THE

VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY—VOL. XXVII.

REPORT

ON THE

SCIENTIFIC RESULTS

OF THE

VOYAGE OF H.M.S. CHALLENGER

DURING THE YEARS 1873-76

UNDER THE COMMAND OF

CAPTAIN GEORGE S. NARES, R.N., F.R.S.

AND THE LATE

CAPTAIN FRANK TOURLE THOMSON, R.N.

PREPARED UNDER THE SUPERINTENDENCE OF

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AND NOW OF

JOHN MURRAY, LL.D., Ph.D., &c.

ONE OF THE NATURALISTS OF THE EXPEDITION

ZOOLOGY—VOL. XXVII.

Published by Order of Her Majesty's Government

PRINTED FOR HER MAJESTY'S STATIONERY OFFICE

AND SOLD BY

LONDON :—EYRE & SPOTTISWOODE, EAST HARDING STREET, FETTER LANE

EDINBURGH :—ADAM & CHARLES BLACK

DUBLIN :—HODGES, FIGGIS, & CO.

1888

Price Thirty Shillings

PRINTED BY MORRISON AND GIBB, EDINBURGH,
FOR HER MAJESTY'S STATIONERY OFFICE.

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EDITORIAL NOTES.

This Volume contains Parts LXIX., LXXIV., LXXV., and LXXVI. of the Zoological Series of Reports.

Part LXIX.—This excellent Report on the Anomura, by Professor John R. Henderson, consisting of 228 pages and 21 lithographic plates, has been prepared by Professor Henderson under exceptional difficulties, arising chiefly from his removal to India, shortly after commencing the work, to fill an appointment in the Madras Christian College.

Part LXXIV.—On the completion of his Reports on the Pteropoda collected by the Expedition, Dr. Paul Pelseneer was requested to make an examination into the Anatomy of the specimens of Deep-Sea Mollusca which had been described in the Systematic Reports, and it is to be regretted that it was necessary to limit him as to the time he should be engaged in the work.

This interesting Report is the result of his investigations, and extends to 42 pages with 4 lithographic plates.

Part LXXV.—This Report on Phoronis Buskii by Professor W. C. M'Intosh, consists of 27 pages and 3 plates.

Two other Reports by Professor M'Intosh have previously appeared in the Challenger Series, viz:—

Annelida Polychæta, forming Part XXXIV. of the Zoological Series, was published as Volume XII. Zoology, in 1885.

Cephalodiscus Dodecalophus, forming Part LXII. of the Zoological Series, was published in Volume XX. Zoology (1887).

PART LXXVI.—The First Part of the Report on the TUNICATA collected by the Expedition, dealing with the ASCIDIÆ SIMPLICES, was published in Volume VI. Zoology (1882), and forms Part XVII. of the Zoological Series of Reports.

The Second Part of the Report, dealing with the ASCIDIÆ COMPOSITÆ, was published in Volume XIV. Zoology (1886), and forms Part XXXVIII. of the Zoological Series.

This is the third and concluding Part of Professor W. A. Herdman's most excellent and extensive Report on the TUNICATA, and its value is enhanced by the fact that it concludes with a statement of the theoretical conclusions at which he has arrived in regard to the relationships of the Tunicata, after ten years of continuous study.

This third section consists of 163 pages and 11 plates.

JOHN MURRAY.

CHALLENGER OFFICE, 32 QUEEN STREET,
EDINBURGH, 1*st September*, 1888.

THE

VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY.

REPORT on the ANOMURA collected by H.M.S. Challenger during the Years 1873–76. By J. R. HENDERSON, M.B., F.L.S., Professor of Biology in the Christian College, and Fellow of the University, Madras.

PREFACE.

SOME time after the return of the Challenger Expedition, the Anomura collected during the voyage were placed for examination and description in the hands of Dr. Jules Barrois, the well-known zoologist of Lille. It is to be regretted that this naturalist, finding insufficient time at his disposal, returned the collection to the Challenger Office. Towards the end of 1884, while engaged in zoological work at the Scottish Marine Station, Granton, I was asked by Mr. John Murray to undertake the work, and immediately after I commenced the identification of the species.

I have to express my regret that the completion of the Report has been so long delayed, but this result has been brought about by causes altogether unforeseen at the time when the work was commenced. In the autumn of 1885 I left Scotland to take up an appointment in India, and the whole of the Report has been written in the latter country. Other engagements prevented me from devoting much time to the collection for upwards of a year after my arrival in Madras, and it is with considerable difficulty that the Report has been completed within the specified time. It was originally my intention to have discussed at greater length some points which I have merely touched on in the following pages, and to have made the Report more comprehensive in its scope; but apart from the insufficient time at my disposal, the distance from any great library or museum has rendered this an impossibility. I am conscious that many of the species merit a fuller illustration than I have been able to give them, but it is hoped that in all cases the figures will be at least sufficient for their identification.

To Mr. John Murray I would express my thanks for the kindness and consideration he has invariably shown me during the progress of the work. I am indebted to him for the opportunity of paying visits, in the early part of 1885, to the British Museum and the Museum of the Jardin des Plantes in Paris, without which the identification of many of the species would have been impossible. I have to thank my friend Mr. Hoyle, of the Challenger Office, for looking up many of the references which I had no opportunity of consulting in Madras.

I am also under deep obligation to Professor A. Milne-Edwards and Mr. E. J. Miers (late of the British Museum staff) for the kind manner in which they placed the collections under their charge at my disposal, no less than for the time which they spent in rendering me assistance. The former naturalist, in addition, allowed me to examine the Anomura taken by the "Blake," as well as the as yet undescribed species from the recent French deep-sea expeditions. My thanks are also due to my friend the Rev. Canon Norman, for affording me the privilege of examining his unrivalled collection of North Atlantic Crustacea, and for other assistance; to the Rev. R. Boog Watson for identifying the Gastropod shells in which many of the Pagurids occurred; and to my friend Mr. Edgar Thurston for allowing me at all times free access to the scientific library and collections under his charge in the Government Central Museum at Madras.

The Report is of necessity almost entirely systematic in its scope, for none of the specimens have been preserved with a view to ultimate anatomical investigation. The Anomura do not offer many features of special interest as regards their internal anatomy, and there is no reason to suppose that even the deep-water types differ to any great extent from their shallow-water relatives.

It is a matter of regret that in many cases the specimens are in an imperfect state of preservation, but there can be little doubt that this condition is due rather to the vicissitudes which the collection has undergone since the return of the Challenger, than to any want of care during the expedition.

CONTENTS.

INTRODUCTION.

THE CLASSIFICATION OF THE ANOMURA.

In the following account I propose to discuss briefly the more important schemes of Classification which have been adopted for the group.

In the first volume of his classical Histoire Naturelle des Crustacés, published in 1834, Professor H. Milne-Edwards separated from the Brachyura and Macrura of older writers, under the designation of "Anomoures," those forms in which the thoracic sterna are linear, the penultimate abdominal segment is provided with appendages, the female genital openings are placed on the basal joints of the legs, and the abdomen is either loosely applied to the under surface of the thorax or semi-extended. In the earlier part of the century Latreille, who occupied a very prominent place among the older carcinologists, divided the Decapod Crustacea into its two branches, Brachyures and Macroures, the latter including a section Anomaux, in which many of the forms we now term Anomura were placed, the remainder being referred to the Brachyura.

In the second volume of his great work, Milne-Edwards subdivided the Anomoures into two families, termed respectively the "Apterures" and the "Pterygures," which were characterised by the absence or presence of terminal abdominal appendages. In the first of these families he included such forms as *Dromia*, *Homola*, *Lithodes*, and *Ranina*, while *Hippa*, *Pagurus*, and *Porcellana* were included in the second. The Galatheidæ were referred by the same naturalist to the Macroures, and the aberrant genus *Latreillia* was placed in the Brachyures.

De Haan, in his fine work on the Crustacea of Japan,[1] divides the Decapoda into five great sections, as follows :—(1) Brachygnatha, including the Dromiacea ; (2) Oxystomata ; (3) Astacina ; (4) Carides ; and (5) Anomala. As regards the Anomala he has followed Latreille, and he further subdivides the group into the following families :—(1) Galatheidea ; (2) Porcellanidea ; (3) Hippidea ; (4) Paguroidea ; (5) Lithodeacea. De Haan's classification is to a large extent founded on the structure of the mouth organs, and it has till quite recently scarcely received from carcinologists that attention which it deserves ; at the same time there can be little doubt that it is in many respects, as

[1] Crustacea in v. Siebold, Fauna Japonica, 1835–49.

regards the Anomura at least, a perfectly natural one. To him we are indebted for first correctly noting the affinities of the Galatheidæ, and since the publication of his work no naturalist has questioned the propriety of including this group in the Anomura.

As a result of his unrivalled opportunities of studying the Crustacea as a whole, enjoyed while naturalist to the United States Exploring Expedition under Captain Wilkes, Professor J. D. Dana paid special attention to the subject of classification, and the result of his investigations has been given to the world in the most elaborate work which has ever appeared on this group of animals.[1] This eminent authority includes under the term Anomoura those groups admitted by Milne-Edwards, with in addition the Galatheidæ, and such doubtful forms as the Bellidea. Proceeding from the standpoint that the Anomura are to be regarded as degraded forms, intermediate between the Brachyura and the Macrura, he subdivides the group into the four following grades :—(1) Anomoura superiora, including the Dromidea, Bellidea, and Raninidea; (2) Anomoura media, including the Hippidea and the Porcellanidea; (3) Anomoura submedia, including the Lithodea; and (4) Anomoura inferiora, including the Paguridea, and the Galathæidea. At the same time he has indicated in each case the Brachyuran group of which he considers the subtribes of Anomura as degraded forms. Dana's classification, though subsequently adopted by many systematic writers, is admittedly cumbersome and inconvenient in many respects, his sections appear unnecessary, and in constituting them he has in several cases separated groups which are closely related.

A few years subsequent to the publication of Dana's great work, another American naturalist, Dr. William Stimpson, who had taken part in the exploring expedition to the North Pacific, published a Preliminary Report on the Crustacea, which includes a synopsis of all the species of Anomura known at that time.[2] In this paper, the value of which to any worker in the group can scarcely be over-estimated, he divides the Anomura into two sections, according to the nature of the last thoracic segment, whether united to the preceding, or free, and termed respectively Teleosomi and Schizosomi. The former includes the Dromidea, Latreillidea, Homolidea, and Raninidea, and the latter the Porcellanidea, Hippidea, Lithodidea, Paguridea, Aegleidea, and the Galatheidea. In the limitations of the group he has followed Professor Dana. It is greatly to be regretted that Stimpson's final Report has never been published. The Crustacea of the North Pacific Expedition were destroyed in the great fire at Chicago, but the complete MS. of the final Report, as far as the end of the Anomura, which it was at one time thought had perished, was afterwards discovered along with figures of the new species among papers left by Stimpson at the Smithsonian Institute. A special feature of this author's work is the large

[1] Crustacea, in United States Exploring Expedition, vols. xiii. and xiv., 1852.

[2] Prodromus descriptionis Animalium evertebratorum quae in Expeditione ad Oceanum Pacificum Septemtrionalem a Republica Federali missa Cadevaladero Ringgold et Johanne Rogers ducibus observavit et descripsit Gulielmus Stimpson, *Proc. Acad. Nat. Sci. Philad.*, December 1858.

number of new genera which he introduced into the Anomura, and most of these are, in my opinion, founded on sufficient grounds. I have in the following Report figured several of Stimpson's species which were retaken by the Challenger, and at the same time have made additions to his original descriptions.

Professor Alphonse Milne-Edwards, in the introduction to his History of the Fossil Stalk-Eyed Crustacea,[1] refers the Anomoures Apterures of his father to the Brachyura, under the designation of "Brachyures Anormaux," while he places the Pterygures in the Macrura, thus abolishing the Anomura as a distinct group.

A somewhat similar plan has been adopted by Professor C. Claus,[2] who places the Galatheidæ, Hippidæ, and Paguridæ in the Macrura, while he ranges the Porcellanidæ, Lithodidæ, and Dromidæ among the Brachyura in a family which he has designated Notopoda. An arrangement which separates such forms as *Porcellana* and *Galathea* cannot, however, be regarded as a natural one.

The most recent and in some respects one of the most important contributions to the subject is that of Dr. Boas.[3] This writer, proceeding on somewhat similar lines to De Haan, restores the Anomala of the latter author to its original position, constituting it a distinct group, equivalent to such others as the Thalassinidæ or Brachyura, rather than a mere collection of heterogenous forms. He subdivides the Anomala into three branches, the Paguroidæ, Galatheidæ, and Hippidæ, while he divides the Brachyura into two sections, viz., the Dromiacea, and the genuine Brachyura. There is much to be said in favour of this view, and all carcinologists owe a debt of gratitude to Boas for his careful work; at the same time I cannot agree with him as to the propriety of reducing a number of previously constituted genera to the rank of subgenera.

The group which was placed in my hands by the Challenger authorities constituted the Anomura as defined by Dana. In the classification adopted in the Report I have followed to a certain extent the arrangement of Boas, but as the Dromidea and Raninidea appear to me groups of very doubtful position, I have retained them with some hesitation and reluctance in the Anomura.

I have adopted the hitherto almost universally accepted term of Milne-Edwards, in its more correctly spelt form Anomura. The Anomaux, as previously constituted by Latreille, formed a group of quite different proportions, and the term Anomala is therefore in my opinion not entitled to claims of priority.

[1] *Ann. d. Sci. Nat.* (Zool.), sér. 4, t. xiv., 1860.

[2] Grundzüge der Zoologie, 4ter Auflage, Bd. i., 1880.

[3] Studier over Decapodernes Slaegtskabsforhold af J. E. V. Boas, *Dansk. Vidensk. Selsk. Skrift.* (6te R.), Bd. i. pp. 26–210, pls. i.–vii., 1880.

TABLE OF CLASSIFICATION.

ANOMURA.

DROMIDEA.

Family I. DROMIDÆ, Dana.

Challenger Genera—

Dromia (Fabr.), Stimpson.	*Eudromia*, n. gen.
Cryptodromia, Stimpson.	*Pseudodromia*, Stimpson.
Dromidia, Stimpson.	*Hypoconcha*, Guérin-Méneville.

Family II. HOMOLIDÆ, nov.

Challenger Genera—

Homola, Leach.	*Latreillopsis*, n. gen.
Homologenus, A. Milne-Edwards.	*Latreillia*, Roux.

RANINIDEA.

Family RANINIDÆ, Dana.

Challenger Genera—

Raninoides, H. Milne-Edwards.	*Cosmonotus*, Adams and White.
Notopoides, n. gen.	*Lyreidus*, De Haan.
Notopus, De Haan.	*Zanclifer*, n. gen.

HIPPIDEA.

Family I. HIPPIDÆ, Dana.

Challenger Genera—

Remipes, Latreille.	*Mastigochirus*, Miers.

Family II. ALBUNEIDÆ, Stimpson.

Challenger Genus—

Albunea, Fabricius.

PAGURIDEA.

Section A. LITHODEA, Dana.

Family LITHODIDÆ, Dana.

Challenger Genera—

Lithodes, Latreille. | *Paralomis*, White.

Section B. PAGURODEA, nov.

Branch I. LAMINIBRANCHIATA, nov.

Family I. CŒNOBITIDÆ, Dana.

Challenger Genera—

Birgus, Leach. | *Cœnobita*, Latreille.

Family II. PAGURIDÆ, Dana.

Challenger Genera—

Diogenes, Dana.
Pagurus (Fabr.), Dana.
Clibanarius, Dana.
Calcinus, Dana.
Eupagurus, Brandt.
Spiropagurus, Stimpson.
Anapagurus, Henderson.
Catapagurus, A. Milne-Edwards.
Paguristes, Dana.
Tylaspis, n. gen.
Glaucothoë, H. Milne-Edwards.

Branch 2. FIBRIBRANCHIATA, nov.

Family PARAPAGURIDÆ, S. I. Smith.

Challenger Genera—

Parapagurus, S. I. Smith.
Pagurodes, n. gen.
Paguropsis, n. gen.
Pylocheles, A. Milne-Edwards.

GALATHEIDEA.

Section A. PORCELLANODEA, nov.

Family PORCELLANIDÆ, Dana.

Challenger Genera—

Petrolisthes, Stimpson.
Porcellana (Lamk.), Stimpson.
Porcellanella, White.
Raphidopus, Stimpson.
Pachycheles, Stimpson.
Polyonyx, Stimpson.

Section B. GALATHODEA, nov.

Family GALATHEIDÆ, Dana.

Challenger Genera—

Galathea, Fabricius.
Munida, Leach.
Munidopsis, Whiteaves.
Elasmonotus, A. Milne-Edwards.
Galacantha, A. Milne-Edwards.
Eumunida, S. I. Smith.
Ptychogaster, A. Milne-Edwards.
Uroptychus, n. gen.

DESCRIPTION OF GENERA AND SPECIES.

ANOMURA.

Anomoures, Milne-Edwards, Ann. d. Sci. Nat., sér. 1, t. xxv. p. 298, 1832.
,, Milne-Edwards, Hist. Nat. des Crust., t. ii. p. 163, 1837.
Anomala, De Haan, Crust. Japonica, p. 195, 1850 (*part*).
Anomoura, Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 398, 1852.
,, Bell, Brit. Crust., p. 163, 1853.
,, Stimpson, Proc. Acad. Nat. Sci. Philad. p. 63, 1858.
,, Miers, Catal. New Zealand Crust., p. 56, 1876.
,, Haswell, Catal. Austral. Crust., p. 138, 1882.
Anomura, Heller, Crust. südlichen Europa, p. 142, 1863.

Cephalothorax always more strongly developed than the abdomen. Carapace broad or elongate; frontal region with in most cases a projecting rostrum which unites below with the antennular sternum; orbits and antennular fossæ seldom present. Antennules and antennæ well developed, the latter usually situated externally to the eyes and with long flagella. Outer maxillipedes elongated and pediform, more slender than in the Brachyura. Last thoracic segment often free and not fused with the preceding segments. Thoracic sterna usually broad in front, narrowed posteriorly, without a median apodeme. The three anterior pairs of legs well developed, the fifth pair (frequently also the fourth) slender and of small size, prehensile, or folded in the branchial chambers. Abdomen bent under the carapace or extended. Genital openings of the females placed on the basal joints of the third pair of legs. Branchiæ nine or more in number on each side.

The Anomura are found in all seas, but much more abundantly in those of tropical or temperate climates; a few forms are terrestrial or fluviatile (*Birgus*, *Cœnobita*). The majority inhabit shallow water or moderate depths; two groups, however—the Pagurids and the Galatheids—are numerously represented in the abysses of the ocean; all are true bottom-living forms.

Our knowledge of the existence of Anomura in former geological ages is very imperfect. Their first undoubted appearance is in the Cretaceous rocks, where they are represented by *Homolopsis*, Carter, from the English Gault and Greensand; and an allied form, *Dromilites*, Bell, occurs in the Eocene. Certain fossils are referable to the Raninidea, and even to the existing genus *Ranina*.

DROMIDEA.

Dromiacea, De Haan, Crust. Japon., p. 102, 1850.
Dromidea, Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 400, 1852.
" Miers, Catal. New Zealand Crust., p. 57, 1876.
" Haswell, Catal. Austral. Crust., p. 138, 1882.

Carapace subglobose or subquadrate, the frontal region narrow. Last pair of legs and frequently also the penultimate pair subdorsal in position and of small size. Abdomen folded under the thorax, the penultimate segment usually without appendages; five pairs of appendages in the female, the first pair rudimentary. Lateral thoracic apodemata united in a common centre, forming a sternal canal. External maxillipedes with the merus and ischium subquadrangular.

To De Haan belongs the credit of having first characterised this group; but the family Dromiacea was referred by this author to his section Brachygnatha. It contains the most highly organised Anomura, *i.e.*, forms which have assumed for the most part Brachyuran characteristics, so much so that by many competent authorities they are placed in the Brachyura; they are, however, separated from the latter by the position of the female openings and the rudimentary condition of the posterior legs.

Family I. DROMIDÆ.

Dromiens, Milne-Edwards, Hist. Nat. des Crust., t. ii. p. 168, 1837.
Dromidæ, Dana, U.S. Explor. Exped., vol. xiv., Crust., part ii. p. 1428, 1852.

Carapace subglobular, rarely flattened. Legs of moderate size, cylindrical, the fourth and fifth pairs (fifth pair only in *Dynomene*) short and subdorsal in position, usually prehensile. Eyes capable of retraction into well-defined orbits; the antennules folded in special fossæ. Males of many species (perhaps of all) with the vasa deferentia protruded from the coxal joints of the fifth pair of legs and forming tubular prolongations. Species inhabiting shallow water and moderate depths; the majority protecting the body by an Ascidian, Sponge, or valve of a Lamellibranch.

Previous to 1858 the majority of the species were included in the genus *Dromia* of Fabricius; in that year Stimpson rearranged this heterogeneous collection into six genera (five being new), relying chiefly for generic characters on the disposition of the sternal sulci in the females. Though some doubt may be entertained as to whether this classification is a natural one, it must be admitted that a subdivision of some kind is necessary and certainly of use to the systematist. Altogether the group at present stands very much in need of revision. In the account which follows I have adopted the arrangement laid down by Stimpson.

Genus *Dromia*, Fabricius (*restrictum*), Stimpson.

Dromia, Fabricius, Suppl. Ent. Syst., p. 359, 1798 (*part*).
,, Milne-Edwards, Hist. Nat. des Crust., t. ii. p. 170, 1837 (*part*).
,, De Haan, Crust. Japon., p. 104, 1850 (*part*).
,, Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 402, 1852 (*part*).
,, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 64, 1858.

Carapace subglobose, usually pilose. Palate smooth. Sternal sulci in the female not approximated, only produced as far as the segment which bears the second pair of legs. Feet of moderate size, the meri not dilated. Chelipedes with their apices calcareous. Last two pairs of legs subchelate, the penultimate joint terminating in a spiniform process. Some of the species reach a length of several inches.

Dromia ciliata, n. sp. (Pl. I. fig. 1).

Characters.—Carapace subglobose, surface minutely punctate, polished, with a dense fringe of hairs extending transversely between the antero-lateral angle of either side; the breadth exceeding the length. Front strongly deflexed, with three subacute teeth, of which the two lateral are more prominent and placed almost horizontally, the mesial tooth channelled superiorly, deflexed, barely visible when the carapace is looked at from above. Gastric region convex, crossed in front by the fringe of hairs previously mentioned, the latter placed on an ill-defined ridge which forms a false anterior boundary to the carapace; the space between this ridge and the frontal border is densely pubescent and directed forwards, a shallow groove, however, exists in the middle line and is continued on to the mesial frontal tooth. The remainder of the gastric region is smooth, with the exception of two small pits towards the posterior limit. Cardiac region moderately circumscribed, smooth. Antero-lateral border of the carapace not defined (unless we consider part of the ciliated ridge to represent this). Lateral border divided into two subequal halves by the well-marked cervical groove, the anterior part is slightly convex (viewed from above) and directed forwards and downwards, the posterior and longer part almost straight, directed backwards and downwards. The cervical groove passes obliquely backwards, and ends by dividing into two branches which embrace the cardiac area; the anterior of these is somewhat curved, and ends in a well-marked pitted depression on the gastric area. The posterior border is slightly curved forwards.

The hepatic area is comparatively smooth and very convex, while the subhepatic region is somewhat excavated, densely pubescent, and armed with two rounded tubercles on its outer border. The pterygostomial area is pubescent, the inner part almost membranous in consistence. The orbital border is furnished with a single prominent tooth above, placed external to the lateral spine of the rostrum, and the inferior border ends in a somewhat larger and more conical process. The eyes are small, and when retracted almost completely hidden in the deep orbits; the basal joints of both pairs of antennæ are robust, and the terminal joints of the internal pair are folded in the orbital cavity; the flagellum of the external antenna is short. The external maxillipedes have the ischial and meral joints subequal, the exognath is moderately stout and reaches almost to the end of the merus; the ischium is crossed by an oblique elevation which passes on to the exognath and then becomes continuous with the outer border of the subhepatic region. These lines on either side form the sides of a triangle which is completed by the ciliated line stretching across the front of the carapace, and includes within its boundaries the eyes, the antennular, and antennal segments, the subhepatic regions, and the upper part of the buccal cavity; the whole being densely ciliated.

The chelipedes are moderately long and furnished with a thick clothing of hairs, the tips of the fingers alone being naked; when these hairs are removed, the joints are found to be smooth. The propodus is longer than the carpus and smooth, with its finger strongly toothed and slightly excavated; the dactylus is also toothed, and its free end fits into the space between the two terminal teeth on the finger below. The carpus has a prominent conical tooth on its upper border, and a similar yet larger projection towards the upper part of the antero-external border; towards the posterior border of the carpus there exists a well-marked fringe of hairs which (when the chelipedes are folded in) is directly continuous with that on the carapace. The merus is somewhat trigonal, and more sparingly pubescent. The first and second pairs of ambulatory limbs are equal in length to the chelipedes, and have the penultimate and antepenultimate joints clothed with long hairs as well as the lower borders of the meri; the latter joints are trigonal, with the anterior and posterior surfaces smooth and polished. The dactyli are long, and each ends in a sharp curved claw which is yellowish in colour. The third pair of ambulatory limbs are shorter than usual, with the merus and carpus subequal, and the short, curved, horny dactylus is opposed to a similar process of the propodus; two small spines are noticeable on the latter joint immediately over the attachment of the dactylus. The fourth pair of ambulatory limbs are more than half as long again as the preceding pair, they are subdorsal in position, and flattened against the sides of the carapace; the merus is nearly twice the length of the carpus, and the terminal claws, though resembling those of the third pair, are slightly less curved.

The abdominal segments are seven in number, the fourth, fifth, and sixth with a well-marked depression on either side of a rounded median elevation; the last four segments have a dense matting of hairs. The male sexual organs are well developed, the first pair robust, the second ending in a long and delicate horny filament; in addition a membranous tubular process (length 5·3 mm.) arises from the coxa of each fourth ambulatory limb. These processes are directed forwards, and lie to the outside of the first pair of genital appendages; they gradually narrow towards the free end.

Breadth of carapace 27·5 mm., length of carapace 25 mm., of chelipede 28 mm., of third ambulatory leg 16 mm.

The fringe of hairs on the carapace, and the position of the cervical groove, are the chief characteristics of this species. *Dromidia excavata*, Stimpson (from Port Jackson), has the subhepatic regions deeply concave, is a much smaller species, and various other points of difference exist. *Dromia globosa*, Lamarck, possesses a tooth on the lateral border in front of the cervical groove, and a prominent tooth divides each antero-lateral border into two parts.

Habitat.—Station 162, off East Moncœur Island, Bass Strait; depth, 38 fathoms; bottom, sand and shells.

The single specimen taken is an adult male, found living with and firmly attached to a large Simple Ascidian.

Genus *Cryptodromia*, Stimpson.

Cryptodromia, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 63, 1858.
„ Miers, Catal. New Zealand Crust., p. 57, 1876.
„ Haswell, Catal. Austral. Crust., p. 138, 1882.

Carapace convex, pubescent, scarcely pilose. Palate furnished with a slight elevation on each side. The sternal sulci in the female remote, terminating in tubercles, produced as far as the segment bearing the second pair of legs. Legs nodose, otherwise similar to those of *Dromia*. Species of small size.

The members of this genus are apparently confined to the Indo-Pacific region. They occur between tide-marks and in shallow water; some, however, including the best known species—*Cryptodromia lateralis*—appear to venture occasionally into greater depths.

Cryptodromia lateralis (Gray).

? *Dromia lateralis*, Gray, Zool. Miscell., p. 40, 1831.
„ *verrucosipes*, White, List. Crust. Brit. Mus., p. 55, 1847.
Cryptodromia lateralis, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 77, 1858.
„ „ Heller, Reise der Novara, Crust., p. 71, 1865.
„ „ Miers, Catal. New Zealand Crust., p. 57, 1876.
„ „ Haswell, Catal. Austral. Crust., p. 139, 1882.
„ „ Miers, Crust. in Zool. H.M.S. "Alert," p. 259, 1884.

Habitat.—Station 162, off East Moncœur Island, Bass Strait; depth, 38 fathoms; bottom, sand and shells. An adult male and a female, the latter with ova.

"April 1874, 2 to 10 fathoms;" on the Australian coast. Two small males, one enveloped by an Ascidian.

Station 163A, off Twofold Bay, Australia; depth, 150 fathoms; bottom, green mud. A single specimen of small size.

This common species extends from Australia and New Zealand to the Japanese coasts. White applied the name *Dromia verrucosipes* to it, without furnishing a description; his examples were from the Philippines.

Cryptodromia japonica, n. sp. (Pl. I. fig. 2).

Characters.—Carapace somewhat pentagonal in outline, the breadth slightly exceeding the length; upper surface moderately convex, smooth, minutely punctate, with the exception of the lateral surfaces which exhibit traces of a densely matted pubescence. Front deflexed, composed of three teeth, the two lateral of which are obtusely rounded and directed forwards, the median is considerably smaller, more conical in shape, and strongly deflexed. Gastric region smooth, convex, bounded posteriorly by a curved shallow groove which is placed slightly nearer the posterior than the anterior end of the carapace. An indistinct furrow bounded on either side by an irregular elevation, and terminating posteriorly in a small ill-defined tubercle, leads to the depression between the lateral rostral teeth. The cardiac area is smooth, with the exception of two minute tubercles placed immediately behind the gastro-cardiac groove. The hepatic and branchial areas are covered by a thick matting of short brownish hairs, the former in addition having its surface somewhat irregular in outline. Antero-lateral border almost straight, with a rounded tubercle above the central portion of the subhepatic area. Lateral border divided into two subequal parts by a well-marked groove which curves back on the carapace and ends by passing directly forwards along the outer border of the cardiac area. This border commences in a prominent tooth which is placed slightly below the level of the tubercle on the antero-lateral margin, a second tooth is placed immediately behind the first, and a third in front of the groove, the three being subequal in size. That portion of the lateral border placed posteriorly to the above-mentioned groove is regular in outline.

The subhepatic area is of small size and slightly excavated. It is bounded above by the elevations already mentioned in connection with the borders of the carapace, but towards the inferior limit two prominent teeth are met with. The larger of these teeth is somewhat oblong in shape and placed beneath the outer border of the orbit. The pterygostomial area bears two small tubercles near its junction with the subhepatic area, and a third is placed on the buccal margin directly over the meral joint of the external maxillipede. The orbital border is sinuous and furnished above with a small rounded lobe which projects forwards, thus rendering the orbit somewhat deficient superiorly. The internal antennæ are partially concealed by the external; the basal joint of the latter is of considerable size, and its outer and distal border ends in a rounded dentiform process, a somewhat longer spine existing on the corresponding inner border. The external maxillipedes have the meral and ischial joints quadrate and subequal, the outer surface of the merus is convex, while the ischium shows a slight hollowing out inferiorly; the exognath extends to the outer angle of the merus. All the parts met with on the under surface are in this species covered with the short matted hairs already referred to.

The chelipedes are of moderate length, and, with the exception of the finger tips, clothed everywhere by a brown velvety pubescence. The merus is trigonal, and about one-half longer than the carpus; the latter joint presents a rounded lobe on its upper border and two conical tubercles on the outer surface near the distal border; an ill-defined projection also exists towards the proximal part of the outer surface. The propodus is nearly twice as long as the carpus, with two tubercles on the upper border near the attachment of the dactylus, and a much smaller one placed opposite the upper of the two tubercles on the outer surface of the carpus. The fingers are excavated internally and furnished with about four teeth each. The ambulatory limbs have a similar clothing to the chelipedes; the first and second pairs are robust though slightly shorter than the latter. The carpal and propodal joints each end in two rounded tubercles, a fringe of long hairs extends along the anterior borders of the meral joints, and each dactylus ends in a curved, yellowish, horny claw, which is beset by a tuft of hairs. The third ambulatory limb is shorter than the fourth, though proportionately stouter, with the carpal and meral joints subequal, in the fourth leg the merus is more than one half longer than the carpus. The two last pairs of ambulatory limbs possess but a single claw each.

The abdomen of the single specimen taken (a female carrying ova) is covered by a velvety pubescence, and the borders are fringed with long hairs, a broad median elevation runs from the second segment almost to the end of the seventh; the lateral margins are slightly convex. The sternal tubercles are strongly developed.

Breadth of carapace 15 mm., length of carapace 14 mm., of chelipede 17 mm., of first ambulatory limb 15 mm.

This species is allied to *Cryptodromia lateralis* (Gray); the latter, however, has the carapace more circular, the lateral rostral teeth triangular, and fewer tubercles on the subhepatic and pterygostomial regions.

Habitat.—Off Yokoska, Japan; 5 to 20 fathoms.

Cryptodromia nodulifera, n. sp. (Pl. I. fig. 3).

Characters.—Carapace somewhat pentagonal in outline, less convex than is usual among the members of this genus, the breadth very slightly exceeding the length; the surface covered with a short bristling pubescence, and furnished with a series of well-marked tubercles on the anterior half. As the regions are but ill-defined in this small species, it is convenient to treat of the carapace as a whole, rather than attempt a description of each division. The frontal region is composed of three subacute teeth, the central of which is strongly deflexed, while the lateral are directed forwards, and each bears a small tubercle on its inner border. The whole anterior half of the carapace is covered by a series of tubercles, the majority of these being roughened by small secondary projections, those on the gastric area are somewhat larger than the others. A single tubercle of small size and smooth surface is present on the cardiac area, but the carapace posterior to this shows only a few slight inequalities. The antero-lateral border is slightly concave in outline, and posterior to the orbital border is ill-defined; the lateral border is marked in front by two prominent tubercles, with a series of smaller ones behind.

The orbit is ill-defined in front, its upper border partly composed of two irregular lobes which are attached to the side of the lateral frontal tooth; the eye is not, however, in actual contact with these. A single tubercle exists at the external angle of the orbit, and this is separated from the supraorbital tubercles by a shallow groove; the lower orbital border also terminates in a prominent tubercle. The antennular peduncle is remarkably stout, the basal joint ending in a blunt process which projects on the outer and distal border; the flagella are partly hidden by the antennal peduncles. The joints of the antennal peduncle are also somewhat swollen, especially the second, and the flagellum is ciliated. The external maxillipedes have the merus and ischium subequal, each of these joints is likewise furnished with a rounded tubercle on its internal border, that of the latter being situated near its junction with the merus. The exognath extends almost to the external angle of the merus. The subhepatic region bears two irregular tubercles placed in a line with those at the commencement of the lateral border of the carapace; a similar protuberance occurs also on the pterygostomial region, immediately over the external angle of the meral joint of the third maxillipede.

The chelipedes are of considerable size. The merus is trigonal and sparingly tuberculate, the carpus presents a series of well-marked tubercles on its outer surface, the largest of these being situated near the junction with the propodus; the latter joint is about one and a half times the length of the carpus, and its outer surface bears three or four rows of small rounded projections, as well as two large processes on the upper border situated near the insertion of the dactylus. The fingers are armed each with about five interlocking teeth, but even when fully closed a slight hiatus is left. The first and second pairs of ambulatory limbs are of moderate size, and the propodal and carpal joints have their outer and posterior surfaces strongly tuberculate, the dactyli end in curved horny processes of a yellowish colour, and a small tuft of hairs projects from the lower surface of each. The third and fourth pairs of ambulatory limbs are comparatively of small size, and the proportions of their various joints agree with those of the last species; each limb terminates in two opposed horny claws. The third pair are slightly tuberculate, while the fourth pair are smooth. The hairs met with on this species—especially those of the ambulatory limbs—are club-shaped.

The abdomen is strongly tuberculate externally, each segment, except the last, with a median series of three tubercles, two of these being placed near the posterior border of the segment, and a lateral series of two on either side of the median pair. The lateral tubercles are, however, fused on the penultimate and antepenultimate segments, so as to form a single projection. The sexual appendages of the male are well developed, more particularly those of the first pair, and the vasa deferentia are protruded as two membranous processes which project forwards under cover of these. In the male also, two rounded tubercles exist on the sterna of the fourth and fifth thoracic segments respectively. The sternal tubercles in the female have the normal arrangement met with in species of *Cryptodromia*.

Breadth of carapace 8·5 mm., length of carapace 7·5 mm., of chelipede 12·5 mm., of first ambulatory leg 9 mm. These measurements are taken from the larger (male) specimen.

It is with considerable hesitation that I venture to describe this species under a new name. Mr. Haswell has furnished the description of an Australian species, *Dromia sculpta*, with which it may subsequently prove to be identical, but not having seen the latter, it is impossible to decide from the short diagnosis in the Catalogue of Australian Stalk and Sessile-Eyed Crustacea. The Challenger specimens at the same time undoubtedly belong to the genus *Cryptodromia*. The British Museum collection contains examples erroneously named *Dromia nodipes*, Lamarck. I have, however, had the opportunity of examining an authentic specimen of the latter in the Paris Museum of Natural History, and of comparing the Challenger specimens with it. *Dromia nodipes* is a much larger species, the carapace is more rotund, its surface glabrous, and the tubercles are small and rounded; moreover the abdominal segments are smooth. *Cryptodromia tuberculata*, Stimpson, has the carapace smooth, and the second and third pairs of feet have the carpal joint armed superiorly with from four to five teeth.

Habitat.—Off the Australian coast; "April 1874, 2–10 fathoms."

Two specimens were taken. The larger of these is a male, apparently fully developed, the other is a female, probably immature. The latter has a small sponge fixed to one of its ambulatory limbs.

Cryptodromia incisa, n. sp. (Pl. I. fig. 4).

Characters.—Carapace subglobose, the length and breadth almost equal, covered by a short pubescence, which is more strongly developed on the anterior portion. Front tridentate, the median tooth of considerable length, nearly vertical in direction and acuminate, the lateral teeth project forwards, and are also acute though to a lesser extent than the median process. The gastric region is convex, its surface glabrous and minutely punctate (after removal of the hairs); on the anterior part, and immediately behind the frontal region, are two slight rounded elevations, separated from one another by a mesial groove, which is continued on to the central rostral tooth. A well-marked depression exists between the orbital border and the gastric elevation on either side. No distinct line of demarcation separates the gastric and cardiac areas, but the latter is bounded laterally by an ill-defined groove, and posteriorly by a depression which lies between it and the posterior border of the carapace; no inequalities are present on the surface of this region. The hepatic area presents a small depression near the antero-lateral angle of the carapace, but is otherwise smooth; the branchial area is of very limited extent. The antero-lateral border is short, and presents no other spines than those met with on the lateral frontal and orbital regions. The lateral border is convex in front of the cervical groove and unarmed, with the exception of a tooth immediately behind the groove; it is fringed by hairs, which are clubbed and of considerable length. The cervical groove is ill-defined, and ends on the surface of the carapace by splitting into two shallow furrows which embrace the cardiac area. The posterior border presents a slight mesial concavity.

The subhepatic area is smooth and slightly hollowed out posteriorly for the inner surface of the meral joint of the chelipede. The pterygostomial area is smooth, but a well-defined border bounds the buccal cavity on either side, and a bilobed tubercle marks its junction with the epistome. The eyes when retracted are almost completely hidden in the deep orbits; the superior border of the latter is armed with an acute spine, the outer angle is marked by a narrow fissure, and the inferior border is produced into a triangular and pointed tooth. The antennules are of small size, and partly hidden by the antennæ; the latter possess a large basal tubercle with an opening of considerable size for the duct of the green gland; the second joint of the antennal peduncle is large, and bears on its outer and distal end a well-marked spine, with a secondary process near its base. The external maxillipedes have the meral joint slightly shorter than the ischial, and the latter is hollowed out inferiorly, the exognath extends to the end of the merus.

The chelipedes are pubescent and of moderate length, the propodal joint (including its finger) is not twice the length of the carpus. The meral joint is trigonal, and the lower edge ends in a rounded tubercle. The carpus is armed with two obtuse teeth on its anterior edge (of which the superior is larger), and a somewhat conical process on the upper border. The propodus bears two rounded tubercles on its outer surface, near the attachment of the dactylus, and the upper border is produced into a lobe-like process which is directed inwards. The opposed fingers have their edges smooth, and the dactylus is remarkably broad and compressed, its outer surface being slightly concave, the inner convex; both fingers are dentate, the upper fitting into the lower, and a few stiff yellow hairs are also present. The first two pairs of ambulatory limbs are of considerable length, and in addition to the usual short pubescence they are sparingly clothed with long club-shaped hairs; the dactyli exceed the propodi and carpi in length, and terminate in a curved yellow claw. The third pair have the merus slightly longer than the carpus, and the propodus bears a short horny claw which is opposed to the dactylus. The fourth pair are of considerable length and folded over the carapace, the basal joint is large, and its attachment to the second joint is strengthened by a small calcareous process which passes between the two; the merus is about one and a half times as long as the carpus, and the propodus bears a horny claw on either side of the dactylus, the latter, however, exceeding these in length. Both the third and fourth pairs possess club-shaped hairs on their borders.

The abdominal segments in the female are broad and pubescent, with a median rounded elevation on the outer surface, and the edges fringed with long hairs. The abdominal appendages are well developed (except the first pair, which are rudimentary), each terminating in a lamellar outer portion and a cylindrical and shorter internal branch. The openings of the oviducts are remarkably large. The sternal sulci pass forwards as far as the segment which bears the second pair of legs (first pair of ambulatory legs), but they do not end in tubercles, their terminations are, however, separated by a slight median elevation.

Breadth of carapace (of the larger specimen), 12 mm.; length of carapace 11·5 mm., of chelipede 15 mm., of first ambulatory limb 16·5 mm.

The orbital fissure, the form of the dactylus of the chelipedes, and of the last pair of legs, are the distinguishing characters of this species. The arrangement of the sternal sulci in the female is particularly noteworthy, showing in this respect an apparent connecting link between Stimpson's genera *Cryptodromia* and *Dromidia*.

Habitat.—Station 163A, off Twofold Bay, Australia; depth, 120 fathoms; bottom, green mud. Two female specimens were obtained; one of these is protected by an Ascidian.

Genus *Dromidia*, Stimpson.

Dromidia, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 63, 1858.

Carapace convex, pilose. Palate furnished with a slight elevation on each side. The sternal sulci in the female produced as far as the segment bearing the chelipedes, approximated towards their termination, and passing into a single tubercle. Appendages of the penultimate abdominal segment minute, concealed. Legs similar to those of *Dromia*.

The characters which distinguish this genus from *Cryptodromia* are few in number, and the most important of these, viz., the arrangement of the sternal sulci in the female, is liable to variation in different species. It is thus a matter of opinion whether the two should not be united; the Challenger material is not, however, sufficient to determine the point. Haswell has united *Dromidia* with *Dromia*.

Dromidia antillensis, Stimpson (Pl. I. fig. 5).

Dromidia antillensis, Stimpson, Notes on North American Crust., Ann. Lyc. Nat. Hist., vol. vii. p. 71, 1859.
,, ,, A. Milne-Edwards, Bull. Mus. Comp. Zoöl., vol. viii. No. 1, p. 31, 1880.

Habitat.—Off Bahia; 7 to 20 fathoms.

I refer to this species, not without some hesitation, several specimens from the above locality. These agree well with the original description, but the following points are to be noted in addition to those enumerated by Stimpson. The carapace presents a few slight inequalities on the posterior branchial and cardiac areas, and the outer angle of the orbit is fissured. The specimens are, with a single exception, females, and of small size, the carapace of the largest measuring 13·5 mm. in length by 13·8 mm. in breadth, whereas Stimpson gives the same measurements as 1·30 inch by 1·28 inch, so it is possible that some of these apparent differences may be due to immaturity.

In many of its characters this species resembles *Cryptodromia incisa*. Five pairs of abdominal appendages are present in the female, the penultimate segment apparently showing no trace of these; the first pair are rudimentary, the second long and slender. The sternal tubercle is placed far forwards so as to lie immediately behind the basal joints of the external maxillipedes, it projects considerably from the segment, and shows a slight trace of bifurcation in front.

Dromidia spongiosa, Stimpson (Pl. I. fig. 6).

Dromidia spongiosa, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 76, 1858.
? ,, ,, Heller, Reise der Novara, Crust., p. 72, 1865.

Habitat.—Simon's Bay, Cape of Good Hope; 10 to 20 fathoms.

The trunk and limbs of this species are everywhere covered by a spongy pubescence, and the dorsal surface of the carapace is marked by a series of depressions chiefly on the gastric area. The cervical and gastro-cardiac grooves of the carapace are well marked. The median rostral tooth is of large size and partially overhangs the basal joints of the antennæ and antennules. A small fissure is present on the lower orbital border, near the external angle. The chelipedes are proportionately of large size.

The original specimens came from the Cape of Good Hope. The Dromiid from St. Paul referred by Heller to this species is stated to have no orbital fissure, and a small tooth present near the posterior part of the lateral border, so it is perhaps a distinct species. *Dromia fulvo-hispida*, Miers, from Senegambia, is closely allied, but the carapace shows no inequalities; it is possible, however, that the characters of this last species have been drawn up from a young individual, and it may yet have to be united with *Dromidia spongiosa*.

The single specimen taken by the Challenger is a male which gives the following measurements: breadth of carapace 13·5 mm., length of carapace 10·7 mm., of chelipede 18 mm., of first ambulatory limb 14 mm.

Dromidia bicornis, Studer.

Dromidia bicornis, Studer, "Gazelle" Crust., Abhandl. d. k. Akad. d. Wiss. Berlin, p. 20, Taf. i. fig. 9 a–b, 1883.

Habitat.—Station 142, off the Agulhas Bank; depth, 150 fathoms; bottom, green sand. Four specimens, two of either sex.

Examples were dredged by the "Gazelle" in or near the same locality (south of the Cape of Good Hope), at a depth of 117 fathoms, on a sandy and stony bottom.

Genus *Eudromia*, n. gen.

Carapace convex, scarcely pilose, ovate, the length exceeding the breadth. Palate with an elevation on each side as in *Cryptodromia* and *Dromidia*. Frontal region strongly developed, antennules large. Chelipedes narrow, the carpal and propodal joints but slightly dilated, the last two pairs of legs subequal and of very small size. Sternal sulci in the female passing forwards to the posterior border of the segment which bears the chelipedes, where they meet in a tubercle. The penultimate abdominal segment of the female furnished with appendages.

In many of its characters this genus resembles *Dromidia*, but it is sufficiently distinguished from the latter by the shape of the carapace, the prominent frontal region, and the small size of the ultimate and penultimate pairs of legs.

