	1	7.5	
VIII.	Η	,,	В.	1	ca. 8	
XI.	Η	20.vi.06	В.	1	7	
XVII.	H	28.vi.06	В.	2	4.5-6	
XX.	Η	20.vii.06	В.	1	6	
XXI.	H	27.vii.06	В.	1	5.5	
XXXV.	H	6.vi.07	В.	6	ca. 5	
LIII.	H	4.vi.08	S.	1	6	
LXVIII.	Η	19.vi.08	В.	1	8	
LXX.	\mathbf{H}	23.vi.08	М.	1	6.7	
LXXI.	Η	.,	В.	2	4.3	
CV.	H	10.vi.09	В.	?	?	
CIX.	H	25.vi.09	В.	1	7	
XIV.	A	18.vi.13	В.	1	7.07	
XCVI.	A	25.viii.13	В.	1	5.695	
CLX.	A	22.ix.13	В.	1	6.7	

TRIGLIDÆ.

Trigla gurnardus L. T. hirundo Bl. T. cuculus L. T. lineata (Ray).

Our knowledge of post-larval gurnards is extremely limited. Only T. gurnardus and T. hirundo, two of the five species that occur at Plymouth, are known with any degree of certainty. Trigla gurnardus is well represented in the collection, and appears to be the commonest post-larval form. T. hirundo has been partially worked out by Emery* for the Mediterranean, and his descriptions of the post-

* Mittheil. Zool. Sta. Neapel, vi, 1886.

larval forms have been extremely helpful. Specific characters which have been found most useful have reference to the pectoral fins. These are extremely long in T. gurnardus, and have the pigment scattered as black dots between the rays mostly on the posterior half of the fin. In T. hirundo the pectorals are much shorter and broader, more deeply pigmented over the whole surface, and appear almost as a uniform brownish black.

An entirely different form appears in August and September. This, by a process of elimination, is most probably T. lineata, which is known to spawn about July. The early post-larva has very little pigment except for a distinct narrow dark band along the dorsal and posterior margin of the abdominal region, somewhat similar to what occurs in *Cottus bubalis*.

With the material at my disposal, I hope to give a fuller account of the different species in a later contribution.

TRACHINIDÆ.

Trachinus vipera Cuv. T. draco L. T. vipera Cuv. (Lesser Weever.)

Pelagic post-larvæ of the lesser weever were found to be generally distributed and comparatively numerous. They were taken at the mouth of the Lynher River, in the Sound, Cawsand Bay, and over depths ranging from ten to about forty fathoms. The frequency was highest beyond the twenty-fathom line. They occurred from April to September, so that the spawning of this species, as with the dragonet, is indefinitely prolonged. The maximum for the post-larvæ lies in July and August.

T. draco L. (Greater Weever.)

Records of the greater weever are limited to four specimens from 6 to 7 mm. in length, secured in August and September. The appearance of these post-larvæ corresponds to Ehrenbaum's Fig. f, "Nordisches Plankton," Vol. I. Adults of this species are by no means common in the neighbourhood. Those which have been observed have been captured in deeper water.

TABLE XXIII.

RECORD OF TRACHINUS DRACO.

No. of Hau	1.	Date.	Depth.	No.	Size.
XCIX.	А.	26.viii.13	М.	2	6-7
CXVII.	Α.	5.ix.13	М.	1	6
CLXXVI.	А.	26.ix.13	В.	1	6.5

CALLIONYMIDÆ.

Callionymus lyra L.

Hefford recorded the eggs of the dragonet from 11th February to 30th August, but they have been observed this year in January. There is thus an indefinitely prolonged spawning period in the Plymouth district. This is borne out by the post-larval records, which extend from March to September, with a maximum for the middle months of the year—May, June, and July. The distribution of the post-larvæ is general, but there is a distinct concentration in numbers between the twenty and thirty fathom lines, where the adults are also very numerous. The frequency is low inshore within the twenty-fathom line. Between the ten and twenty fathom lines, and also between the thirty and forty, the percentage is fairly high, and shows only a slight decrease from the numbers in the area included between these two regions.

GOBIESOCIDÆ.

Lepadogaster bimaculatus Donov. L. gouani Lacep. L. candollei Risso.

The distribution of these three species is well marked by the records in Table 24. There are two types represented—the littoral type in *L. gouani* and *L. candollei*, and the deeper water type in *L. bimaculatus*. The frequency of *L. bimaculatus* is high beyond the twenty-fathom line and low in depths less than twenty fathoms. Post-larval *L. bimaculatus* occurred from June to September with a maximum in July. Spawning thus begins in May and extends to August. Ova were frequently found in June and July attached to the inside of empty pecten shells taken in the otter trawl on the Eddystone Grounds. Adult males were generally in attendance.

TABLE XXIV.

RECORD OF LEPADOGASTER SP.

				L. bi	maculatus.	L. 20	ouani.	L. ca	ndollei.
No. of H	laul.	Date.	Depth.	No.	Size.	No.	Size.	No.	Size.
XIV.	H	20.vi.06	В.	12	7.5 - 11		-	-	
XVII.	H	28.vi.06	В.	4	4-7	-	-	-	-
XIX.	H	20.vii.06	S.	-	-	1	5.5	19	4.5 - 7.5
XX.	H		М.	11	5.5 - 10.5	-	-	2	5-6
XXI.	H	27.vii.06	?	25	5 - 10.5		-	-	_
XXII.	H	.,	?	6	4.7-10		-	1	6
XXVIII.	H	21.ix.06	В.	1	17		-	-	
XXXV.	H	6.vi.07	В.	9	6-10		_	-	_
XXXIX.	H	10.vii.07	В.	3	5-6		-	-	_
XL.	H	19.vii.07	В.	1	7	-	-	-	-
XLIII.	H	28.v.08	M.	-	-	3	5 - 6	-	-
XCVII.	H	3.v.09	?	-	-	1	4.6	-	
CIV.	H	2.vi.09	B.	1	9		-	-	-

TABLE XXIV.-Continued.

RECORD	OF	LEPADOGASTER	SP.	
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No. of Hard Date			_	L. bimaculatus, I		L. go	uani.	L. car	ndollei.
No. of H	laul.	Date.	Depth.	No.	Size.	NO.	Size.	NO.	Size.
CXVIII.	H	13.vii.09	М.	3	$6 - 7 \cdot 5$	-	-	-	-
CXXI.	H	20.vii.09	?	9	6 - 10	-	-	-	-
CXXII.	H	,,	?	11	5 - 8		-	-	-
CXXV.	H	6.viii.09	В.	5	$5 - 7 \cdot 5$	-	-	-	-
III.	A	11.vi.13	М.	1	5.32		-	-	-
V.	A	12.vi.13	М.	1	6	-	-	-	-
Х.	A	16.vi.13	В.	-	-	1	7.46	-	-
XXI.	A	24.vi.13	S.	1	5.18	-	-	-	-
XXV.	A	7.vii.13	В.	-	-	-	-	. 1	6.02
XLVI.	A	29.vii.13	М.	1	8.5	-	-		
XLVII.	A	30.vii.13	S.	-	_	-	-	1	7.5
XLVIII.	A		В.	-	_	_	-	5	6-8
XLIX.	A	31.vii.13	В.	1	9.5	-	-	-	-
LIII.	A	1.viii.13	S.	1	mtd.	-	_	-	-
LVI.	A	2.viii.13	М.	1	8	-	-	-	-
LVIII.	A		S.	8	$5 \cdot 5 - 10$	_	-	-	-
LX.	A	7.viii.13	S.	-	-			1	7.5
LXIII.	A		М.	2	$6 - 6 \cdot 5$			-	_
LXXII.	A	13.viii.13	S.	2	5.025 - 6.6	28	_		_
LXXX.	A	18.viii.13	М.	-	_	1	5.5	1	7
XC.	A	22.viii.13	В.	_	-	1	6.5	1	7.5
XCII.	A	25.viii.13	М.	1	10.5			-	
XCV.	A		М.	1	7		-		-
XCVI.	A		В.	1	6	-	-	-	-
XCVII.	A		В.	3	5-7	_	-	-	-
XCVIII.	A		M.	1	7.5	-	-	_	-
CII.	A	27.viii.13	М.	3	7	-	-	-	-
CXV.	A	5.ix.13	М.	2	7.5 - 9	-	-		
CXXVI.	A	9.ix.13	В.	1	5.5	-			-

BLENNIIDÆ.

Blennius pholis L. B. ocellaris L.

Considerable difficulty has been experienced in determining all the individuals specifically, owing to our incomplete knowledge of the early post-larval stages. Records will be found on Table 25, a general survey of which reveals the presence of two main types, those forms which occur most frequently offshore, and those with a higher frequency inshore. The offshore type is represented by *B. ocellaris*, the inshore chiefly by *B. pholis*.

Eggs of *B. ocellaris* were found continuously from June to August inside empty Buccinum shells which were trawled on the Eddystone Grounds. In nearly every case an adult blenny was taken in attendance. Several of these adults were measured and gave lengths of 120 and 130 mm.

TABLE

EXPLANATION OF

									L'AFLA.	NATION OF
							00	= 8	several	thousands.
							m	= 1	nany.	
							v.r	n. = 1	very ma	any.
	Cla			adartan an	Tohm	houselto	Cten	olabrus	Amori	
No of Houl	No	ipea sp.	Ma	Size	Labrus	s bergynta,	rup	estris.	Mogi	Ossus sp.
NO. 01 Haui,	10.	6120.	190,	Size.	NO.	Size,	140,	Gize.	140.	bize.
1. H	-	-	-	-	-	-			-	-
II. H	-		-		-	-	-		-	-
Ш. Н	19	12-24	4	10 - 29	3	7	-	-	-	-
IV. H	3	9-10	-	-	-	-	-	-	-	-
V. H	70	. 18-30	-	-		-	-		-	-
VI. H	7	9 - 16.5	14	6 - 17.5	7	4.5-7	-		-	-
VII. H	00	26 - 47	1	12	-	-	-	-		-
VIII. H	1	11.5	1	10	-	-	-	-		-
IX. H	1	22	1	10.5	2	4	-	-	1	4.5
Х. Н	4	10 - 12	2	9 - 15	3	4.7-6		-	1	4.5
XI. H	4	17 - 20	1	11	1	. 6	-	-		_
XII. H	7	$12 - 17 \cdot 5$	1	10	_	_	-		2	5.5-7
XIII. H	23	12 - 20	3	10-17	-	-	-	-	_	
XIV. H	1	13	-		1	24	5	3.9-4.5	1	5.5
XV. H	5	9-11	1	7.6	60	3.7-5.5	14	3.8-4.5	ī	4
XVI H	66	10.5-19	28	6.5-18	4	4-7.5		-	3	5-7.5
XVII H	1-	18		-	-				-	0.0
XVIII H	29	11-24	3	7-12.5	56	3.95_7	7	5_8		
XIX H	92	10.5_16.5	4	7-16.5	00	0 20-1	2	6.5 9	1	6.5
XX H	7	15_20	19	8.93	1	7.9	2	0 0-0	T	0.0
XXI H	i	19.5	1	17	2	1.9.7	1	7.5		
VVII II	T	12.0	T	11	0	4-2-1	T	1.0	_	-
VVIII II	-	_			-	-	-		-	-
VVIU II	-	_	_	_	-	-	-	-	10	19 .00
VVV II	-	-	-	_	-	-	-	-	10	13-20
AAV. H	-	-	-	-	-	-	-	-	1	20.0
AAVI. H	-	1 - 10	-		-	-	-	-	2	19-21
AAVII. H	2	4.9-18	T	15	-	-	-	-	-	-
XXVIII. H	-	-	-	-	-	-	-	-	—	-
AAIA, H	-	-	-	-	-				-	-
XXX. H	1	7	-	_	-	-	-	-	-	
XXXI. H	14	10 - 20	1	8.5	-	-	-	-	-	-
XXXII. H	10	3-5	-	-	-	-	-	-	-	-
XXXIII. H	15	$5 - 14 \cdot 5$	3	$6 \cdot 5 - 12 \cdot 5$	-	-	-	-	-	-
XXXIV. H	5	7-11	3	7-8	-	-	-	-	-	-
XXXV. H	3	9-12	-	-	2	- 4	-	_	-	-
XXXVI. H		-	-	-	-	-	-	-	-	-
XXXVII. H		-	-	-	1	5	-	-	-	-
XXXVIII. H	-	-	-	-	6		-	-	-	-
XXXIX. H	1	16	-	-	1		-	-	-	
XL. H	-	-	12	13 - 22	2	8-20	-	-	-	-
XLI. H	20	9-18	-	-	-	-	-	-	-	-
XLII. H	8	4	-	-	-	-	-	-	-	-
XLIII. H		-	-	-	-	_	-	-		-
XLIV. H	27	11 - 21	-	-	3	5-7.5	-		_	-
XLV. H			-	_	-	_	_	-	-	_
XLVI. H	4	10-12	-	-	-		-	-	_	-
XLVII. H	6	12-16	1	23		-	_	_	-	_
XLVIII H	1	10	i	11	_	_	_	-	_	
XLIX H	2	12.5-13.5	-	-			_		_	
LH	7	10-17	7	7-19.5						
LI H	9	8-0		1-12.0			_	_		
	4	0-9			_		_	-	-	and the second second
LIII II	20	7.5 18	_		-		1	7.5	_	-
	90	12 16	_		1	-	1	1.9	_	-
IV. H	4	10-10	-	-	-	-	-	-	-	-
цу. п	-	-	-	-	-	-	-	-		

380

XXV.

ABBREVIATIONS.

z = damaged specimen, size = length in mm.

Scophi	thalmus egicus. Size	Gol	bius sp.	Tr	igla sp. Size	Tr	achinus vipera, Size	Calli l	onymus yra. Size	Blen	nius sp. Size
1.0.	ioneo,		DI20.	110.	5120,	110,		110.	10120.	210	101110
-	-	-	-	-		-	-	-	-	-	-
-	-	1	7.3	-	-	-		1	4-6	-	-
-	-	22	5 - 9	-	_	-		180	3-7	-	—
25	5-8	2	?	-	-	-	-	54	$2 \cdot 5 - 5$	-	-
1	10.5	2	7-15	2	9-10		-	9	$3 \cdot 2 - 7$	1	5.5
19	4-9	8	4-8	13	7-11.5	1	3.5	m.	3-7	1	5.5
_	-	-	_	-		_		2	6.5	-	-
-	-	m.	6-17	-	_	-		3	7-9	_	-
_		_		_		1	3.5	8	3.5-7	5	ca. 4.5
_		3	4-4.5		_	7	3.5-5	ĩ	3.5	20	4.6-6
_	_	150	5-13	1	7.5	-		ĝ	3.5-7	_	_
1	7		0 10	-		_		-		_	
3	5.5_6	96	6.10					19	3.8		-
0	0 0-0	40	4.5_11.5	5	5.5 7.5	6	1_1.7	37	3.5.7.5		
_	_	9	4.0-11.0	0	0.0-1.0	10	2 4	01	0.0-1.0	67	4.7 6.5
00	1.5 0	10	0a. 0.0	-	-	10	9-4	-	9 = 1	90	4.1-0.5
20	4.0-9	10	3-0.3			-	0.7	4	2.0-4	20	4-0
-	-	200	3.9-10	38	7.5-11	1	3.7	100	3.9-1	10	4.9-9
-		4	7-11	1	8.5	19	3.5-6.5	4	3-5	1	4-8
3	5-6	_	-	4	$7 \cdot 5 - 12$	3	$3 \cdot 5 - 5$	55	2.5 - 8	-	-
1 -	6	168	$3 \cdot 5 - 16$	3	$5 - 8 \cdot 5$	3	$6 - 7 \cdot 5$	55	3-8	1	6
-		160	5-13	4	7 - 12	2	4-6	30	$3 \cdot 5 - 8$	1	8
-	-	31	4-10			-	-	4	$3 \cdot 5 - 5 \cdot 5$	1	4
-	-	-		-	-	_	-	-	_		_
		-	-	-	-	-		-	-	-	-
_	-	-		-	-	-	-			_	-
-	-	-	-	-		-	-	_	-	-	-
-		-	-	-	-	-	-	-	-	-	-
-	-	-	-	1	-	-	-	-		-	_
-	-	-		-	-	-		-	-	-	-
-	-	-		-	-	-	-	-	-	-	-
-	-	-	-	-		-	-	13	$2 \cdot 5 - ?$	-	-
-		-	-	-	_	-	-	23	$2 \cdot 5 - 6$	-	-
-	-	-		1	5	1	3.5	23	2.5-7	-	-
-	-	-		1	7	-	-	8	3-6		-
2	5-8	12	5-8	3	7.5 - 17	—	-	79	$2 \cdot 5 - 8$	-	-
-	-	-		-		-	-	-	-	-	-
-	-	-	-	-	_	-	-	-	-	14	-
1	6	-		-		-	-	-	-	19	-
4	6-9	10	7-9	1	17	-	_	5	ca. 5	-	-
-	-	1	12	2	10-17	-	-	3	4-9	-	-
28		—		-		-	-	-	-	-	—
	-	-	-	-		-	-	1	4	-	-
80	_	—		-		-	_	—	-	-	-
6	5-8.5	70	4.5 - 10	-	, -	-	-	80	3-7	2	$4 \cdot 5 - 5$
		1	6 —	-		-		3	3-5	1	5
-		6	4-5	2	10-17	-	-	3	ca. 4	1	5
-		14	4-7.5	3	8-9	-		12	3.67	-	-
-		-	_	-		-		11	3-5		
-		1	5	-	-		-	4	4-7	_	-
-		4	5-8.5	-	_			8	$3 - 7 \cdot 2$	-	-
-	-	54	$3 \cdot 2 - 15$	-	-	-	-		-	-	_
-	_	720	4-11		_	-	-	2	3-6	1	5
14	5.5-8.2	32	4-7.8	1	6	-		7	$2 \cdot 7 - 5$	1	5
	_	1	- 11	-		-		2	4-5		_
-	-	1	4.5	-		-		4	3-5	-	-