Eudromia frontalis, n. sp. (Pl. I. fig. 7).

Characters.—Carapace convex, somewhat oval in shape, the length considerably greater than the breadth, covered by a brownish film which is composed of short, densely arranged hairs. Front bilobed, with a whitish margin, the median portion horizontal and hollowed out superiorly, the lobe on either side extending from the anterior end of the carapace to the outer orbital angle and directed almost vertically upwards. The gastric region is smooth and convex, the anterior part is slightly excavated between the two frontal lobes, posteriorly a slight transverse depression separates it from the cardiac area. This latter region presents a median swelling which in the female is composed of three rounded elevations. The branchial and hepatic areas are also smooth, and the cervical groove is but faintly indicated on the sides of the carapace. The antero-lateral border is made up in great part of the lateral frontal lobe of each side, which, as previously noted, rises to a considerable height above the level of the adjacent portion of the carapace, the remaining part is short and curves backwards and outwards to the antero-lateral angle. The lateral border is armed in front by a prominent blunt spine, and immediately behind this come one or two smaller processes; a tooth of considerable size is placed directly behind the cervical groove, and in one of the specimens a tubercular elevation lies half-way between this last and the posterior border. The posterior border shows a mesial concavity.

The subhepatic area presents a rounded tuberosity, which lies between the antero-lateral angle of the carapace and the anterior end of the pterygostomial area; in front it is slightly concave. The pterygostomial area is smooth. The eyes are of moderate size, and lie in orbits which, though tolerably deep, are yet imperfect above; the orbital cavity is overhung by the lateral rostral lobe on each side, a short and wide fissure occurs on the lower border, and internal to this a prominent tooth. The antennules and antennæ are both placed on the anterior surface of the frontal lobes, the former are of large size, their peduncles exceeding those of the antennæ. The antennal peduncles are four-jointed, the basal joint with a prominent tubercle for the opening of the green gland, the second joint is elongate and furnished with a process at its outer and distal end, the flagellum is sparingly ciliated. The epistome is smooth and triangular, directly continuous with the median frontal prolongation; its buccal margin shows a central notch, and a bilobed process exists on either side. The external maxillipedes have the merus shorter than the ischium and its upper border oblique; the inner border of the ischium is raised and fringed by long hairs.

The chelipedes are slender and of moderate length, the joints being almost uniform in thickness. The merus is trigonal, and twice the length of the carpus, its lower border ending in a rounded prolongation. The carpus has its superior border prolonged into an obtuse tooth, and two well-marked and somewhat blunt spines project outwards from the anterior end. The propodus presents a sinuous outline, and is about twice the length of the carpus; a small tubercle exists on its distal end opposite the upper of the two carpal spines, the superior surface is slightly hollowed out, and two tubercular elevations are placed over the insertion of the dactylus. The dactylus is acute, and both it and the immobile finger are sparingly toothed, and possess smooth polished tips. The first and second pairs of ambulatory limbs are subequal, and in addition to the ordinary brownish pubescence possess stiff hairs on their margins. The carpal joints are dilated, and the upper surface is divided by a longitudinal ridge into anterior and posterior parts; the dactyli are long, and each ends in a yellow claw, a few short yellowish spines also exist on the inferior border. The third and fourth ambulatory limbs are remarkably small and subequal in size, the proportions of the joints being somewhat similar in both. The dactylus is short and curved, and in each case lies between two claw-like prolongations of the propodus; one of these is, however, poorly developed in the third pair. The coxæ of all the ambulatory legs are fringed with long hairs.

The abdomen in the female is broad and rounded, each segment (except the first) possessing a median elevation, and on either side of this a small projection on the anterior edge which overlaps the preceding segment. In the male the seventh segment ends in a pointed spine. The sternal sulci of the female are deeply furrowed, each commences opposite the third pair of ambulatory limbs, and, passing forwards as far as the posterior border of the chelipedal segment, ends by joining its fellow in a raised tubercle which passes some short distance backwards in the middle line. Six pairs of abdominal appendages are present in the female, the ultimate pair being of small size. The male sexual appendages are well developed, especially those of the first pair.

The larger (female) specimen gives the following measurements: breadth of carapace 11·7 mm., length of carapace 15 mm., of chelipede 20 mm., and of first ambulatory leg 19·5 mm.

The peculiarly bilobed frontal region, and the small size of the two last pairs of legs (characters which I regard as of generic importance), at once distinguish this species from all other known Dromiids.

Habitat.—Station 142, off the Agulhas Bank; depth, 150 fathoms; bottom, green sand. Two specimens (male and female). The female has several Foraminifera attached to its carapace and limbs. *Dromidia bicornis*, Studer, was taken in the same locality.

Genus *Pseudodromia*, Stimpson.

Pseudodromia, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 64, 1858.

Carapace elongated, convex, pubescent. Facial region considerably broader than half the width of the carapace. Epistome not joined to the front; palate with an elevation on each side. Feet presenting a general similarity to those of *Dromia*, but the fifth pair exceeding the others in length, much longer even than those of the second pair. Sternal sulci in the female approximate, scarcely produced as far as the segment which bears the chelipedes, ending in a double tubercle.[1]

Stimpson also states as a generic character that the abdomen is but slightly indurated posteriorly. There can be, however, little doubt that this is a misconception founded on the examination of a single young specimen.

Pseudodromia latens, Stimpson (Pl. I. fig. 8).

Pseudodromia latens, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 78, 1858.

Habitat.—Simon's Bay, Cape of Good Hope; 10 to 12 fathoms. A single male specimen protected by an Ascidian.

The carapace of this species is less convex than usual, the gastric and cardiac regions are smooth and polished, while the lateral surfaces are clothed with silky hairs. The cervical groove is particularly well marked and situated far back on the carapace; it receives the carpus of the fifth pair of legs. The posterior border of the carapace is raised. The frontal region is remarkably narrow, and the rostrum is tridentate, all three teeth being directed forwards. A ridge passes from the epistome to the under surface of the mesial rostral tooth, and separates the two antennules; the flagellum of the antennæ is sparingly ciliated. The subhepatic regions are hollowed out. The ischial joint of the external maxillipedes is slightly excavated inferiorly, and its inner border is fringed with long hairs. The chelipedes and first two pairs of ambulatory legs present a denser pubescence than the ultimate and penultimate pairs, though the hairs found on the latter are longer and more silky. The dactyli of the first two pairs of ambulatory legs also present two yellow spines on the under surface of their proximal half. The propodus of the last pair gives rise to two minute curved spines which oppose the dactylus. The abdomen is narrow, and the segments have a comparatively smooth exterior. The single specimen taken is an apparently adult male, and gives the following measurements: breadth of carapace 12 mm., length of carapace 16 mm., of chelipede 17 mm., of first ambulatory leg 16 mm., of fourth ambulatory leg 20 mm.

Stimpson's specimen was of much smaller size and probably immature; it is interesting to note that it was also taken in Simon's Bay, at a depth of 12 fathoms.

[1] I am enabled to make this addition to Stimpson's original description by the examination of a specimen from the Tuticorin Pearl Banks, in the collection of the Government Central Museum, Madras (belonging to a new species which I propose to designate *Pseudodromia integrifrons*).

Genus *Hypoconcha*, Guérin-Méneville.

Hypoconcha, Guérin-Méneville, Rev. et Mag. Zool., sér. 2, No. 6, p. 333, 1854.
„ Stimpson, Proc. Acad. Nat. Sci. Philad., p. 64, 1858.

Carapace flattened, membranous above; the anterior border arcuate and sharply defined, overhanging a triangular frontal region the apex of which is directed downwards. External maxillipedes with the meral joints large, and the external-lateral angles of the latter somewhat produced; the exognath robust. The ultimate and penultimate pairs of ambulatory limbs furnished with Y-shaped dactyli. Sternal sulci in the female widely separate, each terminating in a tubercle opposite the basal joint of the second ambulatory leg.

The members of this genus are, so far as is known at present, confined to the West Indies and the neighbouring shores of America. The protection which so many Dromiids obtain from an Ascidian or Sponge, is in the present case afforded by the detached valve of a Lamellibranch, and the *Hypoconcha* is able to closely adjust the chelipedes and ambulatory legs to the under surface of its body. The genus *Conchoecetes*, established by Stimpson for the *Cancer artificiosa* of Herbst—a native of the Chinese seas,—also possesses this peculiar habit, as well as an Australian species, *Dromia conchifera*, Haswell.

Hypoconcha sabulosa (Herbst).

Faux Bernard l'Hermite, Nicholson, Essai sur l'Hist. Nat. de Saint-Domingue, p. 338, pl. vi. figs. 3, 4, 1776.
Cancer sabulosus, Herbst, Naturg. Krabben u. Krebse, tab. xlviii. figs. 2, 3, 1796.
Faux Bernard l'Hermite de Nicholson, Lamarck, Hist. anim. sans vert., t. v. p. 264, 1818.
Hypoconcha sabulosa, Guérin-Méneville, Rev. et Mag. Zool., sér. 2, No. 6, pl. v. p. 333, 1854.
„ „ Stimpson, Proc. Acad. Nat. Sci. Philad., p. 64, 1858.

Habitat.—St. Thomas, West Indies; shallow water.

Two adult specimens in the collection—a male and a female, the latter bearing ova—agree with Guérin-Méneville's description and figure.[1] The last two abdominal segments in the female are, however, slightly granulated, a character which Stimpson assigns to his species *Hypoconcha arcuata*, originally taken at St. Thomas.

[1] It is to be noted that in this author's plate, figures 1 and 5 represent two very different configurations of the anterior border of the carapace. The Challenger specimens agree with the first of these, in which the border is well rounded off and only a very slight concavity exists on either side.

Family II. Homolidæ.

Homoliens, Milne-Edwards, Hist. Nat. des Crust., t. ii. p. 180, 1837 (*part.*).

Carapace quadrangular or subtriangular. Legs flattened (*Homola*), or remarkably long, slender, and cylindrical (*Latreillia*, *Latreillopsis*); the last pair of small size, prehensile and subdorsal in position. Ocular peduncles usually slender and of great length; orbits scarcely represented. Antennules not capable of retraction into special fossæ. Species extending to moderate depths.

The genus *Latreillopsis* forms an interesting link between *Homola* and *Latreillia*, and emphasises the necessity (previously pointed out by De Haan) of grouping the two together. *Dicranodromia*, A. Milne-Edwards, apparently occupies an intermediate position between the Dromidæ and the Homolidæ; it agrees with the former in the arrangement of the last two pairs of legs, and with the latter in the absence of orbits and antennular fossæ. The features of this genus appear, however, on the whole to warrant its position in the family now under consideration.

Genus *Homola*, Leach.

Homola, Leach, Trans. Linn. Soc. Lond., vol xi. p. 324, 1815; Zool. Miscell., vol. ii. tab. lxxxviii., 1815.
,, Milne-Edwards, Hist. Nat. des Crust., t. ii. p. 181, 1837.
,, De Haan, Crust. Japon., p. 105, 1850.
,, Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 403, 1852.
,, Heller, Crust. südlichen Europa, p. 148, 1863.

Carapace quadrilateral, of greater length than breadth, terminating anteriorly in a bi- or unidentate rostrum, the sides vertical. Orbits incomplete, only affording protection to the basal portion of the eye-stalks. Ocular peduncles composed of a long, slender, basal part, and a shorter but dilated corneal portion. Antenules not placed in special fossæ, the proximal joint of the peduncle swollen, the second and third joints slender. Antennal peduncle slender. Chelipedes of moderate size, with slender dactyli; ambulatory limbs long and compressed, the ultimate pair subdorsal in position, and subcheliform. Abdomen composed of seven segments, of which the first five bear appendages in the female.

The previously known species of *Homola* are three in number, viz., *Homola barbata* (Herbst) and *Homola cuvieri*, Risso, from the Mediterranean and adjacent part of the Atlantic (the former also occurring off the east coast of the United States and in the West Indies), and *Homola vigil*, A. Milne-Edwards, from the West Indies. To these the Challenger collection has added a fourth species from the Eastern seas. All of these live in moderately deep water, and both *Homola barbata* and *Homola vigil* have been obtained from considerable depths.

Homola orientalis, n. sp. (Pl. II. fig. 1).

Characters.—Carapace submembranous, somewhat flattened, the length about one-third greater than the breadth, the sides parallel and the regions not well marked. Frontal region deflexed, the rostrum terminating in two subacute spines which are directed forwards. Gastric area slightly convex, armed with nine rounded tubercular processes arranged after the manner of the spines in *Homola barbata* (Herbst), and somewhat hollowed out mesially, the shallow groove thus formed continued on to the rostral process. Hepatic area armed with two blunt spines as in *Homola barbata*, and of these the larger and more external marks the commencement of the lateral border of the carapace, the second is situated in a line between the former and the outer gastric tubercle. A line continued along the outer border of the carapace passes between the two hepatic spines, so that the antero-lateral spine is perhaps more correctly referred to the subhepatic region of the carapace. The antero-lateral border presents a slight concavity; it is marked by a prominent spine over the basal portion of the ocular peduncle, and external to this a rounded groove into which the ocular peduncle fits. This border ends in two or three insignificant tubercles in front of the subhepatic region. The lateral border is armed in front by the prominent spine already alluded to, posterior to this are two subacute tubercular spines of no great size, and a series of minute rounded tubercles continued almost to the posterior end. The posterior border is slightly raised, and has a mesial curve directed forwards, the first abdominal segment fitting into a well-marked depression. The cervical groove is ill-defined; it passes to the margin of the carapace between the first two spines of the lateral border, and there becomes lost, its position being marked on the surface of the carapace by an oblique elevation which runs in towards the cardiac area.

The ocular peduncles are remarkably long, the basal portion slender and cylindrical, the terminal part slightly constricted near the middle, and bearing a dilated cornea. The basal joint of the antennular peduncle is short and of irregular shape, the second joint is considerably longer than the terminal one; the flagella are of small size. The antennal peduncle is about equal in length to the eye-stalk, and composed of four joints, the first of which has a well-marked auditory tubercle, the second is armed superiorly with a spine which projects over the next joint, the penultimate is long and cylindrical, and about three times the length of the terminal one; the flagellum is about twice the length of the carapace. The epistome bears a well-marked blunt spine, from which a ridge is continued to the under surface of the rostrum. The subhepatic region is divided into two parts by a groove which is directed obliquely forwards; a few small tubercles are present on the posterior division, while the anterior possesses many short and stout subacute spines; several minute tubercles are present also on the pterygostomial area. The external maxillipedes bear a close resemblance to those of *Homola barbata* as figured by

Milne-Edwards and Heller, the chief characteristic being the rounded lobe on the outer border of the meral joint.

The chelipedes are of moderate length, and pubescent towards their termination; the meral joint is trigonal, and each of the three borders is armed with a row of acute spinules, those on the inner border being of very small size; the carpus is about half the length of the propodus, and bears several spinules on its outer surface and upper border. The propodus is without spines, the fingers also are unarmed, each presents a thin cutting edge, and is slightly bent inwards. The three anterior pairs of ambulatory limbs are moderately long, compressed, and pubescent, the second and third pairs subequal in length, the merus is longitudinally canaliculate above, and its anterior border is armed with from three to five acute curved spinules, a few of smaller size existing on the posterior border; the propodus is canaliculate both above and below, and its posterior border, as well as that of the dactylus, is armed with a series of horny spines which are more numerous and shorter on the latter joint; the dactylus is also grooved on both surfaces, and its tip is acute and slightly recurved. The ultimate pair of legs are subdorsal and have the dactyli and propodi greatly reduced in size; the merus bears a single spine on its anterior and distal border, while the posterior border possesses three of larger size; the short curved dactylus is opposed to the propodus, which is likewise bent, and the latter is armed with several long and delicate spines.

The seven abdominal segments in the female are, with the exception of the first three, broad and unarmed, but slightly pubescent; the second bears a pointed tubercle, and a rounded elevation is present on the third; the seventh has the apex acuminate. Five pairs of abdominal appendages are present, the first pair rudimentary.

Breadth of carapace 13·5 mm., length of carapace 17 mm., of second ambulatory leg 41 mm., of fourth ambulatory leg 23 mm., of chelipede 24·3 mm.

The above description and measurements are taken from the Zebu specimen (a female). The Ki specimen (a male) is in a very imperfect condition, only the proximal joints of the limbs being present; it differs, moreover, in having no pubescence on the carapace or abdomen.

Habitat.—Station 192, off Little Ki Island; depth, 140 fathoms; bottom, blue mud. Station 209, off Zebu, Philippine Islands; depth, 95 fathoms; bottom, blue mud.

Genus *Homologenus*, A. Milne-Edwards.

Homolopsis,[1] A. Milne-Edwards, Bull. Mus. Comp. Zoöl., vol. viii. No. 1, p. 34, 1880.

"This genus differs from *Homola* in the more rounded and more ovoid form of the carapace, in the great development of the rostrum, in the form of the eyes, which are very small and not narrowed at their base, and in the feebleness of the legs."

[1] The name *Homolopsis* being preoccupied in Zoology, Professor Milne-Edwards has suggested, in a letter to the writer, that given above.

Homologenus sp. (?), *juv.* (Pl. II. fig. 2).

To this but slightly characterised genus I refer with considerable hesitation a small and apparently immature specimen (Pl. II. fig. 2). I have not, however, ventured to assign a name to this, but merely indicate its more important features.

Carapace ovoid, submembranous, with the regions fairly marked, terminating anteriorly in three spines, the median being the rostrum, the lateral slightly longer and more slender, situated one over the insertion of each eye. The gastric region bears a few spinules, and a small spine is present on each branchial area. Eyes of moderate size, the corneæ dilated; ocular peduncles short and moderately stout. The second segment of the antennal peduncle is armed with a spine on its outer border. The external maxillipedes are slender, the merus is shorter than the ischium and without the dilatation present in the species of *Homola*.

Chelipedes long and slender, all the joints furnished with a series of spinules on the upper and lower borders, and a few scattered hairs; the fingers are incurved and bent over one another at the tips. Ambulatory limbs long and slender, the dactyli but slightly curved; the last pair of small size and subdorsal in position.

Abdomen narrow, composed of seven segments (including the telson); the second to the sixth segment each with a pair of biramous appendages, all well developed with the exception of the last pair, which form with the telson a small swimming fan.

The single example differs from specimens of *Homologenus* taken by the "Blake" and "Talisman" expeditions, in the form of the abdomen and the larger eyes. It is apparently very young, and exhibits a slight advance from the Megalopa stage; possibly it was captured in the surface or intermediate waters. The following are the measurements:—Breadth of carapace 4·5 mm., length of carapace 5·5 mm., of chelipede 12 mm., of longest ambulatory leg 24 mm.

Habitat.—Station 196, off Gilolo Island; depth, 825 fathoms; bottom, hard ground.

Genus *Latreillopsis*, n. gen.

Carapace rectangular, the surface irregular; frontal region moderately wide, with a median spiniform rostrum and a supraorbital spine on each side. Ocular peduncles with the basal segment narrow, cylindrical, and elongated, the corneæ dilated. Antennules and antennæ as in *Homola*. External maxillipedes similar to those of *Homola*, but the merus more regularly four-sided. Chelipedes and ambulatory limbs slender, cylindrical, and of considerable length, the last or subdorsal pair formed as in *Homola*, but exceeding the chelipedes in length; the dactyli smooth and remarkably slender. Abdominal segments broad and well developed in the female; five pairs of appendages present. Special features of the male unknown.

Latreillopsis occupies an intermediate position between the genera *Homola* and *Latreillia*. From *Homola* it is distinguished by the arrangement of the rostrum and supraorbital spines, the greater length of the ocular peduncles, and more especially by the elongated cylindrical legs. In *Latreillia*, on the other hand, the frontal region is narrow and produced so as to give the carapace a triangular outline, the supraorbital spines are more strongly developed, and the eye-stalks and legs are of greater length.

It is to be noted that Station 209, at which the single specimen of *Latreillopsis* occurred, is one of the two localities in which species of *Homola* and *Latreillia* were taken by the Challenger.

Latreillopsis bispinosa, n. sp. (Pl. II. fig. 3).

Characters.—Carapace somewhat rectangular, the length greater than the breadth, the surface irregular. Frontal region with three long acute spines, of these the median or rostrum is directed forwards and is about half the length of the other two, which are supraorbital in position, and placed as regards the rostrum at an angle of about 45°. Gastric region swollen, armed posteriorly with a rounded tubercle and a transverse row of slight elevations in front of this. Cardiac and branchial areas not sharply distinct from one another, their surfaces with numerous irregularities. The pterygostomial area partly appears on the dorsal surface, and gives rise to a well-defined elevation about the middle of the lateral border; anteriorly it is separated from the hepatic and subhepatic regions by a deep groove. The hepatic and subhepatic areas are apparently fused to form an oblique oval elevation capped by two acute anteriorly directed spines (hence the specific name), the superior of which is equal in size to the rostrum, the inferior slightly shorter; this region is separated from the margin of the buccal cavity by a narrow groove. The epistome is somewhat triangular, and the buccal margin remarkably pronounced, with two subacute lobes near the upper angle on each side.

The eyes are of moderate size, and the corneæ dilated; the basal segment of the peduncle is long and cylindrical. The antennules have their basal segment dilated, and the second and third joints cylindrical; the flagella are of small size. Situated between the basal joints of the antennules, and on that portion of the epistome which passes towards the frontal region, is a small unpaired tubercle. The antennal peduncle is apparently composed of four segments; the first is of small size and bears a rounded tubercle on its inner surface (it is also overhung by a small acute spine which rises from the frontal margin); the second joint is stouter than, and about half the length of, the third, it bears a short prolongation at its inner border and distal end; the third and fourth segments are slender and cylindrical, the ultimate about one-third the length of the penultimate; the flagella have been accidentally removed in the single specimen. The external maxillipedes have the dactylus and propodus subequal, and longer than the carpus; the merus is of large size and somewhat rectangular, the outer surface is concave from side to side, and the outer border slightly convex; the ischium is smaller in size, and the outer border slightly concave; the exognath extends almost to the end of the merus.

The chelipedes are long, slender, and smooth, a small spine is placed at the distal end of the merus on its upper surface, and a second is similarly situated on the ischium. The propodus and merus are subequal, and the former is about twice the length of the carpus. The digits are slightly incurved, and their apices cross one another; the opposed edges are thin and entire. The ambulatory limbs, with the exception of the last pair, are long and slender; a spine of moderate size is placed at the distal end of the merus. The propodus is three times the length of the carpus and slightly curved; the dactylus is about half the length of the propodus, remarkably slender and well curved. The last pair of legs are also slender and longer than the chelipedes; the merus slightly exceeds the carpus in length, and is armed with a distal spine; the dactylus is remarkably small and but slightly curved, with its edge dentate, it is folded over the short propodus, the margin of which bears a double row of spines.

The abdomen is composed of seven segments including the telson, which is of small size, triangular and pointed; the fifth segment shows the greatest width. The lateral margins are fringed with hairs, and there is a central rounded prominence running along the dorsal surface of each segment, which becomes tuberculate on the second, third, and fourth, a small spine is also present at the distal end of the sixth segment. Five pairs of appendages are present on the first five segments, the first pair uniramous and of small size, the remainder biramous. The telson fits into a depression between the bases of the external maxillipedes. In the female the sternum between the bases of the legs of the third pair exists as a transverse somewhat curved ridge.

Breadth of carapace 10·5 mm., length of carapace 14 mm., of chelipede 26 mm., of longest ambulatory leg 63 mm., of last leg 33 mm.

The single specimen taken is a female, unfortunately not in a good state of preservation.

Habitat.—Station 209, off Zebu, Philippine Islands; depth, 95 fathoms; bottom, blue mud.

Genus *Latreillia*, Roux.

Latreillia, Roux, Crustacés de la Mediterranée et de son Littoral, livr. v. pl. xxii. 1828.
„ Milne-Edwards, Hist. Nat. des Crust., t. i. p. 277, 1834.
„ De Haan, Crust. Japon., p. 105, 1850.

Carapace elongate, trigonal, not covering the coxæ of the legs; the anterior part subcylindrical. Frontal region narrow, terminating in three spines; the two lateral placed over the eyes, slender, acute, diverging; the median short and acute. Antennules equalling the supraorbital spines in length, separated at the base by a partition; the first joint dilated, the second and third cylindrical. Antennæ rudimentary, not equalling the ocular peduncles in length; the first joint narrow and about equal to the third in length, the second twice as long. Ocular peduncles very long and slender, cylindrical, turned forwards, diverging in the same way as the supraorbital spines. External maxillipedes with the inner margin of the ischium and merus pilose, not spiny, the outer border of the latter joint slightly concave. Legs very long, slender, and cylindrical, the fifth pair of small size and subdorsal in position. Abdomen folded under the thorax, composed of seven segments in the male, of five in the female; five pairs of abdominal appendages present in the female.

This very characteristic genus includes four species, viz., *Latreillia elegans*, Roux, from the Mediterranean and east coast of the United States, *Latreillia valida* and *Latreillia phalangium*, both of De Haan, from the Japanese and neighbouring seas, and a fourth from the Australian coasts, described below.

Latreillia valida, De Haan.

Latreillia valida, De Haan, Crust. Japon., p. 107, tab. xxx. fig. 1, 1850.

Habitat.—Station 209, off Zebu, Philippine Islands; depth, 95 fathoms; bottom, blue mud.

A female with ova is apparently referable to this species. It corresponds closely to the original description, with the exception that the merus of the chelipedes is three- and not five-spined; the supraorbital spines also exhibit a minute spinule on the inferior surface, whereas they are stated by De Haan to be entire.

Latreillia australiensis, n. sp. (Pl. II. fig. 4).

Characters.—Carapace subtriangular, the frontal region narrow. The rostrum is of small size, considerably deflexed and acute; the supraorbital spines are slightly more than half the length of the ocular peduncles, with a slight downward curve, and two to three minute spinules are present on the outer surface in the female. The surface of the carapace is irregular and somewhat glabrous, the regions fairly marked but without spines. The buccal or subhepatic swelling is prominent, but unarmed in both sexes.

The ocular peduncles have the basal joint remarkably long and slender, the corneæ dilated. The antennules are about equal in length to the supraorbital spines, their basal joint subglobose. The antennæ are remarkably short and slender, apparently not equalling the antennules (the imperfect nature of the specimens renders this point doubtful). The epistome is smooth and lengthened out antero-posteriorly. The external maxillipedes have the merus and ischium subequal in length; the former presents a concavity on its antero-external border, and is wider than the latter; the exognath is very slender.

The chelipedes are slender, and the terminal joints but little dilated, the merus is armed with three spinules on its anterior border and two on the posterior (in each case one of these overhangs the insertion of the carpus); the remaining joints are smooth. The fingers are incurved, and their apices cross; they possess a thin, entire, cutting edge. The ambulatory limbs have the meral joints fringed with spinules on both the anterior and posterior borders, but more numerous on the posterior, a few similar processes are present on the carpi, and a few very minute horny spinules on both borders of the propodus; the distal end of this last joint gives rise posteriorly to three or four horny spines articulated to a dilated portion of this segment; the digits are but slightly curved. The last pair of legs are subdorsal in position and of very small size, their total length not equalling the meral joint of the preceding pair; the merus is armed with spinules especially on its posterior border; the carpus and propodus are subequal in length, the former is somewhat flattened and dilated towards its distal end, and armed with spinules on both sides; the dactylus is very minute and opposed by a single spine on the posterior border of the propodus.

In the female the second and third abdominal segments are each provided with a dorsal spine; the fourth is glabrous and shield-shaped, its anterior border with a small tubercular spine on each side, and halfway down the outer surface a rounded elevation on either side; there is also a median rounded elevation running from end to end; the telson is of small size, and its apex acute. Five pairs of appendages are present; the first pair of small size, uniramous, and united at their bases. The fourth, fifth, and sixth abdominal segments in the male are devoid of spines.

A male specimen gives the following measurements:—Length of carapace 10 mm., of chelipede 32 mm., of second leg 63 mm., of last leg 22 mm., of ocular peduncle 7 mm., of supraorbital spine 4 mm. A female specimen is somewhat larger.

This species belongs to the section of the genus in which the last pair of legs do not extend beyond the meral joint of the preceding pair. It differs from *Latreillia phalangium*, De Haan, in the absence of cardiac and buccal spines, and in the presence of only two spines on the fourth abdominal segment of the female.

Habitat.—Station 163A, off Twofold Bay, Australia; depth, 150 fathoms; bottom, green mud. Two adult specimens, male and female, the latter bearing ova, and the remains of a third immature individual.

Off Port Jackson; depth, 30 to 35 fathoms; bottom, hard ground. Two young examples, male and female.

RANINIDEA.

Raniniens, Milne-Edwards, Hist. Nat. des Crust, t. ii. p. 190, 1837.
Raninoidea, De Haan, Crust. Japon., p. 136, 1850.
Raninidea, Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 400, 1852.

Carapace ovato-oblong, smooth, the regions not defined; frontal margin of variable width. Ambulatory limbs with broad flattened dactyli; the last pair of small size and subdorsal in position. Abdomen short, semi-extended, not folded under the thorax, with four pairs of appendages in the female. Sterna of the thoracic legs fused to form a ventral shield which is wide anteriorly. External maxillipedes moderately elongate. Eyes placed in well-marked orbits; antennules not furnished with special fossæ, and placed to a certain extent behind the antennæ. Vasa deferentia protruded in the males.

There can be no doubt that the Raninidea have many characters in common with the Brachyura, indeed Dr. Boas places them without any hesitation in the latter section. According to this observer, the position of the female genital openings is entirely due to the extreme narrowing of the thoracic sterna which has taken place. In many of their external features they show a decided resemblance to the Oxystomatous Brachyura.

The members of this small and distinct group form a single family. Little appears to be known as to their habits, but according to Adams and White they are swimming Crustacea inhabiting deep pools of coral ledges, and moving by rapid jerks like the *Galatheæ*. It seems probable, however, that some of them at least burrow in sand or mud like the Hippidea, to which they bear some resemblance in the structure of the legs. They are almost entirely confined to the tropics, only a few occurring in the warmer temperate seas, where they live in shallow and moderately deep water, apparently not venturing beyond a depth of 300 fathoms.

The genera may be grouped as follows:—

I. External maxillipedes with the ischium longer than the merus—

Ranina, Lamarck.	*Notopoides*, n. gen.
Raninoides, M.-Edw.	*Zanclifer*, n. gen.
Notopus, De Haan.	*Cosmonotus*, Adams and White (?).

Raninops, A. M.-Edw. (?).

II. External maxillipedes with the ischium shorter than the merus.

Ranilia, M.-Edw.	*Lyreidus*, De Haan.

Family Raninidæ.

Raninidæ, Dana, U.S. Explor. Exped., vol. xiv., Crust., part ii. p. 1428, 1852.

Genus *Raninoides*, Milne-Edwards.

Raninoides, Milne-Edwards, Hist. Nat. des Crust., t. ii. p. 196, 1837.
„ Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 403, 1852.

Carapace ovately oblong, smooth, convex from side to side. Fronto-orbital border horizontal, slightly narrower than the carapace at its middle, with a triangular rostrum. Ocular peduncles capable of retraction into well-defined orbits, with the terminal joint basally dilated; the corneæ of small size. Antennal peduncle of large size (especially the second joint), the flagellum minute. Antennules well developed. External maxillipedes elongate, the merus considerably shorter than the ischium; the three terminal joints of small size, inserted near the apex of the merus. Sternal shield broad anteriorly, widely separating the legs of the first two pairs, and becoming narrower between those of the third pair. Last pair of legs short and filiform, situated above and in front of the penultimate pair.

Raninoides personatus, White, MS. (Pl. II. fig. 5).

Characters.—Carapace with its length nearly twice as great as the breadth, smooth and polished, but minutely punctate, especially towards the frontal margin; the regions not indicated. The fronto-orbital border is straight, the lateral borders curved. The rostrum is prominent and entire, its apex obtusely rounded, and the upper surface smooth. The orbital border is fringed with hairs, and possesses an internal pointed lobe on each side of the rostrum, separated by a deep fissure from a larger and squarer external lobe; a smaller fissure separates this last from the prominent antero-lateral spine. The lateral border may be said to commence at the antero-lateral angle in the aforesaid spine, which is acute and slightly incurved; at a short distance posterior to it is a similar but slightly larger spine; for its posterior half this border exhibits a narrow raised and beaded line.

The eyes are of moderate size, and the orbits fringed with hairs both above and below. The basal joint of the antennular peduncle is moderately dilated and partly concealed by the tips of the external maxillipedes and by the antennal peduncles; the second and third joints are subequal in length; the flagella are moniliform. The antennal peduncle is four-jointed, the second joint of large size with a strong prolongation from its outer and distal border, the fourth of small size, and the flagellum short; the third and fourth joints give rise to numerous long hairs. The pterygostomial areas are strongly granulated as well as slightly pubescent. The external maxillipedes are very long and narrow, their apices completely covering the epistomial region; the ischium is about one-third longer than the merus, and both possess a raised inner margin which carries a fringe of hairs; the merus is slightly granulated, and furnished with a strong fringe of hairs on the outer border; the three terminal joints are of very small size, and inserted opposite a slight depression near the end of the merus; the exognath extends to the end of the ischium. The thoracic sternal region is smooth and polished, with a depression opposite the second pair of legs, and an acute granular projection on each side between the basal joints of the first and second legs.

The chelipedes are more than half the length of the carapace; the ischium with a small acute spine on its anterior border; the merus dilated and smooth, except on its inferior surface, where it is slightly granulated; the carpus about half the length of the merus, with two anteriorly directed spines on its upper surface (of which the external is larger); the propodus is somewhat flattened, with a single curved spine above, and three on the lower edge, the immobile finger is set nearly at a right angle to the main body of the propodus, and its inner edge is dentate; the dactylus is entire, slender and acute. The ambulatory limbs are smooth and polished, increasing in size from before backwards till the penultimate pair is reached; the propodus of the first and second pairs is produced into a rounded anterior lobe which is absent from the third pair, but these last have a well-marked posterior lobe; the dactyli are somewhat ovoid, those of the first and second pairs with acute apices; the legs of the third pair are fringed with hairs (especially their dactyli and propodi), the two anterior pairs are more sparsely clothed. The last pair of legs are about half the length of the penultimate pair, with the propodus and carpus subequal; the dactylus is very minute and scarcely curved.

The abdominal segments are smooth and polished above, ciliated laterally; they diminish in size gradually from before backwards. In the male the vasa deferentia are continued externally as tubular prolongations on both sides; the anterior pair of genital appendages are long, and their terminal joints curved, the second pair less than half the length of the first. The abdominal appendages in the female are strongly ciliated.

An adult male gives the following measurements:—Breadth of carapace 12·7 mm., length of carapace 23·5 mm., of fronto-orbital margin 8·5 mm., of chelipede 18 mm., of last leg 9·5 mm., of external maxillipede 9 mm., of abdomen 8·3 mm., of anterior genital organ 9 mm.

The British Museum collection contains specimens of this species from the Eastern seas, named (but never described) by Adam White; I have in the foregoing account adopted his manuscript name. In *Raninoides lævis* (Latr.), the fronto-orbital border has the lobes more strongly marked, drawn out into teeth, and the intervening fissures deeper; the lower border of the hand also is armed with many spines. The West Indian *Raninoides nitidus*, A. Milne-Edwards, has the lateral border armed with two spines behind the antero-lateral angle.

Habitat.—Amboina; 15 fathoms. Several specimens, representing both sexes.

Genus *Notopoides*, n. gen.

Carapace broadly ovate, smooth, convex from side to side and from before backwards. Fronto-orbital border half as wide as the carapace, with a concavity on each side of the rostrum. Ocular peduncles with the terminal joint cylindrical, the corneæ well developed and oblique; orbits deep. Antennal peduncle massive, the second joint with an extensive prolongation from its outer and distal border; the flagellum short. Antennules with the basal joint concealed by the antennal peduncle, the second joint longer than the third. External maxillipedes similar to those of *Raninoides*, the ischium considerably longer than the merus and without the oblique line present in *Notopus*. Sternal shield narrow opposite the second pair of legs, but slightly widening out again between the second and third pairs; all the limbs except the chelipedes inserted close to the middle line. Chelipedes and ambulatory limbs as in *Raninoides*, but the last pair of legs moderate in size and not filiform.

This genus is in some respects intermediate between *Raninoides* and *Notopus*, though more closely allied to the latter. From *Raninoides* it is distinguished by the form of the carapace, ocular peduncles, sternal shield, and last pair of legs; from *Notopus* by the shape of the chelæ, antennal peduncles, and external maxillipedes.

Notopoides latus, n. sp. (Pl. III. fig. 1).

Characters.—Carapace with the length considerably greater than the breadth, polished, finely granular, the granulations more marked towards the anterior half of the lateral border; the regions are not defined, but the carapace rises somewhat abruptly behind and parallel to the fronto-orbital margin, the line thus formed being coarsely granulated. The fronto-orbital border is W-shaped; the rostrum broad at its base, subacute, hollowed out superiorly, with a median carina which loses itself before reaching the transverse elevation; on each side of the rostrum are three lobe-like processes separated by two narrow and deep fissures, the first process triangular, the second somewhat square in outline, the third fused with the antero-lateral spine. The lateral border is entire and convex, the anterior half with a series of granules which tend to become spiniform, the posterior with a raised finely beaded line.

The eyes are retractile into deep orbits, the margins of which are lined by hairs. The antennules have the basal joint moderately long and but slightly dilated. The segments of the antennal peduncles are granular and densely ciliated, the second short and stout, with a very large rectangular prolongation (exceeding the joint itself in length) arising from the outer distal border, the third narrower than, but almost as long as, the second, the terminal of small size; the flagellum equals the peduncle in length.

The external maxillipedes have a raised line running along the inner margin of the merus and ischium, the former joint is faintly granulated, with its outer border ciliated, the latter smooth; the three terminal joints are of very small size (less than half the length of the merus), and inserted opposite a well-marked depression on the inner edge near the apex of the merus; the exognath slightly exceeds the ischium. The epistome is deeply hollowed out on each side of a mesial ridge, and concealed by the apices of the outer maxillipedes. The pterygostomial regions are strongly granular, and pubescent. The sternal thoracic shield is broad between the chelipedes, but becomes narrow between the first pair of ambulatory limbs, between the second and third legs it widens out once more, and becomes linear between the legs of the third pair; the broad anterior portion is separated by a transverse suture in the line of the second pair of legs from the smaller dilated portion behind; immediately in front of this is a median depression. In the female there is an ovoid median opening in the sternum, between the third and fourth pairs (a similar opening is present in *Raninoides personatus* though of very small size). The side lappets present in *Raninoides* between the basal joints of the first and second legs are present in this species also, but obtusely rounded and fringed with hairs.

The chelipedes are similar in shape to those of *Raninoides*, the ischium and merus unarmed, but the latter with several transverse piliferous lines; the carpus and propodus are both granulated, the former with two subequal acute spines on the upper surface, the latter with three acute spines on the lower border, which decrease in size from before backwards; the immobile finger is armed with about six teeth; the dactylus is slightly granular above, entire, with a thin cutting edge. The ambulatory limbs are smooth, and (the last two pairs more especially) clothed with long hairs, the propodi of the first and second pairs are slightly bent upon themselves, and the dactyli are hatchet-shaped, with subacute apices. The last pair are of moderate size, almost equalling the first pair in length; their dactyli elongated and ovate.

The abdominal segments are smooth, with a slight median elevation; the second segment is slightly wider than the first in both sexes; the telson is triangular. The abdominal appendages of both male and female resemble those of *Raninoides;* the protruded vasa deferentia in the male are short.

The following are the measurements of an adult male:—Breadth of carapace 26 mm., of fronto-orbital border 13 mm., length of carapace 34 mm., of chelipede 29 mm., of last leg 22 mm., of abdomen 16 mm., of anterior genital organ 13 mm., of external maxillipede 16·5 mm.

Habitat.—Station 192, off Little Ki Island; depth, 140 fathoms; bottom, blue mud. Many individuals of both sexes.

Genus *Notopus*, De Haan.

Notopus, De Haan, Crust. Japon., p. 137, 1850.
" Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 404, 1852.

Carapace ovate, smooth, convex from side to side and from before backwards. Fronto-orbital border more than half the width of the carapace, the rostrum triangular, carinated. Ocular peduncles cylindrical, the corneæ well developed, oblique; orbits well defined. Antennal peduncle almost equal in length to the eye-stalk, the second joint with a small external prolongation; the flagellum moderately long. Antennules with the basal joint not concealed. External maxillipedes moderately elongate, the ischium but slightly longer than the merus, and with an oblique ridge on its outer surface; the three terminal joints more than half the length of the merus. Sternal thoracic shield becoming narrow between the second pair of legs, furnished with paired lateral processes. Chelipedes with the propodus trilateral; the last pair of legs of moderate size, not filiform.

Notopus ovalis, n. sp. (Pl. II. fig. 6).

Characters.—Carapace ovate, the length about one-fourth greater than the breadth; finely granular, the granulations more marked towards the anterior end. The fronto-orbital border is more than half the breadth of the carapace; the rostrum is triangular and acute, carinated superiorly, the carina passing a short distance back on the carapace; a single lobe exists on each side, forming the upper border of the orbit, and its inner portion is prolonged into an acute spine; this lobe is defined by two shallow fissures, the outer of which separates it from the antero-lateral spine, and is slightly deeper than the other; that portion of the border immediately external to the rostrum is finely serrated. The lateral border is convex, with a prominent acute spine placed about one-fourth of the distance back; posteriorly there is a raised beaded margin.

The eyes are well developed, with the corneæ of large size, oblique, and deeply pigmented; the orbits well defined with but few marginal hairs. The antennules have the basal joint considerably dilated and unconcealed, the second joint slightly longer than the third. The antennal peduncles are granulated, the second segment with a minute external prolongation; the flagella are wanting in the single specimen. The external maxillipedes have the ischium but slightly longer than the merus, with an oblique ridge (in line with the outer border of the first joint) developed on the outer surface of the ischium; the merus is faintly granular, and its inner margin is raised; the three terminal joints taken together are more than half the length of the merus, and inserted into this last at its apex, where there is a slight indentation; the exognath slightly exceeds the ischium. The pterygostomial region is granulated and slightly pubescent, the boundary line between it and the carapace proper is well defined and continued back to the posterior limit of the latter. The thoracic sternum is broad between the chelipedes and becomes narrow between the second pair of legs; both in front of and behind the chelipedes it spreads out to form paired lateral pointed processes.

The chelipedes are slightly granular, the merus and ischium unarmed; the carpus possesses a single small spine overhanging the insertion of the following joint; the propodus is triangular, the immobile finger forms a straight line with the lower border of this joint (which has a raised margin), its inner border is irregularly dentate, one tooth in particular being of large size; the dactylus is entire. The ambulatory limbs are sparingly ciliated and smooth, with the exception of the last pair, which are faintly granular; the dactyli are hatchet-shaped; the last pair of legs are of moderate length and slender, with the carpus serrated on its anterior margin.

The second and third abdominal segments are both slightly wider than the first; the apex of the telson is acute.

The single specimen taken is apparently a young male, and gives the following measurements:—Breadth of carapace 8·7 mm., of fronto-orbital border 6·2 mm., length of carapace 11·7 mm., of chelipede 9 mm., of last leg 7 mm., of external maxillipede 5·5 mm.

In *Notopus dorsipes* (Fabr.) De Haan, the dorsal carina is more marked, and a row of strongly developed tubercles (almost spiniform) cross this at right angles near the anterior end of the carapace; the spines on the antero-lateral border are placed close together, and the last two are not separated by a wide interval as in *Notopus ovalis*. *Notopus atlanticus*, Studer, has the antero-lateral border armed with four spines (only three are present in *Notopus ovalis*), and the rostrum is much narrower than in the Challenger species.

Habitat.—Station 192, off Little Ki Island; depth, 140 fathoms; bottom, blue mud. Taken along with the last species.

Genus *Cosmonotus*, Adams and White.

Cosmonotus, Adams and White, Proc. Zool. Soc. Lond., p. 227, 1847; Voyage of H.M.S. "Samarang," Crust., p. 60, 1848.
,, Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 404, 1852.

Carapace ovate, smooth, compressed laterally, with a prominent median keel strongly marked in front but fainter posteriorly. Fronto-orbital border narrow, concave, without a central rostrum; lateral borders of the carapace convex, unispinose. In other respects agreeing with *Notopus*.

Only a single species is known.

Cosmonotus grayii, Adams and White.

> *Cosmonotus Grayii*, Adams and White, Proc. Zool. Soc. Lond., p. 227, with two woodcuts, 1847; Crust., Voyage of H.M.S. "Samarang," p. 60, pl. xiii. fig. 3, 1848.
> „ „ Stimpson, Proc. Acad. Nat. Sci. Philad., p. 79, 1858.

Habitat.—Amboina, 15 fathoms; a male specimen.

The type specimen came from Borneo, while those recorded by Stimpson were dredged off Formosa at a depth of 90 fathoms, on a sandy bottom.

Genus *Lyreidus*, De Haan.

> *Lyreidus*, De Haan, Crust. Japon., p. 138, 1850.
> „ Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 404, 1852.
> „ Haswell, Catal. Austral. Crust., p. 144, 1882.

Carapace oblongo-ovate, smooth, convex from side to side, and from before backwards. Fronto-orbital border narrow, less than half the width of the carapace; the rostrum broadly triangular. Ocular peduncles short, the corneæ oblique, well developed; orbits ill-defined. Antennules and antennæ of small size, subequal; the second joint of the antennar peduncle with an inconspicuous external prolongation; basal joint of the antennular peduncle incompletely concealed. External maxillipedes linear, the merus considerably longer than the ischium; the three terminal joints minute, less than half the length of the merus. Sternal shield similar to that of *Notopus*, but not narrowing to such an extent between the second pair of legs. Chelipedes as in *Notopoides*. Ambulatory limbs with narrow elongate dactyli, of which those of the second pair are placed at right angles to the propodus; the last pair of legs slender, almost filiform.

Lyreidus tridentatus, De Haan.

> *Lyreidus tridentatus*, De Haan, Crust. Japon., p. 140, tab. xxxv. fig. 6, and tab. J. (mouth organs), 1850.
> „ „ Haswell, Catal. Austral. Crust., p. 144, 1882.

Habitat.—Off Port Jackson, 30 to 35 fathoms; 3rd June 1874. About a dozen examples (of both sexes), taken in this locality, exhibit two prominent dorsal elevations on the third and fourth abdominal segments, that of the third blunt and tuberculate, the fourth acute. This spine is described but not figured by De Haan. The abdominal segments are slightly wider in the female than in the male, and the abdominal appendages long and hirsute.