TABLE XXV.-

						Cter	nolabrus		
	Clupea sp.	Ammo	odytes sp.	Labrus	bergylta.	rup	estris.	Arnog	lossus sp.
No. of Haul. N	o. Size.	No.	Size.	No.	Size.	No.	Size.	No.	Size.
LVI. H -		_	_	_	_	_	_	_	_
TVITH	10 90								
	10-20	_	- 1-	-	~~ 0	-	_	-	-
LVIII. H 3	2 10-19	9	7-15	3	5.9 - 6	1	9	-	-
LIX. H 8	8 8-15	14	6-10		-	-	-		-
LX. H 1	7 10-18	1	7	7	7-11		-	-	-
LXIH	10-14	_		3	5-6	_		_	_
I VII II C	0 15				0 0				
	0-10	-		-		-	-	-	_
LAIII. H 3	\$ 9-12	-	-	-		-	-	-	-
LXIV. H 1	1 11-23	4	11 - 15	12	$4 - 7 \cdot 5$	1	6	-	-
LXV. H 1	9 11-23	8	7-9	_	_	-	_		-
TYVI H 9	5 0.94	1	14						
T XXVII, II 2	0 0-24	T	14	~		_	_	-	_
LAVII. H	. 0	-	-	Ð		-	_	-	
LXVIII. H 2	2 10-12	-		3	$3 - 8 \cdot 5$	-		-	
LXIX. H -		2	7-11	-	_			-	
LXX H 5	3 17-18	29	6-21	5	3.7_7	1	7	_	
TVVI II	0 0 00	20	0 21	17	7 10	т			
	1. 8-20	-		11	7-12		_	-	-
LXXII. H -		-		1	4	-	_	-	-
LXXIII. H -		-	-	6	6-10	-	-	-	-
LXXIV. H 8	8 8-15	5	7.5 - 13	3	5.5-6.8		_	-	
LXXV H (0_11	9	7_0						
TYYYT II I	10	~		17	9 5 5	1	~ ~		
LAAVI. H	10	-	-	11	3.9-9	T	9.9	-	-
LXXVII. H I	8 23-27	-	-	4	3 - 10	-	-	-	-
LXXVIII. H -		-	-	4	$6 - 7 \cdot 5$	-	-		
LXXIX. H (3 13-15	11	6-13	13	$3 \cdot 7 - 5 \cdot 5$	2	6-9.5	_	
LYXY H 4	0 10 15	8	8.13	71	3.5.11				
INVIT II I		00	5 90	0	0.0-11			_	
	1-10	08	5-20	3		-		_	_
LXXXII. H 3	$7 \cdot 5 - 12$	3	$5 - 12 \cdot 5$	17	4.5-6	14	4-7	2	4-6
LXXXIII. H -		-	-	19	4.5 - 7	4	4	3	4-6
LXXXIV H	17	3	9-17	_	_	1	4.7	_	_
IVVVV U		7	7 19				1.		
LAAAY. H -		-	1-13	-	_			_	
LXXXVI. H -		3	8-17.5	—				2	7.5-8.5
LXXXVII. H -		13	5 - 16	1	9			-	
LXXXVIII. H -		6	7-17	1	4	5	$5 \cdot 5 - 7 \cdot 3$	-	
LXXXIX H		1	7	9	4.5-7			1	3.0
VC H		1	10	4	± 0-1			1	0.0
АС. Н -		1	19	-		-		-	
XCI. H -		-	-	-		2	7.5-8.5	-	
XCII. H -		2	-	-		-	-	-	-
XCIII. H -		-	_	-	-	-		_	
XCIV H	2 20			9	3.5_1				
VOV II C	20			4	00-1				
АСУ. П 2	1-9	-		-		-	-	-	
XCVI. H &	5 8-15	1	12	-		-		-	
XCVII. H 1	24	1	27	-	-	-		-	
XCVIII. H	5 22-26	-	-		-				-
YCIY H	19 17								
AUIA. II 4	12-11	_	_	_	_	_			_
С. Н 1	20	-	_	-		-	-	-	
CI. H 3	3 22-27	-	-	-		-		-	
CII. H –		-		_					
CIII H 1	8 12-17	_		1	10	_	_		
CIV H 9	0 19 17	0	16 29	9	ß				
	0 12-17	9	10-54	4	0	_	-	-	-
CV. H -		-	-	1	8	-	-	-	
CVI. H -		-		-			-		
CVII. H -		-		-	-	-	·	-	-
CVIII H	41			-				-	
	10 01	1	10	1	0			-	
CIX. H 4	18-21	1	10	1	9	-	-	-	
CX. H 3	12.5-17	-		1	5.5	-	-	-	
CXI. H 5	2 17-21	4	16	1	10		-		
CXII H I	2 10-20	2	15-17	1	6	-	_	-	
CYTIT H 4	15 10.5	-	10 11	-	0				
CAIL H	10-19.0	-		-	-	-	-	-	-
CAIV. H -		-		-	-	-	-	-	
CXV. H -		-		-			-		

Continued.

Scoph	thalmus	Cab		m:	-1	Trac	hinus	Callio	nymus	Diama	
No	Fino	Gob	Sizo	No	gia sp.	No	Sizo	No	Sizo	No	Sizo
7	5 0	16	1 9.5	140.	5126.	110.	13126.	ß.	9.7 9	1	5126.
	0-9	10	4-0.0	-		-	_	3	2.9 6	T	0
-	1.0	1	10	_	-	_	_		2.0-0		_
0	4-5	9	4-5	1	G			15	3.2 6.5	. 9	6 7.5
	_	51	2.5 15	2	6 7.2		_	m	3.2-0.0	4	0-1-0
9	5 6	11	1 19	1	7.5			m.	3.5_10		
-	0-0	11	1-14	T	10				0 0 - 10		
_		6	5-13	1	5	_					
_		1	11	1	0	1	5	2	3.5-5	17	3_6.7
10	5-0	vm	4_8	4	4-10	-	-	m	3-9		0-01
7	7-11	v.m.	4-15	3	7-10	_		v m	3-9	_	
-		20	4-8	_	. 10	1	2.5	_	_	2	5-6
_		m	4-7.3	2	7-9.5	_	-	3	4.5-8	6	5-7.5
_	_		-	-		_	_	4	2-4	_	
58	3.5-11	84	3_9	29	5-17	3	3.7 - 7	50	3-8	1	5.4
2	-	m	5-12	6	ca. 16	ĩ	4	v.m.	2.7 - 10	-	-
_		2	ca. 13	1	7.5	_	_	_			
_		60	8-26	_	_	_		_	_	2	4-6
17	3.7-6	8	4-7		_	_	-	-	_	_	-
10	5-7	m.	4-8		_	1	3	v.m.	$2 \cdot 5 - ?$	_	_
1	4	24	3.5-5	1	5.2	1	4.5	5	2.8-7.5	7	4.5-6
	_	v.m.	4-14	ĩ	10	_	_	_			
		6	3.7 - 13	_	_	_		-	_	1	4.5
		9	3-6	_		2	$3 \cdot 3 - 5 \cdot 2$	2	4-6	12	4-6
		120	3-11	1	11	_	_ 1	21	$2 \cdot 5 - 8$	1	4.5
		3	$3 - 4 \cdot 5$	_	_	_	-	20	$2 \cdot 2 - 4$	2	$4 \cdot 5 - 5$
		15	$2 \cdot 8 - 6$	-	_	2	4-5	1	3	14	4-5.5
_		_	_	-		4	3-4	_	_	_	_
_		4	5.5-7	-	_		_		-	2	7-8
_	-	-		_	-	-	-	2	$3 \cdot 8 - 5$	_	-
_	_	10	3.7-5	-		1	5	2	$3 \cdot 3 - 7$	1	7
-		5	4-6	-		1	5	1	5	-	-
-		2	6-8	-	_	-	-	-	_	_	-
-	_	3	5-7	-		-		-	—	-	-
	-	7	6.5 - 11.5	-	-	-	-	-	_	-	-
	-	10	10-11	-	-	-		-	_	-	-
_		1	9	_	-	-		-	—	-	-
-	-	9	4.5-7		_	-	-	-	-	-	-
	-	11	3.7 - 8	-	-	-	_	-	-	-	-
	-	2	$2 \cdot 6 - 6$	-	_	-	_	1	12	-	-
	-	52	$3 \cdot 5 - 10$		-		-	-	-	-	-
-	-	62	$2 \cdot 7 - 9$	-		-	-	7	3.7	-	-
-	-	—	_	-	-	-	-	-	_	-	-
-		4	6 - 8.5	-	-	-	-	12	4.7	-	-
		1	4.5	-	-	-	-	-	_	-	-
-				-		-	-	3	4.5	-	-
-		1	7.5	_		-	_	D IO	5-8.5	-	-
-	_	2	7-8	2	7.5-9	-	-	19	3.1-1.5	-	-
3	6-8	5	7-8	15	7-10	-	-	v.m.	4.5 - 8	-	-
-	-	-		-	-	-	-	-		-	-
-	_	1	8-13	-	-	_	-	-	-	-	-
-		1	7.5	-	-	-	-	-	-	-	-
-	-	2	9-13	-	_	-	-	-	-	-	-
-	6.5	-	7.0	-	7.5.10	-	-		2.5.0	-	-
2	0.9	4	1-0	4	7.9-12	1	6.5	v.m.	9.9-9		1 - 0
-		0	10	-	_	5	1 5	2	5.5 0	24	4.0-9
10	7.0	2 2	4-0	1	7.5	0	4-0	14	3.5 7.5	2	1-1.0
10	1-9	0	4-0	1	1.0			14	0.0-1.0	1	0
-	_	17	7.16	_						-	-
	-	14	1-10	_				-			

TABLE XXV.-

	~						Cten	olabrus	Amoglossus	
N	Olupe	ea sp.	Ammo	odytes sp.	Labrus	bergylta.	rup	pestris.	Arnog	lossus sp.
No. of Haul. I	NO.	Size.	NO.	Size.	NO.	Size.	NO.	Size.	NO.	Size.
CAVI. H -	-	-	-	-	1	11	-	- ,	-	-
CXVII. H -	-		-		1	7	-	-	-	-
CXVIII. H	1	7.5	26	7-17	-	-	-	-	2	13
CXIX. H -	-	-	1	9	6	4-7	-		-	-
CXX. H 6	30	$9 - 22 \cdot 5$	1	8	-	-	-	-	3	$5 \cdot 5 - 17 \cdot 5$
CXXI. H 3	30	8-23	8	7-26	1	4.5	-	-	4	$5 - 19 \cdot 5$
CXXII. H 3	36	12 - 16	21	$7 \cdot 2 - 29$	1	5	-	-	-	
CXXIII. H -	-		-		1	4	-	-	1	3
CXXIV. H	1 '	• 10	4	9-14	1	4	-	-	3	$4 - 6 \cdot 5$
CXXV. H	3	17 - 20	8	11 - 22	1	3	-	-	4	5-6
CXXVI. H -	_	-	- 1		1	7	-	-		-
CXXVII. H	2	$16 - 22 \cdot 5$	-	-			-	-	-	-
CXXVIII. H -	-	-			-	-	-	-	-	-
CXXIX. H	1	17	2	5-7	-		-	-	-	-
CXXX. H	4	17	3	12 - 13	_	-	1	7	-	-
CXXXI. H .	_	-	-		_	-	_		-	
CXXXII. H .	-	-	1	11	-	-	_	_	-	_
I. A 1	13	8-18	_	_	_	_	_	_	_	_
II. A	m. 1	8.5-21.5	1	15.5	-	_	-		_	_
III. A 2	63	12-20	2	14.5	_	_	_	_	_	
IV. A -	_	_	8	14.5-20.3	- 1	-	_	_	_	_
V. A 4	48	$7 \cdot 25 - 20$	7	14-23	_	_	-	_	1	5.39
VI. A I	10	12 - 22		_	-		_	_	_	-
VII. A	17	13.5 - 17		_	_	_	_	_	-	-
VIII. A 3	36	12.5 - 20	1	15	1	7.6	-	-	_	-
IX. A S	21	$14 - 32 \cdot 5$	30	67-104	2	8.6-9	_	-		
X. A 1	13	Z	_	_	1	8.9	-		_	-
XI. A	4	13-15	-		_	_	_	_	_	_
XII. A	17	11-18	-		-		_		_	
XIII. A S	27	16-19	_	_	_		-		_	
XIV. A 2	295	14 - 22			_	_	-	_	-	_
XV. A	_		_	-	-		-	-	-	
XVI. A	9 .	$15 - 19 \cdot 5$	1	14	-	-	1	7.14	-	-
XVII. A	5	10-19	-	-	-	_	-		-	-
XVIII. A	42	18 - 25	1	31	1	8.75		-	-	
XIX. A	3	13.5 - 19	-		-		2	$5 \cdot 6 - 6 \cdot 5$	-	-
XX. A	2	16	-		-	-	1	6.95	-	-
XXI. A	2	11.5 - 16	-	_	1	5.95	-	-	-	-
XXII. A	19	9.5 - 20	-		2	$5 \cdot 5 - 6 \cdot 5$	-		-	-
XXIII. A	10	11 - 18.5	1	15.5	-		1	9.8	4	$6 \cdot 4 - 7 \cdot 12$
XXIV. A	13 .	10.5 - 20	3	15 - 28	2	7.7 - 9.9	1	7	-	-
XXV. A	-	-	-		3	$8 \cdot 26 - 9 \cdot 7$	19	$8 - 9 \cdot 2$	-	
XXVI. A	1	12.5	2	6-8	3	Z	4	$5 \cdot 25 - 7$		
XXVII. A	-	-	-		-	-	-	-	-	
XXVIII. A	7	11.5 - 18	2	11.5-14.8	5 1	Z	-		-	
XXIX. A	1	15	4	$9 \cdot 2 - 4$	-		-		-	
XXX. A	1	26	-	-	-	-	-	-	-	
XXXI. A	-	-	-	-	4	$3 \cdot 5 - 7 \cdot 5$	-	-	-	
XXXII. A	6	17.5 - 24	2	$11 - 18 \cdot 5$	1	5.5	1	9.38	-	-
XXXIII. A	2	22.5	-		1	5.18	5	7.35 - 7.7	-	-
XXXIV. A	1	22	4	13 - 21	-		-	-	2	7.9-23
XXXV. A	4	17 - 22	1	8.68	33	5.5 - 8	2	8.4	-	
XXXVI. A	1	Z	1	13.5	8	$5 \cdot 5 - 7$	1	8	-	-
XXXVII. A	3	16 - 23	27	14.5-17.	5 —	-	16	5-7	3	$5 - 12 \cdot 5$
XXXVIII. A	1	21	9	6-10	-	-	1	Z	1	6
XXXIX. A	2	10-21	26	7-14	36	4.5-7	29	5.5-9.5	1	11.5
XL. A	-	-	-	1 -	-		-	-	-	
XLI. A	7	$22 \cdot 5 - 25$	-	-	7	$5 \cdot 25 - 7 \cdot 2$	2	$7 \cdot 28 - 9 \cdot 11$	-	-
XLII. A	2	Z	5	$9 - 15 \cdot 5$	7	$3 \cdot 9 - 6 \cdot 3$	5	$7 \cdot 28 - 9 \cdot 5$	-	
XLIII A	1	21	-	-	-	-	-	_		

Continued.

.

Sco	phthalmus	G	hing on	T	wigle an	Tı	rachinus	Calli	onymus	Die	
No.	Size.	No.	Size.	No.	Size.	No.	vipera. Size.	No.	Iyra. Size.	No.	Size.
-	-	-	_	_	_	.1	5	_	_	_	-
-	-	7	4-6	_		3	$3 \cdot 5 - 5$	3	3.7-5	16	$5 \cdot 2 - 7$
-	-	-	-	-	-	1	4	1	7.5	3	ca. 6
	-	2	ca. 9	_	-	2	4-6	-		24	4-7
-		50	3.7 - 21	-	_	30	3-7	5	4-5.5	6	4.8-6.5
2	7-10	-	-	1	7.5	6	4.5	50	3-10	2	5-8
6	8-10	m.	4-25	6	7-11	4	4-7	40	4-10	1	6
-	-	-		_		_		2	3-5	_	_
-		2	5-10	1	4	4	4-5	14	3-7	2	5.5-8
2	$5 - 6 \cdot 7$	23	3.7-13	ĩ	7.5	î	6	14	3-5	ĩ	6
-		_	_	_	-	_	_		-	_	-
	-	_		_	_	_	_		_		
_	_	_	-	_		_					
_	_	_		_	_	_					
_	_	-	_	_		1	4			_	-
_		_	_	_		1	9.7		_		_
_	_		5-6	_		1	2.1	_	_	-	-
9	6.3-9.64	_	0-0	_		_	_	_	_		-
_	00001			1	7.08	_	_	9		-	
82	9			1	5.05 8	_	-	00	d 7.05	-	-
	·			Ŧ	0.30-0	_	-	00	4-7.00	-	-
55	5.95_19.95		_	0	6.9 11.0	_	-	15	9.0	-	-
1	7.7	_		14	5.6 11.97	_	-	10	3.8-0.9	-	-
-			_	14	0.0-11.21	-	-	10	3.2-0.5	-	-
		-	-	1	0.0 15	_	_	10		-	-
		-	_	T	0.0-10		-	19	9.8-8.9	-	-
8	4.5.7.7	-	-	1	0.0	-	-	-	0.05	-	-
0	5.5.9	1	10.9	T	9.0	-	_	1	0.37 ca.		-
1	0.9	T	10.0	-		_	_	3	0.0-0.9	-	-
à	7.35 10.25	9	11.06 11.60	-		-	-	-	-	-	-
11	6.4 10	10	0 15	-	_	-	-	10		-	
14	6.2 0.9	10	0-10	1	_	-	_	13	5.0-14	-	-
19	5.0	-	_	10	C 19 F	-	-	10		-	-
14	0-9	-		14	0-13.0	-	-	13	4.6-7.3		
	_	-	-	0	0.90-10.9	-	-	23	4.7-7.3	-	-
	_	-	-	-	_	-	-	-	-	-	-
19	1.0 6.5	-		-	-	-	-	3	5.7-7.35		-
14	4.9-0.0	1	e	-	10 17	-	-	11	3.8-7	-	-
8	1.5 9.5	T	0	0	10-17	-		-		-	-
30	5 0.5	-		1	8.4	-	_	8	5.2-6.3	-	-
9	6.65 6.0	-	_	1	14	T	4.9	50	3.8-9.8	-	-
ĩ	0.05-0.9	9	4.6 4.75	1	10	-	_	10	4.2-9.1	-	
-	0.0	4	4.0-4.10	-		-		-		1	9.6
		-	_	-		-		2	7-7-7	-	-
		-	-	-	-	-	-		10.01	-	
		-	_	-	-	-	-	24	4.2-6.4	-	-
		-	_	-	-			1	5.8	-	-
		-	_	-	-	-	_	2	9-0.8	-	-
5	6.5 11	-	_	-		-	_			-	-
2	6.59 9	-	_	-		-	0.05	31	5-8.6	-	
4	0.00-0	-	_	-	-	1	8.05	13	5.6-7.7	1	17.5
-		-	-	-	-	-	_	1	4.8-7.6	-	-
_	_	-		-	-	2	4.9			-	-
1	9.5	10	7 15 5	1	0 - 1-	-	-	11	5-7	-	-
1	9.9	19	1-19.9	2	8.9-19	1	4	1	4.9	1	6.16
-	_	-	_	3	1-17	2	6.3	7	$5 \cdot 5 - 6 \cdot 5$	2	ca. 7.6
-	-	4	Z	-	-	40	5-7.5	1	Z	1	6.5
-	-	-	-	1	7.2	1	6.5	1	5.39	-	-
	-	-	-		-	2	5.6-6.6	-		2	9-14
_	-	-	_	-	-	3	ca. 7.5	-	-	2	ca. 7
		-	-			1	ca. 9	-	-	-	