Station 174, off Kandavu, Fiji Islands; 210 fathoms, Globigerina ooze. The single male specimen possesses a mesial swelling on the third abdominal segment, and on the fourth a very prominent and acute spine directed upwards and forwards.

The discovery of this interesting species—originally described from Japan—at a considerable depth off the Fiji Islands, is an important addition to our knowledge of its distribution. It was previously recorded by Haswell from the Australian coast, where, however, it appears to be of rare occurrence. The Japanese species described by Miers as *Lyreidus elongatus*,[1] and doubtfully referred by this writer to *Lyreidus tridentatus*, appears to be distinct. More recently Professor S. I. Smith has described a third species, *Lyreidus bairdi*, from the east coast of the United States.

Genus *Zanclifer*, n. gen.

Carapace ovate, convex from side to side and from before backwards, its surface partly uneven. Fronto-orbital border very narrow, considerably less than half the width of the carapace, the frontal region trilobate, produced anteriorly. Eyes rudimentary, placed in ill-defined orbits; the peduncles short, and the corneæ of small size though pigmented. Antennar peduncle massive, the first segment fused with the carapace, the second with a very prominent external prolongation; the flagellum short. Antennules of small size, completely concealed by the antennar peduncles, which meet together in the middle line. External maxillipedes moderately broad, with the ischium twice the length of the merus. Sternal thoracic shield narrow, becoming linear between the legs of the second pair, but slightly dilating again between the second and third pairs. Chelipedes of considerable length, the propodus swollen laterally, the fingers long. Ambulatory limbs with uncinate dactyli, the fourth pair of small size but not filiform. Male generative appendages similar to but shorter than those of *Raninoides*.

The form and arrangement of the eyes, antennules and antennæ, distinguish *Zanclifer* from all other genera of Raninidea. In the general shape of the carapace it comes nearest to *Lyreidus*, but this resemblance is probably accidental, for other generic features (especially the formation of the external maxillipedes) are widely different in the two genera. The rudimentary nature of the eyes and the structure of the limbs point to this genus being fossorial in habit.

Zanclifer caribensis (De Freminville) (Pl. III. fig. 2).

Eryon caribensis, De Freminville, Ann. d. Sci. Nat., sér. 1, t. xxv. p. 273, pl. viii.B. figs. 1–2, 1832.
Eryon trilobatus, De Freminville, Icones Crustaceorum quae ad littora America Meridionalis reperiuntur à C. P. de Freminville (unpublished, no date).

Characters.—The surface of this species is everywhere finely granulated. The carapace is ovate, granular, its length one and a half times as great as the breadth, the anterior half with very numerous eroded depressions arranged symmetrically on both sides; immediately behind the frontal region the carapace rises somewhat

[1] *Proc. Zool. Soc. Lond.*, p. 46, 1879.

abruptly, and the edge of the ridge thus formed is drawn out into three processes which are separated from one another by eroded depressions; the floor in all the depressions is more coarsely granular than the rest of the carapace. The fronto-orbital border is narrow, less than one-half the width of the carapace; the frontal region is considerably produced and terminates in three small rounded lobes, of which the median is largest; the orbital portion of this border is remarkably short, and marked externally by a rounded tooth. The lateral border commences anteriorly in a blunt projection which is separated by a concave depression from the antero-lateral (or orbital) tooth; for the first half of its course it is irregular owing to its being encroached on by the erosions of the carapace; posteriorly it exhibits a raised granular line which curves in on the dorsal surface of the carapace so as to leave a portion of the subbranchial or lateral region exposed.

The eyes are of small size and placed in ill-defined orbits; the peduncles with a slight range of movement. The antennules are minute, placed underneath the frontal region and completely concealed by the antennar peduncles; their peduncles are hirsute. The antennal peduncle is broad and composed of only three segments, the first (which is free in the other Raninidea) having fused with the trunk; the second has a strongly developed external prolongation which exceeds the remainder of the peduncle, the terminal segment is of small size; the flagellum is minute, but stout, and ciliated on both sides. The external maxillipedes have the ischium slightly convex and twice the length of the merus, the latter joint with a longitudinal sulcus on its outer surface and rather more coarsely granular than the ischium; the terminal joints are wanting in the single specimen; the exognath reaches to the end of the ischium and its apex is subacute. The pterygostomial region is moderately convex and separated from the carapace proper by a deep groove which becomes continuous with the line on the postero-lateral border. The thoracic sternum is nowhere very broad, reaching its maximum between the chelipedes and the first pair of ambulatory limbs, becoming linear between the basal joints of the latter, but dilating again between the first and second pairs of ambulatory limbs; the anterior part with a sulcus on each side, the posterior with a single median groove.

The chelipedes are well developed, with the surface finely granular; the merus is slightly hollowed out on its inner aspect; the propodus is remarkably swollen; the dactylus and immobile finger are slender, exceeding the propodus in length, their opposed edges with numerous teeth; the apex of the immobile finger is bent over that of the dactylus. The ambulatory limbs are granulated and fringed with long hairs, the propodi of the first three pairs drawn out into several sharp ridge-like processes, the dactyli but faintly granular and uncinate or sickle-shaped (hence the generic name); the fourth pair are of small size and flattened from above downwards, with the dactyli less strongly curved.

The abdominal segments are moderately convex, gradually tapering towards the extremity, and fringed with long hairs; the apex of the telson is rounded. The sexual appendages of the male are similar to those of *Notopoides;* the vasa deferentia are protruded as short tubular outgrowths.

The single specimen is an adult male, and gives the following measurements:—Breadth of carapace 14 mm., of fronto-orbital border (from one orbital spine to the other) 5 mm., length of carapace 21 mm., of chelipede 23 mm., of last leg 11·5 mm., of abdomen 9·5 mm., of first male appendage 7 mm., of external maxillipede 8·7 mm.

This species, which must be classed as one of the most interesting Crustaceans in the collection, was discovered more than fifty years ago in the Bay of Fort Royal, Martinique, by M. C. P. de Freminville, the captain of a French vessel, which was at that time cruising in the West Indies. Only a single specimen was obtained, and it does not appear to have been met with again till its rediscovery by the Challenger on the Brazilian coast. The description and figures originally given by this writer are very inaccurate; he referred the species to the fossil genus *Eryon*, to which it does not even bear a superficial resemblance, described the subdorsal legs as forming the second pair, and the antennules escaped his observation altogether. I should have had great hesitation in identifying the Challenger specimen with the *Eryon caribensis*, were it not that while in Paris, Professor Alphonse Milne-Edwards drew my attention to a collection of pencil-drawings of Crustacea, in the Library of the Museum of Natural History, in which the Challenger species is unmistakably figured under the name of *Eryon trilobatus*, and the locality "Caribbean Sea" assigned to it. It seems unlikely that two species were found, so I have adopted the specific name which appears in De Freminville's published paper.

Habitat.—Off Bahia, 7 to 20 fathoms.

HIPPIDEA.

Hippes, Latreille, Règne Anim. de Cuvier, 1re éd. t. iii. p. 28, 1817.
Hippiens, Milne-Edwards, Hist. Nat. des Crust., t. ii. p. 200, 1837.
Hippidea, De Haan, Crust. Japon., p. xxii, 1850.
,, Dana, U.S. Explor. Exped., vol. xiii., Crust., part. i. p. 400, 1852.
,, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 67, 1858.
,, Miers, Catal. New Zealand Crust., p. 58, 1876; Journ. Linn. Soc. Lond. (Zool.), vol. xiv. p. 312, 1877.
,, Haswell, Catal. Austral. Crust., p. 151, 1882.

Carapace ovate or subquadrate, comparatively smooth, the regions ill-defined; the frontal margin broad. Ambulatory limbs with flattened dactyli; the last pair slender and filiform, folded under the penultimate pair. Abdomen semi-extended, composed of six segments (the fifth and sixth fused), the penultimate with a prominent pair of biramous lamellar appendages, the ultimate of large size, its length exceeding the breadth. Thoracic sterna linear, not forming a shield. External maxillipedes moderately broad, suboperculiform. Eyes not provided with distinct orbits, the corneæ of small size. Antennules strongly developed, without special fossæ, one of the flagella greatly elongated, the other of moderate size or absent. Antennæ with a massive peduncle composed of four or five joints, with or without a movable acicle; the flagellum short. Males destitute of copulatory organs and with only a single pair of abdominal appendages (on the penultimate segment).

Of this small though distinct group the collection contains but four species, all of which have been previously described; two, however, belong to rare and little-known forms. The Hippidea inhabit the shallow water of tropical and subtropical seas; many of the species (if not all) burrow in sand. In some respects they bear a superficial resemblance to the Raninidea, but have apparently undergone slighter modification; the presence of lamellar appendages on the penultimate abdominal segment, and of an antennal acicle—essentially Macruran characters—stamps them as of more primitive type.

Family I. Hippidæ.

Hippidæ, Dana, U.S. Explor. Exped., vol. xiv., Crust., part ii. p. 1429, 1852 (*part*).
,, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 67, 1858.
,, Miers, Journ. Linn. Soc. Lond. (Zool.), vol. xiv. p. 316, 1877.

First pair of legs non-chelate, subcylindrical. Terminal segment of abdomen elongated, lanceolate. External maxillipedes suboperculiform, the merus broad; exognath absent.

Genus *Remipes*, Latreille.

Remipes, Latreille, Gen. Crust. et Insect., p. 45, 1806.
,, Milne-Edwards, Hist. Nat. des Crust., t. ii. p. 204, 1837.
,, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 67, 1858.
,, Miers, Journ. Linn. Soc. Lond. (Zool.), vol. xiv. p. 316, 1877.

Carapace ovate, the fronto-orbital border sinuous. Ocular peduncles slender. Antennular peduncle moderately stout, one of the flagella strongly developed. Second joint of the antennal peduncle of large size, with a slight external prolongation; the flagellum short. External maxillipedes with the merus dilated, the ischium rudimentary, and the dactylus unguiculate. Last thoracic segment free. Terminal abdominal segment lanceolate, exceeding the remainder of the abdomen in length. Female with three pairs of abdominal appendages in addition to the penultimate pair.

Remipes testudinarius, Latreille.

Remipes testudinarius, Latreille, Gen. Crust. et Insect., t. i. p. 45, 1806.
" " Lamarck, Hist. Anim. sans Vert., t. v. p. 223, 1818.
" " Desmarest, Consid. sur les Crust., p. 175, pl. xxix. fig. 1, 1825.
" " Milne-Edwards, Hist. Nat. des Crust., t. ii. p. 406, pl. xxi. figs. 14–20, 1837; Crust. in Cuvier Règne Anim. (3me éd.), Atlas, pl. xlii. fig. 1, no date.
" " Guérin-Méneville, Icon. Règne Anim., Crust., pl. xv. fig. 3, 1829–44.
" " Heller, Reise der Novara, Crust., p. 72, 1865.
" " Hilgendorf, Crust. in Van der Decken's Reisen in Ost-Afrika, p. 94, 1869.
" " Miers, Journ. Linn. Soc. Lond. (Zool.), vol. xiv. p. 316, 1877, *ubi synon.*
" " Haswell, Catal. Austral. Crust., p. 151, 1882.
" *marmoratus*, White, List Crust. Brit. Mus., p. 58, 1847, *sine descr.*
" " Jacquinot et Lucas, Crust. in Voy. Pôle Sud, Zool., t. iii. p. 97, pl. viii. figs. 22–26, 1853.
" " Miers, Catal. New Zealand Crust., p. 59, 1876.
" *pacificus*, Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 407, pl. xxv. fig. 7, 1852.
" " Stimpson, Ann. Lyc. Nat. Hist. New York, vol. vii. p. 241, 1862.
" " Miers, Proc. Zool. Soc. Lond., p. 74, 1877.
" *hirtipes*, Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 408, pl. xxv. fig. 8, 1852.
" *pictus*, Heller, Crust. Rothen Meeres, Sitzungsb. Akad. Wiss. Wien, xliv. i. p. 243, 1862.
" *ovalis*, A. Milne-Edwards, Faune Carcinol. in Maillard, Ile Réunion, t. ii., Annexe F, p. 12, pl. xvii. fig. 5, 1863.

Habitat.—Ternate, October 15, 1874. A single specimen (a female with ova) of this common and widely distributed Indo-Pacific species. The carapace measures 31 mm. in length.

Remipes scutellatus (Fabricius).

Squilla barbadensis ovalis, Petiver, Pterigraph. Amer., pl. xx. fig. 9, 1764.
Hippa scutellata, Fabricius, Ent. Syst., t. ii. p. 474, 1793.
Remipes scutellatus, White, List Crust. Brit. Mus., p. 57, 1847, *sine descr.*
" " Miers, Journ. Linn. Soc. Lond. (Zool.), vol. xiv. p. 319, 1877, *ubi synon.*
" " Studer, "Gazelle" Crust., Abhandl. d. k. Akad. d. Wiss. Berlin, p. 23, 1883.
" *cubensis*, Saussure, Rev. et Mag. Zool., t. ix. pp. 304, 308, 1857; Mém. Soc. Phys. et Hist. Nat. Genève, t. xiv. p. 452, pl. ii. fig. 19, 1858.
" *barbadensis*, Stimpson, Ann. Lyc. Nat. Hist. New York, vol. x. p. 120, 1871.

Habitat.—St. Vincent, Cape Verde Islands. Among a large number of specimens the majority are females with ova; males occur in the proportion of about one to two females.

Bermuda, on the sandy shore. Six females (one with ova) and two males. These have the carapace slightly broader in proportion to its length than the Cape Verde examples.

A great disproportion in size exists between the two sexes; the males also have the terminal abdominal segment narrower. The largest female specimen has a length of carapace of 22 mm., while the largest male similarly measures only 13 mm.

Genus *Mastigochirus*, Miers.

Mastigopus, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 68, 1858, *nom. præocc.*
Mastigochirus, Miers, Journ. Linn. Soc. Lond. (Zool.), vol. xiv. p. 321, 1877.

Carapace ovate, the fronto-orbital border dentate. Ocular peduncles long and slender. Antennules and antennæ similar to those of *Remipes* but shorter. External maxillipedes more slender than those of *Remipes*. First pair of legs remarkably long and slender, exceeding the total length of the body, the terminal segment multiarticulate. Other characters as in *Remipes*.

This genus is separated from *Remipes* chiefly by the form of the first pair of legs. The multiarticulate nature of the terminal segment is altogether exceptional amongst Anomura, and recalls a somewhat similar arrangement in many Macrura.

Mastigochirus quadrilobatus, Miers.

Mastigochirus quadrilobatus, Miers, Journ. Linn. Soc. Lond. (Zool.), vol. xiv. p. 322, pl. v. fig. 8, 1877; Crust. in Zool. H.M.S. "Alert," p. 280, 1884.

Habitat.—Station 186, off Booby Island, Flinders Passage; depth, 8 fathoms; bottom, coral mud. Two males were dredged in this locality.

The type specimen came from the Philippines, and more recently the species has been taken by the "Alert" in Prince of Wales Channel, at a depth of 5 to 7 fathoms.

Family II. ALBUNEIDÆ.

Albunidæ, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 68, 1858.
Albuneidæ, Miers, Journ. Linn. Soc. Lond. (Zool.), vol. xiv. p. 326, 1877.

First pair of legs chelate, flattened. Terminal segment of abdomen ovate. External maxillipedes subpediform, the merus not greatly dilated; exognath of small size. Antennar peduncle usually with a distinct acicle arising from the second joint.

Genus *Albunea*, Fabricius.

Albunea, Fabricius, Suppl. Ent. Syst., pp. 372, 397, 1798.
„ Milne-Edwards, Hist. Nat. des Crust., t. ii. p. 202, 1837.
„ Miers, Journ. Linn. Soc. Lond. (Zool.), vol. xiv. p. 326, 1877.
Albunæa, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 68, 1858.

Carapace subquadrate, the fronto-orbital border serrated, with a median notch. Ocular peduncles lamellar, the corneæ minute. Antennular peduncle of large size, with a single long ciliated flagellum which exceeds the whole body in length. Antennæ with a well-developed peduncle of five joints, the second joint with a movable acicle; the flagellum short and stout. External maxillipedes moderately slender, the merus oblong and not greatly exceeding the carpus in length. Dactyli of second, third and fourth pairs of legs uncinate. Last thoracic segment free. Female with four pairs of abdominal appendages in addition to the penultimate pair.

Albunea microps (White), Miers.

Albunea microps, White, List Crust. Brit. Mus. Appendix, p. 129, 1847, *sine descr.*
„ „ Miers, Journ. Linn. Soc. Lond. (Zool.), vol. xiv. p. 328, pl. v. figs. 12, 13, 1877.

Habitat.—Station 212, Celebes Sea; depth, 10 fathoms; bottom, sand. Three specimens, two of these unfortunately much crushed.

The unique specimen in the collection of the British Museum came from Sooloo Island.

PAGURIDEA.

Paguroidæ, Boas, Vidensk. Selsk. Skr. 6 Række nat. og math. Afd. i. 2. p. 110, 1880.

Frontal region of carapace usually prolonged in the form of a rostrum. Eyes not provided with distinct orbits, the peduncles cylindrical or subcylindrical. Antennal peduncle composed of five segments, the second segment furnished with a projecting spine or acicle. External maxillipedes subpediform, the meral and ischial joints elongate. Chelipedes well developed and in most cases asymmetrical; the last pair of legs always of small size and frequently chelate. Abdomen generally asymmetrical, the number of appendages variable.

The close affinity which exists between the Lithodids and Pagurids, although previously noticed by De Haan, has been up till within comparatively recent times entirely ignored by carcinologists. In 1880, Dr. J. E. V. Boas pointed out that

Lithodes is merely a highly specialised Pagurid (he considers it to be derived from *Eupagurus*), which has assumed certain Brachyuran characteristics. A somewhat similar parallel is seen in the case of *Birgus* and *Cœnobita*, though the distinction between the two latter is less strongly marked. In the Lithodids the abdomen has become bent under the cephalothorax, though its primitive asymmetry is still retained and the appendages of the penultimate segment have entirely disappeared.

The term Paguridea has been retained in order to ensure uniformity of nomenclature among the subtribes of Anomura, though it is of course now used in a much wider sense than that proposed by Dana.

Section A. LITHODEA.

Homoliens, Milne-Edwards, Hist. Nat. des Crust., t. ii. p. 180, 1837, *in part.*
Lithodeacea, De Haan, Crust. Japon., p, 213, 1850.
Lithodea, Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 401, 1852.
Lithodidea, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 68, 1858.

Carapace broadly ovate, uneven, with a prominent median rostrum in front, the regions well defined. Chelipedes and the three anterior pairs of legs well developed, cylindrical or subcylindrical, the posterior pair slender, chelate, folded in either branchial chamber. Abdomen bent under the thorax, composed of seven segments, the first of which is of small size and fused dorsally with the second; abdominal appendages only present in the female, consisting of a rudimentary pair on the first segment, and a single uniramous appendage on each of the four following segments (in *Hapalogaster*, Stimpson, the first of these is biramous). These last appendages are situated on the left side of the abdomen, which is more or less enlarged at the expense of the other side. Legs widely separated by broad thoracic sterna. Antennular peduncles cylindrical and of moderate size, with short flagella.

The members of this group (which form but a single family) inhabit the temperate and colder regions of both northern and southern hemispheres, where they live for the most part in shallow water; certain species have, however, been recently taken at great depths.

Family Lithodidæ.

Lithodidæ, Dana, U.S. Explor. Exped., vol. xiv., Crust., part ii. p. 1430, 1852.

Genus *Lithodes*, Latreille.

Lithodes, Latreille, Gen. Crust. et Insect., t. i. p. 39, 1806.[1]
,, Milne-Edwards, Hist. Nat. des Crust., t. ii. p. 184, 1837.
,, De Haan, Crust. Japon., p. 214, 1850.
,, Bell, Brit. Crust., p. 164, 1853.
,, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 68, 1858.

Rostrum long and spinulous. Abdomen with the third, fourth, and fifth segments provided with paired calcified plates, which in the female are enormously developed on the left side, the median portion membranous, with scattered calcareous particles.

The known species of this genus as restricted by Brandt and Stimpson are as follows:—

I. Northern species—
Lithodes maia (Linn.), North Atlantic.
,, *camtschaticus* (Tilesius), De Haan, Sea of Okhotsk.
,, *brevipes*, M.-Edw. and Lucas, South Pacific (?); Kamtschatka.
,, *spinosissimus*, Brandt, North Pacific.
,, *agassizii*, Smith, North Atlantic, deep water.
,, *ferox*, A. M.-Edw., off the north-west coast of Africa, deep water.

II. Southern species—
Lithodes antarcticus, Jacq. and Lucas, Fuegia.
,, *murrayi*, n. sp., Southern Ocean.

The *Lithode douteuse* of Milne-Edwards, described from a single mutilated specimen, and figured also by Seba, is probably a variety of *Lithodes maia*.

Lithodes agassizii, Smith.

Lithodes agassizii, S. I. Smith, "Blake" Crust., Bull. Mus. Comp. Zoöl., vol. x. p. 8, pl. i., 1882; Proc. Nat. Mus., vol. vi. p. 25, 1883; "Albatross" Crust., Rep. U.S. Fish Comm. 1882, p. 351, 1884.

Habitat.—Station 78, off the Azores; depth, 1000 fathoms; bottom, volcanic mud.

Two very young specimens, the carapace of the larger measuring only 9 mm. in length, are referable to this species. They are characterised by the extraordinary development of the spines on the carapace and rostrum. *Lithodes agassizii* appears to be not uncommon in deep water off the east coast of the United States; it is recorded by Smith from depths varying between 400 and 1250 fathoms.

[1] According to Agassiz (Nomencl. Zool.), the date of the creation of this genus by Latreille is 1802.

Lithodes murrayi, n. sp. (Pl. IV.).

Characters.—The carapace is broadly ovate, with the length (not including the rostrum) slightly greater than the breadth; the regions are well defined and the surface armed with broadly conical spines. The rostrum is five-spined, with a slight upward direction, the proximal part broad and terminating in two prominent diverging spines, which are directed forwards and upwards, the distal portion shorter and more slender, with its apex bifurcate, the spines thus formed being about half the size of the former pair; on the lower surface there is a large basal spine directed downwards and forwards, and at the same time slightly curved. The gastric area is swollen, with a few small tubercles scattered over its surface, and armed with four acute conical spines arranged in two rows, the anterior pair of larger size and separated by a wider interval than the posterior pair. The cardiac area is well-defined and somewhat triangular in outline, separated from the gastric area by a deep transverse sulcus; it bears on its most elevated part two spines similar to the gastric ones, and in front of these two conspicuous tubercles, a few smaller tubercles are also scattered over the region. The branchial area is moderately convex from side to side and armed with two conspicuous spines, one situated in the middle of the region opposite the anterior part of the cardiac area and larger than the other which is situated opposite the posterior part of the cardiac area; a few smaller elevations are placed near the latter, and scattered tubercles exist all over the area. The antero-lateral border possesses two spines, one external to the insertion of the ocular peduncle, the other at the antero-lateral angle. The lateral border is drawn out into about six prominent spines (excluding the antero-lateral one), a few of smaller size intervening; of these the first situated opposite the hepatic area is most prominent, indeed, this exceeds in size any other on the carapace, and is directed upwards and slightly forwards with a faint curve; a second prominent spine is placed a little in front of the first branchial spine, and a third opposite the second branchial. The posterior border possesses about six prominent spines on each side, of these the submedian pair are largest.

The eyes are of moderate size and freely movable, the corneæ well developed and oblique. The antennules have the third joint of the peduncle longer than the second, the first with a conspicuous auditory aperture on its upper surface. The second joint of the antennal peduncle has a conical spine on its outer and distal border, the ultimate joint is twice the length of the penultimate; the flagellum is about equal in length to the carapace. The external maxillipedes are similar to those of *Lithodes maia*, as figured by De Haan, the internal serrated projection of the ischium being well marked. The pterygostomial area presents an anterior convexity, with a concavity immediately behind.

The chelipedes are subequal in length, but the right is somewhat stouter, the ischium has several conical spines of large size on its lower surface, the merus has a prominent curved spine on its inner border, and the carpus several on its upper and outer surfaces; the fingers are excavated internally, and have numerous tufts of bristle-like setæ scattered over their surfaces. The meral, carpal, and propodal joints of the ambulatory limbs are moderately spiny on the superior and inferior borders and the posterior surface; the dactyli have several basal spines both above and below, their apices are black, acute and horny. The legs of the last pair are smooth, with the terminal portion densely pubescent.

The first abdominal segment bears two small submedian spines, the second bears a pair of large size and has a raised posterior border, the penultimate segment has two small spines on its posterior border.

The above description is taken from a male. The female is of larger size and presents the following points of difference—the rostrum is shorter, especially its terminal portion, the chelipedes are less strongly developed, the plates on the left side of the abdomen possess a few marginal spines, and the central abdominal tubercles show a tendency to become spiny; the right border of the abdomen also is armed with a series of elongated spines.

Lithodes murrayi is apparently most closely allied to *Lithodes maia*, but the latter species is of larger size, and the spines on the carapace are more numerous and more uniformly equal in size.

The following are the chief measurements in both sexes:—

	Male.	Female.
Breadth of carapace,	59 mm.	66 mm.
Length of carapace,	64 ,,	73 ,,
,, of rostrum,	23 ,,	21 ,,
,, of right chelipede,	94 ,,	96 ,,
,, of first ambulatory limb,	167 ,,	157 ,,
,, of abdomen,	40 ,,	61 ,,
Diameter of eggs, nearly	...	2 ,,

Habitat.—Station 145A, off Prince Edward Island; depth, 310 fathoms; bottom, volcanic sand.

Two specimens, a male and a female, the latter bearing ova, are in the collection.

I have pleasure in associating this fine species with the name of the Director of the Challenger Commission.

Genus *Paralomis*, White.

Paralomis, White, Proc. Zool. Soc. Lond., p. 134, 1856, *sine descr.*
,, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 69, 1858.

Rostrum usually trispinose. Antennal acicle spinulous and freely movable on the second segment of the peduncle. Abdomen with the lateral plates of the third, fourth, and fifth segments subequal in the female, the median portion with a series of large calcareous plates.

The only previously well-established member of this genus is *Paralomis verrucosus*, Dana, from Fuegia. A second as yet undescribed species was taken by the "Talisman," from the deep water of the Bay of Biscay. The *Lithodes granulosus*, Jacquinot and Lucas, from Fuegia, is probably founded on a young and imperfect specimen of *Paralomis verrucosus*, but the latter name though issued subsequently must in any case be retained.

Paralomis verrucosus (Dana).

Lithodes verrucosus, Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 428, pl. xvi. fig. 16, 1852.
,, ,, Cunningham, Trans. Linn. Soc. Lond. (Zool.), vol. xxvii. p. 494, 1871.
Paralomis verrucosus, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 69, 1858.
,, ,, Miers, Proc. Zool. Soc. Lond., p. 71, 1881.
? *Lithodes granulosus*, Jacquinot and Lucas, Voy. au Pol Sud, Invert., pl. viii. fig. 15, 1855.

Habitat.—Specimens of this common Fuegian species were taken in the following localities:—

Station 316, Port Louis, Falkland Islands; depth, 4 fathoms; bottom, mud. A male, with the legs and under surface of the trunk thickly covered by Hydroids.

Label illegible. A male.

Port Stanley, Falkland Islands. A large male.

Paralomis aculeatus, n. sp. (Pl. V. fig. 1).

Characters.—The carapace is ovate, with the length (excluding the rostrum) slightly greater than the breadth, the regions well defined, and the surface uniformly covered with spiniform tubercles. The rostrum is trispinose, the two upper spines slightly diverging, directed forwards and upwards, the lower considerably larger and curved directly forwards; a single spine exists on either side at the junction of the rostrum with the carapace. The gastric region is very convex, and the tubercles become markedly spiniform towards its anterior and lateral boundaries. The cardiac area is well defined and somewhat triangular in outline; a moderately deep groove separates it from the gastric region. The branchial area is slightly convex, and the tubercles are crowded together, with a decided tendency to become spinulous; the cervical groove is represented by a shallow depression. The antero-lateral border of the carapace is marked by a prominent spine which is placed at the outer border of the ill-defined orbit and is separated by a considerable interval from the first lateral spine. The lateral border is armed with a series of prominent acute spines, about twelve in number, interspersed with somewhat smaller projections. The posterior border is slightly raised and possesses a double row of acute conical tubercles.

The eyes are of moderate size and situated close together, the peduncles with a few small tubercles, one of which is terminal in position and acute; the corneæ are oblique and deeply pigmented. The antennular peduncle slightly exceeds the antennar and the basal joint of the former is elongated. The first joint of the antennal peduncle bears a small spine on its outer and lower surface, the second bears two of larger size in a similar position and one on the superior surface; the acicle is four-spined and has a basal tubercle; the flagellum is not quite equal in length to the carapace. The external maxillipedes have the three terminal joints subequal in size, the serrated internal lobe of the ischium is well marked; the sternum connecting these two appendages is bispinose. The pterygostomial region terminates anteriorly in an acute spine.

The chelipedes are subequal in length but the right slightly stouter; the ambulatory limbs are long and armed with numerous aculeate spines and stiff hairs, especially on the upper and posterior surfaces. The merus of the chelipedes bears two prominent distal spines on the inner border, the carpus also possesses several on its superior surface, the propodus has but few, and the fingers are slightly excavated. The ambulatory limbs have the spines very prominent on the meral, carpal, and propodal joints; the dactyli are compressed and slightly curved, terminating in black horny tips, with a row of horny spines articulated to the lower border. The legs of the last pair have the terminal joints pubescent.

The abdomen of the single specimen (a male) has the plates slightly uneven and covered with tufts of bristle-like hairs; the second segment is armed in a similar way to the carapace.

The following are the measurements: breadth of carapace 39 mm., length of carapace 42 mm., of rostrum 8·5 mm., of right chelipede 70 mm., of first ambulatory limb 98 mm., of last leg 25 mm., of abdomen 32 mm.

Habitat.—Station 145A, off Prince Edward Island; depth, 310 fathoms; bottom, volcanic sand. Taken along with *Lithodes murrayi*.

Paralomis formosus, n. sp. (Pl. V. fig. 2).

Characters.—The carapace is broadly ovate, with the length and breadth subequal, everywhere covered with pearly granulations, which are mostly arranged in groups; the regions are fairly well marked. The rostrum is composed of three subequal spines, the two upper considerably elevated and widely diverging; the lower almost horizontal. The gastric area is convex, and bears towards its centre a conical and acute spine of large size, with, on either side and slightly posterior, a small tubercle, and two short pyramidal processes at the posterior part of the area. The surface of the gastric spine, as in the case of all the other spines found on this species, is granulated. The cardiac area is convex and moderately circumscribed, capped by four tubercular spines arranged as if at the four angles of a square; the groove which separates this region from the gastric area is smooth and devoid of granulations. The branchial area possesses a prominent and acute spine opposite the centre of the cardiac area, and towards the posterior border of the carapace one or two tubercles. The cervical groove is represented on the surface of the carapace by an irregular, sparingly granulated depression, at the anterior end of which there is a smooth oval elevation. The external orbital spine arises internally to but in line with the antero-lateral spine, the lateral border is armed with five or six spines, two of which are situated in front of the cervical groove, while the two immediately behind this are largest in size; the second spine is curved forwards and inwards. The posterior border possesses one or two tubercular spinules on each side and from four to six small subcentral tubercles.

The ocular peduncles are granulated above, and, as in the last species, terminate in a small spine; the corneæ are oblique and deeply pigmented. The second joint of the antennular peduncle extends to a point opposite the end of the antennar peduncle; the first joint of the latter possesses a prominent and acute external spine, the second bears one of much larger size with a secondary projection at its base; the squame is quadrispinose, two of the spines being of small size. The merus of the external maxillipedes is slightly granulated externally. The pterygostomial region bears a somewhat blunt spine anteriorly.

The chelipedes and ambulatory limbs are long, and as in the case of the carapace covered with fine granulations, which are more numerously arranged on the upper surface. The chelipedes are subequal in length, the right being stouter; the meral joint is furnished with two prominent spines on its inner and distal border, and several are also present on the carpus, the two posterior of these being of large size and curved; the propodus bears a double row of large tubercles on its outer surface, and a series of tubercular spines on the upper border; the fingers are each provided with three rounded teeth and numerous tufts of hairs. The meral, carpal, and propodal joints of the ambulatory limbs are bordered anteriorly by stout spiniform processes, of which one at the distal end of the merus and carpus respectively is most prominent; the posterior border of the merus and propodus bears a somewhat smaller series; the propodi are moderately curved, tipped with dark corneous spines, and fringed inferiorly by a row of horny spines.

The abdominal plates are distinctly granulated; the second segment bears two blunt spines on a mesial elevation, and two subcentral tubercles on the posterior border; the penultimate segment bears a terminal projection on each side, and the telson is bituberculate.

The above description is taken from a male. In the female, which is of slightly arger size, the spines on the carapace are comparatively more strongly developed.

The following are the chief measurements in both sexes :—

	Male.	Female.
Breadth of carapace,	14·5 mm.	15·8 mm.
Length of carapace,	14·5 ,,	16 ,,
,, of rostrum,	4 ,,	4·5 ,,
,, of right chelipede,	22 ,,	24 ,,
,, of first ambulatory limb,	28 ,,	31·5 ,,
,, of last leg,	8 ,,	9 ,,
,, of abdomen,	10 ,,	11·5 ,,

Habitat.—Station 320, off Rio Plata; depth, 600 fathoms; bottom, green sand. Two adult specimens (male and female), and two immature.

Section B. PAGURODEA.

Paguriens, Milne-Edwards, Ann. d. Sci. Nat., sér. 2, t. vi. p. 262, 1836; Hist. Nat. des Crust., t. ii. p. 209, 1837.
Paguroidea, De Haan, Crust. Japon., p. 197, 1850.
Paguridea, Dana, U.S. Explor. Exped., vol. xiii., Crust., part. i. p. 401, 1852.
,, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 70, 1858.
,, Miers, Catal. New Zealand Crust., p. 61, 1876.
,, Haswell, Catal. Austral. Crust., p. 152, 1882.

Carapace elongate, the part posterior to the cervical groove membranaceous, or less firm than the anterior portion. Chelipedes and the two anterior pairs of legs well developed, the ultimate and penultimate pairs of small size, and one or both usually chelate. Thoracic sterna linear. Abdomen spirally twisted, or extended, and usually membranous, the tergal elements as a rule rudimentary; abdominal appendages present in both sexes, consisting of a pair always present on the penultimate (sixth) segment, and of usually a single biramous limb present only on the left side of the second to the fifth segments inclusive, the first three of these well developed and ovigerous in the females.

The Hermit Crabs occur in all seas from between tide marks down to very great depths (over 2000 fathoms); they are most numerously represented, however, in shallow water, and a few forms are even subterrestrial. Numerous structural modifications are met with in the different genera, and these, as might be expected, are chiefly confined to the form of the abdomen, that part of the body having suffered most from the curious shell-inhabiting instinct noticeable in the majority of the species. There is every reason to believe that the Hermit Crabs of the present day are descendants of a race of Thalassinid-like ancestors, owing both their form and their persistence to the above-mentioned habit. Many of the species live in a state of commensalism with an Actinia which adheres to the exterior of the shell, and in some cases at least the two are invariably found together.

The Pagurodea are divisible into two branches according to the structure of the gills, whether of the normal phyllobranchiate type as in other Anomura, or of the tricho-branchiate type as in many Macrura. These may be termed Laminibranchiata and Fibribranchiata respectively.

LAMINIBRANCHIATA.

Family I. CŒNOBITIDÆ.

Cœnobitidæ, Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 432, 1852.
„ Stimpson, Proc. Acad. Nat. Sci. Philad., p. 70, 1858.
„ Haswell, Catal. Austral. Crust., p. 159, 1882.

Antennular peduncle greatly elongated, the first joint deflexed and as long as or exceeding the eye-stalks, the second and third joints narrow and cylindrical; one of the flagella enlarged. Antennal peduncle compressed, the terminal joint long. Species subterrestrial.

This family includes the genera *Birgus* and *Cœnobita*, the species of which are confined to tropical and subtropical regions. Their affinity with *Lithodes*, which was noticed by Milne-Edwards, though he did not accordingly group them together, is well seen in the form of the abdomen.

Genus *Birgus*, Leach.

Birgus, Leach, Trans. Linn. Soc. Lond., vol. xi. p. 337, 1815.
„ Desmarest, Consid. sur les Crust., p. 180, 1825.
„ Milne-Edwards, Hist. Nat. des Crust., t. ii. p. 244, 1837.
„ De Haan, Crust. Japon., p. 203, 1850.
„ Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 435, 1852.
„ Stimpson, Proc. Acad. Nat. Sci. Philad., p. 70, 1858.

Carapace broadly ovate, with a prominent rostrum in front. Ocular peduncles cylindrical. Abdomen not twisted, broad, the second, third, fourth and fifth segments each with a large, corneo-calcareous, overlapping tergal plate, which occupies the whole width of the segment, and with smaller lateral plates. Under surface of the abdomen membranous, with a plate situated posteriorly, which represents the sixth segment and is provided with a rudimentary appendage on each side; attached to this is a telson of small size. Respiratory chambers spacious, containing fourteen gills on each side, and in addition vascular pulmonary outgrowths.

Birgus latro (Linné).

Cancer crumentatus, Rumphius, D'Amboinische Rariteitkamer, p. 7, taf. iv., 1705.
„ „ Seba, Thesauri Rerum Natur., t. iii., tab. xxi. figs. 1, 2, 1761.
„ *latro*, Linné, Syst. Nat., ed. xii., t. ii. p. 1049, 1766.
„ „ Herbst, Naturgeschichte der Krabben u. Krebse, t. ii, tab. xxiv. p. 34, 1796.
Pagurus latro, Fabricius, Suppl. Ent. Syst., p. 411, 1798.
„ „ Bosc, Hist. Nat. des Crust., t. ii. p. 76, 1802.
„ „ Latreille, Hist. Nat. des Crust. et Insect., t. vi. p. 164, 1802.
„ „ Olivier, Ency. Méth., t. viii. p. 639, Atlas, pl. cclxxxii., 1811.
„ „ Lamarck, Hist. Anim. sans Vert., t. v. p. 221, 1818.
Birgus latro, Leach, Trans. Linn. Soc. Lond., vol. xi. p. 337, 1815.
„ „ Quoy and Gaimard, Voy. de l'Uranie, pl. lxxx., 1824.
„ „ Desmarest, Consid. sur les Crust., p. 180, pl. xxx. fig. 3, 1825.
„ „ Milne-Edwards, Hist. Nat. des Crust., t. ii. p. 246, 1837; in Cuvier, Règne Anim., éd. 3e, Crust., pl. xliii. fig. 1, no date.
„ „ De Haan, Crust. Japon., p. 212, 1850.
„ „ Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 474, pl. xxx. fig. 5, 1852.
„ „ Hilgendorf, in Van der Decken's Reisen in Ost-Afrika, Crust., p. 100, 1869.
„ „ Brocchi, Ann. d. Sci. Nat., sér. 6, t. ii. p. 34, pl. xv. fig. 44, 1875.
„ „ Willemoes Suhm, Zeitschr. f. wiss. Zool., Bd. xxvi. p. 73, 1875.
„ „ Grube, Jahresb. Schles. Ges., p. 76, 1878.
„ „ Semper, Zeitschr. f. wiss. Zool., Bd. xxx. p. 282, 1878.
„ „ Miers, Crust. in Zool. H.M.S. "Alert," p. 555, 1884.
juv. Birgus laticauda, Latreille, Règne Anim., éd. 2e, t. iv., pl. xii. fig. 2, 1829.
„ „ Desmarest, Consid. sur les Crust., p. 180, 1825.

Habitat.—Philippine Islands. Several large specimens of both sexes.

Ternate, October 15, 1874; a young female.

Birgus latro is the largest and one of the most widely distributed of Indo-Pacific Pagurids.

Genus *Cœnobita*, Latreille.

Cenobita, Latreille, Fam. Nat. du Règne Anim., p. 276, 1826.
Cœnobita, Latreille, Cuvier, Règne Anim., éd. 2e, t. iv. p. 77, 1829.
Cenobita, Milne-Edwards, Hist. Nat. des Crust., t. ii. p. 238, 1837.
„ De Haan, Crust. Japon., p. 203, 1850.
„ Dana, U.S. Explor. Exped., vol. xiii., Crust., part. i. p. 435, 1852.
„ Stimpson, Proc. Acad. Nat. Sci. Philad., p. 70, 1858.
„ Haswell, Catal. Austral. Crust., p. 160, 1882.
Cœnobita, Hilgendorf, in Van der Decken's Reisen in Ost-Afrika, Crust., p. 97, 1869.

Carapace elongated, the rostrum but slightly marked. Ocular peduncles compressed. Chelipedes markedly unequal, the left larger. Abdomen soft and membranous, twisted on itself. First five abdominal segments with narrow tergal plates, the sixth with a well-developed pair of appendages (of which the left is larger), followed by a well-marked telson. The species protect themselves by means of shells.

Cœnobita clypeata (Herbst).

Cancer clypeatus, Herbst, Naturg. Krabben u. Krebse, t. ii. p. 22, taf. xxiii. fig. 2, 1796.
Pagurus clypeatus, Fabricius, Suppl. Ent. Syst., p. 413, 1798.
Cenobita clypeata, Latreille, Fam. Nat. du Règne Anim., p. 277, 1826.
„ „ Milne-Edwards, Hist. Nat. des Crust., t. ii. p. 239, 1837.
„ „ Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 473, pl. xxx. fig. 4, 1852.
„ „ Heller, Reise der Novara, Crust., p. 82, 1865.
Cœnobita clypeata, Latreille, Règne Anim. de Cuvier, éd. 2e, t. iv. p. 77, 1829.
„ „ Miers, Ann. and Mag. Nat. Hist., ser. 5, vol. v. p. 371, 1880.
„ *clypeatus*, Hilgendorf, in Van der Decken's Reisen in Ost-Afrika, Crust., p. 98, taf. vi. figs. 3*c*, 4*a*, 1869.

Habitat.—Wild Island, Admiralty Islands. A large male specimen, in a shell of *Dolium perdix*, Linn.

This species is extensively distributed over the Indo-Pacific region, ranging from the east coast of Africa to the islands of the Pacific.

Cœnobita rugosa, H. Milne-Edwards.

Cenobita rugosa, Milne-Edwards, Hist. Nat. des Crust., t. ii. p. 241, 1837.
„ „ Krauss, Südafrik. Crust., p. 58, 1843.
„ „ De Haan, Crust. Japon., p. 212, 1850.
„ „ Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 471, pl, xxx. fig. 1, 1852.
„ „ Stimpson, Proc. Acad. Nat. Sci. Philad., p. 83, 1858.
„ „ Heller, Sitzungsb. Akad. Wien, p. 254, pl. xliv. fig. 1, 1862; Reise der Novara, Crust., p. 82, 1865.
„ „ Haswell, Catal. Austral. Crust., p. 160, 1882.
Cœnobita clypeata, Owen, Crust. "Blossom," p. 85, pl. xxv. fig. 3, 1839.
Cœnobita rugosus, Hilgendorf, in Van der Decken's Reisen in Ost-Afrika, Crust., p. 99, taf. vi. figs. 2, 3*a*, 4*b*, 1869.
„ *rugosa*, Targioni Tozzetti, Crostac. "Magenta," p. 232, pl. xiii. fig. 6, 1877.
„ „ Miers, Ann. and Mag. Nat. Hist., ser. 5, vol. ii. p. 410, 1878; Phil. Trans. Roy. Soc., vol. clxviii. p. 492, 1879.
„ „ Richters, Decapoda in Möbius, Beiträge zur Meeresfauna der Insel Mauritius und der Seychellen, p. 160, pl. xvii. figs. 14–17, 1880.

Habitat.—The collection contains a large series of this common and almost ubiquitous Indo-Pacific species from the following localities:—

Tracy Island, Nares Harbour, Admiralty Islands. In shells of *Cerithium* (*Vertagus*) *martinianum*, Pfeiffer.

Wild Island, Admiralty Islands, shore. In shells of *Trochus* (*Chrysostoma*) *paradoxus*, Born.

Kandavu, Fiji Islands, July 1874, and August 1874 (from the shore).

Api, New Hebrides, shore. In the shell of *Natica albumen*, Linn.

Tahiti, near the reefs, September 28, 1875. In the shells of a species of *Melania* (a fresh-water Mollusc).

Wokan Dobbo, Arrou Islands, shore.

Cœnobita perlata, H. Milne-Edwards.

Cenobita perlata, Milne-Edwards, Hist. Nat. des Crust., t. ii. p. 242, 1837; in Cuvier, Règne Anim., éd. 3e, Crust., pl. xliv. fig. 1, no date.
,, ,, De Haan, Crust. Japon., p. 213, 1850.
? ,, *purpurea*, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 83, 1858.
Cœnobita perlata, Brocchi, Ann. d. Sci. Nat., sér. 6, t. ii. p. 40, pl. xv. figs. 45–47, 1875.
,, ,, Miers, Ann. and Mag. Nat. Hist., ser. 5, vol. v. p. 372, 1880; Crust. in Zool. H.M.S. "Alert," p. 555, 1884.

Habitat.—Specimens from the following localities are with some hesitation referred to this species:—

Kandavu, Fiji Islands, shore, August 1874. Two males, one of considerable size, the smaller in a shell of *Bulimus* (*Placostylus*) *seemanni*, Dohrn (a terrestrial Mollusc).

Api, New Hebrides, shore. A female, of small size, in a shell of *Natica albumen*, Linn.

Cœnobita perlata occurs at widely separate localities throughout the Pacific.

Family II. Paguridæ.

Paguridæ, Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 435, 1852.
,, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 70, 1858.

Antennular peduncle of moderate size, the first joint short and stout, the second and third slender and cylindrical; both flagella of small size. Antennal peduncle subcylindrical. Species marine.

This family includes the greater number of known Pagurids. A synoptical arrangement of genera, partly based on the tables furnished by Dana and Stimpson, is given below:—

I. Abdomen spirally twisted or bent abruptly, soft and membranous, the segmentation imperfect (Pagurinæ, Dana).
  1. First and second abdominal segments without genital appendages.
    a. Fourth pair of legs chelate or subchelate. Males without a protruded vas deferens.
      Diogenes, Dana. | *Clibanarius*, Dana.
      Pagurus (Fabricius), Dana. | *Isocheles*, Stimpson.
      Aniculus, Dana. | *Eupagurus*, Brandt.
      Calcinus, Dana. | *Ostraconotus*, A. Milne-Edwards.
    b. Fourth pair of legs subchelate. Males with a protruded vas deferens.
      Spiropagurus, Stimpson. | *Catapagurus*, A. Milne-Edwards.
      Anapagurus, Henderson.
  2. First and second abdominal segments provided with genital appendages (the first segment only in the female).
      Paguristes, Dana. | *Tylaspis*, n. gen.
      Sympagurus, S. I. Smith.

II. Abdomen not spirally twisted, composed of distinct movable segments which are usually calcified (Cancellinæ, Dana).
      Cancellus, Milne-Edwards. | *Pomatocheles*, Miers.
      Glaucothoë, Milne-Edwards. | *Mixtopagurus*, A. Milne-Edwards.
      ? *Xylopagurus*, A. Milne-Edwards.

Two of the genera, viz., *Ostraconotus* and *Tylaspis*, agree in having the posterior part of the carapace broad and firm, and the abdomen poorly developed, characters in which they differ from all other Paguridæ.

Genus *Diogenes*, Dana.

Diogenes, Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 438, 1852.
,, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 70, 1858.
,, Heller, Crust. südlichen Europa, p. 169, 1863.
,, Haswell, Catal. Austral. Crust., p. 156, 1882.
,, Henderson, Proc. Roy. Phys. Soc. Edin., vol. ix. part i. p. 66, 1886.

Front with a movable rostriform process situated between the ocular peduncles, but distinct from the rostrum. Antennal acicle with a broad base, occasionally bifid; the flagellum ciliated and frequently short. Chelipedes unequal, the left larger; fingers moving in an oblique plane. Second and third pairs of legs with long dactyli; the fourth pair subcheliform.

Diogenes custos (Fabricius).

Pagurus custos, Fabricius, Suppl. Ent. Syst., p. 412, 1798.
,, ,, Latreille, Hist. Nat. des Crust. et Insect., t. vi. p. 165, 1802.
,, ,, Olivier, Ency. Méth., t. viii. p. 644, 1811.
,, ,, Milne-Edwards, Ann. d. Sci. Nat., sér. 2e, t. vi. p. 284, 1836; Hist. Nat. des Crust., t. ii. p. 236, 1837.
Diogenes custos, Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 439, pl. xxvii. fig. 10, 1852.
,, ,, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 83, 1858.
,, ,, Hess, Decapoden-Krebse Ost-Australiens, p. 35, 1865.
,, ,, Haswell, Catal. Austral. Crust., p. 157, 1882.

Habitat.—Port Jackson; depth, 2 to 10 fathoms. An adult male. It is recorded by Stimpson from the same locality, and by Dana also from New South Wales.

Diogenes custos extends from the Australian seas to the shores of India.

Diogenes brevirostris, Stimpson (Pl. VI. fig. 3).

Diogenes brevirostris, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 83, 1858.
,, ,, Studer, "Gazelle" Crust., Abhandl. d. k. Akad. d. Wiss. Berlin, p. 23, 1883.

Habitat.—Simon's Bay; depth, 10 to 20 fathoms. A female with ova, in an imperfect state of preservation.

Stimpson's types were from the above locality. This species may eventually prove to be synonymous with *Diogenes varians* (Costa), as the latter appears to be subject to considerable variation. The Challenger specimen differs, however, from the typical form of *Diogenes varians*, in having the left chelipede with a tendency towards spinulation on its joints, and the lower border of the propodus curved; the ophthalmic scales also are sparingly dentate.

Diogenes guttatus, n. sp. (Pl. VI. fig. 4).

Characters.—The anterior portion of the carapace is slightly convex from side to side and smooth towards the centre; the front with its median process faintly marked, but a conspicuous projection external to each ophthalmic scale; the antero-lateral border (posterior to the insertion of the antennal peduncle) with an abrupt slope backwards, and armed with a few minute spinules; the lateral margin with about six acute curved spinules. The central portion of the carapace behind the cervical groove has a few granulations.

The rostriform process is entire, narrowing towards the acute apex which scarcely reaches the end of the ophthalmic scales; the latter are subentire, with two or three spinules at the inner and distal margin. The ocular peduncles extend to a point opposite the middle of the terminal joint of the antennal peduncle and the commencement of the same joint in the antennular peduncle. The antennal acicle is short, not reaching beyond the middle of the penultimate joint of the peduncle, and its inner border is quadrispinose; the second joint of the peduncle is broad, and possesses a prominent external spine; the flagellum is not twice the length of the carapace, and its under surface is fringed with long hairs.

The left chelipede has the meral and carpal joints subequal, slightly pubescent, and covered with spinuliform granulations, most strongly marked towards the borders, on which they become distinctly spinulous; the inner surface of the carpus is convex; the propodus is about one and a half times the length of the carpus, its outer surface is covered with perfectly circular, drop-like, and flattened elevations, the upper and lower borders are spinulous and almost straight; on the outer surface and near the carpal articulation are three curved denticles situated near the lower border, the inner surface is faintly granular; the dactylus has a series of dentations on the upper border and numerous granulations on the outer surface, the lower border is minutely toothed; the immobile finger has an obscure median ridge on the upper surface and numerous small teeth on the inner margin. The right chelipede is wanting in the single specimen. The first and second pairs of ambulatory limbs are smooth and sparingly ciliated, with a few spinules on the anterior borders of the meral joints; the dactyli are slightly bent, longitudinally canaliculate on the upper surface, and considerably longer than the propodi. The penultimate joint of the fourth leg has its lower border spinose.

The two terminal segments of the abdomen are smooth and moderately convex, the ultimate is longitudinally channelled.

Length of body[1] 13 mm., of carapace 6·8 mm., of left chelipede 15 mm., of first ambulatory limb 18·5 mm.

The peculiar markings on the left hand at once distinguish *Diogenes guttatus* from all other species of the genus. In some respects it approaches *Diogenes rectimanus*, Miers, but in this latter the outer surface of the hand is granulated and pubescent, and the lower border armed with strong spinules.

Habitat.—Station 187, Torres Strait; depth, 6 fathoms; bottom, coral mud. A single male specimen.

Genus *Pagurus*, Fabricius.

Pagurus, Fabricius, Suppl. Ent. Syst., p. 411, 1798 (*in part*).
,, Milne-Edwards, Ann. d. Sci. Nat., sér. 2e, t. vi. p. 262, 1836; Hist. Nat. des Crust., t. ii. p. 213, 1837 (*in part*).
,, De Haan, Crust. Japon., p. 202, 1850 (*in part*).
,, Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 449, 1852.
,, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 71, 1858.
,, Heller, Crust. südlichen Europa, p. 174, 1863.
,, Miers, Catal. New Zealand Crust., p. 65, 1876.
,, Haswell, Catal. Austral. Crust., p. 155, 1882.
,, Henderson, Proc. Roy. Phys. Soc. Edin., vol. ix. part i. p. 67, 1886.

Front without a distinct rostral projection. Ocular peduncles stout, frequently constricted towards the middle, the basal scales of moderate size and usually separated by a considerable interval. Antennal acicle short and robust, the flagellum long and naked. Chelipedes rarely subequal, the left usually larger; fingers moving in a vertical plane, slightly excavated internally, and corneous at the tips. Penultimate pair of legs chelate.

Pagurus striatus, Latreille.

Cancer arrosor, Herbst, Naturg. Krabben u. Krebse, t. ii. p. 170, Taf. xliii. fig. 1, 1796.
Pagurus strigosus, Bosc, Hist. Nat. des Crust., t. ii. p. 77, 1802.
,, *striatus*, Latreille, Hist. Nat. des Crust. et Insect., t. vi. p. 163, 1802.
,, ,, Olivier, Ency. Méth., t. viii. p. 643, 1811.
,, ,, Risso, Crust. de Nice, p. 54, 1816.
,, ,, Desmarest, Consid. sur les Crust., p. 178, 1825.
,, ,, Roux, Crust. de la Médit., pl. x., 1828.
,, ,, Milne-Edwards, Ann. d. Sci. Nat., sér. 2e, t. vi. p. 270, 1836; Hist. Nat. des Crust., t. ii. p. 218, 1837.
,, ,, Costa, Fauna del Regno di Napoli, p. 7, 1845.
,, ,, Lucas, Anim. art. de l'Algér. Crust., p. 29, 1849.
,, ,, De Haan, Crust. Japon., p. 206, tab. xlix. fig. 1, 1850.
,, ,, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 84, 1858.

[1] Measured from the apex of the rostrum or median point of the frontal margin to the apex of the telson.

Pagurus striatus, Heller, Crust. südlichen Europa, p. 174, 1863.
,, ,, Brocchi, Ann. d. Sci. Nat., sér. 6e, t. ii. p. 34, pl. xiv. figs. 35–39; pl. xv. fig. 43, 1875.
,, ,, Miers, Ann. and Mag. Nat. Hist., ser. 5, vol. viii. p. 274, 1881.
,, ,, Studer, "Gazelle" Crust., Abhandl. d. k. Akad. d. Wiss. Berlin, p. 23, 1883.
,, *incisus*, Lamarck, Hist. Anim. sans Vert., t. v. p. 220, 1818.
,, ,, Latreille, Ency. Méth., Atlas., pl. cccx., 1818.
juv. Savigny, Descr. de l'Egypte, Zool. Crust., pl. ix. fig. 1, 1809–22 (*nomen nullum*).

Habitat.—Reefs, Zebu, Philippines. An adult male, in a shell covered by several specimens of a spotted Anemone.

Stations 204A, 204B, off Tablas Island; depth, 100 to 115 fathoms; bottom, green mud. An adult male, in a shell of *Ranella fijiensis*, Watson, with a single specimen of apparently the same species of spotted Anemone.

The true home of this species is the Mediterranean and north-west coast of Africa; its occurrence in the Oriental region is therefore a matter of extreme interest, for at present there is no evidence to show that it is cosmopolitan in its distribution. It has been previously recorded from Japan by De Haan, who states that on comparing Japanese and Mediterranean specimens no points of distinction could be found; a similar comparison of the Challenger specimens has in like manner failed.

Pagurus granulatus, Olivier.

Cancellus maximus Bahamensis, Catesby, Nat. Hist. Carolina, Florida, and the Bahama Islands, vol. ii. tab. xxxiv., 1731–43.
Macáo, Parra, Descripcion de differentes piezas de historia natural, tab. lxi., 1787.
Pagurus granulatus, Olivier, Ency. Méth., t. viii. p. 640, 1811.
,, ,, Lamarck, Hist. Anim. sans Vert., t. v. p. 220, 1818.
,, ,, Milne-Edwards, Ann. d. Sci. Nat., sér. 2e, t. vi. p. 275, 1836; Hist. Nat. des Crust., t. ii. p. 225, 1837.
,, ,, Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 453, 1852.
,, ,, E. v. Martens, Archiv f. Naturgesch., vol. xxxviii. p. 120, 1872.
Petrochirus granulatus, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 71, 1858.
,, ,, Heller, Reise der Novara, Crust., p. 85, 1865.

Habitat.—Simon's Bay; depth, 10 to 20 fathoms. Two males, the body of the larger measuring $7\frac{1}{2}$ inches (0·190 mètre) in length.

This species—one of the largest of known Pagurids—belongs to the West Indian region, extending as far south as Rio Janeiro, from which locality it is recorded by Dana and Heller; its occurrence at the Cape is therefore of interest as greatly increasing its range of distribution. It was constituted by Stimpson the type of his genus *Petrochirus*, on grounds which appear to be of specific rather than of generic importance.

Pagurus calidus, Risso.

Pagurus callidus, Risso, Hist. Nat. de l'Eur. Mérid., t. v. p. 29, 1826.
" " Roux, Crust. de la Médit., pl. xv., 1828.
" " Milne-Edwards, Ann. d. Sci. Nat., sér. 2e, t. vi. p. 271, 1836; Hist. Nat. des Crust., t. ii. p. 220, 1837.
" " Lucas, Anim. art. de l'Algér., Crust., p. 29, 1849.
" *calidus*, White, Catal. Crust. Brit. Mus., p. 59, 1849.
" " Heller, Crust. südlichen Europa, p. 176, 1863.
" *diogenes*, Costa, Fauna del Regno di Napoli, Crust., p. 5, 1845.

Habitat.—St. Vincent, Cape Verdes. Three specimens (two adult and one young), the largest inhabiting a shell which is covered by Anemones. Bands of a brilliant red colour are still visible on the carapace, ocular peduncles, and ambulatory limbs.

Station VIIP, off Gomera, Canaries; depth, 78 fathoms; bottom, volcanic sand. A single immature specimen.

Pagurus calidus is a well-known Mediterranean species. It is recorded by Miers from Madeira and the Canaries.

Pagurus deformis, H. Milne-Edwards.

Pagurus deformis, Milne-Edwards, Ann. d. Sci. Nat., sér. 2e, t. vi. p. 272, pl. xiii. fig. 4, 1836; Hist. Nat. des Crust., t. ii. p. 222, 1837.
" " Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 449, 1852.
" " Stimpson, Proc. Acad. Nat. Sci. Philad., p. 84, 1858.
" " Heller, Reise der Novara, Crust., p. 86, 1865.
" " Hilgendorf, Monatsber. d. k. preuss. Akad. d. Wiss. Berlin, p. 818, taf. iii. figs. 6, 7, 1878.

Habitat.—Reefs, Papeite. A single incomplete specimen (with the chelipedes wanting) is apparently referable to this widely distributed Indo-Pacific species.

Pagurus imbricatus, H. Milne-Edwards.

Pagurus imbricatus, Milne-Edwards, Ann. d. Sci. Nat., sér. 3e, t. x. p. 61, 1848.
" " Miers, Catal. New Zealand Crust., p. 66, 1876; Crust. in Zool. H.M.S. "Alert," p. 264, 1884.

Habitat.—Station 186, Flinders Passage; depth, 8 fathoms; bottom, coral mud.

A female specimen (in spirit) has the imbricated scales which cover the chelipedes and ambulatory limbs of a beautiful deep red colour, those on the propodal joint of the larger chela marked by conspicuous white tubercles.

Pagurus imbricatus has been taken only in the New Zealand and Australian seas.

Pagurus euopsis, Dana.

Pagurus euopsis, Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 452, pl. xxviii. fig. 6, 1852.

Habitat.—Station 172, off Nukalofa, Tongatabu; depth, 18 fathoms; bottom, coral mud.

Two specimens (male and female) agree closely with Dana's description, though the colours have somewhat faded. The joints of the apical half of the antennal flagellum are characteristically gibbous on the inner side, and the hairs on the limbs are of a reddish colour, tipped with white.

The types came from Upolu, Navigator Group, and Balabac Passage.

Pagurus dearmatus, n. sp. (Pl. VI. fig. 5).

Characters.—The anterior portion of the carapace is somewhat square in outline with a projection external to the insertion of each ocular peduncle, the surface tolerably smooth, with a few hairs towards the margins; the posterior portion is entirely membranous.

The ocular peduncles are of large size, slightly flattened from above downwards, and constricted towards the middle, which is crossed by a broad red band; the corneæ are deeply pigmented and semilunar in outline when seen from above; the ophthalmic scales are broad at the base, their apices with three or four spines each. The antennal peduncles extend almost to the end of the eye-stalks and are sparingly ciliated, the acicle is of small size, not reaching beyond the distal end of the penultimate joint, the second joint is moderately broad, with a slightly marked external prolongation. The terminal joint of the antennular peduncle extends slightly beyond the apices of the eye-stalks.

The left chelipede is considerably larger than the right, with its basal joints sparingly ciliated; the lower border of the merus is sharp and granulated; the carpus is somewhat trigonal, the upper border with two or three curved denticles, the outer surface with a few granulations towards the anterior border; the propodus is more than equal in length to the merus and carpus taken together, its outer surface uniformly covered with fine granulations, which show a tendency to become slightly coarser towards the apex of the immobile finger, the upper border with a series of small denticles; the outer surface of the dactylus is coarsely granular and its lower border irregularly dentate (as is also the corresponding border of the immobile finger), the tips of both fingers are black and corneous. The right chelipede is almost smooth, the joints being but slightly granulated, though clothed with a few hairs; the upper border of the carpus and propodus is provided with marginal denticles; both fingers possess tufts of hairs, and the lower is moderately dilated. The ambulatory limbs are smooth and but sparingly ciliated; the third left leg has the propodus dilated, with its outer surface faintly granular and a well-marked series of granules on the lower border, which is sharp; the dactylus is about one and a half times the length of the penultimate joint, with its outer surface longitudinally canaliculate, the borders are faintly granular, and fringed with hair-like setæ which become yellow and horny towards the apex.

The penultimate abdominal segment bears a T-shaped marking; the terminal segment is irregular in shape, with a sinuous margin.

Length of body 24 mm., of left chelipede 16 mm., of right chelipede 13 mm., of third left leg 22·5 mm., of ocular peduncle 5 mm.

Pagurus dearmatus is allied to *Pagurus deformis*, Milne-Edwards, and *Pagurus pedunculatus* (Herbst); it comes nearest to the latter, in which, however, the propodus of the left chelipede is both tubercular and granular on the outer surface. From *Pagurus deformis* it is distinguished by the form of the penultimate joint of the third left leg, which in that species is carinated on the outer surface.

Habitat.—Admiralty Islands, 16 to 25 fathoms. A female with ova, in a shell of *Strombus variabilis*, Sow.

Pagurus similimanus, n. sp. (Pl. VI. fig. 6).

Characters.—The anterior portion of the carapace is six-sided, the front with a well-marked projection external to the insertion of each ocular peduncle, the surface is smooth towards the middle and bounded by a Y-shaped line posteriorly; a few long hairs arranged in tufts are present towards the lateral margins; the posterior portion is entirely membranous.

The ocular peduncles are of large size and shaped as in *Pagurus deformis*, Milne-Edwards, constricted towards the middle, with the corneæ dilated and not deeply pigmented, and their outline semilunar when seen from above; a dark band runs along the inner and outer surfaces of each peduncle; the ophthalmic scales are broad at the base, their apices with three spines each and several long hairs. The antennal peduncles extend almost to the end of the eye-stalks, while the joints are broad and fringed with numerous long hairs; the acicle is of moderate size and extends beyond the distal end of the penultimate joint, while its surface is pubescent; the external prolongation of the second joint is fairly well marked. The terminal joint of the antennular peduncle extends very slightly beyond the tips of the eye-stalks.

The chelipedes are of equal size and in every respect similar to one another, belonging essentially to the form which is characteristic of the genus *Clibanarius;* the merus is trigonal, with the surface smooth, but the borders are dentate and fringed with hairs; the three terminal joints are remarkably hirsute, the hairs long, of a reddish colour, and arranged in tufts, more sparingly met with on the inner surface; the outer surface of the carpus and propodus (more especially the latter) is armed with numerous acute, corneous-tipped spines arranged in longitudinal rows, on the upper border of both joints the spines are of large size; the fingers are densely hirsute even on the inner surface, their opposed edges are armed with tubercular teeth, and their apices have a black horny external margin. The ambulatory limbs are hirsute, the hairs being confined to the margins, the anterior surface of the three terminal joints is armed with spines similar to those met with on the chelipedes, and a few spinules exist on the posterior borders of the meri. The last two pairs of legs are moderately pubescent.

The penultimate abdominal segment bears a deep T-shaped impression; the terminal segment has its sinuous margin thrown into four lobes.

Length of body 34 mm., of chelipede 26 mm., of third right leg 41 mm., of ocular peduncle 8 mm.

This species is characterised by the form of its chelipedes, which are those of a *Clibanarius* (the fingers moving almost in a horizontal plane as in that genus), though in all other respects it is a true *Pagurus;* it thus serves to illustrate the close connection which exists between these two genera.

Habitat.—Station 212, Celebes Sea; depth, 10 fathoms; bottom, sand. A female specimen, in the shell of a species of *Fusus.*

In addition to the above recorded species, the collection contains a *Pagurus* from off Port Jackson, 30 to 35 fathoms, too young to be satisfactorily identified.

Genus *Clibanarius*, Dana.

Clibanarius, Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 461, 1852.
,, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 72, 1858.
,, Heller, Crust. südlichen Europa, p. 177, 1863.
,, Miers, Catal. New Zealand Crust., p. 67, 1876.
,, Haswell, Catal. Austral. Crust., p. 159, 1882.

Front with a distinct rostral projection. Ocular peduncles usually slender, the basal scales of small size and situated close together. Antennal acicle short, the flagellum naked. Chelipedes subequal and of similar conformation; the hand small, with the fingers moving in a horizontal plane, excavated internally, and corneous at the tips. Ambulatory limbs often with longitudinal colour markings, the penultimate pair chelate.

Clibanarius strigimanus (White).

Pagurus strigimanus, White, Proc. Zool. Soc. Lond., p. 122, 1847; Ann. and Mag. Nat. Hist. ser. 2, vol. i. p. 224, 1848.

Habitat.—Station 162, off East Moncœur Island, Bass Strait; depth, 38 fathoms; bottom, sand and shells. An adult male, in a shell of *Voluta undulata*, Lam.

The type specimen in the British Museum is from Tasmania.

As in the case of *Pagurus similimanus* this species shares the characters of *Pagurus* and *Clibanarius*, though its affinities are more with the latter genus; the chelipedes are subequal, a distinct rostral projection is present, and the ocular peduncles are tolerably long and slender, at the same time the ophthalmic scales are arranged as in *Pagurus*. The special features of *Clibanarius strigimanus* are the curious striated (stridulating?) areas on the inner surface of the hand of each chelipede, and the narrow and acute terminal portions of the ophthalmic scales.

The carapace of a Pagurid from Station 192, off the Ki Islands, with a very prominent rostrum and acute ophthalmic scales, is probably referable to the genus *Clibanarius*.

Genus *Calcinus*, Dana.

Calcinus, Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 456, 1852.
,, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 72, 1858.
,, Haswell, Catal. Austral. Crust., p. 158, 1882.

Front with a distinct rostral projection. Ocular peduncles usually slender, the basal scales of moderate size and situated close together. Antennal acicle short, the flagellum naked. Chelipedes unequal, the left larger; the fingers moving in a vertical plane, excavated internally and calcareous at the tips. Second and third pairs of legs with short dactyli. Surface comparatively smooth and often highly coloured.

The species are confined to the tropics.

Calcinus tibicen (Herbst).

? *Cancer tibicen*, Herbst, Naturg. Krabben u. Krebse, t. ii. p. 25, pl. xxiii. fig. 6, 1796.
Pagurus tibicen, Latreille, Hist. Nat. des Crust. et Insect., t. vi. p. 169, 1802.
,, ,, Olivier, Ency. Méth., t. viii. p. 646, 1811.
,, ,, Milne-Edwards, Ann. des Sci. Nat., sér. 2e, t. vi. p. 278, 1836; Hist. Nat. des Crust., t. ii. p. 229, 1837; in Cuvier, Règne Anim., éd. 3e, Crust., pl. xliv. fig. 3, no date.
,, *laevimanus*, Randall, Journ. Acad. Nat. Sci. Philad., vol. viii. p. 135, 1839.
Calcinus tibicen, Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 457, 1852.
,, ,, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 85, 1858.
,, ,, Heller, Reise der Novara, Crust., p. 87, 1865.
,, ,, Hilgendorf, Monatsber. d. k. preuss. Akad. d. Wiss. Berlin, p. 823, 1878.
,, ,, Miers, Phil. Trans. Roy. Soc., vol. clxviii. p. 491, 1879; Crust. in. Zool. H.M.S. "Alert," p. 557, 1884.

Habitat.—Tahiti, near reefs, September 28, 1875. A female specimen of this widely distributed Indo-Pacific species, still retaining much of the original vivid coloration.

It has been pointed out by Hilgendorf that the description and figure of *Cancer tibicen*, Herbst, agree much better with the West Indian *Calcinus sulcatus* (Milne-

Edwards), and that the species referred by Milne-Edwards to *Pagurus tibicen* is probably distinct from that of Herbst. Herbst gives no locality, and his types have apparently been lost.

Genus *Eupagurus*, Brandt.

Eupagurus, Brandt, Middendorff's Sibirische Reise, Zool., Thl. i. p. 105, 1851.
,, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 74, 1858.
,, Heller, Crust. südlichen Europa, p. 158, 1863.
,, Miers, Catal. New Zealand Crust., p. 62, 1876.
,, Haswell, Catal. Austral. Crust., p. 152, 1882.
,, Henderson, Proc. Roy. Phys. Soc. Edin., vol. ix. part i. p. 68, 1886.
Bernhardus, Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 440, 1852.

Front with a distinct rostral projection. Ocular peduncles scarcely so massive as those of *Pagurus*, the basal scales of moderate size and separated by a wide interval. Antennal acicle elongated and slender, the flagellum long and naked. Chelipedes rarely subequal, the right usually larger; the fingers moving in a horizontal plane, and calcareous at the tips. Penultimate pair of legs subchelate.

Eupagurus contains a larger number of species than any other genus of Paguridæ.

Eupagurus excavatus (Herbst), var. *meticulosa*, Roux.

Cancer excavatus, Herbst, Naturg. Krabben u. Krebse, t. ii. p. 31, tab. xxiii. fig. 8, 1796.
Pagurus angulatus, Risso, Crust. de Nice, p. 58, pl. i. fig. 8, 1816; Hist. Nat. de l'Eur. Mérid., t. v. p. 39, 1826.
,, ,, Desmarest, Consid. sur les Crust., p. 178, 1825.
,, ,, Roux, Crust. de la Médit., pl. xli., 1830.
,, ,, Milne-Edwards, Ann. d. Sci. Nat., sér. 2e, t. vi. p. 268, 1836; Hist. Nat. des Crust., t. ii. p. 217, 1837.
,, ,, Costa, Fauna del Regno di Napoli, Crust., p. 7, 1838.
,, ,, Lucas, Anim. art. de l'Algér., p. 28, 1849.
Eupagurus angulatus, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 75, 1858.
,, ,, Heller, Crust. südlichen Europa, p. 166, 1863.
,, *excavatus*, Miers, Ann. and Mag. Nat. Hist., ser. 5, vol. viii. p. 280, 1881.
,, ,, Henderson, Proc. Roy. Phys. Soc. Edin., vol. ix. part i. p. 70, 1886 (*ubi synon*).
var. *Pagurus meticulosus*, Roux, Crust. de la Médit., pl. xlii., 1830.
,, ,, Milne-Edwards, Ann. d. Sci. Nat., sér. 2e, t. vi. p. 268, 1836; Hist. Nat. des Crust., t. ii. p. 217, 1837.
Eupagurus meticulosus, Heller, Crust. südlichen Europa, p. 167, 1863.
Pagurus tricarinatus, Norman, Brit. Assoc. Rep., p. 264, 1868.
Eupagurus tricarinatus, G. O. Sars, Norske Nordhavs-Exped., Crust., p. 11, pl. i. figs. 8–10, 1885.

Habitat.—"Label lost, probably Madeira." Two specimens, one a female with ova in a shell of *Fusus* (*Siphonorbis*) *amblyterus*, Watson.

The Rev. R. Boog-Watson, who identified the shell, states that the locality is more probably the Bay of Biscay, where *Eupagurus excavatus*, var. *meticulosa*, has more recently been taken in deep water by the "Travailleur." The spines on the carpal and propodal joints of the second pair of ambulatory limbs are almost obsolete, though well-marked on those of the first pair, and the dactylus of the right chelipede has the tip folded under that of the immobile finger. In other respects the two examples agree closely with the recently published description of Sars. In British specimens (= *Pagurus tricarinatus*, Norman) the central carina on the larger hand is more strongly marked.

St. Vincent Harbour, Cape Verdes, 7 to 20 fathoms, July 1873. A specimen in a shell of *Pisania lineata*, Gmel., is referred somewhat doubtfully to the above species. The larger chela is wanting, and the smaller has the central carina less strongly developed than usual; the ophthalmic scales are also proportionately larger.

Eupagurus excavatus is a Mediterranean and North Atlantic species; the variety ranges as far north as the Norwegian seas and appears to be most prevalent in moderately deep water.

Eupagurus lacertosus, n. sp. (Pl. VI. fig. 7).

Characters.—The anterior portion of the carapace is smooth and moderately convex, the lateral border is also convex, the median frontal process prominent and acute, the lateral projections less strongly marked, but each tipped by a small spine; the posterior portion is entirely membranous, and raised somewhat above the level of the anterior part.

The ocular peduncles are moderately slender, with the corneæ but slightly dilated, and a few indistinct piliferous lines are seen on the upper surface; the ophthalmic scales have their apices slender and acute, with a faint inward inclination. The antennal peduncles exceed the eye-stalks by almost the whole length of the ultimate joint; the acicle is long and slender, with a slight double curve, and the inner border is pubescent, it extends to the middle of the terminal joint; the second joint has a well-marked external prolongation extending to the middle of the penultimate joint, and its inner border is spinulous, an acute spinule is also present in a corresponding position on the inner margin of the joint; the under surface of the third joint is densely pubescent. The second joint of the antennular peduncle has its distal end situated nearly opposite the end of the eye-stalk.

The right chelipede is considerably larger than the left, both are of large size as compared with the trunk, and the surface is granular and spiny. The right chelipede has the merus somewhat trigonal, the upper border with two or three spinules and a few hairs, the antero-external border is armed with a series of acute spines, and the lower surface is tubercular, the outer surface is slightly granular, and the superior and distal border bears two spinules situated close together; the upper surface of the carpus is covered with tubercular spines (with the exception of an elongated strip near the inner margin), the outer surface slopes abruptly and is granular, the inner border gives rise throughout its extent to a row of acute spines, the two anterior of which are bifid; the propodus is about one-third longer than the carpus, its upper surface granular, with two oblique tubercular ridges, one running from near the outer margin of the posterior border to the external border of the immobile finger, the other from the inner margin of the posterior border to the middle of the base of the dactylus, an indistinct central row of tubercles is also present; the fingers are finely granular and less than half the total length of the propodus, their opposed edges are irregularly toothed, and the apex of the dactylus is slightly folded under that of the immobile finger; the dactylus has an obtuse median carina on its upper surface, and both fingers possess a minute corneous apical spine. The left chelipede has the merus similar to that of the right chelipede, with the exception that the spinules on the superior border are absent; the carpus is moderately pubescent, and bears two rows of acute spines above, those of the inner row being more numerous, a large bifid spine is placed near the centre of the anterior and upper border; the propodus has an acute central carina armed with tubercular spines, and the outer border is likewise acute, the surface is finely granular except the under part of the fingers, where there are numerous tufted hairs; the fingers cross one another towards their apices and are excavated inferiorly. The ambulatory limbs have the carpal joints slightly spiny on the anterior margin, a few spinules also exist on the posterior border of the merus of the first pair; the dactyli are curved and considerably longer than the propodi, their posterior surface is slightly canaliculate, and the apices are corneous.

The penultimate abdominal segment is crossed by a deep transverse impression; the ultimate segment is composed of four lobes, the two terminal with their margins spinulous.

Length of body 33 mm., of right chelipede 40 mm., of left chelipede 29 mm., of third left leg 47 mm., of ocular peduncle 5·5 mm.

This species belongs to that section of the genus in which the hand of the left chelipede is carinated superiorly. It bears some resemblance to *Eupagurus excavatus*, but is at once distinguished by the absence of the central carina from the propodus of the right chelipede.

Habitat.—Station 166, off New Zealand; depth, 275 fathoms; bottom, Globigerina ooze. Two specimens, one an adult male, the other immature.

Eupagurus lacertosus, n. sp., var. *nana*, nov. (Pl. VII. fig. 1).

Characters.—Those of *Eupagurus lacertosus* with the following exceptions:—the lateral frontal projections are not tipped by spines, the antennal acicle extends only as far as the end of the eye-stalk, and the external prolongation of the second antennal joint is shorter; the chelipedes have essentially the same form and armature, though the spines are less strongly marked, and in some positions fewer in number, the granulations on the surface of the right hand are also almost obsolete in some individuals. The difference in size is, however, the only one of importance.

In spite of the disparity in size this can only be regarded as a remarkably dwarfed variety of the above species, possibly confined to shallow water. In a tolerably large series of specimens, the body of the largest (a male) measures only 12 mm. in length, and several females bearing ova are even considerably less.

Eupagurus sinuatus, Stimpson, from Port Jackson, has the hand of the right chelipede armed with median and marginal series of spines, and the upper surface of the dactylus with a median row of acute tubercles. In *Eupagurus acantholepis*, Stimpson, from the same locality, the median frontal projection is obsolete, the eye-stalks exceed the antennal peduncles, and the hands of the chelipedes are spinulose. *Pagurus minutus*, Hess, also from Port Jackson, is unrecognisable; indeed, the short description given of this species is not sufficient to identify even the genus.

Habitat.—Station 161, off the entrance to Port Philip; depth, 33 fathoms; bottom, sand. Several specimens inhabiting shells of *Nassa pauperata*, Lam., *Turritella* sp., and *Natica* sp.

Station 162, off East Moncœur Island, Bass Strait; depth, 38 fathoms; bottom, sand and shells. Many specimens, in the following shells:—*Nassa pauperata*, Lam., *Turritella lamellosa*, Watson, *Turritella runcinata*, Watson, *Turritella cordismei*, Watson, *Murex cordismei*, Watson, and *Eburna australis*, Sow. One specimen from this locality has a species of *Peltogaster* adhering to its abdomen.

Station 163B, off Port Jackson; depth, 35 fathoms; bottom, hard ground. Several specimens in shells of *Ancilla oblonga*, Sow., *Nassa pauperata*, Lam., *Turritella sinuata*, Reeve, *Pleurotoma* sp., and *Natica* sp.

Eupagurus pubescens (Kröyer), var. *kroyeri*, Stimpson.

Pagurus pubescens, Kröyer, Conspect. Crust. Groenl., Naturh. Tidsskr., ii., p. 251, 1839; in Gaimard, Voyages en Scandinavie, pl. ii. fig. 1, 1849.
„ *Thompsoni*, Bell, Brit. Crust., p. 372, 1853.
„ „ White, Pop. Hist. Brit. Crust., p. 78, 1857.
Eupagurus pubescens, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 75, 1858.
„ „ Henderson, Crust. Decap. Firth of Clyde, p. 26, 1886; Proc. Roy. Phys. Soc. Edin., vol. ix. part i. p. 71, 1886.
var. *Eupagurus kroyeri*, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 75, 1858; Ann. Lyc. Nat. Hist. New York, vol. vii. p. 89, 1859.

Habitat.—Station 49, south of Halifax, Nova Scotia; depth, 85 fathoms; bottom, gravel, stones. Two small specimens in shells of *Natica affinis*, Gmel.

Eupagurus pubescens is one of the commonest North Atlantic Pagurids found in moderately deep water, the variety usually occurring in a state of commensalism with a species of *Epizoanthus*. It is recorded by Stimpson from the North Pacific.

Eupagurus tristanensis, n. sp. (Pl. VII. fig. 5).

Characters.—The anterior portion of the carapace is smooth, with the median frontal process moderately prominent, and subacute, the lateral projections less strongly marked; the posterior portion is entirely membranous.

The ocular peduncles are stout, with the corneæ slightly dilated; the ophthalmic scales have the terminal portion slender and acute. The antennal peduncle slightly exceeds the eye-stalks in length; the acicle is slender and curved, reaching the middle of the ultimate joint, its inner margin slightly pubescent; the external prolongation of the second joint is short, extending only as far as the middle of the penultimate joint. The antennular peduncle exceeds the eye-stalk by more than half the length of the terminal joint, which broadens out towards its distal end.

The chelipedes are unequal and of moderate size, the terminal joints are armed with acute spinules. The right chelipede has the meral joint trigonal, the upper and anterior border possesses three minute spinules, and a few spinules are also present on the lower surface and outer border; the carpus is more than two-thirds the length of the propodus, and its upper surface is uniformly covered with projections which become distinctly spiniform on the inner margin, the outer surface is smooth and of considerable vertical extent; the propodus is of almost the same breadth as the carpus, and the spinules on its upper surface are arranged in longitudinal rows, the margins are distinctly spinulous; the upper surface of the dactylus possesses a median row of tubercular spinules, and its tip is folded under that of the immobile finger. The left chelipede has the merus unarmed, with the exception of a few minute spinules on the lower border; the carpus has two rows of spinules on its upper surface, with a groove-like portion between, and the outer surface is granular; the propodus bears a central carina on the upper surface, surmounted by a row of spinules, and elsewhere it is obscurely tubercular; the dactylus is unarmed. The ambulatory limbs are smooth, a few indistinct spinules alone existing on the propodi of the first pair; the dactyli are canaliculate and but little curved, they exceed the propodi in length, and their lower border is fringed by a series of delicate corneous spines.

The penultimate abdominal segment is divided by a transverse constriction, and the ultimate segment is obscurely four-lobed.

Length of body 10 mm., of right chelipede 11 mm., of left chelipede 9 mm., of third left leg 13·5 mm., of ocular peduncle 2 mm.

This species is distinguished by its small size and the armature of the right chelipede.

Habitat.—Station 135c, off Nightingale Island, Tristan da Cunha; depth, 110 fathoms. A male specimen in a shell of *Murex* (*Pseudomurex*) *aëdonius*, Watson.

Eupagurus comptus (White), var. *jugosa*, nov. (Pl. VII. fig. 2).

Pagurus comptus, White, Proc. Zool. Soc. Lond., p. 122, 1847; Ann. and Mag. Nat. Hist., ser. 2, vol. i. p. 224, 1848.
Eupagurus comptus, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 75, 1858.
" " Miers, Zool. "Erebus" and "Terror," Crust., p. 3, pl. ii. fig. 5, 1874; Proc. Zool. Soc. Lond., p. 72, 1881.
Pagurus forceps, Cunningham, Trans. Linn. Soc. Lond. (Zool.), ser. 1, part. xxvii. p. 495, 1871.

Habitat.—Station 308, off Tom Bay, Patagonia; depth, 175 fathoms; bottom, blue mud. Many specimens were obtained in this locality.

Station 315, Falkland Islands; depth, 5 to 12 fathoms; bottom, sand, gravel. A young specimen, still retaining the red banding of the ambulatory limbs noted by White.

The Challenger examples all belong to the above-named new variety, which is characterised by the prominence of the ridges on the hand of the larger chelipede, the inner being especially raised; towards the centre there is a conspicuous bifurcate λ-shaped ridge extending from the base of the immobile finger to the carpo-propodal articulation. In addition to the typical form Miers has described a variety which he terms var. *latimanus*, distinguished by the breadth of the hand and the prominence of its ridges.

Eupagurus comptus is only known as an inhabitant of the Patagonian region.

Eupagurus constans, Stimpson (Pl. VI. fig. 8).

Eupagurus constans, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 86, 1858.

Habitat.—Off Yokohama, Japan.

Originally taken by Stimpson in the Bay of Hakodadi, Yedo Island, at a depth of 4 fathoms, on stony ground. The front possesses three prominent acute projections, the mesial more produced than the two lateral. The chelipedes are elongated and of large size, the terminal joints armed with conical spines and setigerous tubercles; the right ischium possesses a prominent internal spine, and the merus has several spinules on its upper and distal border; the carpus and propodus have the conical spines arranged in marginal and central series, with the bristle-tufted tubercles scattered between; the dactylus of the left chelipede is devoid of spines. The ambulatory limbs are comparatively smooth. In the allied *Eupagurus spinulimanus*, Miers, from New Zealand, the median frontal tooth is almost obsolete, the spines on the hand of the larger chelipede are arranged in two rows, and the carpal joint of the second pair of ambulatory limbs is spinose on the upper surface.

Eupagurus spinulentus, n. sp. (Pl. VII. fig. 3).

Characters.—The anterior portion of the carapace is flattened but perfectly smooth, the median frontal projection is rounded and less prominent than the lateral processes, which are subacute; the posterior portion is also smooth and entirely membranous.

The ocular peduncles are stout, and constricted towards the base, with the corneæ much dilated and of a semilunar outline when seen from above; the ophthalmic scales are broad at the base, with the apices rounded and slightly pubescent, each tipped by a single spinule. The antennal peduncles slightly exceed the eye-stalks in length; the acicle is long and slender, extending almost to the distal end of the terminal joint, and its surface is provided with a few hairs; the external prolongation of the second joint is spinulous and almost reaches the distal end of the penultimate joint. The second joint of the antennular peduncle has its distal end situated nearly opposite the end of the eye-stalk.

The right chelipede is considerably larger than the left, and the surface of both is armed with numerous conical spines. The right chelipede has the merus somewhat trigonal, with its lower surface tubercular and pubescent, the upper and distal border is armed with eight or nine conical spines; the carpus is about two-thirds as long as the propodus, and its length exceeds the breadth, the upper surface is pubescent, and everywhere covered with the characteristic short and conical, yet acute spines, these being slightly more strongly marked towards the inner margin; the upper surface of the propodus is armed in a similar way, but the central part is elevated, and a groove devoid of spines runs parallel to the inner margin, the spines show a tendency towards arrangement in rows, more especially those near the margins, the lower surface of both carpus and propodus is armed with rounded tubercles; the dactylus is armed with tuberculiform spines, and its apex passes under that of the immobile finger; both fingers are sparingly toothed and possess numerous tufts of short setæ, their length is less than that of the remaining part of the hand. The left chelipede has the merus and carpus both trigonal, the upper and distal end of the former with two unequal spines, the upper surface of the latter is pubescent, and the carina strongly spinose; the upper surface of the hand is similar to that of the right chelipede, but the fingers are proportionately longer. The ambulatory limbs are long; the anterior border of the carpal and propodal joints is spinose, of the meral joint simply granular; the dactyli are remarkably long, and slightly tortuous, with the anterior surface longitudinally canaliculate, and fringed by a double row of yellow hairs. The last two pairs of legs are moderately pubescent.

The penultimate abdominal segment bears a deep transverse groove; the terminal segment is composed of four nearly equal and symmetrical lobes.

Length of body 41 mm., of right chelipede 40 mm., of left chelipede 32 mm., of third right leg 55 mm., of ocular peduncle 7·2 mm.

This species is allied to *Eupagurus constans*, Stimpson, and *Eupagurus spinulimanus*, Miers; from the former it is distinguished by the absence of the spine on the inner surface of the ischial joint of the right chelipede, the spines on the hand are scattered all over the upper surface, and the setigerous tubercles are absent; in the latter species the eyes are slender, the antennal acicle does not exceed the ocular peduncle, and the spinules on the right hand are mostly arranged in two rows. *Eupagurus armatus* (Dana), is an allied species, but the corneæ are not dilated, and the general form of the chelipedes is different.

Habitat.—Stations 204A, 204B, off Tablas Island; depth, 100 to 115 fathoms; bottom, green mud. A female with ova, in a shell of *Fusus niphonicus*, E. A. Smith.

Eupagurus rubricatus, n. sp. (Pl. VII. fig. 4).

Characters.—The anterior portion of the carapace is smooth and moderately flat, the frontal projections are scarcely indicated, the median being obtusely rounded; the posterior portion is entirely membranous.

The ocular peduncles are moderately stout, with the corneæ dilated; the ophthalmic scales have the terminal portion slender and acuminate. The antennal peduncle slightly exceeds the eye-stalks in length; the acicle is long and slender, reaching nearly to the end of the peduncle, its inner margin is pubescent and has a double curve; the external prolongation of the second joint is spinulous, and extends as far as the distal end of the penultimate joint, a minute spinule is also present on the inner margin of the second joint. The second joint of the antennular peduncle has its distal end not reaching the termination of the eye-stalk.

The chelipedes are unequal and of moderate size, the terminal joints are covered with a matted pubescence, and the hands are swollen from side to side. The right chelipede has the meral joint trigonal, its lower surface tuberculate, and its distal and upper border with a single spine and a fringe of hairs; the carpus is a little more than half the total length of the propodus, with its breadth considerably less, the upper surface is pubescent, and a number of conical spines are scattered over the inner half, those on the free margin being specially prominent; the propodus is much broader than the carpus, its upper surface is covered with a matted pubescence, and possesses an irregular central elevation; scattered somewhat sparingly here and there, but especially towards the centre of this surface, are white rounded tubercles, the inner and outer margins are fringed with long hairs, and bear in addition a row of somewhat blunted spines; the upper surface of the dactylus possesses several rows of rounded tubercles, and its inner margin is armed with tubercular spines, the tip is folded under that of the immobile finger. The left chelipede has the merus similar to that of the right chelipede, the upper surface of the carpus is traversed by two rows of spines, with a smooth portion between; the propodus is placed at an angle to the preceding joint, and its surface is covered by the characteristic short dense pubescence seen on the right chelipede, the outer border is strongly convex, and armed with blunt spines; the upper surface of the dactylus is densely pubescent, and the joint terminates in a minute horny claw. The ambulatory limbs have the carpal joints moderately spiny in front, the meri and propodi with a series of transverse piliferous lines on the upper surface; the dactyli are considerably longer than the propodi, slightly twisted towards their ends, and each terminates in a yellow horny claw; the borders, more especially towards the apex, are fringed with delicate horny spines.

The abdomen is wanting in the single specimen taken.

The following colour markings are still evident, though the specimen is preserved in spirit. At the distal end of the meral joint of both chelipedes and of the second and third pairs of legs, there is a conspicuous red band, deficient on the under surface, and the carpus of either chelipede has a patch of the same colour on both its inner and outer surfaces, near the junction with the merus; an indistinct patch is present also on the anterior surface and proximal end of the carpal joints of the second and third legs.

Length of carapace 13 mm., of right chelipede 28 mm., of left chelipede 21 mm., of third right leg 36 mm., of ocular peduncle 5·8 mm.

The form of the left chelipede is very characteristic of this species. It bears some resemblance to *Eupagurus novi-zealandiæ* (Dana), but the latter has the hand of the right chelipede not broader than the wrist, and the tubercles are arranged in six rows, the margins of the ambulatory limbs are also densely hirsute. In *Eupagurus angustus*, Stimpson, the hand of the left chelipede is somewhat swollen externally, but the median frontal process is acute, the carpus and propodus of the right chelipede are merely granulated, and there is a prominent tubercle on the under surface of the merus.

Habitat.—Station 169, off New Zealand; depth, 700 fathoms; bottom, blue mud. A male specimen.

Eupagurus occlusus, n. sp. (Pl. VII. fig. 6).

Characters.—The anterior portion of the carapace is smooth and moderately convex, with the median frontal process prominent and subacute, the lateral projections but slightly marked; the posterior portion is entirely membranous, and its surface is thrown into numerous folds.