TABLE XXV.-

							Cten	olabrus		
	CI	upea sp.	Amn	odytes sp.	Labrus	s bergylta.	ruj	pestris.	Arnog	glossus sp.
No. Haul.	NO.	Size,	NO.	Size.	NO.	Size.	NO.	Bize.	NO.	Size.
XLIV. A	1	20	27	ca. 20	-	-	-		5	4.5-14.5
XLV. A	-	_	6	11 - 15	-		-	-	1	15
XLVI. A	1	23	2	$7 - 26 \cdot 5$			7	$4 \cdot 5 - 6 \cdot 5$	22	$4 \cdot 5 - 14 \cdot 5$
XLVII. A	1	25	-	_	-		-	-	-	-
XLVIII. A	-		1	7	20	$3 \cdot 4 - 7 \cdot 5$	2	7.5 - 8	-	-
XLIX. A	1	14	20	6.5 - 16.5	-	-	-	-	21	$3 \cdot 5 - 20 \cdot 5$
L. A	-	-	-	-	—		-	-	28	$7 - 21 \cdot 5$
LI. A	-	- 2	-		-		-		5	6.5 - 12.5
LII. A	2	25	1	7	1	5.5	1	6	_	
LIII. A	2	14 - 20	2	10 - 21	-			_	7	4.5 - 23.5
LIV. A	15	12 - 22	8	6.5 - 13	3	6.5 - 8	-		25	4-15
LV. A	20	12-17	3	7-16			-		33	4-14
LVI. A	4	11-16	-		-		-		20	5.5 - 12
LVII. A	4	13.5 - 16.5	2	10.5 - 16			-		9	$5 - 8 \cdot 5$
LVIII. A	17	9.5 - 21	-	1 - 1	1	5.49	-		6	$5 - 13 \cdot 5$
LIX. A	1	36	-	-	_		-	-	-	_
LX. A			2	9-14			2	5.5-6	14	$7 - 21 \cdot 5$
LXI. A			7	$7 \cdot 5 - 23 \cdot 5$	1	5.25	1	6	31	4.5 - 14.5
LXII. A			12	4.5 - 12	1	5.2	-		14	5.5 - 17
LXIII. A	1	11	6	6-16.5	_	_	-		13	5-12
LXIV. A	_	_	14	10-19			-	_	2	5-7.5
LXV. A	_		13	7-15	1	6.16	_	_	3	Z
LXVI. A	_		1	14.5	_	_			1	8.5
LXVII. A	_		_		_		_	_	4	9-19.5
LXVIII. A		_	1.	7	_		_		7	6.5-10
LXIX A	_		2	13-17.5	_				- 4	5-15
LXX A	_		_	-	2	8	_		2	6-6.5
LXXI A	_		_		_				_	_
LXXII A	1	24.5	_		_				_	_ *
LXXIII A	-	210	_				_		2	12-16
LXXIV A	_		_					_ 11	ĩ	11
LXXV A	_		2	8.5-10.5		_	1	7.5	4	7.5-11
LXXVI A	1	93	-	00100	1	4	_		8	6-21
LXXVII A	-		3	11-17	-	_	_		5	8-18
LXXVIII A	_		5	6.5-21	_				6	7.5-18
LXXIX A	1	7	1	6	-		·		4	10.5-15
LYXY A	T	4	9	14	4	6.5_8			_	100 10
LYXXI A			-	II	Ŧ	00-0				
I XXXXII A	1	92							1	6
TVVVIII A	т	20	1	0	_				1	20
I V V VIV A	1	94.5	T	9	-		_		Т	20
IXXXV. A	т	24.0	_	_	-	_				
TVVVVI A	-		1	6.5	-	_	_	_		
TYYYUII A	-	_	Т	0.0	_					
I V V V VIII A	-	_	_	_	_	-		_		
TYVVIV A	1	95	-	_	-	_				
LAAAIA. A	T	20	-		1	7	_	_	_	
- AU. A	-	_	-		Т	'	_	-	_	_
VOIT A	0	91 99	19	10.5 10.5	_	_		_	7	7.5 90
VOIII. A	4	21-20	14	7 5 10	-	_		_	9	12.5 20.5
NOIT A	-	14	10	1.0-10	-	-	-	_	20	11 19.5
ACIV. A	T	14	10	8.0-14	-	_	100	_	19	11-15.5
AUV. A	-	_	00	0.0-17	-	-	_	-	10	4-10.0
ACVI. A		-	40	8-20	-		_		10	8-20
ACVII. A	-		42	7.9-19.5	-	-	-		0	61-0
ACVIII. A		_	3	9	_	_	-		8	ca. o
ACIX. A	-		56	11.5-22	-	-	1	1	22	8-28.0
. C. A	5	20-20-5	20	0-16.5	-		-		00	1 = 00
CI. A	-		17	8.5-16.5	-		-	-	12	4.0-20
CII. A	4	15.5-17	32	7-18	-	-	-	-	09	4-22
CIII,- A	1	19.5	31	8.5 - 14.5	-				13	4-19.5

Continued.

Scophthalmus norvegicus. Go		bius sp.	us sp. Trigla sp.			achinus	Cal	lionymus Ivra	Blennius sp.		
No.	Size.	No.	Size.	No.	Size.	No.	Size	No.	Size.	No	Size
-	· · ·	-		-		17	4.5 - 9	9	$5 \cdot 5 - 8$	_	_
-	-	-					-	1	7	-	-
-	-	-		3	7 - 12	112	$3 \cdot 5 - 8$	28	4-8.5	4	$5 \cdot 6 - 7 \cdot 5$
-		-		. —		-	-	-	-	-	
-	-	-	-		7 5 19 5	17	4.8	1.7	1 - 0	1	8.0
	-	_	_	9	1.9-13.9	11	3.9-9.9	11	4.9-8	3	9.9-8
_	_	-	_	1	0	-	_	1	Z	-	-
				Т	9	1	-	-		1	
_	3 _ 2	8	4.5-16.5		_	2	4.5_6.5	5	2.9	1	Z G
_	_	7	4.5-13			13	4-7.5	20	2 11	1	4.5
	1. L_ 1-	3	ca. 11.5	1	7	10	4-7.5	8	4-7	1	4.0
	_	ĩ	3.5	î	8.5	4	3-5.5	4	3.5-5	2	ca 6
-	- 13	5	6-13	_	_	2	4-5.5	4	4-10	-	
_	-	1	10	2	9 - 16.5	5	4-6.5	4	5-13	1	10
	-	1	31	-		1	18	_		ĩ	7
-	2 - 2	3	6-7	_		27	3.5 - 9	_		2	5.5-7.5
-	-	_		-		25	$3 - 11 \cdot 25$			1	_
-	_	_		-	_	4	3.75 - 5	7	$3 \cdot 7 - 4 \cdot 6$	1	6.03
-		-		1	4.69	3	$4 \cdot 4 - 5 \cdot 1$	13	$3 \cdot 0 - 6 \cdot 7$		_
-	- 62	-		-		1	7	10	2.75 - 7.3	-	_
-	-	-		-		2	3.6	6	3.68 - 7.2	-	-
	-	-	-	-		1	5.4	2	$5 \cdot 3 - 6 \cdot 7$	-	-
		-		-	-	2	$4 \cdot 5 - 5 \cdot 6$	3	$3 \cdot 6 - 6 \cdot 7$	1	4.8
-		_		1	5.36	6	4.5 - 8.5	1	5.5	1	5.3
-		1	7	-	-	2	4.35	1	4.5	1	6.03
	-	-		-	-	2	5.5 - 8.5	5	$3 \cdot 8 - 5 \cdot 7$	1	13
-	—	-		-	-	-	_	-		-	-
-	-	-	-	-		3	Z	10	5.6-8.7	-	-
-	-	-	_	-	-	-	-	-		-	
	-	_	_	-	-	-	-	0	0.3-0.0	1	11
_				2	4.5.11	7	5 0	2	4.0-0.0	4	0.9-8
-		1		1	4.0-11	1	1.25	0	4-0	T	4
_	_	1	4	1	5.0	1	12.5	Т	0.03	-	
_	_	3	8.5-11	6	7-10	Т	10.0	2	5.9 8.8	-	
_	_	_		_	,-10	4	6-7	0	0.7-0.0		-
	_	2	3.5-4	1	7	2	4-9.5	_		4	4.5-6.5
_	-	_	_	î	8	ĩ	5.5	_	_	1	10
-	-	_	_	2	6-6.5	ĩ	4	-	-	2	5-7
-	-	-	-	-	_	1	6.5	-		_	_
-	-	1	5.06	-	_	_	_	1	6	1	5.5
-	-	1	4.02	_	-	1	4.4	-		3	ca. 8
	-	1	$2 \cdot 8$	-	·	4	5-10	-	-	_	
-		2	11-18	-		-		-	-	1	12.5
-	-	-	-	1	8.5	-	-	-	-	-	-
-	-	2	3-6	-		1	8	1	6.5	1	18.5
-	-	-	_	-	_	1	6.5		-	1	7
-	-	2	9-12	4	6.5 - 15	7	3-9	1	8	2	9-13
-	-	1	6.5	4	5.5 - 20	-	-	1	7.5	3	5-6
-	-	-	-	1	10.5	1	5.5	4	4.5-8.5	-	
_	-	-	-	2	0-16.0	4	ca. 4.5	10	3-6	3	$4 \cdot 5 - 5 \cdot 5$
-	-	2	0-8	4	7.5-13.5	1	Z	11	4.5-9	-	-
		T	0	2	Ca. 8	1	8.75	29	3.5-8.5	-	-
_	_		-	2	13.9-19.5	4	4.0-0	4	4.0-1	-	-
		1	9.3. 56	0	4.9.99	20	4-9.0	11	4-8	-	5.9.05
-	_	9	3-4	4	4.2-22	10	4-0 2.5 G	0	3-8	2	5.0
_		3	ca 4.5	10	6_18	93	3.5_6.0	18	1-5.1	1 7	1 10.5
-	_	_	-			3	2.68-5.9	10	5.3	-	4-10.9
						0	- 00 0 4	*	00		

NEW SERIES.-VOL. X. NO. 2. JUNE, 1914.

2в

TABLE XXV.-

	CL	1000 00		- 3-4-			Cten	olabrus		. College and
No of Haul	No	sizo	Amm	odytes sp.	Labrus	bergylta.	rup	estris.	Arnog	glossus sp.
CTV A	1	16.5 10.5	10.	Size.	NO.	Size.	NO.	Size.	NO.	Size.
CV A	9	10.5 90	20	0-10.0	-		-	-	1	4.9-18
CVT A	1	19.0-20	20	0-17	-	-		-	21	4-18.5
CVI. A	T	20.9	6	11.2-18	-			-	14	$5 - 21 \cdot 5$
CVIII. A	-		-	-	-	-	-	-	_	-
CVIII. A	-		-	-	-	-	-		2	5-11
CIX. A	-	-	-		-	-	-	-	1	Z
CX. A	-	-	-	-	-	-	-	-	-	
CXI. A	1	9.5	-		-			-	4	$5 - 7 \cdot 5$
CXII. A	-	-	-		-	_	-		-	
CXIII. A	-	-		-	-	-	-	_	3	4.5 - 5
CXIV. A	-			_	_		-	-	1	6
CXV. A	-	-	1	7	-	-		-	4	4.5 - 10
CXVI. A	-	-		-	-	_	-		33	4-9.5
CXVII. A	-	-			_	_	_		21	4-21
CXVIII. A		-	-	_	_	-			13	4-19
CXIX. A		_	_						8	6.5.10
CXX. A			_						3	4.4_11.5
CXXI. A	_	_	_			_			4	6 14
CXXII A	_		1	5.5			_	_	11	0-14.
CXXIII A	_		1	0.0	-	-			11	0-1.0
CXXIV A				-		_		-	8	4.5-9
CXXV A	7		-	_	-		-	-	25	4.8-9.5
CXXVI A		4.9-9.9	-	-	-	_	-	-	1	4
OXXVII A	-	_	-	-	-	-	-		1	6
OVVVIII A	-	_	-	-	-	-	-	-	-	
CAAVIII. A	z	3.4	-	-	-		-	-	-	
CAAIA. A	-	-	-	-		-		-	—	-
CAAA. A	-	-	-		-	_	-	-	—	
CAAAI. A	-	-	-	-	-	-	-	-	6	4.5 - 8
CXXXII. A	-		-	-	-			-	8	5.5 - 16
CXXXIII. A	-	-	-	-	-	-	-	-	5	4.5 - 7
CXXXIV. A	-		-	-	-			-	20	4.5 - 11
CXXXV. A	-	-	-		-		_	-	1	7.5
CXXXVI. A	-	-	-	-	_	-	-	_	4	4.5-5
CXXXVII. A	-	-	-	-	-	-	_	-	?	4.8-6.5
CXXXVIII. A	-	-	_	-	_		_	_	5	6-8.5
CXXXIX. A	-	_	-	_	_			_	10	6.5-8
CXL. A	-		_	-	-	-	_	_	7	5-9.75
CXLI. A	-	_	-		_		_		ii	5.5-19
CXLII. A		_		_	_				93	4.5.10
CXLIII. A	-	_	1	6.5					4	1.95 6.95
CXLIV. A	_	_	-	00		_	_	_	÷	4.70-0.70
CXLV. A	_	_		_	-	_			0	5.96 5.67
CXLVI A	2	5-5.6		_	_	-	-	_	9	9.90-9.01
CXLVII A	ĩ	5	-		-	-		-	-	
CXLVIII A	1	4.5	-		-	-	-	-	-	
CXLIX A	9	4.75 5	-		-	-	-		-	-
CI A	4	4.19-9	-		-	-	-	-	-	-
OLL. A	4	Ð	-	-	-		-	-	-	-
CLI. A	-		-	-	-		-		1	6.25
CLII. A	T	6.25	1	11.25	-	0.8 - A	-		5	7-10
CLIII. A	-	-	-	-	-	-	-	_	1	Z
CLIV. A		-	-		-	- 1	-	_	4	10.25 - 18
CLV. A	2	$5 \cdot 25 - 13$	1	20	-		-	-	10	9.5 - 17
CLVI. A	2	$3 \cdot 5 - 5$	2	9.5 - 10.5	-	-		-	49	4.5-18.5
CLVII. A	1	5.25	-	-	-	-	-	-	-	_
CLVIII. A	16	4-12	-	-	-	-			3	3.5-31
CLIX. A	2	3.5 - 8.5		-	-	-	_	-	9	8.5-16.5
CLX. A		-		-	-	_	_		9	6.5-15
CLXI. A	3	4.5-6	_		-	-	_	_	6	ca. 3-16
CLXII. A	1	Z	-		_			_	7	7
CLXIII. A	3	6-8.5	_	_				_	3	

Continued.

Scopht	thalmus	Gel	himn an	m	ulala an	Г	rachinus	Call	lionymus	Die	
No	Sizo	Mo	Sino	No	rigia sp.	No	vipera.	No	Iyra,	No	Sizo
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-	-	-	-	2	8.9-14		-	-	_	-	-
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_	-	4	2.0-0.0	_	_	_		4	0.0-1.0	_	
_	_	1	25	-	_	-				-	_
-	-	T	9.9	-	-	-		-	-	1	6.5
-	-	_	-		-	1	4	-	_	1	0.0
-	-	-	_	-	-	1	4	-	-	1	7
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-	_	-		2	ca. 5.5	-	-	-		-	
-	-			1	6.5	-	-	2	5.9-6	1	7.5
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-	-	-	-	-		-	-	-		1	7.25
-		-	-	2	$5 \cdot 5 - 7 \cdot 5$	-		-	-	-	
	-	-	-	-		-		-		-	-
-	-	-	-	2	5-7.5	-		-	-	-	
-	-	-	-	4	6-10.5	1	18	-		4	5-11.5
-	-	-	-	1	9.5	2	3.2-2.2	3	5.2	1	7.5
-	-	-	-	4	5.75 - 6.5	-	-	-		-	-
-	-	-	-	3	6-1	-		-		1	6
-	-	-	-	-	-	1	Z	-	-	1	13.25
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	-	-	-	-	-	-	-	-		-	
-	-	-	-	-	_		-	-	-	-	-
-	-	-	-	1	6	-	-	1	7	-	-
-	-	-	-	2	6.5 - 7	-	-	-	_	-	
-	-	-	-	1	13	-	-	1	5	1	Z
-	-	-	-	5	$5 \cdot 25 - 7$	1	4.25	-	-	1	6.25
-	-	-	-		-		-	-	—	-	-
-	-	-	_	1	Z		_	-	-	-	-
-	-	1	4.25	2	5.5 - 11.5	1	Z	-	-	1	8.5
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	1	Z	-		-	-	-	-
-	-	-	-	9	$6 \cdot 5 - 15$	-	-	2	Z	-	-
				1	9.5	1	9	-		-	

TABLE XXV.-

	Clunes on		1			Cteno	labrus	1	
	Clupea sp.	Ammo	bdytes sp.	Labrus	bergylta.	rupes	stris.	Arnogl	lossus sp.
No. of Haul.	NO. Size.	No.	Size.	NO.	Size.	NO.	Size.	No.	Size.
CLXIV. A	7 14-24	-	-	-		_	-	-	-
CLXV. A		-	-	-	-	-	-	-	-
CLXVI. A	20 5-8		-	-	-	-		-	-
CLXVII. A	2 5.25	-	-	-	-	-		2	Z
CLXVIII. A	$38 7 \cdot 5 - 8$	-	-	-	-	-	-	-	-
CLXIX. A	24 5-9		-	-	- 22		-	12	5 - 11
CLXX. A	5 6.5-8				-	_	-	?	-
CLXXI. A	6-15.5	1	17.5	-	-	-	-	145	5 - 20
CLXXII. A		2	19 - 24		-	-	-	2	Z
CLXXIII. A		1	12		-	-	-	17	5-11.5
CLXXIV. A	9 7-16	1	12	-		_	-	24	4.5 - 19
CLXXV. A	2 10-19		_	_	-	_	-	2	17-19
CLXXVI. A	$12 5 - 9 \cdot 5$	_	-	-	_			57	4-13.5
CLXXVII. A	4 5-8.5	-		_	_	_	-	10	4.5-11.5
CLXXVIII A-	7 6-11	_	_	_	_	_	_	4	6-17
CLXXIX A	5 7.5-8	_	_	_	_	_		24	5-18
CLXXX A	22 5.5-10			1	4.5	_	_	2	4.5
CLXXXI A	3 7-13			-	10	_	_	ĩ	6
CLXXXII A	3 6-10	1	22				_	7	9.5-18
CLXXXIII A	2 10.5-12	-						13	5-18.5
CLXXXIV A	9 8-13							10	0 10 0
CLXXXV A	8 45-105								
CIXXXVI A	4 9.5 11	_			_			1	7
CLYXXVII A	4 7 10	-	_		_	/		T	
CIXXXVIII A	4 7-10	-	_	_	-	-	_	-	_
CLAAAVIII. A	17 0 - 12	-	-	-	-	-	-	-	_
CLAAMA, A 2	0 0-18	-			-	-	_	1	-
CXC. A	7 7.5-17	-	-	-	-	-	-	1	Z
CXCI. A	9 8.5-12.5	-	-	-		-	-	-	-
CXCII. A 2	28 5.5-24	-	-	-		-	-	-	-
CXCIII. A 4	$4 8 - 15 \cdot 25$	-	-	-	-			-	-
CXCIV. A	$02 \ 7 \cdot 25 - 18 \cdot 5$	-	-	-	-	-	-	-	
CXCV. A	3 5-10.5	-	-	-		— " - 1 - 1	-	-	-
CXCVI. A	$2 7 - 19 \cdot 5$	-	-	-	-	-	-	-	-
CXCVII. A 3	37 7-16	-	-		-	-	-	-	-
CXCVIII. A 1	7 7.5-21	-	-	-	-	- ;		-	-
CXCIX. A 2	$22 5 \cdot 5 - 19$	-		-	-		-	-	-
CC. A	4 11-16	-	-	-	-	-	-	-	
CCI. A	2 10-11	-			-	-	-	-	-
CCII. A	3 8-13	-	-	-	-	-	-	-	-
CCIII. A	3 11-13	-	_	_	_	-	-	-	-
CCIV. A	4 10.5-12.5	-	-	-			_	-	_
CCV. A	1 13	_	_ *	_	_	_		-	_

Continued.