The ocular peduncles are short and moderately stout, with the corneæ slightly dilated; the ophthalmic scales are slightly curved and hollowed out towards their apices, which are subacute. The antennal peduncle exceeds the eye-stalk by nearly the whole length of the ultimate joint; the acicle is slender and curved, reaching almost to the end of the peduncle, the external prolongation of the second joint is short and somewhat stout.

The antennular peduncle exceeds the eye-stalk by nearly the whole length of the last joint, which also extends considerably farther than the end of the antennal peduncle.

The chelipedes are very unequal and almost devoid of spines, the right with a broad and flattened hand. The right chelipede has the merus with its outer surface rugose, the lower surface convex and granular, a few spiniform tubercles are present on the lower and outer edge; the carpus is more than half the total length of the propodus, its upper surface is coarsely granular, and the lateral borders are raised and slightly spinose, the lower surface is somewhat angular and covered with small tubercles; the propodus is much broader than the carpus though its vertical dimension is considerably less, the upper surface is polished, slightly convex from side to side, and everywhere finely granular, the lateral borders are convex and remarkably thin, the lower surface is also finely granular; the free edge of the dactylus is very thin and the upper surface is finely granular. The left chelipede is of small size and extremely narrow, the lower surface of the merus is slightly spinose, and the carpus possesses a median row of spinules, its inner border also is somewhat tubercular; the propodus is a little wider than the carpus, a short tubercular carina exists on its proximal half, and the outer border is thin, the fingers are slightly bent downwards, and are more than half the total length of the hand. The ambulatory limbs are subequal in length to the right chelipede, and comparatively smooth, a few spinules exist on the anterior border of the carpal joints of the first pair; the dactyli are longer than the propodi, moderately curved, with a few setæ on the outer border towards the apex.

The terminal portion of the abdomen is wanting in the single specimen.

Length of body 16 mm., of right chelipede 22 mm., of left chelipede 15 mm., of third left leg 22 mm., of ocular peduncle 3 mm.

The form of the right chelipede—the broad flattened hand of which probably serves to plug up the mouth of a shell—is characteristic of this species; in this respect it bears some resemblance to "*Pagurus severus*," A. Milne-Edwards, from the "Talisman" dredgings.

Habitat.—Station 122, off Pernambuco; depth, 350 fathoms; bottom, red mud. A male specimen, in a shell of *Pleurotoma* sp.

A Pagurid without chelipedes from Station 201, off Samboangan, Philippines, appears to belong to the genus *Eupagurus*. It occurred in the shell of a species of *Trochus*.

Genus *Spiropagurus*, Stimpson.

Spiropagurus, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 74, 1858.

Anterior portion of the carapace depressed, the cervical groove deep; front with the rostral projection but slightly marked. Ocular peduncles short and stout, with the corneæ dilated; the basal scales of moderate size and separated by a considerable interval. Antennal acicle slender, the flagellum naked. Chelipedes subequal and of small size, the right slightly larger; the fingers moving in a horizontal plane and calcareous at the tips. Second and third pairs of legs with long, flattened and ciliated dactyli. Coxa of the fifth left leg in the male with a long, spirally coiled, membranous organ (formed by a protrusion of the vas deferens), strengthened along its outer surface by a corneous band; the vas deferens of the right side scarcely produced.

Spiropagurus spiriger (De Haan).

Pagurus spiriger, De Haan, Crust. Japon., p. 206, tab. xlix. fig. 2, 1850.
Spiropagurus spiriger, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 86, 1858.

Habitat.—Torres Strait. A young male.

Station 188, Arafura Sea; depth, 28 fathoms; bottom, green mud. An adult male.

Station 190, Arafura Sea; depth, 49 fathoms; bottom, green mud. A female with ova.

Hong Kong, 10 fathoms. An adult female, in a shell of *Pleurotoma tuberculata*, Gray.

Station 208, off Manila; depth, 18 fathoms; bottom, blue mud. Two male specimens, one of which is young.

Admiralty Islands, 16 to 25 fathoms. A female with ova.

The Challenger dredgings have increased the known area of distribution of this species, previously recorded only from the Japanese and Chinese Seas.[1] Great variation is exhibited in the size of the piliferous lines on the chelipedes and legs, and in the amount of pubescence. The inner border of the carpus in both chelipedes possesses a row of spinules which vary considerably as to prominence in different individuals; the piliferous lines on the upper surface of both hands are usually arranged in double series; the flagellum of the antennæ is broad and flattened towards its base. In very hairy individuals the piliferous lines may occur even on the upper surface of the ocular peduncles and on the posterior part of the carapace, especially the branchial region (where they tend to become piliferous tubercles). The ocular peduncles only extend as far as the commencement of the penultimate joint of the antennal peduncle, and they are slightly exceeded by the acicle; the external prolongation of the second joint of the antennal peduncle is spinulous but of no great length; the ophthalmic scales are obtusely rounded at their apices. The terminal abdominal segment is bifid, and the margin spinuliferous. The female differs from the male in being of larger size, the chelipedes are proportionately smaller, and no sexual appendage is present; in the male the abdominal appendages—except those of the penultimate segment—are of very small size.

[1] *Spiropagurus spiriger* occurs also in the Indian seas, the writer having taken it recently at Madras, where it is apparently common in shallow water.

Spiropagurus elegans, Miers.

Spiropagurus elegans, Miers, Ann. and Mag. Nat. Hist., ser. 5, vol. viii. p. 278, pl. xvi. fig. 5, 1881.

Habitat.—Station VIIIᴇ, off Gomera, Canaries, February 10, 1873; depth, 78 fathoms; bottom, volcanic sand. An adult male without the right chelipede.

This species is very closely allied to the last, and distinguished chiefly by the absence of piliferous lines from the chelipedes. The type specimen came from Goree Island, Senegambia.

Genus *Anapagurus*, Henderson.

Anapagurus, Henderson, Clyde Decapoda, Trans. Nat. Hist. Soc. Glasgow, p. 27, 1886; Proc. Roy. Phys. Soc. Edin., vol. ix. part i. p. 73, 1886.

Anterior portion of the carapace depressed, the cervical groove deep; front with the rostral projection but slightly marked. Ocular peduncles usually short and stout, with the corneæ dilated; the basal scales of moderate size and separated by a considerable interval. Antennal acicle slender, the flagellum usually ciliated. Chelipedes unequal, the right larger (in adult males the disparity in size is often very striking), the fingers moving in a horizontal plane and calcareous at the tips. Ambulatory limbs long and slender, the dactyli but slightly ciliated. Coxa of the fifth left leg in the male with a short, curved, membranous organ (formed by the protruded external portion of the vas deferens). Species of small size.

Anapagurus was originally described as constituting a subgenus of *Spiropagurus;* I am now, however, of opinion that it is entitled to rank as a separate genus. It is distinguished from the latter by the form of the chelipedes, ambulatory limbs, and sexual appendage.

The following species are referable to this genus:—

Anapagurus chiroacanthus (Lilljeborg), Scandinavian and British Seas.
Anapagurus hyndmanni (Thompson), British Seas.
Anapagurus lævis (Thompson), Scandinavian and British Seas; Mediterranean, in deep water ("Travailleur").
Anapagurus pusillus, n. sp., Azores, Canaries, and Cape of Good Hope (?).
Anapagurus australiensis, n. sp., New South Wales.

Anapagurus pusillus, n. sp. (Pl. VII. fig. 7).

Characters.—The anterior portion of the carapace is smooth. The ocular peduncles extend as far as the end of the penultimate joint of both the antennal and the antennular peduncles; the corneæ are moderately dilated, and the ophthalmic scales are long and acuminate. The antennal acicle slightly exceeds the eye-stalk; the external prolongation of the second peduncular joint is well-marked and acute, and a smaller spine is also present on the inner margin of the same joint; the flagellum is almost naked.

The right chelipede has three acute spinules on the outer and distal border of the merus, and several curved and acute spines on the inner border of the carpus, towards the outer surface of the latter joint there is a second but very indistinct row of spinules; the carpus is about equal in length to the propodus (not including the immobile finger), and the upper surface of both joints is finely granular; the hand is but little dilated, and two slight elevations are present on its upper and inner surface, near the articulation with the carpus. The left chelipede is very narrow; the carpus possesses two rows of spinules on its upper surface; the fingers are slightly pubescent and comparatively long, exceeding in length the remainder of the propodus. The ambulatory limbs are smooth, a few spinules alone existing on the anterior border of the carpal joints; the dactyli are long and but slightly curved, that of the second pair being slightly longer on the left side.

The above description is taken from a male. In the female the antennal acicle and the external prolongation of the second peduncular joint are both less strongly marked, the dactyli of the ambulatory limbs are also shorter.

A full-grown male measures about 8 mm. in length, and females with ova even less.

In *Anapagurus chiroacanthus* (Lilljeborg) = *Pagurus ferrugineus*, Norman, to which this species bears some resemblance, the hand is pubescent, and the ophthalmic scales are shorter, with their apices subobtuse. In *Anapagurus lævis* (Thompson), the ophthalmic scales are rounded and their apices obtuse.

Habitat.—Station 75, near the Azores; depth, 50 to 90 fathoms; bottom, volcanic mud. Several specimens; the original shells have disappeared, leaving an investment which appears to consist of an *Epizoanthus.*

Station VIIIp, off Gomera, Canaries, February 10, 1873; depth, 78 fathoms; bottom, volcanic sand. Many specimens; the majority firmly ensconced in shells of *Turritella bicingulata*, Lam., one individual in a shell of *Nassa limata*, Chem.

Simon's Bay, 18 fathoms. A male specimen, in a shell of *Trochus benzi*, Krauss. It is with some hesitation that this is referred to the present species, and subsequent investigation may show it to be distinct. The chelipedes and ambulatory limbs are more hairy, and the dactyli of the latter are ciliated and slightly longer on the right side; the hand of the right chelipede is more strongly granulated, and a distinct finely tubercular line is present near the outer border. In other respects it agrees with *Anapagurus pusillus.*

Anapagurus australiensis, n. sp. (Pl. VII. fig. 8).

Characters.—The anterior portion of the carapace is smooth. The ocular peduncles are long and slender, exceeding the antennal peduncle and reaching the end of the antennular peduncle, with the corneæ not dilated; the ophthalmic scales terminate in four small spines. The antennal acicle is short, only extending as far as the middle of the eye-stalk; the external prolongation of the second joint is fairly well marked.

The chelipedes are clothed rather sparingly with long hairs. The right chelipede has the carpus armed with three or four spines on its inner border; the propodus is subovate and but slightly dilated, its total length being greater than that of the carpus, the outer border possesses a row of prominent upturned spines, a few similar processes are met with on the inner border, and two prominent curved spines occur on the upper surface in the middle line and near the carpal articulation; the fingers are shorter than the remaining part of the propodus. The left chelipede is slender; the carpus is not equal in length to the propodus and its upper surface bears a few spinules arranged in two rows; the outer border of the propodus is slightly concave, and the inner border possesses a rounded projection near the insertion of the dactylus; the fingers are more than half the total length of the propodus and of considerable width, each terminating in a short, curved, horny claw. The ambulatory limbs are moderately pubescent; the dactyli are by no means slender, and scarcely equal in length to the propodi, their surface is curved, and a few horny spines are present on the lower border.

The sexual appendage in the male is rather long in proportion to the size of the species.

The total length is about 8 mm.

Anapagurus australiensis is characterised by the length of the eye-stalks, the form of the ophthalmic scales, and the armature of the chelipedes.

Habitat.—Port Jackson; depth, 2 to 10 fathoms. Two specimens (male and female); one of these occurred in a shell of *Trochus* (*Ziziphinus*) *decoratus*, Phil.

Genus *Catapagurus*, A. Milne-Edwards.

Catapagurus, A. Milne-Edwards, Bull. Mus. Comp. Zoöl., vol. viii. p. 46, 1880.
„ S. I. Smith, "Blake" Crust., Bull. Mus. Comp. Zoöl., vol. x. p. 14, 1882.
Hemipagurus, S. I. Smith, Ann. and Mag. Nat. Hist., ser. 5, vol. vii. p. 143, 1881; Proc. Nat. Mus. Washington, vol. iii. p. 422, 1881.

Front with the rostral projection but slightly marked. Ocular peduncles short and stout, with the corneæ dilated; the basal scales well developed and separated by a considerable interval. Antennal acicle slender; the flagellum not distinctly ciliated. Chelipedes slender and unequal, the right longer and stouter; the fingers moving in a horizontal plane and calcareous (?) at the tips. Ambulatory limbs long and slender, the dactyli distinctly ciliated. Coxa of the fifth right leg in the male with a membranous protrusion of the vas deferens, which is curved over the right side of the abdomen.

The species described below is referred with some uncertainty to this genus, although on the whole it agrees with the general characters furnished by Professor S. I. Smith.

It is to be noted, however, that the sexual appendage is rather longer and more slender than in the case of American specimens,[1] and there is indication of a slight protrusion on the left side. The gills are of the normal phyllobranchiate type.

The previously known species are two in number, viz., *Catapagurus sharreri*, A. Milne-Edwards (= *Hemipagurus socialis*, S. I. Smith), from off Barbados and the east coast of the United States, and *Catapagurus gracilis*, S. I. Smith, also from the latter locality; both are from moderately deep water.

Catapagurus australis, n. sp. (Pl. VIII. fig. 1).

Characters.—The anterior portion of the carapace is smooth. The eye-stalks are long, slightly exceeding the antennal peduncle, and reaching the middle of the last joint of the antennular peduncle; the corneæ are slightly dilated; the ophthalmic scales have their apices rounded, but a prominent acute spine is present on the inner and distal margin of each. The antennal acicle reaches the middle of the last joint of the antennal peduncle; the external prolongation of the second joint is but slightly marked.

The right chelipede has the merus armed with two or three spines on the outer and distal border; the carpus is not equal in length to the propodus, its upper surface is densely pubescent and carries three rows (two marginal and one central) of curved acute spinules; the upper surface of the propodus is covered with a matted pubescence, and the margins are fringed with long hairs, a median ridge capped by about five spinules is present, though most prominent towards the proximal end, where it finally passes on to the upper surface of the immobile finger, and several spinules smaller than those of the carpus are found on the inner margin; the fingers are less than half the total length of the propodus, and a ridge is present on the upper surface of the dactylus. The left chelipede is more slender and slightly shorter than the right, but the armature is the same, the fingers are, however, more than half the total length of the propodus, and they terminate in well-marked horny claws. The ambulatory limbs are smooth, with the anterior borders of the carpal and propodal joints very slightly spinulous; the dactyli are considerably longer than the propodi, and moderately curved, a series of long horny setæ is present on the anterior border, and a few shorter setæ on the posterior border.

The abdomen is wanting in the better preserved specimen, but the carapace measures 4·8 mm. in length, and the ocular peduncle 2·5 mm.

Habitat.—Station 188, Arafura Sea; depth, 28 fathoms; bottom, green mud. A male specimen, from which the above description is taken.

Reefs at Levuku, Fiji Islands. A very imperfect specimen; in this the antennal acicle is slightly longer than in the above, almost reaching the end of the eye-stalk.

[1] *Vide* "Albatross" Crust., Rep. U.S. Fish. Comm., 1882, pls. iii., iv.

Genus *Paguristes*, Dana.

Paguristes, Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 436, 1852.
" Stimpson, Proc. Acad. Nat. Sci. Philad., p. 73, 1858.
" Heller, Crust. südlichen Europa, p. 172, 1863.

Front with the rostral projection prominent and often acute. Ocular peduncles remarkably long and slender, the ophthalmic scales of moderate size and separated by a considerable interval. Antennules long. Antennal acicle robust, the flagellum usually short and ciliated. Chelipedes subequal, or of equal size, the fingers moving in a horizontal plane and calcareous or corneous at the tips. Penultimate pair of legs not chelate. Abdomen of the male with the first two segments bearing each a pair of appendages; in the female a single pair present on the first segment and a membranous oviferous sac borne on the left side of the second, third, and fourth segments.

Paguristes pilosus (H. Milne-Edwards).

Pagurus pilosus, Milne-Edwards, Ann. d. Sci. Nat., sér. 2e, t. vi. p. 282, pl. xiv. fig. 1, 1836; Hist. Nat. des Crust., t. ii. p. 233, 1837.
" " White, in Dieffenbach's New Zealand, vol. ii. p. 266, 1843.
" " Miers, Catal. New Zealand Crust., p. 66, 1876.
Paguristes pilosus, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 74, 1858.

Habitat.—Station 167A, off New Zealand; depth, 10 fathoms; bottom, mud. A male specimen, from which the left chelipede and ambulatory limbs have disappeared, apparently belongs to this species. The hairs on the chelipede and other parts are characteristically branched.

Paguristes pilosus has hitherto been taken only in the New Zealand seas.

Paguristes subpilosus, n. sp. (Pl. VIII. fig. 2).

Characters.—The anterior portion of the carapace is smooth, with a few slight rugosities towards the front, the anterior border is raised and the median frontal process is prominent and subacute, passing between the ophthalmic scales, the lateral processes are subacute and less prominent; the posterior portion is semicalcareous towards the centre.

The ocular peduncles are long and slender, reaching the end of the antennular peduncle and passing considerably beyond that of the antenna, each is slightly curved from above downwards, and with the exception of a small part near the cornea is of a faint reddish tinge; the ophthalmic scales are bidentate, one of the terminal spines being of small size. The antennal acicle extends almost to the end of the peduncle, its surface is pubescent and is armed with two spinules on the posterior border and one on the inner border near the base, the external prolongation of the second joint is broad and quadrispinose, with its surface pubescent; the flagellum is very short (about equal in length to the anterior part of the carapace) and but slightly pubescent.

The chelipedes are of equal size and similar configuration. The merus is smooth above, with a few denticles on the lower and inner margin; the upper surface of both carpus and propodus is spinulous and densely pubescent, the spinules being most prominent on the inner margin, and some having corneous apices; on the carpus the pubescence is less striking and many of the hairs appear to arise from tubercles; the propodus is longer than the carpus, and its lower surface is considerably swollen, the fingers are more than half the total length of the propodus, and each terminates in a black horny claw, their upper surfaces are both spinulous and pubescent. The ambulatory limbs are moderately pubescent, and the propodal, carpal, and the ends of the meral joints are slightly spinose on the anterior border; the dactyli are half as long again as the propodi, somewhat flattened, and moderately curved, with both margins densely ciliated, they terminate also in strong horny claws. The last two pairs of legs are moderately pubescent.

The penultimate abdominal segment is traversed by a cross-shaped impression, the ultimate segment is trilobed, one of the lobes being greatly produced.

The larger (female) specimen gives the following measurements:—Length of body 28 mm., of chelipede 16 mm., of third right leg 26 mm., of ocular peduncle 5·5 mm.

The hairs on the surface of this species are regularly pinnate. It is allied to *Paguristes pilosus*, but distinguished at once by the greater prominence of the rostrum, and the form of the ophthalmic scale, antennal acicle, and external prolongation of the second joint of the antennal peduncle. A New Zealand species of *Clibanarius*, the *Clibanarius barbatus* of Heller, apparently presents many points of resemblance, but the dactyli of the ambulatory limbs are described as scarcely shorter than the corresponding propodi.

Habitat.—Station 167, off New Zealand; depth, 150 fathoms; bottom, blue mud. Two specimens, male and female, in shells of *Ancilla pyramidalis*, Reeve.

Paguristes visor, n. sp. (Pl. VIII. fig. 3).

Characters.—The anterior portion of the carapace is somewhat rugose in front, moderately convex from side to side, and the anterior border is slightly raised; the median frontal process is very prominent, with its apex subacute and slightly depressed, passing a considerable distance between the ophthalmic scales, the lateral processes are slightly less prominent and each is capped by one or two minute spinules; the posterior portion of the carapace is semicalcareous towards the centre.

The ocular peduncles have a slight lateral curve and are remarkably long and slender, extending to the end of the antennular peduncle and for more than one-third of their length beyond the antennal peduncle, a few hairs are present on their upper surface; the ophthalmic scales are of small size and obscurely bidentate. The antennal acicle extends to the middle of the last joint of the peduncle, its surface is pubescent, and it is armed with two spines on the outer border and one or two on the inner; the external prolongation of the second joint is short and its apex bidentate; the flagellum is nearly as long as the body and but slightly ciliated.

The chelipedes are similar in appearance and subequal in size, with their terminal joints slightly pubescent. The merus has a circular red patch of large size on both its inner and outer surfaces towards the distal end, the external surface is also slightly tuberculate, and the inner and distal margin inferiorly bears a few spinules; the carpus is of small size, not equalling the dactylus in length, its upper surface, which is somewhat narrow, is covered with scattered spiniform tubercles; the upper surface of the propodus is armed in a similar way, many of the tubercles having corneous tips, and a specially prominent row is found on the inner margin; the fingers are more than half the total length of the propodus, and armed in the same manner as the last joint, their opposed edges are provided with small, regular, pearly teeth. The ambulatory limbs are moderately pubescent, and the anterior borders of the carpal and propodal joints are slightly spiny; the dactyli are slightly more than one and a half times the length of the propodi, and both their surfaces and margins are clothed with long stiff hairs, the terminal horny claws also are well developed. The penultimate pair of legs are moderately pubescent, but the last pair are almost smooth. The merus of the external maxillipedes possesses a few minute spinules on the internal border.

The penultimate abdominal segment is traversed by a deep transverse impression, and a faint longitudinal groove is also present, the ultimate segment is four-lobed, two of the lobes being produced.

The above description is taken from an adult male which gives the following measurements:—Length of body 43 mm., of carapace 16 mm., of chelipede 30 mm., of third right leg 42 mm., of ocular peduncle 10 mm.

This species is distinguished by the remarkable development of the ocular peduncles.

Habitat.—Station 122, off Pernambuco; depth, 350 fathoms; bottom, red mud. Two specimens (one of which is immature), in shells of *Cassidaria* (*Sconsia*) *striata*, Lam.

Paguristes hians, n. sp. (Pl. VIII. fig. 4).

Characters.—The anterior portion of the carapace is ovate, and slightly tuberculate towards the margins and anterior border, the projections on the frontal margin are subacute and but slightly prominent, the two lateral being more strongly marked than the median; the posterior portion is membranous and shows very slight traces of calcification towards its centre.

The ocular peduncles are long and of extreme tenuity, slightly exceeding the antennular peduncle and extending for more than one-third of their length beyond that of the antenna, they are also slightly curved from above downwards; the ophthalmic scales are elongated, with their apices hirsute and obscurely bidentate. The antennal acicle is stout and densely hirsute, extending as far as the middle of the terminal joint of the peduncle, it is armed with three spinules on the inner and two on the outer margin; the external prolongation of the second joint is short and stout, with its apex bidentate, the whole outer border of the peduncle is fringed with long hairs; the flagellum is sparingly ciliated and remarkably short, its total length being less than that of the ocular peduncle.

The chelipedes are similar in appearance and subequal in size, with the joints pubescent and spiny. The merus has its surface almost smooth, but the upper border is armed with a few spinules towards the distal end; the carpus is less than half the total length of the propodus, its upper surface is clad with long hairs and a few spinules are also present, four prominent spines are found on the inner margin; the upper surface of the propodus is slightly convex, the lower strongly so, above there are numerous long hairs and spinules, also several spines on the inner margin near the articulation with the carpus; the fingers are more than half the total length of the propodus, and both are pubescent and tubercular above, even when their apices meet a considerable hiatus exists between their inner margins. The ambulatory limbs have their borders, and to a certain extent the posterior surface also, covered with long delicate hairs; a few spines are present on the anterior border of the carpal and propodal joints, especially the latter; the dactyli are longer than the propodi and their margins are densely pubescent.

The penultimate abdominal segment bears a T-shaped impression, and the ultimate segment is four-lobed.

Length of body 18 mm., of carapace 9 mm., of chelipede 13 mm., of third right leg 17 mm., of ocular peduncle 4·5 mm.

This species is characterised by its extremely slender eye-stalks, the short antennal flagella, and the hiatus which exists between the fingers.

Habitat.—Station 208, off Manila; depth, 18 fathoms; bottom, blue mud. A male specimen.

A single specimen of a *Paguristes* taken along with the last species is in too imperfect a condition to be described in detail. The eye-stalks extend only as far as the end of the antennal peduncle and are exceeded by the antennular peduncle; the corneæ are dilated; the antennal acicle is long and slender, without lateral spinules. The carpus of the chelipede is clothed with iridescent hairs, and two rows of curved spinules are found on the upper surface; the propodus has its upper surface tuberculate, the tubercles being arranged in three rows; there is no hiatus between the fingers.

Genus *Tylaspis*, Henderson.

Tylaspis, Henderson, Narr. Chall. Exp., vol. i. p. 900, 1885.

Carapace subcalcareous throughout, the anterior part strongly convex, the posterior part (behind the cervical groove) of considerable breadth. Front with a prominent rostral projection. Ocular peduncles moderately slender, the corneæ scarcely dilated; ophthalmic scales absent. Antennules long. Antennal acicle slender, the flagellum of moderate length. Chelipedes slender and unequal, the right larger, fingers moving in a vertical plane and calcareous at the tips. First two pairs of ambulatory limbs elongated and flattened, with long slender dactyli; the penultimate pair not chelate, and the last pair of small size. Abdomen semi-extended and of comparatively small size, with two pairs of genital appendages in the male; the appendages of the penultimate segment slender and subsymmetrical.

The form of the carapace alone suffices to distinguish *Tylaspis* from all other Pagurids. It indeed presents some points of similarity to *Ostraconotus*, A. Milne-Edwards, but the latter genus has the dactyli of the ambulatory limbs broad and flattened, and a strikingly reduced abdomen. The single specimen came from the greatest depth at which any Anomurous Crustacean was taken by the Challenger. The form of the abdomen points to the species having occupied some other dwelling-place than the Gastropod shell usually selected by the soft-tailed Pagurids.

Tylaspis anomala, Henderson (Pl. VIII. fig. 5).

Tylaspis anomala, Henderson, Narr. Chall. Exp., vol. i. p. 900, fig. 329, 1885.

Characters.—The anterior portion of the carapace is subglobose, and provided with several smooth rounded tubercles, of which two of large size are situated near the lateral border, and two others of small size nearer the median line. The anterior or frontal border possesses a well-marked median rostrum, with the apex subacute and the upper surface carinated; a slight lateral projection is also present opposite the base of each antennal peduncle. The posterior portion of the carapace is bounded anteriorly by the deep and continuous cervical grooves; the cardiac area is smooth and convex, distinctly circumscribed, with its wall calcified; the lateral or branchial region is of considerable extent, the surface is slightly convex and slopes downwards, while the outer border is convex, a longitudinal curved line divides it into two subequal areas covered everywhere with small irregular elevations. The posterior border of the carapace has a well-defined median concavity into which the first abdominal segment fits. The pterygostomial region is slightly pubescent, and separated from the remainder of the carapace by a conspicuous groove.

The ocular peduncles are somewhat slender, and the corneæ (which are deeply pigmented) but slightly dilated, the proximal end of the peduncle is, however, enlarged. The antennal peduncle exceeds the eye-stalk by half the length of its terminal joint; the acicle is slender and but slightly curved, extending almost to the end of the terminal joint of the peduncle; the second joint is without an external prolongation, and a minute spinule is present on the inner border of the third joint; the last joint is broad and flattened; the flagellum slightly exceeds the body of the animal in length. The antennular peduncle is extremely long, as the eye-stalk only reaches to the middle of its second joint, the terminal joint is broad and flattened vertically; the inferior of the two flagella is composed of only six segments. The propodus of the external maxillipedes exceeds any of the other joints in length.

The right chelipede is considerably longer and very much stouter than the left; the merus is slightly longer than the ischium, and the lower border of both joints is armed with a row of minute spinules; the carpus is not half the total length of the propodus, its surface is trigonal, and armed both above and below with numerous small tubercular spinules; the hand is somewhat dilated, with the lower surface convex, and a series of minute tubercles on the inner margin; the fingers are considerably longer than the palm, to the axis of which they are placed at an obtuse angle, the dactylus bears two and the immobile finger three teeth on the inner margin. The left chelipede is slender, the merus and ischium are subequal, the carpus is longer than the palm, and its upper surface bears a few insignificant tubercles; the propodus is smooth and not dilated; the fingers are slender and incurved, with their opposed edges straight and minutely serrated. The first and second pairs of ambulatory limbs are long and flattened, those of the second pair greatly exceeding the first, the anterior and posterior borders of the meri, carpi, and propodi, more especially the first of these, carry a series of minute spinules, and their upper surfaces are granulated; the dactyli are subcylindrical, remarkably long and slender, and slightly tortuous. The ultimate and penultimate pairs of legs are extremely short, the former being almost rudimentary, the penultimate terminates in a curved horny claw-like dactylus.

The abdomen is short and membranous, without the usual spiral twisting seen in the majority of shell-inhabiting Pagurids. The appendages of the penultimate segment are almost symmetrical, and somewhat slender; the terminal segment is oblong, with its margins entire. The male has in addition three minute biramous appendages on the left side, and two pairs of genital appendages attached to the anterior segments.

Length of body of a male 16 mm., of right chelipede 17 mm., of left chelipede 14 mm., of first ambulatory leg 30 mm., of second ambulatory leg 46 mm., of ocular peduncle 3 mm.

Habitat.—Station 285, Mid South Pacific; depth, 2375 fathoms; bottom, red clay. A male specimen. There is nothing to indicate the manner in which the abdomen was protected.

Genus *Glaucothoë*, H. Milne-Edwards.

Glaucothoë, Milne-Edwards, Ann. d. Sci. Nat., sér. 1e, t. xix. p. 334, 1830; Hist. Nat. des Crust., t. ii. p. 306, 1837; in Cuvier, Règne Anim., Crust., éd. 3e, pl. xliii. fig. 2, no date.
? *Prophylax*, Latreille, in Cuvier, Règne Anim., éd. 2e, p. 78, 1829.

Carapace submembranous, with or without a median rostral projection. Ocular peduncles well-developed; ophthalmic scales absent. Chelipedes subequal or unequal, the fingers moving in a vertical plane; penultimate pair of legs subchelate, the ultimate pair chelate. Abdomen composed of seven distinct segments (including the telson), with submembranous terga, the second to the sixth segments inclusive each provided with a pair of biramous appendages (one of the rami being rudimentary), the last pair forming with the telson a symmetrical swimming fin.

Although such eminent authorities as Milne-Edwards and Dana placed *Glaucothoë* in the Thalassinidæ among the Macrura, there can now be no doubt, since the discovery of allied forms, that the general characters of this interesting and little-known genus justify its position in the family Paguridæ. The form of the abdomen is really its only essentially Macruran character, and this part more than any other is subject to modification in the Paguridæ; indeed the abdomen is scarcely less developed in *Cancellus*, a genus the position of which in the Paguridæ has never been questioned. It is exceedingly probable that we have in *Glaucothoë* and allied forms, Pagurids of a very primitive type, still retaining many of the ancestral Thalassinid characters. Mr. Spence Bate, in a paper[1] written many years ago, maintains that *Glaucothoë* is merely an immature stage of *Pagurus* (or *Eupagurus?*), and he supports this theory by the description and figures of a larval Crustacean, taken on the surface off the south coast of England; it seems, however, that these are insufficient to prove that his specimen belonged to this genus, and he adduces no evidence to show that it subsequently becomes transformed into a soft-tailed Pagurid. The theory that ordinary Pagurids pass through a *Glaucothoë*-stage prior to taking possession of a shell, and even up to their attaining some size, is rendered improbable by the fact that specimens of *Glaucothoë* are extremely rare, while Hermits of very small size are frequently met with, in which the abdomen agrees with that of the adult in being soft and imperfectly segmented. The Challenger species described below has all the appearance of an adult animal, and, judging from the nature of its appendages, must have lived on the bottom. The previously known species of *Glaucothoë* are two in number, viz. *Glaucothoë peronii*, Milne-Edwards, which probably came from the Asiatic seas, and *Glaucothoë rostrata*, Miers, taken by the "Alert" off Madeira, at a depth of 15 to 50 fathoms. The genus *Prophylax*, Latreille, of which the type specimen has apparently been lost, is very closely allied to and perhaps identical with *Glaucothoë;* the latter name

[1] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. ii. p. 116, pl. ix., 1868.

has in any case received general acceptance by later writers. Mr. E. J. Miers has described an allied genus *Pomatocheles* from the Japanese seas, found living in the shells of a *Dentalium*, distinguished chiefly by the form of its chelipedes (the fingers of which move in a horizontal plane), the shape of the ocular peduncles and of the carapace.

Glaucothoë carinata, n. sp. (Pl. IX. fig. 1).

Characters.—The anterior part of the carapace is slightly convex from side to side, and produced into a broad and subacute median projection situated between the bases of the ocular peduncles. The frontal process possesses a sharply defined median carina, which after passing a short distance back, loses itself on the carapace; a slight lateral ridge also diverges from each margin of the rostrum, and between this and the median carina a depression exists. The posterior part of the carapace is considerably broader than the anterior portion, and a somewhat shallow cervical groove separates the two. The cardiac area is narrow and triangular; the branchial area is convex.

The ocular peduncles are of large size, almost equalling half the length of the anterior part of the carapace; the corneæ are broad and dilated, and each peduncle is constricted towards its middle. The antennular peduncle exceeds the eye-stalk by half the length of its terminal joint. The antennal peduncle is provided with a small pointed acicle, and the terminal joint is long and cylindrical, slightly exceeding the eye-stalk.

The chelipedes are equal in size, with the joints smooth and polished, though clothed with a few short silky hairs; the propodus is more than twice the length of the carpus, and considerably swollen from side to side, the outer surface is rather more pubescent than the remainder of the chelipede; the fingers are not equal in length to the hand, and even when closed a slight hiatus exists between their opposed edges, on the margin of which one or two obscure teeth can be made out; their apices are slightly corneous. The ambulatory limbs are smooth; the dactyli are long and moderately curved, ending each in a small back claw, two minute spinules and a few hairs are present on their posterior margins.

The abdominal segments are smooth; the telson is oblong and narrows slightly towards the apex, which presents a slight median emargination, the lateral borders are straight and more than twice as long as the breadth at the apex. The appendages of the penultimate segment are broad and symmetrical.

The single specimen taken is an apparently adult male, with the following measurements:—Length of body 10 mm., of chelipede 6 mm., of first ambulatory leg 10·5 mm., of ocular peduncle 1·3 mm.

In *Glaucothoë peronii*, Milne-Edwards, there is no median frontal projection, and the chelipedes are unequal. In *Glaucothoë rostrata*, Miers, with which the Challenger specimen agrees in many respects, the rostrum is not carinated superiorly, the dactyli of the ambulatory limbs are less strongly curved, and without black horny tips, while the apex of the telson is rounded.

Habitat.—Station 163A, off Twofold Bay, Australia; depth, 120 fathoms; bottom, green mud.

FIBRIBRANCHIATA.

Family PARAPAGURIDÆ.

Parapaguridæ, S. I. Smith, "Blake" Crust., Bull. Mus. Comp. Zoöl., vol. x. p. 20, 1883.

Antennular peduncle elongated or of moderate size, the first joint short and stout, the second and third joints slender and cylindrical; both flagella of small size. Antennal peduncle subcylindrical. Species marine and confined to deep water.

With the exception of the important difference in the structure of the branchiæ,[1] and the fact that the species appear to occur only in deep water, the general characters of this family are those of the Paguridæ.

Genus *Parapagurus*, S. I. Smith.

Parapagurus, S. I. Smith, Trans. Connect. Acad., vol. v. p. 50, 1879; "Blake" Crust., Bull. Mus. Comp. Zoöl., vol. x. p. 20, 1883.

Front with the rostral projection but slightly marked. Ocular peduncles usually slender; the ophthalmic scales spinular and of small size, separated by a considerable interval. Antennules long. Antennal acicle well developed; the flagellum longer than the body, and usually naked. Chelipedes markedly unequal, the right larger; fingers moving in an oblique plane and calcareous or but slightly corneous at the tips. Ambulatory limbs with long and slightly tortuous dactyli; the penultimate pair of legs subchelate. Abdominal segments with fairly well developed terga; the male with the first two segments bearing each a pair of appendages, in the female the second is biramous and represented only on the left side, while the first pair are absent; in both sexes the third, fourth, and fifth segments are provided with a biramous appendage on the left side, one of the rami being rudimentary in all the male appendages, and in that of the fifth segment in the female.

All the females of this genus which I have had the opportunity of examining, possess the remarkable peculiarity of having an external genital opening present only on the coxa of the third left leg; but owing to the very imperfect state of preservation of

[1] In all, the gills are modified trichobranchiæ, each consisting of a central stem which gives rise to two collateral rows of rounded filaments, gradually decreasing in size towards the apex, whereas in the Paguridæ the stem gives rise to two rows of flattened leaflets.

the soft parts, I have been unable to ascertain by dissection whether there exists any corresponding deficiency as regards the right ovary. The previously known species of this characteristically deep-water genus are *Parapagurus pilosimanus*, S. I. Smith (= *Eupagurus jacobii*, A. Milne-Edwards), which has been taken in abundance off the east coast of the United States, by the Fish Commission and Coast Survey vessels, and *Parapagurus dimorphus* (Studer) recorded below.

Parapagurus dimorphus (Studer) (Pl. X. fig. 1).

Eupagurus dimorphus, Studer, "Gazelle" Crust., Abhandl. d. k. Akad. d. Wiss. Berlin, p. 24, taf. ii. figs. 11–12, 1883.

Habitat.—Station 135c, off Nightingale Island, Tristan da Cunha; depth, 110 fathoms. Several specimens of small size, in shells of *Murex* (*Pseudomurex*) *aëdonius*, Watson, taken along with *Eupagurus tristanensis.*

Station 142, off the Agulhas Bank; depth, 150 fathoms; bottom, sand. A large number of specimens (including several females with ova), inhabiting shells which have become almost completely absorbed by an investing *Epizoanthus.*

Station 145 or 145a, off Marion Island; depth, 140 or 310 fathoms; bottom, volcanic sand. A single specimen in a very imperfect state of preservation.

Station 311, off Port Churruca, Patagonia; depth, 245 fathoms; bottom, blue mud. A female with ova, in a shell of *Pleurotoma acanthodes*, Watson.

In this species the eye-stalks are of considerable size and the corneæ dilated, although these organs are slender in all other known members of the genus. The sexual dimorphism chiefly manifests itself in the form of the right chelipede, which in the female has the hand short and broad, with the dactylus (when closed) bent almost at a right angle to the upper border, whereas in the male the hand is proportionately narrower and the fingers are elongated and oblique. Dr. Studer has figured what is evidently an old male, for the fingers of the right chela are represented as meeting only at the tip, leaving a considerable intervening hiatus; in none of the Challenger specimens is this condition observable. The right chelipede has a prominent and acute dentate lobe on its lower and distal margin, and a similar less extensive, though more pronounced, lobe occurs in the same position on the carpus; the lateral margins of the hand are sharp and dentate. The ophthalmic scales are poorly represented, and a reddish band is still visible on each lateral surface of the eye-stalk. The antennal peduncle extends to the end of the eye-stalk, the external prolongation of the second joint is moderately long and acute, and the third joint bears a prominent spinule on its inner surface; the inner margin of the aciele is distinctly spinose, and the flagellum is faintly ciliated. The terminal joint of the antennular peduncle is considerably shorter than the antennal peduncle. The ambulatory limbs, with the exception of a few spinules on the anterior border of the carpal joints, are comparatively smooth. An adult male measures 31 mm. in length.

Parapagurus dimorphus was dredged by the "Gazelle" off the Cape of Good Hope, at a depth of 117 fathoms, living in shells of *Buccinum porcatum*, Gm., which were completely covered by colonies of *Epizoanthus cancrisocius*, von Martens.

Parapagurus abyssorum, A. Milne-Edwards, MS. (Pl. IX. fig. 2).

Characters.—The anterior portion of the carapace is strongly calcified, somewhat square in outline, and moderately convex both from side to side and from before backwards. The surface is smooth and polished, though certain slight inequalities are noticeable towards the lateral margins, and the frontal border is raised. The median frontal projection is obtusely rounded, scarcely reaching the bases of the ocular peduncles, the lateral projections are even less strongly marked, but with pointed apices. The carapace behind the cervical groove is submembranous, with the exception of the narrow cardiac area which is calcified; the branchial regions are strongly convex.

The ocular peduncles are narrow, especially towards the centre, but dilated somewhat at the base; the corneæ are of small size though deeply pigmented; the ophthalmic scales are narrow and spinulous, and each terminates in a pointed projection. The antennal peduncles are massive and exceed the eye-stalks by the whole length of the ultimate joint; the acicle is long and slender, extending slightly beyond the distal end of the terminal joint, it has a slight sigmoid curve and the inner margin bears a row of small spinules; the external prolongation of the second joint is short and its apex rounded; the terminal peduncular joint is broad and somewhat flattened; the flagellum is more than twice the total length of the body. The first joint of the antennular peduncle has its distal end situated opposite the end of the eye-stalk, the terminal joint is half as long again as the second joint, and almost equal in length to the whole antennal peduncle.

The chelipedes are moderately slender and of considerable length, with the joints granular and pubescent. The right chelipede has the merus somewhat shorter than the carpus, with its outer surface granular, and a dense pubescence underneath, the inner surface is comparatively smooth, and a raised tubercular line exists immediately behind the anterior margin, at the inner and distal margin on the under surface a few tubercular spines of small size are met with; the carpus is about equal in length to the hand (not including the fingers), and the upper surface is uniformly granulated, the lower surface is convex from side to side, and is both pubescent and granular, while the lateral borders are not sharply defined; the propodus is but little dilated and its general characters are those of the carpus. The immobile finger is placed at an obtuse angle to the lower border and its upper margin bears two irregular compound teeth, in addition to some small tufts of setæ; the dactylus has its upper surface granular, and like the immobile finger is slightly incurved, its lower margin bears two compound teeth and numerous tufts of setæ. The left chelipede is slender and the joints are comparatively smooth, though the inner border of the carpus is raised and tubercular, and its lower surface is densely pubescent; the dactylus is equal to more than half the total length of the propodus, whereas that of the right chelipede is less than half the length. The ambulatory limbs are remarkably long and slender, the extreme tenuity of the dactyli being a special feature; the second exceeds the first by about half the length of its dactylus; the meral, carpal, and propodal joints have their anterior, and to a certain extent their lateral surfaces granular; the dactyli are comparatively smooth and slightly tortuous, with the apex acute, they are also obscurely canaliculate, their length appears to vary considerably in different specimens, and in certain adult males may equal that of the body. The ultimate and penultimate pairs of legs have their borders fringed with delicate hairs.

The penultimate abdominal segment bears a cruciform impression; the terminal segment is composed of a single lobe with a sinuous margin.

The above description is furnished by an adult male taken at Station 300, which gives the following measurements:—Length of body 50 mm., of right chelipede 73 mm., of left chelipede 55 mm., of third right leg 140 mm., of dactylus of same leg 49 mm., of ocular peduncle 6 mm.

A certain amount of variation is noticeable in specimens from different localities, more especially as regards the amount of pubescence and granulation on the chelipedes and ambulatory limbs. In a specimen from Station 133, the ophthalmic scales are bidentate, and the external prolongation of the second antennal peduncular joint is dentate. In spite of these apparent incongruities, an examination of the numerous specimens taken by the Challenger has convinced me that they all belong to a single species. Females are of much smaller size than males, indeed one with ova from Station 300 (where the largest males occurred) measures only 29 mm. in length; in females also, the immobile finger of the right chela is bent at a more obtuse angle to the hand than in males.

Parapagurus abyssorum is of special interest on account of its very extended distribution and deep-water habitat. It was taken by the Challenger in all the great ocean beds explored (with the exception of the Southern Ocean between the Cape and Australia), and nowhere in less than 1000 fathoms of water. It appears to be invariably associated with an Anemone which exerts a solvent action on the Gastropod shell originally selected as a dwelling-place by the Hermit; in many cases the shell has entirely disappeared, and in others it is greatly reduced, while the Anemone forms a soft and saccular covering on the exterior. The "Talisman" collection at Paris contains examples of this species, named *Pagurus abyssorum* by Professor A. Milne-Edwards; I have therefore in the above description adopted his specific name. In *Parapagurus pilosi-*

manus, S. I. Smith, the chelipedes are more densely pubescent, the immobile finger of the right chela is not bent at an angle to the lower border of the hand, and the fingers of the left chela are relatively shorter than in the present species.

Habitat.—Station 56, off Bermuda; depth, 1075 fathoms; bottom, coral mud. A female with ova in a shell of *Trochus* (*Margarita*) *infundibulum*, Watson.

Station 106, off Sierra Leone; depth, 1850 fathoms; bottom, Globigerina ooze. Several specimens in shells of *Pleurotoma* sp. and *Dentalium* sp.

Station 133, near Tristan da Cunha; depth, 1900 fathoms; bottom, Globigerina ooze. Three specimens in shells of *Ianthina rotundata*, Leach (a pelagic Mollusc, the shells of which had sunk to the bottom), and *Pleurotoma* sp.

Station 195, off Banda; depth, 1425 fathoms; bottom, blue mud. Several specimens protected merely by Anemones.

Station 205, off the Philippines; depth, 1075 fathoms; bottom, blue mud. A single specimen in a shell of *Pleurotoma* sp.

Station 218, north of Papua; depth, 1070 fathoms; bottom, blue mud. A single specimen protected by an Anemone.

Station 237, off Yokohama; depth, 1875 fathoms; bottom, blue mud. Several specimens protected by Anemones, as well as two young individuals in bare shells of *Pleurotoma* sp. (?).

Station 300, west of Valparaiso; depth, 1375 fathoms; bottom, Globigerina ooze. Many fine specimens protected by Anemones, with the shells absent or so wasted as to be unrecognisable.

Station 304, Port Otway, Patagonia; depth, 45 fathoms; bottom, green sand; a single specimen in a shell of *Trochus* sp. There can be little doubt that in this case some error has arisen in the labelling, as a shallow-water habitat for the species is quite out of the question.

Station 335, near Tristan da Cunha; depth, 1425 fathoms; bottom, Pteropod ooze; A single specimen in a shell of *Pleurotoma* sp.

Parapagurus abyssorum, A. Milne-Edwards, var. *scabra*, nov. (Pl. IX. fig. 3).

Characters.—The granulations present on the chelipedes and ambulatory limbs in the typical form of the species, are replaced in the variety by short thick spinules. In the chelipedes these are most strongly developed on the upper surface of the carpus, and on the lower surface of the merus, while in the ambulatory limbs they are well marked on the anterior border of the meral, carpal, and propodal joints. The external prolongation of the second antennal peduncular joint is dentate, and an acute spinule is present on the inner and distal margin of the same joint; the antennal acicle has a series of distinct spinules on its inner border. The eye-stalks as well as the antennal peduncles show a slight amount of pubescence. A small tuft of corneous hairs is noticeable towards the apex of the ambulatory dactyli—a feature which may also be detected in some specimens of the typical form.

The single specimen taken is a female measuring 37 mm. in total length; but for the large series of examples of *Parapagurus abyssorum*, and the occurrence of intermediate forms, I should have felt inclined to regard it as belonging to a distinct species.

Habitat.—Station 68, between Bermuda and the Azores; depth, 2175 fathoms; bottom, Globigerina ooze. A female with ova, in an investment of Zoanthoid polypes.

Parapagurus affinis, n. sp. (Pl. IX. fig. 4).

Characters.—The anterior portion of the carapace is moderately convex, and slightly pubescent towards the lateral margins, the frontal projections are scarcely represented, the median being obtusely rounded; the posterior portion is entirely membranous.

The ocular peduncles are moderately slender, and pubescent above, with the corneæ slightly dilated; the ophthalmic scales terminate in from four to six minute denticles. The antennal peduncle exceeds the eye-stalk by more than half the length of its terminal joint; the acicle extends almost to the distal end of the last joint, and is moderately curved, its inner margin is pubescent and armed with a row of minute teeth; the external prolongation of the second joint is short, with its apex dentate, an ill-defined tooth is also present on the inner and distal margin of the second joint; the remaining joints of the peduncle as well as the flagellum are slightly pubescent. The antennular peduncle exceeds the eye-stalk by the length of its terminal joint and about half that of the second joint; the ultimate joint is slightly pubescent, and somewhat shorter than the antennal peduncle.

The chelipedes are unequal and of moderate size, the terminal joints granular, and covered with long delicate hairs. The right chelipede has the meral joint almost smooth, with a few granulations on the lower surface, and a serrated lobe on the distal inferior margin, a piliferous line is seen on the upper surface running parallel to the anterior border; the carpus is about two-thirds the length of the propodus, the upper surface is granular and faintly pubescent, and a raised piliferous line runs parallel to the anterior border, with the exception of its inner margin the lower surface is comparatively smooth; the propodus is considerably broader than the carpus, the granulations are well marked on the rounded lateral margins, while the remainder of the upper surface is smooth, though clothed with long silky hairs, the lower surface is densely pubescent, especially towards its anterior end; the dactylus is more than half the total length of the hand, and its upper border and inner surface are densely clothed with hairs; the fingers terminate in minute horny tips, and several ill-defined teeth are present on their opposed edges. The left chelipede has the carpus almost equal in length to the propodus, its inner surface is hairy, and two acute spinules are seen on the anterior border; the fingers are almost straight, and more than half the length of the hand, with their opposed edges parallel and minutely serrated. The ambulatory limbs are smooth and moderately long, the anterior border of all the joints is pubescent, and a small spine exists on the anterior border and distal end of the carpi; the dactyli are about equal in length to the propodi and carpi taken together, each terminates in a yellow horny spine, and a tuft of corneous hairs is present on the anterior surface near the apex. The last two pairs of legs are moderately pubescent.

The penultimate abdominal segment bears a T-shaped impression; the terminal segment is irregularly lobed.

An adult female gives the following measurements:—Length of body 25 mm., of right chelipede 30 mm., of left chelipede 22 mm., of third right leg 43 mm., of ocular peduncle 4 mm.

This species is allied to *Parapagurus abyssorum*, from which it is distinguished by the form and armature of the right chelipede, ophthalmic scales, and the dactyli of the ambulatory legs, in addition to other less important distinctions. The form of the eye-stalks, and the diminished length of the terminal antennular peduncular joint, separates it from *Parapagurus pilosimanus*, S. I. Smith.

Habitat.—Station 214, off the Meangis Islands; depth, 500 fathoms; bottom, blue mud. A female with ova, in a shell of *Pleurotoma* sp.

Parapagurus latimanus, n. sp. (Pl. X. fig. 2).

Characters.—The anterior portion of the carapace is slightly convex, and rugose towards the lateral margins, the three frontal projections are obtusely rounded and but slightly marked; the two cervical grooves form a rounded line separating the two portions; the posterior portion of the carapace is smooth and entirely membranous.

The ocular peduncles are slender though dilated towards the base, with a few hairs on their upper surface; the ophthalmic scales are short, entire, and subacute. The antennal peduncle exceeds the eye-stalk by more than half the length of its terminal joint, the acicle is but slightly curved, extending almost to the end of the ultimate joint, and its surface is pubescent, especially towards the apex which is provided with a tuft of hairs; the external prolongation of the second joint is well marked, and terminates in two subacute teeth; the flagellum is of moderate length and slightly pubescent. The first joint of the antennular peduncle has its distal end situated almost opposite the end of the eye-stalk, the terminal joint slightly exceeds the total length of the antennal peduncle.

The disparity in size is very marked in the chelipedes; the surface of both is pubescent, and the larger is also granulated. The right chelipede has the merus with an oval impressed line on its inner surface (seen to a lesser extent in other members of the genus) and the lower and distal margin is produced into a serrated lobe, the upper surface is faintly granular, and bears a raised line parallel to and adjoining the anterior border; the carpus is about two-thirds the length of the propodus, and its upper surface is uniformly granular and pubescent, a few granulations are also present on the lower surface; the propodus is considerably dilated and its upper surface is glabrous, a number of granulations with a tendency towards linear arrangement exist over the greater part of this surface, but towards the lateral borders these are replaced by short crowded spinules, with hairs interspersed, the lower surface is smooth and polished, a few granulations and hairs being merely present towards the lateral margins, the immobile finger is not bent at an angle to the lower margin of the hand; the dactylus is slightly more than half the total length of the propodus, while its upper surface is pubescent, and covered with short crowded tubercular spinules, the opposed edges of the fingers are provided with short hairs and a few small irregular teeth. The left chelipede has its joints unarmed though pubescent, the upper surface of the carpus being specially hairy, the hand is but little dilated, and the fingers are more than half the total length of the propodus. The ambulatory limbs are smooth and unarmed, the dactyli are remarkably long and slender, being nearly twice the length of the propodi, and a series of corneous setæ is present on the anterior border near the apex. The last two pairs of legs are smooth and moderately pubescent, especially towards the terminal joints.

The penultimate abdominal segment bears a cruciform impression; the terminal segment is obscurely bilobed.

Length of body 22 mm., of right chelipede 18 mm., of left chelipede 13 mm., of third right leg 26 mm., of ocular peduncle 3 mm.

Habitat.—Station 167A, off New Zealand; depth, 10 fathoms; bottom, mud. A male specimen.

Parapagurus gracilis, n. sp. (Pl. X. fig. 3).

Characters.—The anterior portion of the carapace is smooth and moderately convex, submembranous towards the middle, with the lateral surfaces calcified, and each traversed by an oblique line which passes outwards and backwards from the submembranous part, the frontal projections are scarcely evident; the two cervical grooves form an evenly rounded line; the posterior portion is entirely membranous.

The ocular peduncles are stouter than is usual in this genus, with a few hairs on the upper surface and a faint reddish band still evident along each lateral surface, the corneæ are slightly dilated and of rather large size; the ophthalmic scales are broad towards the base, but acute and spinulous at the apex. The antennal peduncle scarcely exceeds the eye-stalk; the acicle is moderately curved, and almost reaches the end of the terminal joint, with its surface pubescent and the inner margin dentate; the external prolongation of the second joint is moderately long, and entire. The antennular peduncle exceeds the eye-stalk by the length of its terminal joint, which at the same time is greater than the total length of the antennal peduncle.

The chelipedes are narrow and elongated, with the joints slightly pubescent and faintly granular. The right chelipede has the merus provided with a serrated lobe on its lower and distal margin; the carpus is slender and elongated, almost equalling the hand in length, the granules are most strongly developed on its lower surface which projects considerably; the propodus is almost twice the breadth of the carpus, the outer border is thin and curved, while the inner is thick, and traversed by two ridges, of which the inner (as regards the axis of the joint) is continued back to the carpo-propodal articulation, and the outer or marginal is deficient behind, the granulations are almost obsolete on the upper surface, though a few can be made out towards the lateral margins, the lower surface is smooth, and concave in front; the fingers are short and remarkably incurved, the upper surface of the dactylus is dentate and densely pubescent, while a few ill-defined teeth of small size are seen on the opposed margins. The left chelipede is slender, and compressed laterally, with the carpus slightly longer than the propodus; the fingers are bent downwards and slightly incurved, while their length is less than that of the palm. The ambulatory limbs are smooth, with the exception of a few hairs scattered over the joints (a minute spinule is seen in one of the specimens on the anterior border and distal end of the carpal joints); the dactyli are not twice the length of the propodi, and their anterior margin is fringed by long and delicate setæ, a patch of dark colour is still evident at the distal end of the meral, carpal, and propodal joints, in the more perfect specimen.

The penultimate abdominal segment is traversed by a deep transverse impression; the ultimate segment is obscurely rounded.

The smaller though more perfect specimen (a male) gives the following measurements:—Length of body 11 mm., of right chelipede 13 mm., of left chelipede 9 mm., of third right leg 18 mm., of ocular peduncle 2 mm. The larger specimen measures 14 mm. in length.

Habitat.—Station 122, off Pernambuco; depth, 350 fathoms; bottom, blue mud. Two male specimens in the shells of a species of *Pleurotoma*.

Genus *Pagurodes*, n. gen.

Front with the rostral projection of moderate size. Ocular peduncles short; the ophthalmic scales spinular and separated by a considerable interval. Antennules long. Antennal acicle strongly developed, the flagellum long. Chelipedes slender and unequal, the right larger; fingers moving in a horizontal plane, and calcareous or but slightly corneous at the tips. Ambulatory limbs with long and slightly tortuous dactyli, the penultimate pair subchelate. Males with a short curved tubular organ (formed by the protruded vas deferens) attached to the coxa of the fifth right leg. Abdominal segments with the terga linear; males with three minute appendages on the left side, of which the first and second are uniramous, and the third is partially concealed by the appendage of the penultimate segment; females with four appendages on the left side, the first two of which are biramous and oviferous.

This genus agrees in some respects—particularly in the position of the protruded vas deferens,—with *Catapagurus*, A. Milne-Edwards, from which it is, however, distinguished by the form of the eyes, and the non-ciliated ambulatory dactyli, as well as by the trichobranchiæ. The shape of the chelipedes, the protruded vas deferens, and the absence of genital appendages from the first two abdominal segments in the male, separate it from *Parapagurus*, S. I. Smith.

Pagurodes inarmatus, n. sp. (Pl. X. fig. 5).

Characters.—The anterior portion of the carapace is smooth and moderately convex, with the median frontal process fairly prominent and acute, the lateral projections are also acute and no less prominent; the frontal margin is slightly raised, and a few slight inequalities are seen towards the lateral margins; the cervical groove forms a straight line on each side of the carapace, placed obliquely to a deep transverse sulcus which connects the two, and a deep sinuous depression runs immediately in front of and parallel to each; the posterior portion is entirely membranous.

The ocular peduncles are short and compressed laterally, with a few hairs on the upper surface, and their bases swollen, the corneæ are slightly dilated; the ophthalmic scales are short and spinulous, with their apices acute. The antennal peduncle exceeds the eye-stalk by the length of its two last joints; the acicle is strongly curved and extends beyond the apex of the ultimate joint; the second joint has a prominent and acute external prolongation, as well as an acute spinule on the inner and distal margin; the first joint bears a minute spinule on its outer border; the proximal half of the flagellum shows slight lateral compression. The antennular peduncle exceeds the eye-stalk by the length of the ultimate and penultimate joints, the former broadens out towards its distal end, and a tuft of long hairs is placed at the apex overhanging the two flagella.

The chelipedes are slender and not strikingly unequal in size, the disparity being chiefly noticeable in the chelæ. The right chelipede has the meral joint elongated and about equal in length to the carpus, the outer surface is covered with granules which tend to become tubercular on the lower and inner margin; the upper and outer surfaces of the carpus are uniformly granular, the inner margin is moderately sharp and the lower surface is comparatively smooth; the propodus is about one and a half times the length of the carpus and one-third stouter, the upper surface is convex from side to side, with the granules somewhat deficient towards the centre, where the surface is glabrous, towards the carpal articulation a short median tubercular carina is present, in addition to two less prominent elevated lines which are situated nearer the outer border and pass some distance forwards on the upper surface, the lower surface is comparatively smooth, and slightly concave towards the inner margin; the fingers are pubescent and slightly curved, their length is less than that of the hand, the dactylus bears two teeth and the immobile finger a single tooth on the inner margin. The left chelipede differs from the right in the following respects:—the hand is but slightly dilated, and a short median carina is alone noticeable on the upper surface, the fingers are longer than the palm, and more curved than those of the right side, while their opposed edges are sharp and devoid of teeth. The ambulatory limbs are long and slender, with slight granulations present on the meral, carpal, and propodal segments; the dactyli are slender and elongated, with a well-marked sigmoid curve, and a few setæ are present on their anterior surface near the apex. The penultimate pair of legs are considerably shorter than the ultimate pair, with which they agree in being slightly pubescent. The protruded vas deferens is moderately curved and entirely membranous.

The penultimate abdominal segment is divided by a deep transverse depression; the ultimate segment is bilobed, with its margins fringed by short setæ.

The above description is furnished by an adult male taken at Station 168, which gives the following measurements:—Length of body 28 mm., of right chelipede 36·5 mm., of left chelipede 34 mm., of third left leg 49 mm., of ocular peduncle 2·5 mm., of protruded vas deferens 2 mm.

Some amount of variation is to be noted as regards the pubescence of different individuals; in certain specimens the chelipedes are almost completely clothed with short silky hairs. Females are of much smaller size than males, of two with ova from Station 168, the larger measures only 17 mm. in length.

Habitat.—Station 146, near Marion Island; depth, 1375 fathoms; bottom, Globigerina ooze. Two males and a female.

Station 168, off New Zealand; depth, 1100 fathoms; bottom, blue mud. Three males and two females, both the latter bearing ova, in shells of *Pleurotoma* sp., and *Nassa* sp.

Pagurodes piliferus, n. sp. (Pl. IX. fig. 5).

Characters.—The anterior portion of the carapace is smooth and convex, with a few scattered tufts of hairs, the lateral borders are also convex and slightly pubescent, the median frontal projection is obtusely rounded and fairly prominent, the lateral projections are well marked and acute; the posterior portion is wholly membranous and somewhat wrinkled.

The ocular peduncles are stout, with the corneæ strongly dilated, a few short hairs are seen on their upper surface; the apices of the ophthalmic scales are bidentate. The antennal peduncle is somewhat pubescent, and considerably longer than the eye-stalk; the acicle is slender and curved, slightly exceeding the ocular peduncle; the external prolongation of the second joint extends almost as far as the proximal end of the terminal joint. The antennular peduncle exceeds the eye-stalk by more than half the length of its terminal joint.

The chelipedes are subequal in length, but the right is considerably stouter; both are uniformly pubescent. The merus of the right chelipede bears a few piliferous lines on its upper surface, and a small spine is present on the lower and outer border; the carpus is more than half the total length of the propodus, and the latter is slightly dilated, the upper surface of both joints, but particularly of the propodus, is clothed rather densely with long hairs, those of the carpus appearing to take their origin from tubercles, the free borders are also pubescent, and a few spinules exist on the inner margin of the carpus; the fingers are less than half the total length of the propodus, and the upper surface of the dactylus is hairy. The left chelipede, with the exception of the difference in size, is similar to the right; the tubercles on the upper surface of the carpus are well marked, and the fingers are slightly longer in proportion to the hand. The meral, carpal, and propodal joints of the ambulatory limbs are crossed anteriorly by transverse piliferous lines, and one or two spinules exist on the carpi; the dactyli are longer than the propodi, moderately curved, and ciliated externally.

The penultimate abdominal segment is crossed by a deep transverse groove, and the ultimate segment is obscurely four-lobed.

Length of body 20 mm., of right chelipede 19 mm., of left chelipede 18 mm., of third right leg 26 mm., of ocular peduncle 3·8 mm.

This species is distinguished from *Pagurodes inarmatus* by the larger size of the eye-stalks and the dilatation of the corneæ, the ambulatory dactyli are also shorter, and without the double or sigmoid curve seen in the former.

Habitat.—Station 204A or B, off Tablas Island; depth, 100 to 115 fathoms; bottom, green mud. A female with ova.

Arafura Sea. A small male in a very imperfect state of preservation, from this locality, is doubtfully referred to the present species.

Pagurodes limatulus, n. sp. (Pl. X. fig. 6).

Characters.—The anterior portion of the carapace is smooth and convex, as are also the lateral borders, the median frontal projection is prominent and obtusely rounded, the lateral projections are less strongly marked, with their apices obtuse; the posterior portion of the carapace is entirely membranous.

The ocular peduncles are remarkably short, with the corneæ not sensibly dilated, and a few hairs are seen on their upper surface; the apices of the ophthalmic scales are rounded and entire. The antennal peduncle is two and a half times the length of the eye-stalk, the acicle is long, slender, and curved; the external prolongation of the second joint terminates opposite the end of the eye-stalk, and a slight prolongation is present on the inner margin of the same joint. The antennular peduncle exceeds the eye-stalk by the whole length of the last joint and a portion of the penultimate joint.

The chelipedes are long and remarkably slender, with the length subequal, though the right is considerably stouter. The right chelipede has the merus with its upper surface crossed by transverse piliferous lines, the lower surface is slightly tuberculate, and three spinules are present on the lower and outer border at its distal end; the carpus is about two-thirds the total length of the propodus, with its upper surface pubescent and slightly granular, while the inner border is spinulous, especially towards its distal end; the upper surface of the propodus is smooth and polished, convex from side to side, and with traces of granulation towards the inner margin; the fingers are smooth, and less than half the length of the propodus, while they are provided with a few short hairs. The left chelipede is unusually slender, with the lower surface of the merus tuberculate and slightly pubescent; the carpus nearly equals the propodus, its upper surface bears two indistinct rows of spinules separated by a considerable interval, and a rounded swelling is present on the inner and distal surface; the upper surface of the propodus has an obscurely marked central ridge, the fingers are longer than those of the right chelipede and perfectly smooth above. The ambulatory limbs slightly exceed the chelipedes in length; the anterior surface of the meral, carpal, and propodal joints bears a few indistinct pubescent ridges, the dactyli are one and a half times the length of the propodi, slender, and but slightly curved, their lower borders are armed with delicate corneous spines, and each terminates in a yellow horny claw.

The penultimate abdominal segment is crossed by a moderately deep transverse groove; the ultimate segment is four-lobed, with the two terminal lobes of small size.

Length of body 15 mm., of right chelipede 20 mm., of left chelipede 19 mm., of third left leg 23 mm., of ocular peduncle 2 mm.

The armature of the meral and carpal joints of the chelipedes, and the form of the ambulatory dactyli, at once distinguish this species from *Pagurodes inarmatus*, to which it is in other respects closely related. The single male specimen is without the protruded vas deferens, but as it is otherwise mutilated it is possible that this organ has been accidentally removed.

Habitat.—Station 214, south of the Philippines; depth, 500 fathoms; bottom, blue mud. A male, in a shell of *Pleurotoma* sp.

A minute Pagurid found in the shell of a species of *Pleurotoma* from Station 73, near the Azores; depth, 1000 fathoms; bottom, Pteropod ooze, is probably referable to the genus *Pagurodes*. It is, however, in too imperfect a condition for satisfactory identification.

Genus *Paguropsis*, n. gen.

Front with a prominent rostral projection. Ocular peduncles stout; the ophthalmic scales minute and separated by a considerable interval. Antennules of moderate length. Antennal acicle of small size; the flagellum of moderate length. Chelipedes subequal and well developed; the fingers moving in a horizontal plane, slightly corneous and excavated towards the tips. Ambulatory limbs compressed and of moderate length, with long, slender, and tortuous dactyli; the last two pairs chelate and subdorsal in position. Abdomen short and simply bent, the terga membranous and of moderate width; males with two pairs of genital appendages on the ventral aspect of the first and second segments, and a minute uniramous appendage on the right side of the third and fourth segments respectively; females with a pair of appendages on the first segment, and three biramous appendages of large size on the right side of the second, third, and fourth segments, enclosed in a spacious marsupial pouch.

The characters of this interesting genus are in many respects peculiar, indeed two of these are sufficient to give it a unique position among Hermit Crabs, viz., the subdorsal position of the last two pairs of thoracic legs, and the presence of the unpaired abdominal appendages on the right side. Among the Pagurids generally, the soft abdomen, as a result of its being thrust into a Gastropod shell the spiral of which is normally right handed, has assumed a similar curve, and the original right side thus closely applied to the columella loses its appendages. In the species described below there is nothing to indicate the nature of the habitation selected by the animal, and an examination of the abdomen leaves little doubt that it must have been protected in some way; the presence of the abdominal appendages on the right side, and the fact that the abdomen is simply bent on itself, render it probable that in this case a Gastropod shell has not been selected.

Paguropsis typicus, n. sp. (Pl. X. fig. 4).

Characters.—The anterior portion of the carapace is smooth, strongly convex from side to side, and firmly calcified; the rostral projection is compressed laterally and carinated superiorly, with its apex which is acute and slightly deflexed extending beyond the tips of the ophthalmic scales, a slight swelling is seen on the carapace on either side of the base of the rostrum, and the lateral frontal projections are but slightly marked; on the posterior portion the cardiac area is calcified, as is also though to a lesser extent the antero-internal margin of the branchial area.

The ocular peduncles are short, with the corneæ deeply pigmented, strongly dilated, and semi-lunar in outline when viewed from above; the ophthalmic scales are of small size, and each terminates in an acute spinule. The antennal peduncle scarcely exceeds the eye-stalk in length; the acicle is poorly developed and but slightly curved, not reaching the middle of the last joint of the peduncle; the external prolongation of the second joint is almost obsolete. The antennular peduncle exceeds the eye-stalk by the length of its terminal joint; the upper of the two flagella is strongly developed, and densely ciliated.

The chelipedes are of similar conformation and almost equal size (in the single male specimen the left is somewhat larger, a condition possibly due to accident), while the terminal joints are thickly clad with bristle-like hairs. The lower and inner margin of each ischial joint bears a few tubercular spinules; the merus is twice the length of the carpus and distinctly trigonal in shape, the upper margin is tuberculate and slightly rounded, the two lower margins are pubescent, and armed with blunt spinules, the surfaces are comparatively smooth, and the anterior margin is slightly raised on the superior surface; the carpus is about half the length of the propodus, and its surface is remarkably deficient below, so that the hand can be folded till it comes in contact with the proximal half of the limb, the upper surface is slightly oblique, and armed with numerous long setæ, most of which arise from tubercles; the upper surface of the propodus also shows a slight amount of obliquity, the lateral borders are rounded (especially the outer), and the marginal setæ are of considerable length, the setæ on the upper surface arise from tubercles which show a tendency towards arrangement in rows, and numerous tufts of setæ are present on the lower surface; the fingers are slightly more than half the total length of the hand and but slightly curved, the dactylus bears a few small teeth on its inner proximal margin, and the corresponding margin of the immobile finger is finely crenated, the lower surface is slightly excavated towards the apices, which are tipped by small horny processes, the setæ are chiefly seen on the upper and outer surfaces and are mostly arranged in tufts. The ambulatory limbs are of moderate length, with the meral, carpal, and propodal joints smooth and flattened, a few marginal hairs alone being present; the dactyli of the second pair are twice the length of the propodi and decidedly tortuous. The last two pairs of legs are folded up on the sides of the carapace; those of the third pair are one-half longer than the fourth pair and extend forwards as far as the sides of the eye-stalks, the joints are smooth, and a few hairs are present on the borders, the dactylus is small and curved, forming a perfect chela with a similar process of the propodus, which latter bears two or three minute teeth on its inner margin, and a hiatus exists between the two processes; the legs of the last pair are slightly more cylindrical, and are situated over the branchial regions, their margins are somewhat pubescent, and the terminal chela is without a hiatus between the claws.

The abdomen is short and stout; the first pair of appendages are of small size in the female, whereas in the male they are large and closely applied together in the middle line; the second pair in the male are long and slender; the lateral appendages in the female consist of an elongated protopodite, a long slender and curved exopodite, and a shorter and stouter endopodite. The penultimate segment is crossed by a transverse impression, and its lateral appendage on each side bears a long and slender exopodite and a rudimentary endopodite; the ultimate segment is somewhat rectangular, and its free margins are ciliated.

The above description is taken from the larger (female) specimen, which gives the following measurements:—Length of body 20 mm., of carapace 11 mm., of chelipede 25 mm., of third right leg 31 mm., of ocular peduncle 4 mm. The male specimen measures only 18 mm. in length, and in it the left chelipede exceeds the right by more than half the length of its fingers.

Habitat.—Station 204A or B, off Tablas Island; depth, 100 to 115 fathoms; bottom, green mud. Two specimens, male and female, both apparently adult.

Genus *Pylocheles*, A. Milne-Edwards.

Pylocheles, A. Milne-Edwards, Bull. Mus. Comp. Zool., vol. viii. p. 38, 1880.

Carapace completely calcified; front with the rostral projection but slightly marked. Ocular peduncles long and slender, the ophthalmic scales of small size and separated by a considerable interval. Antennules of moderate length. Antennal acicle short and stout; the flagellum short. Chelipedes of equal size; the fingers moving in an oblique or almost horizontal plane, and corneous at the tips. Ambulatory limbs slender, with short dactyli; the penultimate pair of legs subchelate. Abdomen symmetrical and well developed, the segments with broad semi-calcareous terga, the ventral region membranous and provided with rudimentary sterna on the first and sixth segments; males with two pairs of genital appendages on the ventral aspect of the first two segments, and a pair of symmetrical biramous appendages on the third, fourth, and fifth segments; females with a single minute pair of genital appendages on the ventral aspect of the first segment, and four pairs of symmetrical biramous appendages on the second, third, fourth, and fifth segments, of which the first two are of large size; the appendages of the penultimate segment are large and symmetrical in both sexes, forming with the telson a powerful swimming fin.

The characters of this remarkable genus are extremely primitive, and it forms, as has been pointed out by Professor A. Milne-Edwards, a connecting link between the Thalassinids and the Pagurids; at the same time there can be no doubt that its affinities justify its position in the latter group. In *Pylocheles* we have as it were one of the first downward steps in the series of degenerative changes which have transformed certain Macrura into soft-tailed Hermit Crabs. It is closely allied to *Pomatocheles*,[1] Miers, in which, however, the carapace is narrower and more elongated, the chelæ are operculiform, and the fingers move in a distinctly horizontal plane. The only previously known species is *Pylocheles agassizii*, A. Milne-Edwards, dredged by the "Blake" at a depth of 200 fathoms off Barbados, and found inhabiting an excavation in a piece of sandstone, the mouth of which was closed by its chelæ. It is doubtful whether the Challenger species possessed any such habitation.

Pylocheles spinosus, n. sp. (Pl. XI. fig. 1).

Characters.—The anterior portion of the carapace is broad and moderately convex, with a few slight inequalities towards the lateral surfaces and in front. The frontal margin is slightly raised, the median process projects but slightly and is broad and subacute, though tipped by a minute spinule; the lateral processes are more prominent, and their apices are acute. A transverse depression exists on the carapace a slight distance behind the median part of the frontal margin, and a few hairs are scattered over the surface; the posterior portion is less strongly calcified than the anterior, and the cardiac area is triangular in shape; the cervical groove is moderately shallow.

The ocular peduncles are slightly compressed from above downwards, and extend for about one-third of their length beyond the apices of the antennal peduncles, the corneæ are slightly dilated, and semilunar in outline when viewed from above; the ophthalmic scales are of small size and their apices are acute. The antennal acicle does not reach the middle of the last peduncular joint, and its apex is bidentate, a small spinule is present on its anterior surface and another on the outer margin; the external prolongation of the second joint is short and its apex bidentate, while an acute spinule is present on the anterior surface of the same joint; the terminal joint is slender and subcylindrical; the flagellum is about equal in length to the carapace, and its segments are faintly pubescent. The terminal joint of the antennular peduncle extends slightly beyond the tip of the eye-stalk.

The chelipedes are of equal size and similar appearance, with their terminal joints

[1] I have provisionally included this genus in the section Laminibranchiata, but so far as I know its gills have not yet been examined.

spinose and pubescent. The merus is smooth and trigonal, two small spinules are present at the distal end of its superior margin, separated by a transverse groove, and a few minute tubercles are present on the lower and internal margin, in line with a series of short spinules on the corresponding part of the ischium; the carpus is less than half the length of the propodus and remarkably deficient below, so that the hand can be folded under the merus, its upper surface bears three conical spines on the inner margin, with others of smaller size situated externally to these; the propodus is rather more pubescent than the carpus, and bears five curved acute spines on its inner margin, the spines on the upper surface are of small size, and towards the outer rounded border become replaced by granules, the outer surface is smooth; the fingers are less than half the total length of the propodus, and each is provided with a black horny terminal plate; their external surfaces are tubercular and pubescent, and each is provided with from two to three ill-defined pearly teeth. The ambulatory limbs are of moderate length and slightly pubescent, the anterior border of the carpal and propodal joints bears a row of curved acute spines (nearly obsolete on the carpus of the second pair), the dactyli are almost straight, and more densely clothed with hairs than the preceding joints, each terminating in a curved brownish claw. The last two pairs of thoracic legs are smooth and subchelate; in each case the propodus bears at its distal end the oval punctate area seen in this position in most Pagurids; the dactylus of the last pair is of very small size.

The abdominal segments are all distinct, and their posterior margins are fringed with extremely short hairs. The sixth segment is more strongly calcified than the others, its length and breadth are subequal, and a deep fissure is present on each lateral margin, while a shallow median groove traverses its upper surface; the telson is oblong and its distal end is bilobed, with the margins fringed by long hairs, and a transverse line present near the apex, placed at right angles to an obscure median carina. The appendages of the sixth segment have a firmly calcified protopodite, the posterior margin of which bears a single spine. The ova are moderately large in size.

Length of the largest specimen (a female with ova) 26 mm., of carapace 8 mm., of chelipede 14 mm., of third right leg 18 mm., of ocular peduncle 4·5 mm. The largest male measures only 18·5 mm. in length.

This species is distinguished from *Pylocheles agassizii*, A. Milne-Edwards, by the spiny armature of its chelipedes and ambulatory limbs; in the latter species the chelæ are simply granulated, and the ambulatory limbs are smooth.

Habitat.—Station 163A, off Twofold Bay, Australia; depth, 150 fathoms; bottom, green mud. Several specimens of both sexes, including two females with ova.

GALATHEIDEA.

Galatheidæ, Boas, Vidensk. Selsk. Skr., 6 Række, nat. og math. Afd., i, 2, p. 124, 1880.

Carapace well developed; the frontal region prominent, provided with a median rostrum and frequently lateral processes. Eye-stalks short and stout. Antennal peduncle composed of four segments (the second and third having fused); the flagellum long and slender. Chelipedes elongated and not markedly asymmetrical; the first three pairs of ambulatory limbs well developed, the ultimate pair slender and inflexed, frequently chelate. Thoracic sterna broad. Abdomen symmetrical, composed of seven segments, of which the first is usually concealed by the carapace; the penultimate segment with a pair of lamellar appendages, which form with the telson a broad swimming fin; the second segment in the males nearly always provided with genital appendages.

This group as instituted by Boas includes the Porcellanids and the Galatheids, which were placed in separate subtribes by previous writers, several of whom had, however, noted their close affinities. The former must be regarded as highly specialised Galatheids, which have to a certain extent assumed Brachyuran characteristics, and though the abdomen still retains its primitive form, it has, in accordance with altered life-habits, become reduced in size and of secondary importance as an organ of locomotion.

As in the case of the Paguridea I have retained, though with wider significance, the subtribal name formerly applied to one of the sections only.

Section A. PORCELLANODEA.

Porcellaniens, Milne-Edwards, Hist. Nat. des Crust., t. ii. p. 246, 1837.
Porcellanidea, De Haan, Crust. Japon., p. 199, 1850.
„ Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 400, 1852.
„ Stimpson, Proc. Acad. Nat. Sci. Philad., p. 65, 1858.
„ Miers, Catal. New Zealand Crust., p. 59, 1876.
„ Haswell, Catal. Austral. Crust., p. 145, 1882.

Carapace broadly ovate, smooth, with the regions but faintly defined; the front usually trilobed, and the processes never of great length. Chelipedes broad and often flattened, the ambulatory limbs robust and of moderate length. Antennules concealed; the antennal peduncle directed backwards. Eyes always pigmented and partially concealed in orbits. External maxillipedes with the ischium broad, and the merus provided with a prominent internal lobe. Abdomen bent under the thorax; females with two (or three) pairs of slender uniramous appendages borne on the fourth, fifth (and third) segments; males with a single genital pair on the second segment.

The members of this well-defined group are not confined to any special geographical area, but occur in all seas, and are found under stones between tide-marks, a situation for which their flattened body and chelipedes are peculiarly adapted, or in shallow water living among Corals, Sponges, or stones. Stimpson in his useful Synopsis of the Anomura has arranged the genera in two divisions, which form, however, but a single family; in the first of these the basal joint of the antennal peduncle is of small size and partially concealed in the orbital cavity, whereas in the second this joint forms an acute and somewhat flattened projection placed externally to the orbit. They may be arranged as follows:—

I. First joint of the antennal peduncle short, not reaching the superior margin of the carapace—

Petrolisthes, Stimpson.
Pisosoma, Stimpson.
Petrocheles, Miers.

II. First joint of the antennal peduncle more or less produced, and joined to the margin of the carapace, the second joint placed at a distance from the orbit—

Porcellana, Lamarck (*restrictum*).
Porcellanella, White.
Raphidopus, Stimpson.
Pachycheles, Stimpson.
Megalobrachium, Stimpson.
Minyocerus, Stimpson.
Polyonyx, Stimpson.

Family Porcellanidæ.

Genus *Petrolisthes*, Stimpson.

Petrolisthes, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 65. 1858.
„ Miers, Catal. New Zealand Crust., p. 59, 1876.
„ Haswell, Catal. Austral. Crust., p. 145, 1882.

Carapace subovate, depressed, the length usually slightly greater than the breadth. Frontal region triangular, usually depressed, with the margin more or less undulated. Eyes of rather large size. First joint of the antennal peduncle remarkably short. Chelipedes broad and flattened, the carpus of moderate length and often provided with teeth on the inner margin. Ambulatory limbs with the dactyli short and robust, terminating in a single claw.

The species, many of which live between tide-marks, are distinguished from those of the genus *Porcellana*, in addition to the important difference in the antennal peduncle, by the form of the chelipedes and front. They appear to be scarcely represented in the temperate and colder seas of the northern hemisphere.

Petrolisthes violaceus (Guérin).

Porcellana violacea, Guérin, Voy. "Coquille," Crust., p. 33, pl. iii. fig. 2, 1830; Bull. Soc. Sci. Nat. de France, p. 115, 1835; Mag. de Zool., p. 5, pl. xxv. fig. 2, 1838.
" " Milne-Edwards, Hist. Nat. des Crust., t. ii. p. 250, 1837.
" " Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 416, pl. xxvi. fig. 6, 1852.
" *macrocheles*, Poeppig, Crust. Chili, Wiegm. Arch. f. Naturgesch., Jahrg. ii. Bd. i. p. 142, pl. iv. fig. 1, 1836.
Petrolisthes violaceus, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 65, 1858.
" " Targioni Tozzetti, Crost. "Magenta," p. 219, tav. xiii. fig. 2, 1877.

Habitat.—Valparaiso beach, November 1875. Four specimens, three of which are females.

This species is a well-known inhabitant of the Chilian coast.

Petrolisthes validus (Dana).

Porcellana valida, Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 415, pl. xxvi. fig. 5, 1852.
Petrolisthes validus, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 65, 1858.

Habitat.—Valparaiso beach, November 1875. Several specimens, male and female, one of the latter bearing ova, taken along with the last species.

Messier Channel, South America, January 1876. A male specimen.

This species is rather closely allied to the preceding. Dana's types were probably from Valparaiso.

Petrolisthes armatus (Gibbes).

Porcellana armata, Gibbes, Proc. Amer. Assoc., p. 190, 1850.
Petrolisthes armatus, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 65, 1858; Ann. Lyc. Nat. Hist. New York, vol. vii. p. 73, 1859.

Habitat.—Bermuda; shallow water. A female with ova.

The single specimen taken agrees with Gibbes' brief description. The carpus of the right chelipede has, however, four acute spines, and that of the left side but three (the normal number). The outer edge of the hand is distinctly serrated as described by Gibbes, though Stimpson expressly states that these marginal spinules are rarely present. The spine on the anterior edge and distal end of the merus is present on the second and third legs, but absent from the fourth. It is a Floridan and West Indian species.

Petrolisthes annulipes (White), Miers.

Porcellana annulipes, White, List. Crust. Brit. Mus., p. 63, 1847 (*sine descr.*).
Petrolisthes annulipes, Miers, Crust. in Zool. H.M.S. "Alert," pp. 270, 558, pl. xxix. fig. B, 1884.

Habitat.—Station 186, Flinders Passage, North Australia; depth, 8 fathoms; bottom, coral mud. Two females, one with ova.

Miers has described this species from specimens collected by Dr. Coppinger in the Australian Seas, and at Ile des Neufs, Indian Ocean. He suggests that it may prove synonymous with *Petrolisthes scabricula* (Dana) from the Sooloo Sea, and *Petrolisthes militaris*, Heller, from the Nicobars, but it is at least a very distinct variety. White's specimen in the British Museum came from the Philippine Islands.

Petrolisthes unilobatus, n. sp. (Pl. XI. fig. 3).

Characters.—The carapace is ovate and smooth, though minutely punctate, the length considerably greater than the breadth, with a few faintly marked rugosities, especially towards the branchial regions. The front is broad, and depressed towards the apex which is obtuse, with a rounded excavation on each side for the ocular peduncle, while in front of the latter the margin slightly dips down. The lateral border is convex and entire, with a slight bulging in the anterior branchial region. The posterior border is raised, with a double outline, and presents a broad posterior concavity. The cervical grooves are well marked, uniting in front of the cardiac area to form a broad V-shaped marking. The gastric area possesses two slight elevations situated opposite the posterior border of the eye-stalks, separated by a shallow median groove which passes forwards to the apex of the rostrum; in front of these elevations the surface gradually slopes downwards. The cardiac area is distinctly circumscribed. The branchial area is of considerable extent and crossed transversely by a V-shaped impression, one limb of which passes to the posterior part of the cervical groove, while the other reaches the outer boundary of the cardiac area. The ocular peduncles are short and stout, with the corneæ deeply pigmented; the antennal flagellum is almost twice the length of the carapace. The pterygostomial area possesses a series of well-marked elevated lines.

The ischium of the external maxillipedes has the inner margin broadly rounded, and the outer and distal border prolonged into a subacute lobe, the external surface is crossed by a few faint lines; the merus has a large subacute lobe projecting from its inner margin, and the external surface is traversed by a few oblique rugosities, especially towards the outer border.

The chelipedes are of moderate size and finely granular. The anterior border of the merus is produced into a rounded tooth; the carpus is about equal in length to the hand, and slightly more than half the length of the carapace, its anterior border bears a single lobe of small size (hence the specific name) near the proximal end, the posterior border is raised, and the surface immediately behind is marked by numerous slight vertical rugosities, a faint median elevation runs along the upper surface of the joint, and the border overhanging the insertion of the propodus bears four unequal teeth; the propodus is narrow proximally but dilates somewhat towards its distal end, the anterior margin is raised and has a double outline, while a median elevation runs along the upper surface, in some specimens there is a small rounded lobe on the under surface fitting into a depression at the end of the merus; the fingers are somewhat curved, with their apices subacute and bent, the tip of the dactylus being folded under that of the immobile finger. The ambulatory limbs are comparatively smooth, a few slight transverse lines being present on the meral joints, and the carpi have their upper surface faintly carinated; the dactyli are acute and curved, with a few horny spines on their posterior margin; a few hairs and minute horny spinules are also present on the posterior margin of the propodi.

The abdominal segments are smooth and polished externally.

Breadth of carapace of a male 6 mm., length of carapace 7 mm., of extended abdomen 5·5 mm., of chelipede 12 mm., of third ambulatory leg 8 mm. The female is apparently of much smaller size.

This species is allied to *Petrolisthes japonicus* (De Haan), and *Petrolisthes elongatus* (Milne-Edwards). In the former the chelipedes are longer, and the carpus is equal in length to the carapace, with one or two teeth on its inner border, and two on the outer border. In *Petrolisthes elongatus* the outer border of the carpus is armed with from two to three teeth.

Habitat.—Station 172, off Nukalofa, Tongatabu; depth, 18 fathoms; bottom, coral mud. Two males and two females, the latter with ova.

Petrolisthes serratus, n. sp. (Pl. XI. fig. 2).

Characters.—The carapace is ovate and smooth, with numerous short transverse lines most conspicuous on the branchial and gastric areas, a few slight granulations are also present on the mid-branchial and frontal regions. The front is broad and slightly depressed, with the margin faintly crenated, and the apex rounded; a small fissure is present opposite the anterior border of the eye-stalk, bounded posteriorly by a short acute tooth. A small slightly convex lobe is placed between the antero-lateral angle and the point where the cervical groove passes on to the carapace, immediately behind this the lateral border commences in an acute spinule, and a slight carina is continued backwards for some distance but loses itself opposite the mid-branchial area; the postero-lateral border is not sharply defined, being represented simply by a rounded surface. The posterior border has an obscure double outline. The cervical grooves are but slightly indicated and they unite in front of the cardiac area. The gastric area possesses two faintly curved transverse ridges situated behind a point opposite the posterior border of the eye-stalks, and separated by a shallow median groove which is continued forwards on the frontal lobe; the surface gradually slopes downwards in front of these ridges. The branchial area bears a faint transverse V-shaped marking as in the last species. The ocular peduncles are short and stout, with the corneæ deeply pigmented. The first free joint of the antennal peduncle bears a small acute tooth on its upper surface, the penultimate joint is not twice the length of the ultimate; the flagellum is more than twice the length of the carapace. The pterygostomial area is separated from the carapace by a well-marked fissure, its surface projects somewhat and bears a series of elevated lines with a slight granular concavity above.

The external maxillipedes have the ischium broadly rounded on the inner margin, with its outer surface as well as that of the merus traversed by faint wavy lines; the merus has a conical subacute lobe projecting from its inner margin.

The chelipedes are of large size and finely granular, with the carpus distinctly serrated on both margins. The merus has its inner and distal margin produced into an obtuse tooth, a few minute tubercles are present on the outer surface, and an acute spinule occurs on the distal and inferior margin; the carpus is armed with five or six pointed teeth on its internal border, the proximal four of which are separated from one another by distinct fissures, the external border is slightly raised and bears about six pointed teeth of small size, the lower surface is smooth and polished, with a deep concavity along the inner margin; the propodus when folded has its articulation with the dactylus situated opposite the proximal end of the carpus, the upper surface is convex, with a decided slope towards the outer border which is also convex and moderately sharp, a few hairs and minute tubercles are present on the proximal half of the margin, while the lower surface is glabrous and comparatively free from granules; the dactylus is considerably twisted, and almost equal in length to the hand, the inner portion is distinctly raised; the fingers of the right chelipede are in contact, while a tolerably large hiatus exists between those of the left side and their opposed margins are devoid of teeth. The ambulatory limbs are slightly pubescent, a few minute spinules are present on the anterior borders of the meral joints, and in the first two pairs of legs one or two also on the posterior border near the distal end; the dactyli terminate in a black horny claw, and each bears three horny spinules on its posterior margin.

The abdominal segments are smooth and polished externally.

Breadth of carapace of a male 8·8 mm., length of carapace 9·5 mm., of extended abdomen 8 mm., of chelipede 27 mm., of second ambulatory leg 18 mm.

I have had considerable hesitation in separating this species from *Petrolisthes similis*, Stimpson, with which it is closely allied; possibly the examination of a larger series of specimens may show that *Petrolisthes serratus* is only a well-marked variety of the latter. In *Petrolisthes similis* (of which typical specimens named by Stimpson exist in the collection of the Paris Natural History Museum) the chelipedes have a shallow groove on the upper surface of the carpus near its inner margin, the propodus is proportionately longer, with its outer border and the whole upper surface less convex, and the granulations are of larger size; the transverse ridges on the gastric region of the carapace are more strongly developed, and the frontal lobe is narrower, with a more pronounced median concavity.

Habitat.—Off Bahia, 7 to 20 fathoms. An adult male specimen.

Genus *Porcellana*, Lamarck.

Porcellana, Lamarck, Syst. des anim. sans vert., p. 153, 1801 (*in part*).
,, Latreille, Gen. Crust. et Insect., t. i. p. 48, 1806 (*in part*).
,, Desmarest, Consid. sur les Crust., p. 199, 1825 (*in part*).
,, Milne-Edwards, Hist. Nat. des Crust., t. ii. p. 247, 1837 (*in part*).
,, De Haan, Crust. Japon., p. 199, 1850 (*in part*).
,, Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 410, 1852 (*in part*).
,, Bell, Brit. Crust., p. 188, 1853 (*in part*).
,, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 66, 1858.
,, Heller, Crust. südlichen Europa, p. 181, 1863.
,, Targioni Tozzetti, Crost. "Magenta," p. 210, 1877.
,, Haswell, Catal. Austral. Crust., p. 147, 1883.
Pisidia, Leach, Dict. d. Sci. Nat., t. xviii. p. 53, 1820 (*in part*).

Carapace suborbicular or subovate, the length usually greater than the breadth. Frontal region prominent and dentate, the teeth usually well developed. Eyes of moderate size, the orbits deep. Chelipedes moderately flattened, the carpus short and usually provided with a single projecting lobe near the proximal end of the internal margin; the digits frequently contorted. Ambulatory limbs with the dactyli short and robust, terminating in a single claw.

Porcellana sayana (Leach).

Porcellana galathina, Say, Journ. Acad. Nat. Sci. Philad., vol. i. p. 56, 1817 (not *Porcellana galathina* of Bosc).
Pisidia sayana, Leach, Dict. d. Sci. Nat., t. xviii. p. 54, 1820.
,, ,, Desmarest, Consid. sur les Crust., p. 199, 1825.
? *Porcellana sayii*, Gray, Zool. Miscell., p. 15, 1831.
,, *ocellata*, Gibbes, Proc. Amer. Assoc., p. 190, 1850.
,, ,, Stimpson, Ann. Lyc. Nat. Hist. New York, vol. vii. p. 77, 1859.
,, *sayana*, Kingsley, Proc. Acad. Nat. Sci. Philad., p. 407, 1879.