Scophthalmus norvegicus,		Gob	oius sp.	Trigla sp.		Trachinus vipera.		Call	ionymus lyra.	Blennius sp.	
No.	Size.	No.	Size.	No.	Size.	No.	Size.	No.	Size.	No.	Size.
-	-	-	-	-	_	1	7	_	-	1	21
	-	1	19	-	-	-	-		-	-	-
-	-	1	6	2	6.5 - 7.5	1	5.5	_	_		
-	-	-	-	_	-	1	7	-	-	-	_
-	-	-	-	1	Z		-		-		-
-	-	-	-	-	_	1	5	1	5	-	-
-	-	-	_	-	-	-	-	1	7		-
	-	-	-	2	$8 - 28 \cdot 5$	4	Z	11	6-9.5	5	$6 \cdot 5 - 8$
-		-	-	2	ca 18	4	$5 - 6 \cdot 5$		_	_	-
-	-	-	_	5	5-13	1	6	_	-	1	7
-	-	1	6	3	5 - 12	3	$5 - 7 \cdot 5$	6	4.5 - 10	6	$6 \cdot 5 - 12$
-	-	-	_	1	14	1	9	_	_	-	-
-		1	5.5			1	7.5	2	6-8	-	-
-	-	-	-	1	7.5	3	$5 \cdot 5 - 7$	1	8	-	
-	-	-	_	2	6-8	1	7	1	7.5	-	-
	-	3	8-10	3	5-7	4	5-7	6	5.8	_	-
-	-	-	_	-	-	-	-	-	-	-	-
-	-	-	-	_	_	_			_	_	_
		-		5	7.5 - 14.5	1	8	-	-	1	13
-	-	-	-	8	7.5 - 12.5	-	-	-	-	_	-
-	-	-	-	-	_	-	_	_	_	-	
		1	6	-	-	-	-	-	-	-	-
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R. S. CLARK.

CONCLUDING REMARKS.

The Tables of the occurrence of the various species with the number and size of individuals show that all those recorded spawn either in the immediate neighbourhood or at localities not far distant.

It may be of interest to note here the capture of the young stages of those adult forms which have approximately their most northern limit of distribution in Plymouth waters.*

The spawning period is definite for most of the species, though in cases such as the sprat and dragonet, it is prolonged indefinitely over a considerable part of the year. In closely related species of the same genus there may be wide variation in the length and time of spawning.

One of the most interesting problems suggested by the study of the distribution of pelagic larval and post-larval forms is the question of the nature of the causes which bring about the movements of young fishes from the inshore to the offshore waters and vice versa. There appears to be evidence in favour of the view that in some localities these movements are the result of inshore and offshore currents which are not constant and which seem to vary according to the prevailing winds. In narrow waters like the English Channel, the currents are doubtless modified by the general set of the main currents from the Atlantic, and by the contour of the coast-line. In addition, the tidal streams tend to make conditions more complex. The present records bring some evidence to bear on the matter. For example, pelagic larval and post-larval forms of Ctenolabrus rupestris, an inshore spawner, occurred in the waters south of the Eddystone rocks, while similar stages of Solea variegata, a deeper water type, were taken in comparatively shallow areas. The whole question is one of great interest and might well repay further investigation.

The vertical distribution of the young was found to vary considerably during day and night hauls. The latter yielded a much larger percentage of young forms from the surface layers.

Finally, incompleteness in the study of the *Clupeidæ*, *Ammodytidæ*, *Triglidæ*, *Bothinæ*, *Gobiidæ*, and *Bleniidæ* must be acknowledged, but these are now receiving special attention.

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* Since this paper went to press, the larvæ and post-larvæ of *Serranus cabrilla* have been identified from the 1913 material. I am indebted to Prof. Ehrenbaum for confirmation of my identification. APSTEIN, C. Die Verbreitung der pelagischen Fischeier und Larven in der Beltsee und den angrenzenden Meeresteilen. 1908–1909.

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Marine Biological Association of the United Kingdom.

Report of the Council, 1913.

The Council and Officers.

Four ordinary meetings of the Council were held during the year, at which the average attendance was 11. A Committee of the Council visited and inspected the Plymouth Laboratory.

The Council has to record with regret the death of three of its Vice-Presidents, Lord Avebury and Dr. A Günther, who had been connected with the Association since its foundation, and Sir John Murray, as well as that of Professor Adam Sedgwick and of Dr. P. L. Sclater, who were both members of the original Council and always took a deep interest in the Association.

The thanks of the Association are due to the Royal Society and to the Linnean Society, in whose rooms the meetings of the Council have been held.

The Plymouth Laboratory.

No important repairs to the building were necessary during the year. As regards the machinery, the small gas-engine which is used for circulating sea-water through the tanks has been fitted with a new piston and cylinder liner, and the arrangements for cooling the engine have been altered. The pumps will soon require some attention, but in other respects the machinery is in an efficient condition. The circulation of sea-water through the tanks has been maintained without any interruption.

The Boats.

The Oithona was put in commission in May, and has been working continuously since that time. Mr. E. T. Browne having undertaken to use the vessel in connection with his work on hydroids and medusæ and to pay her expenses during a portion of the winter, the Council has been able to keep the vessel in commission throughout the whole year. This has been a very great advantage in many ways, especially Dr. TH. MORTENSEN, Copenhagen (Echinoderms). E. W. NELSON, Plymouth (Antarctic Plankton). F. A. Ports, Cambridge (Polychætes). L. N. G. RAMSAY, Cambridge (Nereids). R. W. H. Row, London (Sponges). J. T. SAUNDERS, Cambridge (Alkalinity of Fresh-water and Sea-water). R. E. SAVAGE, London (Fishes). Mrs. E. W. SEXTON, Plymouth (Amphipoda). Prof. H. D. SENIOR, New York (Nervous System of Elasmobranchs). C. SHEARER, M.A., Cambridge (Echinus). GEOFFREY SMITH, M.A., Oxford (Crustacea). Capt. F. H. STEWART, Lahore (Nematodes). Dr. NILS SVEDELIUS, Upsala (Nitophyllum). Miss A. W. THOMSON, Oxford (Nicothöe). Dr. STUART THOMSON, Manchester (Brain of Selachians). H. C. THORNTON, Oxford (Hæmosporidia). A. W. WATERS, Bournemouth (Polyzoa).

The usual Easter Vacation Course in Marine Biology was conducted this year by Mr. F. A. Potts, M.A., and was attended by twenty-one students. Mr. J. T. Cunningham, M.A., brought a class of five students from the South-Western Polytechnic, Chelsea, at Whitsuntide.

General Work at the Plymouth Laboratory.

Considerable progress has been made with the different researches upon which the scientific staff has been employed. A number of reports upon this work were published in the Journal (Volume X, No. 1) issued during the year, and still further reports are now in the press and will be published immediately.

Mr. R. S. Clark, who is carrying out investigations on fishes and fishery questions, was engaged during the early part of the year in studying the spring mackerel fishery carried on off the west coast of Cornwall. The season was in some ways unfortunate, as the fishery was for the most part abnormally bad. Nevertheless observations made during such a season are not without value, since they yield useful material for comparison with years when the fish are abundant. By examining the stomach contents of fishes caught with lines and trawls, Mr. Clark was successful in obtaining evidence of the presence of mackerel near the bottom in places where the fishermen were unable to capture any at the surface.

After the *Oithona* was put in commission in May, Mr. Clark devoted his time to the collection of larval, post-larval and young stages of fishes occurring in the neighbourhood of Plymouth. These were captured by means of the Petersen young-fish trawl and with large tow-nets, and a very extensive collection was made. The collection has

REPORT OF THE COUNCIL.

since been studied and a detailed report upon it, including a number of illustrations of different stages in the life-histories of the fishes, is in the press.

Mr. Orton has continued to study the modes of feeding and the rate of growth of invertebrates. The growth rate of many species has been determined by fixing in convenient positions in Plymouth Sound various objects, such as shells, tiles and pieces of wood, and measuring the growth of the different animals which attach themselves to these objects. Similar measurements have been made of animals growing on marked objects put on the bottom in the Sound and subsequently dredged up. The growth of many of these fixed species has been shown to be surprisingly rapid, and frequently several generations may be produced in the course of a year. A preliminary report on the subject is in the press.

The Director has continued his experiments upon the growth of plankton diatoms under laboratory conditions, which have been referred to in previous reports, and a paper on the subject is in course of preparation. The Director has also been continuing his studies of the marine annelids of the Plymouth area, and a number of new records have been added to the local fauna.