Habitat.—St. Thomas, West Indies; shallow water. Several specimens, including two females with ova. The colour markings have faded to a great extent, though circular spots of light colour can still be recognised on the carapace and chelipedes.

This species inhabits the West Indies and the southern shores of the United States. It has been previously recorded from St. Thomas by Stimpson.

Porcellana streptocheles, Stimpson.

Porcellana streptocheles, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 81, 1858.

Habitat.—Simon's Bay, Cape of Good Hope; depth, 5 to 18 fathoms. Two females with ova, the carapace of the larger measuring only 4·5 mm. in length and 4·2 mm. in breadth.

In this species the front is of moderate size, and composed of three acute teeth with denticulate margins, of which the median is deflexed and obscurely tridentate, while the lateral teeth are scarcely less prominent; the lateral margins of the carapace are also denticulate. The chelipedes are unequal, with the carpi armed by two or three teeth on each lateral margin, of which those on the outer border are minute; the propodus is granulated above, and bears a median carina, its outer margin is obscurely denticulate. According to Stimpson the carapace is smooth, but in the Challenger specimens short stout hairs arranged in tufts are noticeable on the gastric, cardiac, and branchial areas. *Porcellana streptocheles* is closely allied to *Porcellana dehaanii* described by Krauss from the coast of Natal,[1] in which, however, the chelipedes are smooth and the carpi unarmed, the median frontal tooth is conical and prominent, and the antero-lateral margin of the carapace is denticulate over the insertion of the antennal peduncle.

The type specimens were dredged in Simon's Bay, at a depth of from 6 to 12 fathoms.

Porcellana serratifrons, Stimpson (Pl. XI. fig. 5).

Porcellana serratifrons, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 80, 1858.

Habitat.—Hong Kong; depth, 10 fathoms. An adult male (from which the figures are taken).

Arafura Sea. A male specimen.

The types of this species were taken at Hong Kong. The front is composed of three serrated lobes, of which the median is large and rounded, while the two lateral are subacute and scarcely less prominent. The antero-lateral margin of the carapace bears two or three acute spinules immediately over the insertion of the antennal peduncle, and the lateral margin is also provided with from one to three similar processes of slightly larger size. The chelipedes are smooth and punctate, the inner angle of the merus is prominent, and either smooth or armed with from one to two spinules; the inner margin

[1] Krauss, Südafrik. Crust., p. 59, tab. iv. fig. 2, 1843.

of the carpus bears three indistinct teeth, and two or three spinules are present on the outer margin; the propodus bears a median rounded carina on the upper surface, and on the smaller chelipede a row of minute spinules on the outer margin (not represented in the figure). Five segments are distinctly visible in the antennal peduncle, and of these the first, third, and fourth are spinose.

Porcellana robertsoni, n. sp. (Pl. XI. fig. 6).

Characters.—The carapace is ovate, and smooth though minutely punctate, numerous transverse lines occur on the posterior branchial areas, and a few hairs are present on the gastric region. The front is broad and tridentate, with the apices of the three projections subacute, the median tooth is considerably broader and more prominent than the two lateral teeth, slightly deflexed, and with a shallow median groove on the upper surface. The antero-lateral tooth placed immediately external to the orbit is subacute. The lateral border is convex and unarmed, with the exception of a rounded projection behind the point where the ill-defined cervical groove passes on to the carapace; the anterior portion of this border is sharply defined, the posterior third is simply rounded. The posterior border has a double outline and is almost straight. The eyes are of small size, with the corneæ deeply pigmented. The first joint of the antennal peduncle is prominent and acute, forming a flattened process below the orbit; the flagellum is of moderate length. The pterygostomial area bears a series of well-defined longitudinal lines below, while the upper part is slightly concave.

The external maxillipedes have the ischium and merus subequal in length, with their outer surfaces crossed by a few indistinct lines; the inner margin of the former is convex, while that of the latter is concave above and below, with a large rounded projection situated somewhat nearer the proximal than the distal end.

The chelipedes are of moderate size, and their upper surface is densely pubescent. The merus has its inner and distal margin produced into a small flattened lobe which overlaps the carpus; both the carpus and propodus have the upper surface crossed by numerous short and ill-defined lines, while the outer margin bears a fringe of long hairs; the inner border of the carpus is armed with a single acute tooth of large size situated near the proximal end, the inner surface is hollowed out, and the lower and internal margin is also provided with a tooth, which, however, is of small size; the inner border of the propodus is short and strongly curved; the lower surface of both carpus and propodus is glabrous and crossed by fine oblique lines, and the outer margin of the propodus is seen from this point of view to be finely crenated; the fingers are more than half the total length of the propodus and but slightly tortuous, the inner margin of the dactylus is carinated. The ambulatory limbs are short and slightly pubescent, with the posterior surface of the meral joints crossed by faint transverse lines; the dactyli are short and moderately curved, each terminating in a yellow horny claw.

The abdominal segments are smooth and polished externally.

Breadth of carapace 4·5 mm., length of carapace 5 mm., of extended abdomen 5 mm., of chelipede 6·5 mm., of second ambulatory leg 6 mm.

This small species owes its chief interest to the depth at which it occurred—one which is quite exceptional among the members of this group. Apart from the difference in size it bears some resemblance to the common European *Porcellana platycheles* (Pennant), a young specimen of which from Millport, Firth of Clyde, is figured beside it (Pl. XI. fig. 7); the Challenger species, however, possesses a less prominent frontal region, shorter chelipedes and ambulatory limbs, and the lobe on the inner margin of the carpus is larger and less pointed. I have pleasure in naming it after my friend Mr. David Robertson, the veteran naturalist of the Clyde district.

Habitat.—Station 24, off Culebra Island, West Indies; depth, 390 fathoms; bottom, Pteropod ooze. A female specimen.

Genus *Porcellanella*, White.

Porcellanella, White, in Macgillivray's Voyage of H.M.S. "Rattlesnake," vol. ii., Appendix, p. 395, 1852 (*sine descr.*).
„ Stimpson, Proc. Acad. Nat. Sci. Philad., p. 67, 1858.

Carapace oblong, the length considerably greater than the breadth, with the lateral borders almost parallel, and the gastric elevations obsolete. Front prominent, composed of three flattened horizontal teeth. First joint of the antennal peduncle elongated and acute. Chelipedes smooth, with the carpus short and the propodus elongated. Ambulatory limbs of small size, with the meral joints robust, the dactyli short, compressed, and multiunguiculate.

This genus approaches *Porcellana* somewhat closely in its characters. Stimpson described a second species, *Porcellanella picta*, from the Chinese Seas.

Porcellanella triloba, White.

Porcellanella triloba, White, in Macgillivray's Voyage of H.M.S. "Rattlesnake," vol. ii., Appendix, p. 394, pl. v. fig. 2, 1852.
Porcellana triloba, Haswell, Catal. Austral. Crust., p. 149, 1882.

Habitat.—Station 212, Celebes Sea; depth, 10 to 20 fathoms; bottom, sand. Several specimens, two of which are females with ova.

Station 315, Port William, Falkland Islands; depth, 5 to 12 fathoms; bottom, sand, gravel. A male specimen.

This species has hitherto been recorded only from the Australian coasts; it has, however, probably an extended distribution in the Indo-Pacific region. I have examined fresh specimens taken recently by Mr. E. Thurston, the Superintendent of the Madras Government Museum at Ráméswaram, South India, on the carapace and chelipedes of which circular patches of a brownish hue with a lighter centre were apparent. Immersion in spirit appears to have the effect of rapidly removing these colour markings.

Genus *Raphidopus*, Stimpson.

Raphidopus, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 66, 1858.

Carapace suborbicular, the breadth greater than the length. Frontal region not prominent and almost straight, armed with three minute teeth. Eyes of small size. Antennal peduncle elongated. Chelipedes elongated, with narrow curved digits; ambulatory limbs slender, the dactyli flattened and ciliated, almost straight, with the apex acute.

The form of the carapace, chelipedes, and ambulatory limbs, render this one of the most distinct genera in the group. Only a single species has hitherto been described, but the writer has recently taken a second with well-marked points of difference in the Indian Seas at Madras.

Raphidopus ciliatus, Stimpson.

Raphidopus ciliatus, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 79, 1858.
„ „ Targioni Tozzetti, Crost. "Magenta," p. 222, tav. xiii. fig. 4, 1877.

Habitat.—Hong Kong; depth, 10 fathoms. An adult male with the carapace measuring 9 mm. in length, by 11·5 mm. in breadth, and the right chelipede (unstretched) with a length of 31 mm.

The type was dredged off Hong Kong at a depth of 6 fathoms. No locality is assigned to the specimens taken by the "Magenta."

Genus *Pachycheles*, Stimpson.

Pachycheles, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 66, 1858.

Carapace suborbicular, the length not exceeding the breadth, with the posterior part of the branchiostegite quadrate, and separated by a slight membranous interval from the larger anterior portion. Front but little produced, without distinct teeth. First joint of the antennal peduncle slightly elongated. Chelipedes massive and rugose, the carpus short. Dactyli of the ambulatory limbs normal.

The majority of the species inhabit the Indo-Pacific area.

Pachycheles barbatus, A. Milne-Edwards (Pl. XI. fig. 4).

Pachycheles barbatus, A. Milne-Edwards, Bull. Soc. Philom. Paris, sér. 7, t. ii. p. 228, 1878.

Habitat.—St. Vincent, Cape Verde Islands.

The carapace of the single specimen, a young male referred with some hesitation to this species, measures 4·5 mm. in length and 4 mm. in breadth. The carapace is flattened, with the front depressed; a few slight granulations are seen towards the lateral borders on the gastric and hepatic areas, and a series of transverse lines occurs on the branchial areas. The front is pubescent and obscurely trilobed, bounded posteriorly by two transverse ridges on the gastric area, at the point where the carapace becomes level. The chelipedes are granulated and pubescent above, the hairs with which they are clothed being short and stiff; the anterior border of the carpus bears from three to five acute teeth, and the lower surface of the propodus is glabrous, with numerous rounded granulations towards the outer border. The ambulatory limbs are moderately pubescent.

The type-specimen came from the Cape Verde Islands.

Pachycheles pulchellus (Haswell).

Porcellana pulchella, Haswell, Proc. Linn. Soc. N.S.W., vol. vi. p. 758, 1881; Catal. Austral. Crust., p. 148, 1882.

Pachycheles pulchellus, Miers, Crust. in Zool. H.M.S. "Alert," p. 273, pl. xxx. fig. A, 1884.

Habitat.—Station 186, Flinders Passage, North Australia; depth, 8 fathoms; bottom, coral mud. A female with ova.

Station 188, Arafura Sea, South of Papua; depth, 28 fathoms; bottom, green mud. A female with ova.

The specimens described by Haswell and Miers were taken at various localities on the northern coasts of Australia.

Genus *Polyonyx*, Stimpson.

Polyonyx, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 67, 1858.

Carapace suborbicular, smoothly convex, the breadth slightly greater than the length. Front but little produced, with an almost straight margin. First joint of the antennular peduncle smooth; the corresponding joint of the antennal peduncle greatly elongated. Eyes of small size. Chelipedes smooth, with the merus broad. Dactyli of the ambulatory limbs short, and furnished with two or more well-developed claws.

The form of the ambulatory dactyli distinguishes *Polyonyx* from all other genera of Porcellanidæ; in other respects it appears scarcely to differ from *Megalobrachium*, founded by Stimpson for the reception of a West Indian species, and Miers has lately expressed a doubt as to the distinctness of the two genera. The ambulatory claws are merely special developments of the horny spines met with on the posterior surface of the dactyli in many other Porcellanids.

Polyonyx obesulus (White), Miers.

Porcellana obesula, White, List Crust. Brit. Mus., p. 130, 1847 (*sine descr.*).
Polyonyx obesulus, Miers, Crust. in Zool. H.M.S. "Alert," p. 272, pl. xxix. fig. D, 1884.

Habitat.—Station 186, Flinders Passage, North Australia; depth, 8 fathoms; bottom, coral mud. Three specimens, one of which is a female with ova, taken from the interior of a sponge (*Hippospongia anomala*, Poléjaeff); a female with ova also occurred in a free state at the same locality.

The types in the British Museum came from the Madgica-Sima group, and those described by Miers were taken on the Australian coasts.

Section B. GALATHODEA.

Galatheidæ, Leach, Dict. d. Sci. Nat., t. xviii. p. 52, 1820.
Galathéides, Milne-Edwards, Hist. Nat. des Crust., t. ii. p. 270, 1837.
Galatheidea, De Haan, Crust. Japon., pp. xxii, 198, 1850.
,, Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 401, 1852.
,, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 76, 1858.
,, Miers, Catal. New Zealand Crust., p. 68, 1876.
,, Haswell, Catal. Austral. Crust., p. 161, 1882.

Carapace elongate, the regions well defined and usually rugose, with the front produced into a prominent and acute rostrum. Chelipedes and ambulatory limbs elongated and frequently slender. Abdomen broad and well developed, simply bent, or folded on itself, never closely applied to the under surface of the thorax, terminating in a powerful swimming fan formed by the telson and the appendages of the sixth segment. Females with four pairs of simple and slender ovigerous appendages on the second, third, fourth, and fifth segments (those of the second and fourth segments may be rudimentary); males furnished with two pairs of well-developed accessory genital organs on the first and second segments (those of the first segment may be rudimentary or absent), and three pairs of short, usually flattened appendages on the third, fourth, and fifth segments, all of which may, however, be rudimentary. Antennules exposed; the antennal peduncle directed forwards. External maxillipedes subpediform, with the ischium and merus narrow and frequently spinose internally. Eyes placed in very incomplete orbits.

The representatives of this section occur in all seas, but only the two genera *Galathea* and *Munida* are found in shallow water. So slight and at the same time so numerous are the modifications met with in those parts of the body from which the generic characters are derived, that it is questionable whether many of the deep-water (so-called) genera should not be united; the examination of a number of species shows at least that in otherwise closely allied forms there is considerable variation in the form and armature of the rostrum, carapace, chelipedes, and external maxillipedes. The number of gills in most if not all the genera[1] agrees with that of the Porcellanodea, viz., fourteen on each side, arranged as follows:—

Segment.	VIII.	IX.	X.	XI.	XII.	XIII.	Totals.
Pleurobranchiæ,	...	...	1	1	1	1	4
Arthrobranchiæ,	2	2	2	2	2	...	10
Podobranchiæ,	...	...	...	...	...	...	0

The genera as at present constituted may be arranged in two divisions, forming a single family:—

I. Abdomen simply bent.

a. Eyes normal. Many of the species inhabiting shallow water.

Galathea, Fabricius. | ? *Grimothea*, Leach.
Munida, Leach.

b. Eyes non-pigmented. Species confined to deep water.

Munidopsis, Whiteaves. | ? *Anoplonotus*, S. I. Smith.
Elasmonotus, A. Milne-Edwards. | *Galacantha*, A. Milne-Edwards.

II. Abdomen folded on itself. Species confined to deep water.

Eumunida, S. I. Smith. | *Ptychogaster*, A. Milne-Edwards.
Uroptychus, Henderson.

Family GALATHEIDÆ.

Galatheidæ, Dana, U.S. Explor. Exped., vol. xiv., Crust., part ii. p. 1431, 1852.

[1] I have examined the branchiæ in various species of *Galathea*, *Munida*, *Munidopsis*, *Elasmonotus*, *Galacantha*, and *Uroptychus*.

Genus *Galathea*, Fabricius.

Galathea, Fabricius, Suppl. Ent. Syst., p. 414, 1798.
Galatea, Leach, Dict. d. Sci. Nat., t. xviii. p. 50, 1820.
Galathée, Desmarest, Consid. sur les Crust., p. 188, 1825.
Galathea, Latreille, Fam. Nat. du Règne Anim., p. 278, 1826.
,, Milne-Edwards, Hist. Nat. des Crust., t. ii. p. 273, 1837.
,, De Haan, Crust. Japon., p. 198, 1850.
,, Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 478, 1852.
,, Bell, Brit. Crust., p. 195, 1853.
,, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 76, 1858.
,, Heller, Crust. südlichen Europa, p. 188, 1863.
,, Haswell, Catal. Austral. Crust., p. 161, 1882.

Rostrum flattened and of moderate breadth, with the margins usually spinose. Carapace with pubescent transverse striæ; the surface usually unarmed, with the exception of the anterior gastric area; the cardiac area not prominent. Abdominal segments unarmed.

The members of this genus occur chiefly in shallow water, but certain species are found at considerable depths; they live commonly on rocky ground, or among Corals and Sponges, and swim backwards in the water by a rapid jerking movement of the tail. The distinctive characters are in many cases so slightly marked that it is extremely difficult to decide whether the specimen in question is entitled to rank as a species or merely as a variety. The fact that in some species the merus of the external maxillipedes is shorter than the ischium, while in others it is longer, serves to show that generic characters based on the form of this joint must, in the Galathodea at least, be regarded with suspicion. The supraorbital spines so prominent in the genus *Munida* are visible at the base of the rostrum in most of the *Galatheæ*, but they are of small size, and in most cases are associated with other lateral rostral spines.

Galathea elegans, White.

Galathea elegans, White, List Crust. Brit. Mus., p. 66, 1847 (*sine descr.*).
,, ,, Adams and White, Crust. Voyage of H.M.S. "Samarang," pp. i, ii, pl. xii. fig. 7, 1848.
,, ,, Haswell, Catal. Austral. Crust., p. 163, 1882.
,, ,, Miers, Crust. in Zool. H.M.S. "Alert," p. 278, 1884.

Habitat.—Station 212, in the Celebes Sea; depth, 10 to 20 fathoms; bottom, sand. Two males, and a female with ova.

This species is characterised by the length of its rostrum and the brilliancy of its colour markings, which are arranged in the form of purplish longitudinal bands on the trunk and chelipedes. The rostrum is more than half the length of the remaining part of the carapace, and its lateral margin is armed with seven or eight minute denticles; the lateral border of the carapace bears from eight to nine spinules. The merus of the external maxillipedes is short, with the inner margin bispinose. In the female the chelipedes are more slender than in males. This species appears to be widely distributed; it has been recorded from the Philippines and the Australian coast, and I have recently examined specimens which were taken by Mr. E. Thurston off the Pearl Banks at Tuticorin, South India.

Galathea longirostris, Dana, from the Fiji Islands, is a closely allied species, but the rostrum is apparently narrower, the spinules on the margins of the carapace are less distinct, and the second abdominal segment is acute on either side.

Galathea australiensis, Stimpson (Pl. XII. fig. 5).

Galathea australiensis, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 89, 1858.
„ „ Haswell, Catal. Austral. Crust., p. 161, 1882.

Habitat.—Station 190, Arafura Sea; depth, 49 fathoms; bottom, green mud. A female without chelipedes or legs.

This agrees on the whole with Stimpson's brief diagnosis. The ischium of the external maxillipedes has a median curved ridge on its outer surface; the merus is slightly shorter than the ischium, with two well-marked spines on the inner margin, one of which is situated near the distal end. The types were taken at Port Jackson. Haswell is of opinion that it may have to be united with *Galathea spinosirostris*, Dana.

Galathea subsquamata, Stimpson (Pl. XII. fig. 4).

Galathea subsquamata, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 90, 1858.

Habitat.—Stations 204A or 204B, off Tablas Island, Philippines; depth, 100 to 115 fathoms; bottom, green mud. A female (bearing ova) without chelipedes or legs.

This specimen is apparently closely allied to or identical with Stimpson's species. The striæ on the anterior gastric and hepatic areas are short, wavy, and scale-like, those on the hepatic area and the front row of the gastric area being tipped by spinules. The rostrum bears four well-marked acute spines on each side, and its upper surface is provided with numerous indistinct scales of small size; each lateral spine is separated by a rounded notch from the base of the one immediately in front. The ischium of the external maxillipedes has its outer margin produced into a strong spine; the inner border of the merus is trispinose—the third or distal spine being of small size—and the outer border is provided with two small spines near the distal end; the outer surface of both merus and carpus is obscurely squamose. The basal joint of the antennular peduncle is armed with somewhat larger spines than is usual in species of *Galathea*. The carapace measures 10·5 mm. in length, and the rostrum 4 mm.; Stimpson's type-specimen came from Ousima Island and was of smaller size.

Galathea grandirostris, Stimpson (Pl. XII. fig. 3).

Galathea grandirostris, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 90, 1858.
? *Galathea deflexifrons*, Haswell, Catal. Austral. Crust., p. 163, 1882.

Habitat.—Station 209, off Zebu, Philippines, January 19, 1875; depth, 95 to 100 fathoms; bottom, blue mud. A male without chelipedes or limbs.

As in the case of the two preceding species this identification must be held to be somewhat doubtful. The rostrum is broad, triangular, and deflexed, with five or six minute teeth on each lateral border, and the upper surface pubescent. The striæ on the carapace are numerous and strongly ciliated; the gastric region is unarmed. The merus of the external maxillipedes is slightly shorter than the ischium, its inner margin is bispinose, and the outer surface is obscurely squamose; a few minute dentations are present on the outer margin of both merus and carpus. The sculpture of the abdominal segments is more strongly marked than usual. I believe that *Galathea deflexifrons*, Haswell, will prove to be identical with this species and not with *Galathea elegans*, White, as suggested by Miers, for Stimpson expressly states that his types are allied to the latter. The carapace of the Challenger specimen measures 7 mm. in length.

Galathea dispersa, Spence Bate.

Galathea dispersa, Spence Bate, Proc. Linn. Soc. Lond. (Zool)., vol. iii. p. 3, 1859.
,, ,, Kinahan, Trans. Irish Acad., vol. xxiv. p. 99, woodcut, 1871.
? *Galathea labidolepta*, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 89, 1858.

Habitat.—Station VIIp, off Tenerife, Canaries, February 10, 1873; depth, 75 fathoms; bottom, volcanic sand. Two specimens, male and female, the latter with ova.

The rostrum is armed with four spines on each side which increase in size from behind forwards, and its upper surface is pubescent. The first striated ridge on the gastric area, situated at the base of the rostrum, bears from two to six spinules, but in some cases they are obsolete; the number of spines on the lateral border of the carapace varies considerably and one or two spinules may be present on the hepatic area. The ischium of the external maxillipedes bears an elevated longitudinal line near the middle of its outer surface, and the lateral margins are prolonged distally into two acute spines, of which the external is more prominent; the merus is shorter than the ischium, and an acute spine always exists near the middle of its inner margin, the two lateral margins are usually prolonged distally into minute spinules, and one or two spinules are frequently present on the inner margin between the central spine and the distal end. The merus and carpus of the chelipedes are spinose internally, the propodus usually bears a row of short spinules on its outer border, and the upper surface is pubescent and somewhat flattened; the fingers are as a rule straight and in close contact, but in old males those of the right side become bent, the dactylus is provided with a prominent tubercular tooth on the inner margin, and there is a considerable intervening hiatus; a slight hiatus may also exist between the fingers of the left side.

The foregoing characters are furnished by specimens taken in the British seas, where this species occurs commonly in shallow water. After careful examination I am unable to find any points of difference in the Challenger examples.

Two species of *Galathea* were taken in Simon's Bay, South Africa, at a depth of 5 to 18 fathoms, from which locality the type of *Galathea labidolepta*, Stimpson, was procured. The first of these, represented by a single male specimen (figured twice the natural size on Pl. XII.), which I refer with considerable hesitation to Stimpson's species, is either very closely allied to or identical with *Galathea dispersa*. The second species, represented by three imperfect specimens, is of much smaller size, the body of a male measuring 17·5 mm. in length, while a female with ova measures only 11 mm. In these the merus of the external maxillipedes is considerably longer and narrower than the ischium (a character in which it agrees with the common European *Galathea squamifera*, Leach), the inner margin bears two acute spinules near its distal end, and a few minute spinules are present on the outer margin. The chelipedes in the single specimen in which they are still present (a female) are very slender, and the fingers exceed the palm in length. It is impossible to say which of these species, or indeed whether either of them, is referable to *Galathea labidolepta*. The original description of the latter is very incomplete and the size is not recorded; the brief diagnosis would indeed apply to either of the Challenger species in most respects, but as regards the external maxillipedes, in the form of which they differ to a marked extent, Stimpson has furnished no account.

Galathea aculeata, Haswell.

Galathea aculeata, Haswell, Proc. Linn. Soc. N.S.W., vol. vi. p. 761, 1882; Catal. Austral. Crust., p. 162, 1882.

Habitat.—Station 172, off Nukalofa, Tongatabu; depth, 18 fathoms; bottom, coral mud. A male specimen.

Station 208, off Manila; depth, 18 fathoms; bottom, blue mud. Several specimens, including a female with ova.

The brevity of Haswell's description renders the identification of this species very uncertain. It is apparently allied to *Galathea australiensis*, Stimpson, but the gastric spinules are absent, the lateral rostral denticles are less markedly spinulous and of smaller size, while the median rostral spine is very long, narrow, and acute. The striæ on the carapace are well marked, and fringed with tolerably long hairs. The merus of the external maxillipedes is much shorter than the ischium, and its inner margin bears two or three slender spinules, while, in some specimens at least, one or two obscure dentations are present on the outer margin. In the single specimen which still retains the chelipedes (a male) the fingers are separated by a hiatus, whereas Haswell states that they do not gape; this cannot, however, be considered a difference of much importance. The largest specimen measures about 12 mm. in length. The types came from the coast of Queensland.

Galathea pusilla, Henderson (Pl. XII. fig. 1).

Galathea pusilla, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 407, 1885.

Characters.—The carapace is comparatively smooth, only about eight transverse striæ being present, and these are fringed with very short hairs; the regions are ill defined, and each lateral border bears eight or nine spinules. The gastric area is armed anteriorly with two pairs of spinules separated by a rather wide median interval. The rostrum is broadly triangular[1] and slightly depressed, a prominent spine is placed at either side of the base immediately over the ocular peduncle, and a minute spinule is situated on either side near the apex (in one specimen this spinule is absent); the apex is narrow and acute.

The ischium of the external maxillipedes has its outer border prolonged distally into an acute spine; the merus is much shorter than the ischium, the inner border is armed near its middle with a curved acute spinule, and a similar projection is present at the distal end of the outer border. The anterior prolongation of the first antennal peduncular joint present in most (if not all) species of *Galathea* is very long, slender, and acute, indeed, it is visible from above as a spine lying outside the eye-stalk.

The chelipedes (which have become detached) are pubescent, and the lateral margins and upper surface of the merus, carpus, and propodus bear a few curved spinules; the fingers do not equal the palm in length, and their opposed edges are irregularly toothed. The ambulatory limbs have the anterior borders of the meri and carpi armed with short spinules; the dactyli are more than half the length of the propodi and almost straight, with the posterior margin bearing a series of minute horny spines.

The abdominal segments are comparatively smooth, the striæ being almost devoid of hairs.

Length of body of a male 10 mm., of chelipede (detached) 11 mm., of carapace 5 mm., of rostrum 1·8 mm.

[1] In the figure it is represented as rather narrower than it actually is, and the size of the lateral apical spinules is exaggerated.

This species is at once distinguished by the form and armature of the rostrum, and the comparative smoothness of the carapace, in addition to its small size.

Habitat.—Station 163A, off Twofold Bay, Australia; depth, 150 fathoms; bottom, green mud. A male and two female specimens; both of the latter have a curious parasite (apparently belonging to the Rhizocephala) adhering to the under surface of the abdomen.

Galathea inconspicua, Henderson (Pl. XII. fig. 2).

Galathea inconspicua, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 408, 1885.

Characters.—The transverse striæ on the carapace are well developed and fairly numerous (about fourteen can be made out). They form raised lines and are apparently devoid of setæ; the regions are not circumscribed, and the lateral borders are indistinctly spinulous, about eight dentations being visible. The gastric area is armed anteriorly with six minute spines. The rostrum is narrow, but not twice the length of the ocular peduncles, which are of rather large size, and the upper surface is excavated towards the base, while the lateral border possesses four minute spinules which diminish in size as they pass forwards; the apex is narrow and acute.

The ischium of the external maxillipedes is slightly longer than the merus, the inner border of the latter is armed with three minute spines of which the second is most prominent, while the outer border terminates distally in a single spinule.

The chelipedes and ambulatory limbs are wanting in the single specimen.

The striæ on the abdominal segments are somewhat pronounced but apparently devoid of hairs.

Breadth of carapace 2·5 mm., length of body 8 mm., of carapace 4 mm., of rostrum 1·5 mm.

The specimen which has furnished the above description is unfortunately in a very imperfect state of preservation. The species is, however, distinguished by its small size, the armature of the gastric region, the prominent striæ, and the narrow rostrum.

Habitat.—Station 194, off Banda Island; depth, 360 fathoms; bottom, volcanic mud. The single specimen is apparently an adult male.

Galathea sp.

The collection contains specimens of a *Galathea* taken at Station 75, off the Azores; depth, 50 to 90 fathoms; bottom, volcanic mud; and at St. Vincent, Cape Verde Islands, which I had hitherto referred to *Galathea intermedia*, Lilljeborg, a Scandinavian and British species. It agrees with this species in the following respects:—The carapace is comparatively smooth, about eight transverse striæ being present, the first of these (on the gastric area) short, curved, and armed with two spinules; the rostrum possesses four acute teeth on each side, the first of which is slightly smaller than the others; the merus of the external maxillipedes is longer than the ischium, and its inner border is armed with two acute and subequal spines near the distal end. All the specimens are imperfect, but several detached chelipedes preserved in the same bottle, which I believe belong to this species, induce me to regard it as distinct from *Galathea intermedia*. The hand is somewhat swollen, and in all cases the immobile finger is bent, so that a hiatus often of considerable size exists between the fingers, whereas in *Galathea intermedia* the whole chelipede is extremely slender, and the fingers are in contact along the whole of their inner margins. A closer examination also shows that in the Challenger specimens the rostrum is slightly broader, the lateral teeth are of larger size, and the terminal acute spine is shorter than in *Galathea intermedia*. I do not, however, feel justified in assigning a new name to the species, but regret at the same time that the lateness of this discovery prevents me from figuring any of the specimens.

Genus *Munida*, Leach.

Munida, Leach, Dict. d. Sci. Nat., t. xviii. p. 52, 1820.
„ Desmarest, Consid. sur les Crust., p. 190, 1825.
„ Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 478, 1852.
„ Bell, Brit. Crust., p. 206, 1853.
„ Stimpson, Proc. Acad. Nat. Sci. Philad., p. 76, 1858.
„ Heller, Crust. südlichen Europa, p. 192, 1863.
„ Miers, Catal. New Zealand Crust., p. 68, 1876.

Rostrum slender and styliform, with a well-developed supraorbital spine on either side of its base. Carapace with the surface usually spinulose and the cardiac area as a rule distinctly circumscribed. Chelipedes and ambulatory limbs elongated and slender. One or more of the abdominal segments usually with a series of spinules on the anterior dorsal margin.

At the date of publication of the Histoire Naturelle des Crustacés only a single species, the common European *Munida rugosa* (Fabricius), was known to science, which Milne-Edwards, following the example of many of the older writers, placed in the genus *Galathea*. With the exception of the striking difference in the form of the rostrum and supraorbital spines, it is evident that the two genera share many features in common. Recent deep-sea investigations have increased the number of species from about half a dozen to upwards of thirty, and have shown at the same time that the genus has an extended bathymetrical distribution, some at least of the species reaching a depth of over 1000 fathoms, while the majority are found most abundantly at depths varying from 100 to 300 fathoms. The appendages of the first abdominal segment are occasionally absent in the male.[1]

[1] They are absent in the following species :—*Munida normani*, Henderson, *Munida squamosa*, Henderson, *Munida granulata*, Henderson, and *Munida scabra*, Henderson.

Munida subrugosa (White).

Galathea subrugosa, White, List Crust. Brit. Mus., p. 66, 1847 (*sine descr.*).
„ „ Cunningham, Trans. Linn. Soc. Lond. (Zool.), vol. xxvii. p. 495, 1871.
Munida subrugosa, Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 479, pl. xxx. fig. 7, 1852.
„ „ Miers, Zool. "Erebus" and "Terror," Crust., p. 3, pl. iii. fig. 2, 1874; Catal. New Zealand Crust., p. 68, 1876.
„ „ Targioni Tozzetti, Crost. "Magenta," p. 234, pl. xiii. fig. 5, 1877.
„ *gregaria*, Miers, "Alert," Crust., Proc. Zool. Soc. Lond., p. 73, 1881.
juv. (?) *Galathea gregaria*, Fabricius, Ent. Syst., t. ii. p. 473, 1793.
juv. (?) *Grimothea gregaria*, Leach, Dict. d. Sci. Nat., t. xviii. p. 50, 1820.
„ „ Desmarest, Consid. sur les Crust., p. 188, 1825.
„ „ Guerin,[1] Voy. "Coquille," Crust., pl. iii. fig. 1, 1830.
„ „ Milne-Edwards, Hist. Nat. des Crust., t. ii. p. 277, 1837; in Cuvier, Règne Anim., éd. 3, Crust., pl. xlvii. fig. 2, no date.
„ „ Dana, U.S. Explor. Exped., vol. xiii., Crust., part i. p. 483, pl. xxxi. fig. 1, 1852.
„ „ Cunningham, Trans. Linn. Soc. Lond. (Zool.), vol. xxvii. p. 496, 1871.

Habitat.—Station 304, Port Otway, Patagonia; depth, 45 fathoms; bottom, green sand. Several young specimens with the total length of body varying from 10 mm. to 14 mm.

Station 305A, Messier Channel, Patagonia; depth, 125 fathoms; bottom, blue mud. An adult male and a young female.

Station 312, Port Famine, Patagonia; depth, 10 to 15 fathoms; bottom, blue mud. A large series of adult specimens.

Gray's Harbour, Patagonia. Several specimens from the stomach of a fish.

Station 315, Port William, Falkland Islands; depth, 5 to 12 fathoms; bottom, sand and gravel. Two adult males and a female, the latter with ova, also a young specimen measuring 13 mm. in total length.

Station 320, off Monte Video; depth, 600 fathoms; bottom, green sand. A male specimen in a very imperfect state of preservation.

Munida subrugosa is abundant in the Patagonian region; it occurs also at the Auckland Islands (White), in the New Zealand seas (Miers), and I am enabled to record the species from the South Atlantic and a variety from South Australia. It may be said, indeed, to represent *Munida rugosa* in the southern hemisphere. In the Catalogue of New Zealand Crustacea, and subsequently in a more recent work, Mr. E. J. Miers states his conviction that the so-called *Grimothea gregaria* is merely an immature stage of this species, a belief based on the facts that the two exhibit many points of similarity and occur in the same localities. The *Grimothea* is moreover apparently pelagic in habit, and it may be added that its general appearance favours the theory of immaturity. In spite

[1] Milne-Edwards regarded Guerin's figure as that of a distinct species, and applied the name *Grimothea* "*Duperreii*" to it.

of the considerable attention paid to surface netting, and the fact that the *Grimothea* is known to be a common form, no specimens appear to have been taken by the Challenger, though two examples, presumably from New Zealand—labelled "Wellington Museum,"—are preserved in the collection. An examination of the material at my disposal in no way enables me to confirm Mr. Miers' theory, for a number of young specimens, undoubtedly belonging to *Munida subrugosa*, and taken on the bottom along with that species, have all the general characters of the adult, and are yet not more than one-third the size of ordinary specimens of *Grimothea;* nor have I been able to discover in these any great variation in the length of the external maxillipedes. It may, however, be possible that some of the newly hatched young pass to the surface and exist for a longer or shorter period in the *Grimothea* state; an examination of fresh specimens of the latter can alone decide the question.

In *Munida subrugosa* a certain amount of variation is noticeable as regards the number and size of the spines on the carapace, chelipedes, and abdominal segments, also as regards the length of the rostrum. In all the specimens which I have examined there is considerable uniformity in regard to the external maxillipedes; the ischium and merus are subequal in length, and their outer surface is as a rule grooved longitudinally, the lateral margins of the former joint terminate distally in spines, and the latter has usually a single spine on the inner margin and one at the distal end of the outer margin; the carpus is without a prominent lobe. In *Grimothea gregaria* the whole body is soft and adapted for a pelagic life, the abdomen is proportionately narrower, the eyes are of larger size, and the spines everywhere less strongly developed. The external maxillipedes are of great length (about two-thirds the length of the body), and the various joints are smooth and flattened; the merus is considerably longer than the ischium, and the carpus and propodus are each provided with a prominent lobe on the inner margin, while the dactylus is subovate in shape; the hairs which clothe the four terminal joints are of considerable length. It cannot, however, be denied that the external maxillipedes furnish the only important difference between the two forms, and there can be little doubt that these organs are specially adapted for the pelagic life of their owners.

Munida subrugosa (White), var. *australiensis*, nov. (Pl. XIII. fig. 3).

Characters.—The median rostral spine appears to be longer than usual, a character probably common to young specimens of the species. The spinules on the carapace are more numerous than in the typical form, and arranged as follows:—A row of four spinules stretches across the carapace, two being situated on the anterior margin of the cardiac area, and one on the anterior margin of each branchial region; a single spinule is placed on the inner aspect of the area formed by a splitting of the cervical groove, and a single spinule is placed on each hepatic region immediately external to the anterior gastric spine (which lies behind the supraorbital). In other respects this variety cannot be distinguished from the typical form of *Munida subrugosa*; indeed, on examining a series of the latter nearly all the above-mentioned spinules can be made out in different specimens, though I have failed to see any in which so many were present at the same time.

Habitat.—Station 162, off East Moncœur Island, Bass Strait; depth, 38 to 40 fathoms; bottom, sand. Several specimens, the majority of which are females; the body of the largest measures only 25 mm. in length.

Munida stimpsoni, A. Milne-Edwards (Pl. XIV. fig. 1).

Munida Stimpsoni, A. Milne-Edwards, Bull. Mus. Comp. Zoöl., vol. viii. No. 1, p. 47, 1880.

Habitat.—Station 122, off Pernambuco; depth, 350 fathoms; bottom, red mud. A male specimen measuring as follows:—Length of body 36 mm., of rostrum 5·6 mm., of chelipede 73 mm.

The chelipedes are extremely long and slender, somewhat scaly, and armed with spines; the propodus is more than twice the length of the carpus, and the fingers are long, slender, and straight. The eyes are slightly compressed. The rostrum is not twice the length of the supraorbital spines, and all three are slender. The gastric region of the carapace is armed with two pairs of spinules placed posterior to the supraorbitals, and a single spinule is present on its lateral aspect; the cardiac area is slightly elevated and bears a median and two lateral spines, these last being situated on the confines of the branchial regions. The lateral margin of the carapace is but slightly spinose, though the first or postorbital spine is well developed; two spinules are placed near the middle of the posterior margin, which is marked by a line of considerable width. The hairs on the carapace are slightly iridescent. The merus of the external maxillipedes possesses a single spine on its inner margin. The ambulatory limbs are slender and slightly flattened. The second, third, and fourth abdominal segments are armed with spinules on the anterior margin.

This species appears to be abundant in moderately deep water throughout the West Indies. It was taken by the "Blake" at no less than twenty stations, in depths varying from 62 to 1105 fathoms.

Munida miles, A. Milne-Edwards.

Munida miles, A. Milne-Edwards, Bull. Mus. Comp. Zoöl., vol. viii. No. 1, p. 51, 1880.
„ *valida*, S. I. Smith, Proc. U.S. Nat. Mus., vol. vi. No. 1, p. 42, pl. i. 1883.

Habitat.—Station 122, off Pernambuco; depth, 350 fathoms; bottom, red mud. Four males and three females, one of the latter with ova. The body of the largest specimen (a male) measures 70 mm. in length, and the chelipede 83 mm.

Two forms of chelipede are met with in the males of this species. In the one the chela is narrow, while the fingers are slender and elongated, with their opposed margins in contact throughout; in the other the chela is slightly dilated, the fingers are broad, and a distinct hiatus exists between their opposed edges towards the proximal end. There is reason to believe that this sexual dimorphism is of not uncommon occurrence among the Galatheids generally. The Challenger specimens differ from those taken by the "Blake" in having the chelipedes longer, the carapace slightly narrower, and the eyes of larger size, but there is no reason to suppose that they belong to a different species.

The types were taken in the West Indies at depths varying from 37 to 320 fathoms, and the species was afterwards carefully described and figured by Professor S. I. Smith, from specimens taken in deep water off the south coast of New England by the U. S. Fish Commission.

Munida microphthalma, A. Milne-Edwards (Pl. III. fig. 4).

Munida microphthalma, A. Milne-Edwards, Bull. Mus. Comp. Zoöl., vol. viii. No. 1, p. 51, 1880.

Habitat.—Station 24, off Culebra Island, West Indies; depth, 390 fathoms; bottom, Pteropod ooze. An adult male (figured), the body of which measures 32 mm. in length, and the chelipede 42 mm.

Station 171, north of the Kermadec Islands; depth, 600 fathoms; bottom, hard ground. A young male.

Station 343, near Ascension Island; depth, 425 fathoms; bottom, volcanic sand. A male of small size.

This species is distinguished at once by the small size of its eyes, the corneæ of which are but slightly dilated and of a light-brown hue. The gastric area of the carapace is armed in front with a transverse row of spinules, two of which situated behind the supraorbitals are of rather large size, while the others vary in number and size in different specimens. The rostrum is about half the length of the carapace and is slightly upturned towards the apex, while the supraorbitals have a more obvious elevation. The lateral margins of the carapace are distinctly spinose, the first two spines being of large size. The chelipedes are of moderate length, and the various joints (especially the merus) are spinose; the upper surface of the hand is somewhat flattened, and no hiatus exists between the fingers. The merus of the external maxillipedes has a well-marked spine on the inner margin, situated nearer the proximal than the distal end. The second abdominal segment bears a transverse row of spinules on its anterior margin (these are obsolete in the specimen taken at Station 171).

This species was taken by the "Blake" at four stations in the West Indies, the depths varying from 573 to 1030 fathoms; its occurrence in the Pacific is a matter of extreme interest.

Munida spinulifera, Miers.

Munida spinulifera, Miers, Crust. in Zool. H.M.S. "Alert," p. 279, pl. xxxi. fig. A, 1884.

Habitat.—Amboina; depth, 15 fathoms. An imperfect male specimen (without chelipedes) measuring 16 mm. in length.

This species is allied to *Munida japonica*, Stimpson, as well as to *Munida militaris*, Henderson. The rostrum is arcuate and more than twice the length of the supraorbital spines. The gastric area of the carapace is armed in front with a transverse row of spinules, about twelve or thirteen in number; a spinule is also present on each branchial area immediately behind the cervical groove. The external maxillipedes are somewhat pubescent, and the merus is armed with a single spine near the proximal end of its inner margin. The second abdominal segment has several spinules on its anterior margin, and a few of very small size also occur on the third segment.

The types were dredged by the "Alert" in the Arafura Sea at a depth of from 32 to 36 fathoms.

Munida spinosa, Henderson (Pl. III. fig. 3).

Munida spinosa, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 408, 1885.

Characters.—The rostrum is about half the length of the carapace and slightly upturned towards the apex; the supraorbital spines are distinctly elevated, with a slight divergence, and extend a little beyond the middle of the rostrum. The striæ on the surface of the carapace are strongly developed, and as a rule without hairs; the gastric area is distinctly circumscribed, and bears in front from six to ten spines arranged in a semilunar-shaped row, of which the two largest are situated behind the supra-orbitals, a single spinule (occasionally absent) is found on each branchial region immediately behind the cervical groove, and a spine occurs in front of this on the area formed by the splitting of the cervical groove. The lateral margin of the carapace is armed with about seven well-marked spines, two of which are placed in front of the anterior division of the cervical groove; the first or postorbital is longer than any of the others.

The chelipedes are long and of moderate width, with all the joints strongly spinose, the largest spines being, however, situated on the merus; the spines on the upper surface of the propodus are more curved than usual and arranged in three rows; the fingers are scarcely equal in length to the palm, slightly bent and comparatively smooth, with their opposed edges finely dentate, in contact almost throughout, and fringed with hairs. The ambulatory limbs have the meral and carpal joints strongly spinose, the former on both margins, the latter merely in front.

The eyes are of large size and somewhat rounded. The various joints of the antennal peduncle are spinose, the anterior prolongation of the first joint being of moderate length. The ischium of the external maxillipedes has its inner margin terminating distally in one or two short stout spinules, and the merus is armed with three spines on its inner margin, the first of large size, the second of small size, and the third placed at the distal end; the outer surface of the merus is obscurely tubercular.

The abdominal segments are comparatively smooth, the second is, however, provided with six prominent spines on its anterior margin.

Breadth of carapace (of an adult male) 17 mm., length of body[1] 43 mm., of carapace (not including rostrum) 20 mm., of rostrum 9·5 mm., of chelipede 81 mm., of chela 33 mm., of first ambulatory leg 50 mm.

The strongly developed spiny armature of this species distinguishes it from all other members of the genus. Females are of slightly smaller size, with the spines less strongly developed, the chelipedes narrower, and the rostrum apparently slightly longer than in males. In young specimens most of the adult characters can be recognised.

Habitat.—Station 145A, off Prince Edward Island; depth, 310 fathoms; bottom, volcanic sand. Many specimens, including adults of both sexes and young; some of the females are with ova.

Station 320, off Rio de la Plata; depth, 600 fathoms; bottom, green sand. Several specimens, the majority of which are young.

Munida normani, Henderson (Pl. XIII. fig. 5).

Munida Normani, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 408, 1885.

Characters.—The rostrum is little more than one-third the length of the carapace and horizontal in direction; the supraorbital spines are about two-thirds the length of the rostrum, with a very slight upward inclination. The striæ on the surface of the carapace are well marked, and but slightly pubescent; the gastric area is moderately convex, with two spines in front placed immediately behind the supraorbitals; the cardiac area is distinctly elevated, and its front margin, which is separated by a depression from the gastric area, bears a transverse row of minute spinules (not figured); four or five spines are placed in a longitudinal row on the boundary between each branchial region and the cardiac area. The lateral margin of the carapace is armed with about six spines of moderate size; two of these, including the first or postorbital which exceeds the others

[1] In all the species of *Munida* I take this to exclude the rostrum.

in size, are situated in front of the anterior division of the cervical groove. The posterior margin of the carapace is usually provided with two spines.