The trustees of the "Ray Lankester Fund," established by Mr. G. P. Bidder, elected Professor E. L. Bouvier of the Natural History Museum at Paris as the first "Ray Lankester Investigator." Prof. Bouvier arrived at the Laboratory in July and remained until the end of August, the special object of his work being to study the lifehistory of the sea-crayfish (*Palinurus vulgaris*). One of the most interesting stages in the later larval development of this animal, the *puerulus*, which was known to occur in many foreign species of the genus Palinurus, had never been observed in the case of the common European form. This, as well as nearly all the earlier stages, was obtained by pelagic fishing with the young-fish trawl in the neighbourhood of the Eddystone. Prof. Bouvier also obtained specimens of the interesting crustacean larva Trachelifer, which had not previously been recorded from the English Channel.

Dr. Mortensen, of Copenhagen, worked during the summer at the development of Echinoderms, and has published a paper in the Journal of the Association containing descriptions of a number of larvæ belonging to this group, which he had obtained by fertilizing the eggs and rearing the larval stages in the Laboratory.

Some interesting experimental work on the electrical conductivity of Echinus eggs was carried out by Mr. J. Gray, and a preliminary account of his experiments has been published in the Journal.

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Dr. C. Shearer has continued his work on the hybridization of different species of Echinus, and during the year a detailed memoir containing an account of the previous work on this subject carried out by Dr. Shearer, Mr. De Morgan, and Mr. Fuchs, has been published in the Philosophical Transactions of the Royal Society.

Mrs. Matthews has continued her work on the development of Alcyonium, and has succeeded in obtaining and studying all stages in the development of this form.

Mr. W. De Morgan has been studying the protozoan fauna of Plymouth, especially the ciliates found in the Laboratory tanks.

Dr. Stuart Thomson spent three months at the Laboratory during the summer, which he devoted to researches on the anatomy of the brain of Elasmobranchs.

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The thanks of the Association are due for the following books and current numbers of periodicals presented to the Library during the year :---

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 - On *Gypsina plana*, Carter, and the Relations of the Genus. By M. Lindsey.

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- --- On Methods of Producing Artificial Parthenogenesis in *Echinus esculentus*, and the rearing of the Parthenogenetic Plutei through metamorphosis. By C. Shearer and D. J. Lloyd.
- -- Herpyllobius arcticus. By K. Haddon.
- ----- Report of the Committee appointed to investigate the Biological Problems incidental to the Belmullet Whaling Station.
- ---- The Inheritance of the Aboral Process of the Echinocardium-Pluteus. By H. M. Fuchs.
- ---- Stolon Formation in Certain Species of Trypanosyllis. By F. A. Potts.
- Mycetomorpha, a new Rhizocephalan (with a note on the sexual condition of Sylon). By F. A. Potts.

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Blegvad, H. Some small Leptocephalids from the Atlantic.

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- Buddenbrock, W. v. Über die Funktion der Statocysten im Sande grabender Meerestiere (Arenicola und Synapta).
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- Clark, R. S. Scottish National Antarctic Expedition. Scotia Collection of Fishes from St. Helena.
- Cligny, A. Sardines et Pseudo-Sardines. Contribution à l'Histoire de la Pêche et de l'Industrie Sardinière.
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- Report on the Echinoderms collected by the Danmark-Expedition at North-East Greenland.
- ____ Ctenophora.
- ----- On the alleged Primitive Ophiuroid *Ophioteresis elegans* Bell. With description of a new species of Ophiothela.
- Müller, H. Inosital and some of its Isomerides.

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Nansen, F. The Waters of the North-Eastern North Atlantic. Investigations made during the Cruise of the *Frithjof* of the Norwegian Royal Navy in July, 1910.

Nicoll, W. New Trematode Parasites from Fishes of the English Channel.

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- On two new Larval Trematodes from the Striped Snake (Tropidonotus ordinatus sirtalis).
- Statistical Note on the Worm Parasites collected from the Animals dying in the Zoological Gardens from December, 1910, till April, 1912.

Norman, A. M. Synogoga mira, a Crustacean of the Order Ascothoracica.

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Vinciguerra, D. Relazione sulla visita a stagioni estere di biologia marina e a piroscafi per ricerche talassografiche.

Walker, A. O. Apherusa jurinei (M. Edw.).

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- The Distribution of some Littoral Trochidæ and Littorinidæ in Cardigan Bay.
- Walton, C. L., and Rees, O. M. Some Rare and Interesting Sea Anemones from Plymouth.

Waters, A. W. Bryozoa.

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 :—

ARENDSEN HEIN, S. A. Over oogleden en fornices conjunctive bij Teleostom Tijdschr. d. Ned. Dierk. Vereen. (2). Dl. XII, 1913, pp. 238-79.

BOUVIER, E. L. The Post-Embryonic Development of the Spiny Lobster. Nature, vol. 91, 1913, p. 633.

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WIJNHOFF, G. Die Gattung Cephalothrix und ihre Bedeutung für die Systematik der Nemertinen II. Zool. Jahrbuch., Bd. 34, 1913, pp. 291-320.

Donations and Receipts.

The receipts for the year include the grants from His Majesty's Treasury (£1000) and the Board of Agriculture and Fisheries Development Fund (£500), Fishmongers' Company (£800), Special Donations (£280), Composition Fees (£47), Annual Subscriptions (£147), Rent of Tables in the Laboratory (£151), Sale of Specimens (£516), Admission to Tank Room (£130).

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THE MARINE BIOLOGICAL ASSOCIATION

	Dr.	Statement of	f Rece	eipts	s and	11	Pa	yments	s f	or
					£	s.	d.	£	8.	đ.
To B	alance from Last Ye	ear :—								
	Cash at Bankers.				135	11	10			
	Cash in hand				10	5	10	145	17	8
To C	urrent Receipts :									
	H.M. Treasury fo	r year ending 31st March	h, 1914		1,000	0	0			
	The worshipful C	ompany of Fishmongers	(includi	ng	000	0	0			
	£200 attributat	ole to 1912)	••••••		146	10	0			
	Rent of Tables (i £20; Universit	ncluding Ray Lankeste y of Cambridge, £25;	r Truste Univers	es, ity	140	19	0			
	of London, £2	5)			151	12	0			
	Composition Fees				47	5	0	2,145	16	0
,, E	xtraordinary Receip	ots :—								
	Donations-									
	"Anonymous"		200 0	0						
	Dr. C. Shearer (pa	rt payment as Founder)	75 18	9						
	Professor G. C. B	ourne	3 19	0						
	G. H. Fox		0 10	6	280	8	3			
	Board of Agricu	lture and Fisheries, G	Frant fr	om						
	Development H	und, for year ending	B1st Mar	ch,						
	1914				500	0	0	780	8	3
					-	-	-			

The Association's Bankers hold on its behalf £410 14s. 8d. New Zealand 4 % Stock, 1943-63.

£3,072 1 11

OF THE UNITED KINGDOM.

the Year ending 31st December, 1913.

Cr.

		0	1	-			
By	Salaries and Wages-	£	s,	а.	£	S.	. a.
	Director	309	3	2			
	Hydrographer	16	13	4			
	Senior Naturalist	199	5	4			
	Second Naturalist	189	17	8			
	Additional Naturalist	28	11	4			
	Assistant Naturalists	32	1	5			
	Salaries, Wages, and Compensation	701	2	10			
	, , , , , , , , , , , , , , , , , , , ,	1 476	15	1			
	Less Compensation recovered from Employers' Lia-	1,110	10	1			
	bility Corporation	16	5	11	1 460	0	9
				11	1,100	0	4
,,	Travelling Expenses				81	13	7
,,	Library	179	11	1			
	Less Duplicates sold	0	8	10	179	2	3
				-	-10	-	
,,	Journal	130	10	5			
	Less Sales	19	6	1	111	4	4
	Buildings and Public Tank Boom-						
,,	Gas Water and Coal	199	10	10			
	Stocking Tanks and Feeding	122	10	5			
	Maintenance and Renewals	05	16	11			
	Rent Rates Taxes and Insurance	78	14	10			
	tono, nacos, razos, and insurance	10	14	10			
	Leve Admission to Tank Doom	319	15	0	100	-	
	Less Aumssion to Tank Room	130	1	11	189	1	1
,,	Laboratory, Boats, and Sundry Expenses-						
	Glass, Apparatus, and Chemicals	208	15	3			
	Purchase of Specimens	80	8	4			
	Maintenance and Renewal of Boats, Nets, etc	361	4	3			
	Insurance of s.y. Oithona, less Rebate	9	14	0			
	Coal and Water for Steamer	120	5	6			
	Stationery, Office Expenses, Carriage, Printing, etc.	142	7	1			
		922	14	5			
	T Gl Ch .	022	11				
	Less Sales of Apparatus 85 12 2						
	", Specimens 516 4 0						
	,, Nets, Gear, etc 144 12 5						
	Hire of Boat and Gear $\dots \dots \dots$	817	4	9	105	9	8
,,	Purchase of £410 14s. 8d. New Zealand 4% Stock				400	0	0
	Balance :						
"	Cash at Bankers	540	13	4			
	Cash in hand	4	9	6	544	15	10
			4	0	044	10	10
					£3,072	1	11

Examined and found correct.

28th January, 1914.

(Signed) N. E. WATERHOUSE, L. W. BYRNE, J. O. BORLEY, W. T. CALMAN,

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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 Library at Plymouth.

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

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, the late Lord AVEBURY, the late Sir JOSEPH HOOKER, the late Dr. CARPENTER, the late Dr. GÜNTHER, the late Lord DALHOUSIE, the late Professor MOSELEY, the late Mr. ROMANES, and Sir E. RAY 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 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 seawater 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 solary of the Resident Director and Staff. At the commencement of this number will be found the names of the gentlemen on the Staff.

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.