The chelipedes are narrow and subcylindrical, with the joints squamose and slightly spiny, the spines being most strongly developed on the merus; the propodus (including the immobile finger) is about three times the length of the carpus, and the spines are confined to its inner surface; the fingers are remarkably slender, and slightly curved, their length being almost equal to that of the palm, the opposed edges are finely dentate and in contact throughout, though three or four slightly more obvious teeth can be made out on the immobile finger. The ambulatory limbs are flattened; the upper surface of the meral, carpal, and propodal joints is squamose, while the two former have their anterior and posterior margins in addition spinose; the dactyli are short and their front margins are finely crenated.

The eyes are of moderate size and slightly compressed. The anterior prolongation of the first antennal peduncular joint is short, not exceeding the second joint. The ischium and to a slight extent also the merus of the external maxillipedes are squamose externally, the inner border of the first of these joints terminates distally in a spine, and a slightly larger one is placed near the middle of the corresponding border of the merus.

The second, third, and fourth abdominal segments bear four spines each on the anterior margin, the two lateral of these are almost obsolete on the fourth segment, but a prominent median spine occurs near the posterior margin; the dorsal surface of the fifth and sixth segments is squamose.

Breadth of carapace (of an adult male) 14 mm., length of body 35 mm., of carapace 15 mm., of rostrum 6 mm., of chelipede 62 mm., of chela 26 mm., of first ambulatory leg 44 mm.

The subcylindrical and scaly chelipedes, along with the armature of the carapace, characterise this species. Females are of slightly smaller size than males, and they along with young individuals have the various spines less strongly developed; in some cases the transverse cardiac spinules may even be absent.

I have pleasure in dedicating this species to the Rev. Canon Norman, well known for his labours among the North Atlantic Crustacea, to whom I am personally much indebted for assistance and advice, rendered when the collection was first placed in my hands.

Habitat.—Station 173, off Matuku, Fiji Islands; depth, 315 fathoms; bottom, coral mud. Eleven specimens, eight of which are males.

Munida incerta, n. sp. (Pl. XIII. fig. 4).

Characters.—The rostrum is about half the length of the carapace and slightly depressed; the supraorbital spines are about two-thirds the length of the rostrum and somewhat bent. The striæ on the surface of the carapace are numerous and pubescent; the gastric area is moderately convex, with two spines in front placed immediately behind the supraorbitals; the cardiac area is unarmed and almost flat; three spines placed in a longitudinal row are present on the boundary between each branchial region and the cardiac area. The lateral margin of the carapace bears five or six spines, but with the exception of the first none are of large size; the posterior margin is unarmed.

The chelipedes are wanting in the single specimen. The ambulatory limbs are flattened; the upper surface of the merus, carpus, and propodus is covered with hair-clad scales of small size, and the lateral margins of the two former joints are spinose; the dactyli are more than half the length of the propodi.

The eyes are of large size and strongly compressed, with a fringe of long hairs passing over the upper surface of each cornea. The anterior prolongation of the first antennal peduncular joint is long, slightly curved, and freely movable, forming a spine visible from above which lies external to the eyes. The ischium and merus of the external maxillipedes are finely squamose externally, the former has a short conical spine at the distal end of its inner border, while the latter has a single well-marked spine near the middle of the same border, and a spine of smaller size at the distal end of the outer border.

The second, third, and fourth abdominal segments are armed precisely as in the last species; the dorsal surface of the fifth and sixth segments, telson, and last pair of appendages is covered with minute ciliated scales.

Breadth of carapace (of a female) 17 mm., length of body 39 mm., of carapace 16 mm., of rostrum 8 mm., of first ambulatory leg 46 mm.

This species, inadvertently omitted from the diagnoses of the new species of Galathodea taken by the Challenger, is allied to *Munida normani*, from which, however, it is distinguished by its longer rostrum, the different form of the cardiac area of the carapace, the smaller and pubescent scales on the ambulatory limbs and last abdominal segments, but above all by the great development of the antennal spine.

Habitat.—Station 200, off Sibago Island, Philippines; depth, 250 fathoms; bottom, green mud. An imperfect female specimen.

Munida squamosa, Henderson (Pl. XIII. fig. 1).

Munida squamosa, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 409, 1885.

Characters.—The rostrum is almost horizontal and a little more than one-third the length of the carapace; the supraorbital spines are slightly curved and about three-fourths the length of the rostrum. The striæ on the surface of the carapace are finely granulated and slightly pubescent; the gastric area is convex, with a pair of spines placed immediately behind the supraorbitals; the cardiac area is distinctly circumscribed, and triangular in outline, with a well-developed median spine on the anterior margin which overhangs a narrow area posterior to the united cervical grooves; a single spinule (occasionally absent) is present on each branchial region, placed behind the cervical groove and near the confines of the cardiac area. The lateral margin of the carapace is armed with about six spines, only the first of which reaches any considerable size, two being situated in front of the anterior division of the cervical groove. The posterior margin of the carapace is raised, and bears two spines.

The chelipedes are moderately long, and the merus, carpus, and propodus are covered with large almost smooth scales, some of which, on the inner surface of the same joints, more especially the merus, are produced into spines; in females and young males the chelipedes are narrow and cylindrical, whereas in adult males the hand is slightly dilated; the propodus is about two and a half times the length of the carpus (in adult males it is somewhat longer) and comparatively few spines are present on the inner surface; the fingers are long and slender, being about two-thirds the length of the palm, and the tip of the dactylus fits in between two small teeth at the apex of the immobile finger; in females the fingers are straight and in contact throughout, with their opposed edges finely crenated, while in adult males both—but especially the immobile finger—show a prominent bulging which gives rise to a basal hiatus, and a single tubercular tooth is present on the inner margin of each along with a dense clothing of stiff hairs. The ambulatory limbs are similar to those of *Munida normani*, but the scales are more strongly developed and the dactyli are slightly longer.

The eyes are of large size, and somewhat compressed, and as in the last two species distinctly reniform in shape. The antennal peduncle is pubescent, and the anterior prolongation of the first joint is short. The ischium and merus of the external maxillipedes are both squamose externally and strongly pubescent; the inner margin of the former is prolonged distally into a slender acute spine, while the latter joint has a slightly larger spine situated near the middle of the same margin.

The second, third, and fourth abdominal segments are armed as in *Munida normani*, the two lateral spinules on the fourth segment being occasionally obsolete; the dorsal surface of the fifth and sixth segments, telson, and last pair of appendages, is covered with scales which are of smaller size and more numerous than in *Munida normani*.

This species is nearly related to *Munida normani*, from which it is distinguished by the different armature of the cardiac and branchial areas of the carapace, the greater development of the striæ, the form of the chelipedes, and other less important distinctions. The cardiac spine is uniformly well developed even in very young individuals. The most important sexual difference has already been referred to in treating of the chela.

Breadth of carapace (of an adult male) 17 mm., length of body 45 mm., of carapace 16·5 mm., of rostrum 6·3 mm., of chelipede 85 mm., of chela 36 mm., of first ambulatory leg 58 mm. Females are apparently of slightly smaller size than males.

Habitat.—Station 219, north of Papua; depth, 150 fathoms; bottom, coral mud.

About twenty specimens were taken, two of which are females with ova; one has the carapace swollen laterally from the presence of a Bopyrid in the branchial chamber, and another has a Sacculinid attached to the under surface of its abdomen.

Munida granulata, Henderson (Pl. XIV. fig. 3).

Munida granulata, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 409, 1885.

Characters.—The rostrum is slightly more than one-fourth the length of the carapace and twice the length of the supraorbital spines; all three are distinctly upturned. The carapace is covered everywhere with granulations, some of which are compound, and with hairs, but transverse striæ are not defined; the gastric area is moderately convex, with a pair of spines placed behind the supraorbitals, though separated by a slightly wider interval, and a median spine of larger size near the posterior limit of the area, while a few spinules occur on the lateral surfaces; the cardiac area is triangular in outline, and somewhat elevated, with a median row of three spinules, the first of which, situated on the anterior margin, is most prominent; several spinules are found on the branchial regions, the best marked being three or four which occur near the confines of the cardiac area. The lateral border of the carapace bears five or six spines, none of which are of large size, with the exception of the postorbital, which from its position can scarcely be included in this border; the posterior margin is distinctly raised, with a number of equidistant spinules, all of which may be obsolete, though the central one is slightly larger than the others and usually present.

The chelipedes are long and subcylindrical, and the merus, carpus, and propodus are covered with flattened granulations which tend to become squamose on the last of these joints, while the merus and carpus, especially the former, are slightly spinose on the inner surface. The chela is slightly more than twice the length of the carpus; the fingers are slender and almost equal in length to the palm, with a slight incurvation, their outer and inner surfaces are faintly carinated, and the opposed edges finely crenated; the dactylus extends beyond the tip of the immobile finger, and its slender apex fits in between two minute teeth at the end of the latter. In male specimens the fingers are somewhat bent, the dactylus being slightly curved upwards, and a narrow hiatus is left between the two, at either end. The ambulatory limbs are remarkably slender, and the meral, carpal, and propodal joints are granulated, the first of these also has a series of spines on the anterior border; the dactyli are long, slender, and somewhat curved.

The eyes are of moderate size and considerably flattened, a series of hairy "lashes," extending over the corneæ from both the upper and lower margins of the peduncle. The antennal spine is pubescent and remarkably long, exceeding the whole peduncle in length, while the second joint is prolonged into a similar spine of almost equal length; both spines are visible from above lying internal to the antenna. The antennal flagellum is pubescent and extremely short, not exceeding the carapace in length. The ischium and merus of the external maxillipedes are tuberculate externally, the inner margin of the former is prolonged distally into an acute spine, while the latter is armed with a small spine near the middle of its inner border, and a few minute spinules on the outer border.

The second and third abdominal segments bear six spinules each, four of which are arranged on the anterior and two near the posterior margin, the third segment bears five spinules, a mesial one being present on the posterior margin, which is somewhat prominent. A considerable variation is seen in the number of these abdominal spinules, though in no case are all obsolete. The fifth and sixth segments, and to a certain extent the telson also, are covered externally with small setigerous scales.

This species is characterised by the short rostrum, the absence of striæ from the carapace, the extremely short antennal flagellum, the two prominent antennal spines, and certain less striking features, as the armature of the carapace, chelipede, and other parts.

Breadth of carapace (of an adult male) 11·5 mm., length of body 32 mm., of carapace 12 mm., of rostrum 3 mm., of chelipede 65 mm., of chela 27·5 mm., of first ambulatory leg 42 mm.

Habitat.—Station 173, off Matuku, Fiji Islands; depth, 315 fathoms; bottom, coral mud. Six males and three females, one of the latter with ova; two specimens have Sacculinids adhering to the under surface of the abdomen.

Munida scabra, Henderson (Pl. XV. fig. 1).

Munida scabra, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 409, 1885.

Characters.—The rostrum is less than one-fourth the length of the carapace, and not twice the length of the supraorbital spines; all three are distinctly upturned. The carapace is slightly pubescent, and covered everywhere with minute spinules which tend to be arranged in transverse rows; the gastric area is well defined, and bears a pair of spines behind the supraorbitals and a median spine near the posterior margin; the cardiac area is somewhat triangular in outline, with three rather prominent curved spines arranged in the median line; the branchial area bears three or four spines near the branchio-cardiac boundary. The lateral border of the carapace is armed with nine spines, only the first two of which reach any considerable size; the posterior border is distinctly raised, with a median spine and numerous spinules on either side.

The chelipedes are shorter but in other respects similar to those of the last species; the joints are, however, covered with well-marked flattened and glabrous scales, the anterior margins of which are pubescent. The fingers are slender and cross one another at the tips, the dactylus is slightly bent upwards in male specimens, but no hiatus exists between the two; the opposed edges are finely dentate, and the dactylus bears in addition three or four equidistant tubercular teeth of small size. The ambulatory limbs are slender, and the meral, carpal, and propodal joints are squamose, the two first of these also with their margins spinose; the dactyli are moderately long, and but slightly curved.

The eyes are similar to those of the last species, though separated by a wider interval. The antennal spine is pubescent and extremely long, projecting for a considerable distance in front of the eyes; the anterior prolongation of the second joint is short, not exceeding the joint itself in length; the antennal flagellum is slender and of moderate length. The ischium and merus of the external maxillipedes are squamose externally, and in other respects similar to those of *Munida granulata*, though the spine on the inner margin of the merus is slightly larger than in the last species.

The second, third, and fourth abdominal segments are armed as in *Munida granulata*; the spines are, however, more strongly developed. The fifth and sixth segments are glabrous externally, and crossed by curved concentric lines.

This species is in many respects closely allied to the last; it can, however, be at once distinguished from *Munida granulata*, which is a smaller species, by the substitution of spinules for granules on its carapace, the shorter chelipedes, the absence of a second lengthy antennal prolongation, and the peculiar markings on the fifth and sixth abdominal segments.

Breadth of carapace (of an adult male) 14 mm., length of body 36 mm., of carapace 14 mm., of rostrum 3 mm., of chelipede 59 mm., of chela 24·5 mm., of first ambulatory leg 44 mm. Female specimens appear to be very slightly inferior in size to males.

Habitat.—Station 192, off Little Ki Island; depth, 140 fathoms; bottom, blue mud. Nine females, one with ova, and six males; one specimen has a Sacculinid attached to the abdomen.

Munida proxima, Henderson (Pl. XIII. fig. 2).

Munida proxima, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 410, 1885.

Characters.—The rostrum is less than one-fourth the length of the carapace, and not twice the length of the supraorbital spines, with its basal portion broad and the terminal part slightly upturned; the supraorbitals are horizontal in direction. The carapace is slightly pubescent and covered everywhere with minute spinules, arising from short transverse ridges on the posterior half, which do not, however, form striæ passing from side to side; the gastric area is well defined, and its surface is clothed with small though distinct scales which are slightly pubescent and give off a median spinule in front, a pair of spines are placed behind the supraorbitals, but there is no trace of a posterior median spine; the cardiac area is distinctly triangular in outline and armed as in the last species, but the spines are in some specimens at least more bluntly tuberculate; the branchial area has one or two small spines in front near its junction with the cardiac area, and some of the ordinary spinules of the carapace in this vicinity are slightly enlarged. The lateral border of the carapace bears a row of spinules continued back almost to the posterior margin, and of which the first eight or nine are of moderate size, the first or postorbital greatly exceeds all the others; the posterior border is distinctly raised but with the exception of a very minute median spinule is unarmed.

The chelipedes bear a general resemblance to those of *Munida granulata*, but the joints are covered with distinct overlapping scales, the margins of which are ciliated. The fingers are slender and straight in the female, agreeing closely with those of *Munida scabra*. The ambulatory limbs are slender, with the meral, carpal, and propodal joints subsquamose, and the first of these with both margins spiny, the spines being more strongly developed anteriorly; the dactyli are moderately curved, and more slender than in either of the preceding species.

The eyes are flattened, with the corneæ overhung by long iridescent "lashes." The antennal spine is long and pubescent as in the last species, projecting considerably beyond the eyes; the anterior prolongation of the second joint is bent forwards but does not exceed the joint itself in length. The ischium and merus of the external maxillipedes are distinctly squamose externally, and armed as in *Munida scabra*.

The second, third, and fourth abdominal segments are armed as in the two preceding species. The fifth and sixth segments agree as to the markings on their dorsal surface with *Munida scabra*.

This species is distinguished from *Munida scabra*, to which it is in many respects closely related, by its smaller size, the less upturned rostrum, the presence of scales on the gastric area, and the absence of a posterior median spine from this region, the rudimentary state of the spinules on the posterior margin of the carapace, and the more slender dactyli of the ambulatory limbs.

Breadth of carapace (of an adult female) 9 mm., length of body 24 mm., of carapace 9 mm., of rostrum 2·3 mm., of chelipede 41 mm., of chela 17 mm., of first ambulatory leg 30 mm.

Habitat.—Station 219, north of Papua; depth, 150 fathoms; bottom, coral mud. Three adult female specimens, one with ova.

The three preceding species agree with one another in the possession of certain somewhat abnormal features, such, for instance, as the flattened ciliated eyes, the short acuminate rostrum, the replacement of the striæ on the carapace by short rows of granules or spinules, and the great elongation of the antennal spines. Not one of these characters is, however, peculiar to the three species in question.

Munida militaris, Henderson (Pl. XIV. figs. 2, 5).

Munida militaris, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 410, 1885.
„ *vitiensis*, Henderson, *loc. cit.*, p. 410, 1885.

Characters.—The rostrum is usually about half the length of the carapace (but shows considerable variation in this respect), with a slight double curve, the basal half being slightly convex above, while the apical half is distinctly upturned; the supraorbital spines are usually about half the length of the rostrum. The transverse striæ of the carapace vary greatly in different specimens, but are as a rule well developed, and fringed with short hairs; in some cases they are even granulated. The gastric area is armed in front with a prominent curved row of spinules, two of which placed behind the supraorbitals are somewhat larger than the others, and the posterior spinule at each end of the row is also somewhat conspicuous, and situated nearly halfway back on the area, near the confines of the hepatic region; the rostrum is itself continued backwards for some distance, and a minute spinule is found on either side near its posterior termination, and internal to the largest spinule of the gastric row; occasionally also there is a third spinule of very small size, placed in the median line. The area enclosed by the bifurcation of the cervical groove bears two or three spinules, one of which is somewhat prominent, while the others may be absent, and a single spinule is also often present on the anterior margin of each branchial area immediately behind the posterior branch of the cervical groove, and near the anterior and outer limit of the cardiac region; the cardiac area is but slightly marked and completely unarmed. The antero-lateral or orbital border of the carapace is straight and slightly oblique, as in *Munida miles*, A. Milne-Edwards; the lateral border bears from six to nine spines, the first of which is of considerable length and directed forwards; the posterior border is unarmed.

The eyes are of large size and but slightly flattened, with the upper fringe of cilia frequently well marked; the pigmentation of the corneæ shows considerable variation in intensity. The antennal spine is of moderate length; the second joint of the peduncle bears two lateral distal spines, the inner of which is considerably produced. The ischium and merus of the external maxillipedes are granulated externally, the inner margin of the latter bears two spines, one of large size situated near the proximal end, the other (of small size and not always present) at the distal end, with frequently a few minute irregularities between the two.

The chelipedes are of moderate length, but in some males are even elongated. The merus and carpus are pubescent, and armed with spines—some of considerable size—on their upper and inner surfaces, two spines at the distal end and on the upper surface of the merus being larger than the others; the propodus is slightly pubescent on its upper surface, and three rows of short spines are present, arranged in median and marginal series; the fingers are straight and about equal in length to the palm, with their opposed edges minutely dentate and in close contact; the dactylus has a short curved apex, which folds over a corresponding process on the immobile finger, and the latter has a spine on its outer margin near the proximal end. The meri and carpi of the ambulatory limbs are pubescent and spiny, the spines placed at the distal ends of these joints being of considerable size; the posterior margin of the propodi bears a row of horny spinules, and the dactyli are but slightly curved, each terminating in a short, yellow, horny claw.

The second abdominal segment bears a transverse row of spinules (usually ten in number) on its anterior margin, the two nearest the middle line being separated by a considerable interval; the remaining abdominal segments are comparatively smooth and glabrous, with but few transverse impressions.

Breadth of carapace (of an adult male) 12 mm., length of body 31 mm., of carapace 14 mm., of rostrum 6 mm., of chelipede 47·5 mm., of chela 21 mm., of first ambulatory leg 32 mm.

The close similarity of this species to *Munida miles*, A. Milne-Edwards, is at once apparent. It is distinguished from the above-named Atlantic species by its smaller size and the stronger development of the gastric row of spinules, though in *Munida miles* the two spines situated behind the supraorbitals are of much larger size; in the latter species also the chelipedes are more elongated, and armed with a greater number of spines, while spinules are present on the second and third abdominal segments, and in some cases even on the fourth. In *Munida spinulifera*, Miers, a small species, which is also characterised by the presence of a gastric row of spinules, the supraorbitals are much shorter, the striæ on the carapace are more densely pubescent, and the second and third abdominal segments are spinulose. A closer examination of the specimens, and a wider knowledge of the individual variations to which certain species of *Munida* are subject, has shown that the form which I designated *Munida vitiensis* must be united with the species in question. I have also deemed it safer to rank *Munida curvirostris* as a variety rather than as a distinct species.

Habitat.—Station 173, off Matuku, Fiji; depth, 315 fathoms; bottom, coral mud. Five specimens, two of which are females with ova.

Station 192, off Little Ki Island; depth, 140 fathoms; bottom, blue mud. A female with ova and a young female; in these the following somewhat abnormal characters are noticeable:—The rostrum is longer than usual, the carapace is comparatively smooth and glabrous (though the various spinules are present), the chelipedes are short and slim, and the spinules on the second abdominal segment are almost obsolete. The specimens are, I think, in spite of these differences, undoubtedly referable to this species.

Amboina, 100 fathoms. An adult male.

Munida militaris, Henderson, var. *curvirostris*, Henderson (Pl. III. fig. 7).

Munida curvirostris, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 412, 1885.

Characters.—The rostrum is more than half the length of the carapace, above the level of which it is distinctly curved, with the proximal half not convex above; the supraorbitals are about half the length of the rostrum and but slightly upturned. The spines of the gastric row are fewer in number than in the typical form, and the pair behind the supraorbitals are of larger size; the lateral gastric spinule is of small size, and the remainder of the carapace is unarmed.

The eyes are of large size, with the corneæ of a light brown colour. The chelipedes are short, with the spines strongly developed, especially the pair at the distal end of each merus.

The spinules on the second abdominal segment are few in number, and the submedian pair considerably larger than the others.

Habitat.—Station 200, off Sibago, Philippines; depth, 250 fathoms; bottom, green mud. An adult male measuring 25 mm. in length (not including the rostrum).

Station 210, off Zebu, Philippines; depth, 375 fathoms; bottom, blue mud. An adult female measuring 20 mm. in length.

Munida haswelli, Henderson (Pl. III. figs. 5, 5*b*).[1]

Munida Haswelli, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 411, 1885.

Characters.—The rostrum is about half the length of the carapace and twice the length of the supraorbital spines; all three are slightly curved, and the rostrum is upturned towards its apex. The striæ on the carapace are well marked, and finely granulated, the hairs with which they are fringed being somewhat numerous; the gastric area possesses a pair of spines immediately behind the supraorbitals, as well as a second pair placed behind the former, several spinules are present towards the lateral margins, and two of very small size are situated between the first pair of spines; the cardiac area is unarmed and but poorly defined; a few spinules, including one of rather large size, are present on the branchial region, behind the cervical groove and near the outer border of the cardiac area, while one or two spinules occur on the space between the two branches of the cervical groove, in which part the striæ have assumed a squamose appearance. The lateral border of the carapace bears six or seven spines, which decrease in size from before backwards; the posterior margin is unarmed, but distinctly granulated.

The chelipedes are absent in the single adult specimen;[2] in young individuals they are

[1] Fig. 5*a* represents the chela of a specimen from Station 173, which must, I think, be ranked with *Munida militaris*.

[2] They are represented in the figure and were doubtless lost when the drawing was being executed.

slender and moderately spiny, with the fingers narrow, scarcely equal in length to the palm, and in contact throughout. The ambulatory limbs are slightly flattened, and pubescent above, the meral joints being in addition somewhat scaly; the dactyli are moderately curved towards their apices, and a few horny spinules are present on the posterior margin.

The eyes are of moderate size and slightly flattened, while a series of long and prominent hairy "lashes" extend over the corneæ from both the upper and lower margins. The antennal spine is of moderate length, not exceeding the second joint of the peduncle, which last is armed with two prominent spines on its inner border, and one on the outer. The ischium and merus of the external maxillipedes are clothed externally with pubescent scales, the inner margin of the former joint terminates distally in a short obtuse spine, while the latter possesses three spines on its inner margin, one being situated at the distal end, another near the middle, and a third of smaller size between the two, in addition to an acute spine of small size at the distal end of the outer margin.

The second abdominal segment bears from six to eight spinules on the anterior dorsal margin. The transverse striæ are smooth and polished, though fringed with hairs; on the sixth segment they are somewhat broken up.

This species is closely allied to *Munida militaris*, Henderson, from which it may be distinguished by the presence of a second pair of gastric spines, and the pronounced "lashes" overhanging the corneæ. I have named it after Mr. W. A. Haswell, in recognition of the assistance I have derived from his work on the Australian Crustacea.

Breadth of carapace (of an adult male) 9 mm., length of body 25 mm., of carapace 11 mm., of rostrum 6 mm., of first ambulatory leg 28 mm.

Habitat.—Station 163A, off Twofold Bay, Australia; depth, 150 fathoms; bottom, green mud. One male and three young specimens.

Munida inornata, Henderson (Pl. XIV. fig. 6).

Munida inornata, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 411, 1885.

Characters.—The rostrum is more than half the length of the carapace, and three times the length of the supraorbital spines; all three are slightly upturned, and the rostrum is somewhat flattened from side to side. The carapace is crossed by fairly numerous and prominent granulated pubescent striæ; the gastric area is moderately convex, and is armed in front with a transverse row of spinules—ten or twelve in number—of which only the two placed behind the supraorbitals attain any considerable size; the posterior part of the gastric area is mapped out as an oval patch, circumscribed in front by a line passing between the two cervical grooves, and posteriorly by the grooves themselves at the point where they unite; the cardiac area is not defined, and it, as well as the remaining surface of the carapace, is unarmed. The lateral border of the carapace is deeply notched near its anterior end by the cervical groove, in front of which there is the well-marked postorbital spine, while behind about five minute spinules can be made out; the posterior margin is unarmed.

The chelipedes are slender and elongated, more especially in the male, in which they are about one and a half times the length of the body, whereas in females they about equal that length; the joints are covered with raised pubescent scales, most prominent on the upper surface, and several spinules are present on the inner margin, and, to a lesser extent, on the upper surface of the merus, carpus, and propodus. The chela is about twice the length of the carpus, and, in addition to three spinules present on the inner margin, there is a fourth on the outer border, near the base of the immobile finger. The fingers are slender, more particularly in the male, and their opposed edges, which are densely clothed with short hairs, are in contact; the apices cross one another, and that of the dactylus is bispinose, while the immobile finger is trispinose. The ambulatory limbs are moderately slender, and the meral, carpal, and propodal joints are subsquamose; the first two of these joints also have a series of spines on their anterior border, and a row of delicate spinules is present on the posterior margin of the propodi. The dactyli are slender, and but slightly curved.

The eyes are of moderate size and considerably flattened, with well-developed "lashes"; and there are also, in addition, two distinct rows of cilia on the upper surface of the peduncle. The antennal spine does not extend beyond the distal end of the second joint of the peduncle, and the latter joint is provided with two spines, on either side of the distal end, and a spinule on the inner margin. The ischium and merus of the external maxillipedes are comparatively smooth externally, and the latter is pubescent; the merus bears a spinule on either side at the distal end, and a prominent acute spine near the middle of its inner border.

The second abdominal segment bears two minute spinules, both of which may in some cases be obsolete. The striæ are smooth and glabrous, with the hairs short, but there is a tendency towards a scale-like arrangement on the last two segments.

This species is allied to *Munida militaris*, from which it is separated by the short supraorbitals, the form of the eyes, the armature of the carapace and first abdominal segment, and the more slender chelipedes. The two approach one another in so many respects that it is possible a larger series of specimens from different localities might show *Munida inornata* to be only a variety of the former. It also bears some resemblance to *Munida constricta*, A. Milne-Edwards, a species in which there are, however, only two gastric spines.

Breadth of carapace (of an adult male) 8 mm., length of body 19 mm., of carapace 9 mm., of rostrum 5 mm., of chelipede 40 mm., of chela 15·5 mm., of first ambulatory leg 22·5 mm.

Habitat.—Station 219, north of Papua; depth, 150 fathoms; bottom, coral mud.

A male and two females, one of the latter with similar parasites to those occurring on *Galathea pusilla*, Henderson.

Munida sancti-pauli, Henderson (Pl. III. fig. 6).

Munida sancti-pauli, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 411, 1885.

Characters.—The rostrum is about half the length of the carapace, and more than twice the length of the supraorbitals, which are slightly upturned and situated close together. The carapace is glabrous, and the striæ comparatively few in number, though fringed with short hairs; the gastric area exhibits but little convexity, and is armed with a transverse row of from six to eight spinules placed parallel to the frontal margin, of which the second on either side (counting from the middle line) slightly exceeds the others in size; the cardiac area is unarmed and scarcely defined; three small spinules occur on the branchial area, two of these being situated on the portion immediately posterior to the anterior division of the cervical groove. The lateral margin of the carapace is armed with seven comparatively large spines, of which the two in front of the cervical groove are specially prominent; the posterior margin is unarmed.

The chelipedes are of moderate size, with the joints strongly spinose, the spines being most strongly developed on the merus; the propodus is somewhat narrower than the carpus, and its upper surface carries a median and two lateral rows of short curved spines; the fingers are about equal in length to the palm and in contact throughout, while two or three short spines are present on the outer border of the immobile finger. The ambulatory limbs are of moderate length; the upper surface of the meral, carpal, and propodal joints is faintly granular, while the two former have a series of well-marked spines on their anterior and posterior margins, those at the distal end of the merus exceeding any of the others in size; the dactyli are curved only towards the apex, and a few horny spinules are present on their posterior margin.

The eyes are of comparatively large size, and but slightly flattened, with the corneæ deeply pigmented. The anterior prolongation of the first antennal peduncular joint is short, not exceeding the second joint. The ischium and merus of the external maxillipedes are almost smooth externally; the inner margin of the latter gives rise to two prominent spines, the larger of which is situated near the middle of the joint, and the other, which is slightly less pronounced, at the distal end, while a minute spine is placed opposite the last on the outer margin.

The second abdominal segment bears from eight to ten minute spinules on the anterior margin; the remaining segments are glabrous, and the striæ almost obsolete.

Breadth of carapace (of a female with ova) 8·8 mm., length of body 22·5 mm., of carapace 10 mm., of rostrum 5·8 mm., of chelipede 28 mm., of chela 12 mm.

This species is nearly related to *Munida miles*, A. Milne-Edwards, and it is not without considerable hesitation that I have ventured to separate the two; it is distinguished by its smaller size, the broader and flatter carapace, the non-diverging supraorbital spines, the presence of spinules on only the second abdominal segment, and the shallow-water habitat.

Habitat.—St. Paul's Rocks; depth, 10 to 60 fathoms. A female with ova and a young male.

Munida gracilis, Henderson (Pl. XIV. fig. 4).

Munida gracilis, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 412, 1885.

Characters.—The rostrum is about two-thirds the total length of the carapace, and more than twice the length of the supraorbital spines; all three are distinctly upturned, but especially the rostrum, which reaches a considerably higher level than the carapace itself. The transverse striæ on the carapace are granulated, and comparatively few in number, the fringing hairs being poorly developed; the gastric area is somewhat swollen, and is armed in front with a transverse row of spinules from eight to ten in number, two of which, placed behind the supraorbitals, greatly exceed the others in size, a second, but very much smaller, pair of gastric spines is placed immediately behind the first pair, and there is a single spinule on each side towards the lateral boundary of the area; the cardiac area is unarmed, and indistinctly circumscribed; a prominent spinule is placed on each branchial region behind the cervical groove, and in close proximity to the outer border of the cardiac area; a minute spinule may also exist on the anterior branchial region. The lateral border of the carapace bears seven spines, only two of which, situated in front of the cervical groove, attain any great size; the posterior margin is almost straight and distinctly elevated, but unarmed.

The chelipedes are subcylindrical and remarkably long and slender; the upper surface of the merus, carpus, and propodus is armed with prominent spinules, which are most strongly developed on the first of these joints. The chela is narrower than, and slightly more than twice the length of, the carpus; the fingers are slender and almost straight, with their length considerably less than that of the palm, and the opposed edges finely toothed; the dactylus is bispinose at the apex, and the immobile finger trispinose. The ambulatory limbs are slender, and provided with a pair of prominent spinules at the distal end of the meri and carpi, both margins of the meri also are armed with spinules, and the anterior is in addition pubescent; the dactyli are about two-thirds the length of the propodi, and moderately curved.

The eyes are of moderate size and slightly flattened, while the corneæ in both the specimens examined are of a light brown colour. The antennal spine scarcely reaches the middle of the second peduncular joint, and the latter is provided with a pair of prominent spines at its distal end. The ischium and merus of the external maxillipedes are almost smooth externally; the lateral margins of the former joint are prolonged distally into short conical spines, while the latter is armed with a single prominent spine near the middle of its inner border, and in one of the specimens there is a minute spinule at the distal end of the same border.

The second abdominal segment is armed with eight spinules on its anterior margin, of which the submedian pair are most pronounced; the third segment bears four spinules in the same position, the two lateral of which are of very small size. The remaining segments are glabrous, with comparatively few transverse striæ present.

This species finds its nearest ally in *Munida tenuimana*, G. O. Sars, a form common in the deeper water of the North Atlantic; the latter attains a larger size, its rostrum is less elevated, the posterior margin of the carapace is armed with a row of spinules, the eyes are rounder and more deeply pigmented, and the fourth abdominal segment carries two spines on its anterior dorsal margin.

Breadth of carapace (of an apparently adult female) 6 mm., length of body 17 mm., of carapace 7·8 mm., of rostrum 6 mm., of chelipede 36 mm., of chela 16·5 mm., of ambulatory leg (detached) 18·5 mm.

Habitat.—Station 166, west of New Zealand; depth, 275 fathoms; bottom, Globigerina ooze. A female and a young male specimen.

Munida spinifrons, Henderson (Pl. XV. fig. 1).

Munida spinifrons, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 412, 1885.

Characters.—The rostrum is about three and a half times the length of the supra-orbital spines, and almost equal to that of the carapace, with its apical half decidedly upturned and furnished on each side with about six distinct spinules; the supraorbitals are horizontal in direction, and of small size. The striæ are fairly numerous on the carapace, and fringed with short iridescent hairs; the gastric area is armed with a pair of small spines situated behind the supraorbitals, and a few minute spinules are present on either side of these; the cardiac area is indistinctly circumscribed, and it, as well as the remainder of the carapace, is unarmed. The lateral border of the carapace is provided with seven small spines, and the portion in front of the cervical groove is placed at a very slight angle to the orbital margin; the posterior border is smooth and unarmed.

The chelipedes are somewhat elongated, with the joints minutely squamose, and spinulose on the inner margin; the fingers are remarkably slender. The right chela has, in addition to the spines on the inner margin of the propodus, two or three also present on its upper surface in the median line; the fingers are finely toothed, and their opposed margins are in contact; the tip of the dactylus is bent over that of the immobile finger.

The left chela has the propodus almost devoid of spines, and the fingers are longer than those of the right chela, exceeding the palm in length; a few minute spinules are present at the apices of both fingers. The ambulatory limbs are slender, with the meral and carpal joints spinose on the anterior margin; the dactyli are of moderate length and comparatively broad, though the apices are acute.

The eyes are of moderate size and but slightly flattened, with the peduncles tolerably elongated. In place of the four segments met with in the antennal peduncle of Galatheids generally, five distinct segments can be distinguished in this species, a result apparently due to a splitting of the first segment, and the anterior portion probably in part represents the antennal spine, which is otherwise almost obsolete. The external maxillipedes are more slender than usual; the ischium and merus are smooth externally, and a few very minute denticles are present on the inner margin of the latter.

Two minute spinules separated by a rather wide interval are present on the anterior dorsal margin of the second abdominal segment; the terminal segments are glabrous, with the striæ but faintly marked.

This interesting species is distinguished from all the other known members of the genus by its upturned serrated rostrum, and the presence of five separate segments in the antennal peduncle.

Breadth of carapace (of a female with ova) 4·7 mm., length of body 16 mm., of carapace 6·5 mm., of rostrum 5·3 mm., of left chelipede 22 mm., of chela 9·5 mm., of ambulatory leg (detached) 14 mm.

Habitat.—Station 113A, anchorage off Fernando Noronha; depth, 7 to 25 fathoms; bottom, volcanic sand and gravel. A single specimen.

Munida tuberculata, Henderson (Pl. XV. fig. 2).

Munida tuberculata, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 413, 1885.

Characters.—The rostrum is slightly more than half the length of the carapace, and about four times the length of the supraorbital spines; all three are somewhat broad and flattened, almost horizontal in direction, and the rostrum has a median carina on its upper surface. The striæ on the surface of the carapace are granulated and very prominent; the gastric area is armed anteriorly with a transverse band of short irregular tubercles, arranged in two or three rows, and a few similar, though less distinct, elevations are present on the hepatic and anterior branchial regions; the cardiac area is fairly well defined, and one of the striæ crossing it near its middle is specially prominent. The lateral margin of the carapace bears a few minute teeth; the posterior margin is raised and prominent, but unarmed.

The chelipedes are of moderate size, and the various joints are armed with short conical spines, a few of larger size being situated at the distal end of the merus. The chela is slightly broader than the carpus and about three times its length, and the upper surface of the propodus is somewhat densely covered with short spinules; the fingers are broad and slightly overlap towards their apices, while their opposed edges are almost devoid of teeth, and in contact throughout. The upper surface of the meral joints of the ambulatory limbs is obscurely tubercular, and a crowded series of short denticles is present on the anterior margin of the same joints; the dactyli are comparatively long, and exhibit a faint sigmoid curve.

The eyes are of moderate size, and considerably flattened. The antennal spine is fairly prominent, but does not extend beyond the second joint of the peduncle. The ischium and merus of the external maxillipedes are obscurely tubercular externally, and the inner margin of the latter joint is provided with four or five irregularly conical teeth, the largest of which is situated towards the centre.

The second abdominal segment bears a submedian pair of short curved spines, and in some specimens one or two minute spinules can be detected towards the lateral margin of the same segment. The second, third, and fourth segments have the anterior dorsal margin elevated, and the upper surface carinated transversely towards the posterior margin; the remaining segments are almost smooth.

Breadth of carapace of the largest specimen (a male from Station 173) 5 mm., length of body 13 mm., of carapace 5·8 mm., of rostrum 3·2 mm. In this specimen the chelipedes and ambulatory legs are wanting, but in another example of much smaller size, from Station 172, the body of which measures only 8 mm. in length, the chelipedes attain a length of 11·5 mm., and the chela 5 mm.

This small species is distinguished by the presence of a crowded transverse row of tubercles on the gastric area of the carapace, and by the form of the rostrum, chelipedes, and other parts.

Habitat.—Station 172A, off Nukalofa, Tongatabu; depth, 240 fathoms; bottom, coral mud. A young male.

Station 173, off Matuku, Fiji; depth, 315 fathoms; bottom, coral mud. A male specimen apparently adult, and a young female.

Munida spinicordata, Henderson (Pl. XV. fig. 3).

Munida spinicordata, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 413, 1885.

Characters.—The rostrum is about half the length of the carapace, and nearly one-third longer than the supraorbital spines; all three are horizontal in direction, though they have a slight downward inclination towards their apices, and the rostrum is more slender than the lateral processes. The striæ on the surface of the carapace are fairly numerous and faintly granulated, with short fringing hairs; the gastric area is moderately convex, and bears in front two small spines placed immediately behind the supraorbitals on a raised transverse elevation which overhangs the bases of the frontal processes; the cardiac area is distinctly circumscribed, somewhat swollen, and triangular in outline, with a median curved spine of small size placed on the anterior margin, which is considerably elevated; the branchial and hepatic regions are unarmed. The lateral margin of the carapace is provided with five or six spinules, all of which, with the exception of the first or postorbital, are very minute; the posterior margin is fairly prominent, but unarmed.

The chelipedes are long and slender, with a few curved spinules on the merus, and on the inner margin of the carpus and propodus; the same joints are also covered with slightly marked tubercular scales. The chela is more than twice the length of the carpus; the propodus has a row of spinules on its inner margin, and two spinules are present on the outer margin near the base of the immobile finger; the upper surface is faintly tubercular, and bears a single spinule at the base of the dactylus. The fingers are slender and almost straight, with their opposed edges in contact and their apices overlapping; a few minute teeth are present on the inner margin of the immobile finger. The ambulatory limbs are slender and elongated; two prominent spinules are placed at the distal end of the merus, and a few of smaller size along both its margins; the dactyli are long and moderately curved.

The eyes are of large size, and somewhat compressed. The anterior prolongation of the first antennal peduncular joint is of moderate length, scarcely exceeding the second joint. The ischium of the external maxillipedes is finely tubercular externally, and its lateral margins terminate distally in short spines; the merus is of relatively small size, and a single spinule is present near the middle of its inner margin.

The second and third abdominal segments bear four spines each on the anterior dorsal margin, of which the submedian pair are slightly larger than the lateral. The fourth segment bears three spines, two on the anterior margin, and one in the median line near the posterior margin. The outer surface of the terminal segments is glabrous, and the striæ are arranged in short concentric lines.

Breadth of carapace (of a male) 4·5 mm., length of body 11 mm., of carapace 5 mm., of rostrum 2 mm., of chelipede (detached) 19 mm., of chela 7·8 mm., of ambulatory leg (detached) 15 mm.

This small and distinct species is characterised by the length of its supraorbital spines, the form and armature of the cardiac area of the carapace, and the arrangement of the abdominal spinules.

Habitat.—Station 174D, off Kandavu, Fiji; depth, 210 fathoms; bottom, coral mud. A male specimen.

Munida sp.

A single imperfect specimen of a *Munida* from Station 23, off Sombrero Island, West Indies; depth, 450 fathoms; bottom, Pteropod ooze, is preserved in the collection. It is apparently a young individual, and probably belongs to one of the numerous species described by Professor Alphonse Milne-Edwards from the West Indies. The body is smooth and glabrous, the striæ being faintly granular; the gastric area of the carapace is armed in front with a transverse row of spinules, only two of which (placed behind the supraorbitals) attain any considerable size; the rostrum is almost half the length of the carapace, and twice the length of the supraorbital spines, while the latter are somewhat flattened. The second, third, and fourth abdominal segments are armed with a pair of submedian spines each, and the first of these segments bears in addition three lateral spinules on each side. The eyes are of a light brown hue. The merus of the external maxillipedes is elongated, and provided with two spinules on the inner margin,—one at the distal end, the other near the proximal end.

Genus *Munidopsis*, Whiteaves.

Munidopsis, Whiteaves, Amer. Journ. Sci., ser. 3, vol. vii. p. 212, 1874.
Galathodes, A. Milne-Edwards, Bull. Mus. Comp. Zoöl., vol. viii. No. 1, p. 53, 1880.
Orophorhynchus, A. Milne-Edwards, Bull. Mus. Comp. Zoöl., vol. viii. No. 1, p. 58, 1880.

Rostrum spinulous, and usually more or less triangular, with its margins rarely dentate or spinose. Carapace rugose, or spinose, and in most cases glabrous. Chelipedes and ambulatory limbs of variable length, and frequently spinose, the dactyli of the latter with their posterior margins often dentate. Eyes devoid of pigment, with the peduncle frequently prolonged beyond the cornea in the form of a spine or spines. Antennal peduncle usually stout. Eggs few in number and of large size.

The members of this genus have been taken in almost all seas the deep water of which has been explored by the dredge, and they are found at depths varying from about 100 to upwards of 2000 fathoms. The species differ widely among themselves in the form of those parts which in other Crustacea afford generic characters; and yet it is impossible to effect a natural subdivision, or one which is not founded on a single character to the exclusion of others. It is probable that the loss of sight is compensated by a greater development of the tactile sense, and in some species this is evidenced by the great length of the antennal flagella, which in all probability enable the animal to grope its way about on the bottom.

Munidopsis erinacea (A. Milne-Edwards) (Pl. XVI. fig. 4).

Galathodes erinaceus, A. Milne-Edwards, Bull. Mus. Comp. Zoöl., vol. viii. No. 1, p. 53, 1880.

Habitat.—Station 122, off Pernambuco; depth, 350 fathoms; bottom, red mud. A male, and a female with ova; the latter, which is the larger, measuring as follows:—Breadth of carapace 7 mm., length of body 25 mm., of carapace (including rostrum) 14 mm., of chelipede 23·5 mm., of first ambulatory leg 18 mm., diameter of ova 1·1 mm.

The carapace is pubescent, and armed with slender curved spines, of which there are four on the gastric area, four on the cardiac area, and three on the branchial area; the first gastric pair exceed the others in size, and the second cardiac pair are smallest. The rostrum is upturned, and trispinose, a single curved spine being present on either side near its middle. Three well-marked spines are situated on the lateral border of the carapace, two being placed in front of the cervical groove, and a smaller spine is present on the antero-lateral margin behind the eye-stalk; the posterior margin is unarmed. The eyes are well developed, and the corneal surfaces extensive, but the peduncle is not prolonged into a spine. The merus of the external maxillipedes is provided with three spines, two on the inner margin (of which the first or proximal is larger), and one at the distal end of the outer border. The chelipedes are of moderate length, and the merus and carpus are both pubescent and spiny; the propodus is smooth, and the fingers are excavated inferiorly. The ambulatory limbs are pubescent and somewhat spiny, with the dactyli dentate on the posterior margin, and only curved towards their apices. The second, third, and fourth abdominal segments are pubescent, and each bears from four to six spines placed on a transverse ridge, while the second and third segments have the lateral margin produced backwards into a short spine.

This very distinct species was taken by the "Blake" at five stations in the West Indies, in depths varying from 151 to 451 fathoms. The Challenger specimens differ only in being more pubescent.

Munidopsis serratifrons (A. Milne-Edwards) (Pl. XVI. fig. 3).

Galathodes serratifrons, A. Milne-Edwards, Bull. Mus. Comp. Zoöl., vol. viii. No. 1, p. 55, 1880.

Habitat.—Station 56, off Bermuda; depth, 1075 fathoms; bottom, coral mud. Two males, and a female with ova; one of the former gives the following measurements:—Breadth of carapace 7 mm., length of body 19 mm., of carapace (including rostrum) 11 mm., of chelipede 25 mm., of first ambulatory leg 15 mm. The eggs measure 0·8 mm. in diameter.

The surface of the carapace is granulated. The gastric area is extremely swollen, and is armed with a pair of short spines placed behind the base of the rostrum.[1] The cardiac area is somewhat triangular in outline, and considerably elevated, with its highest point surmounted by a broad conical spine, while a second spine of smaller size is occasionally present behind the first; a few spinules are present on the posterior branchial region, near the lateral border. The rostrum is acuminate and carinated superiorly, with its lateral margins minutely serrated towards the apex, and a slight concavity, into which the eye-stalk fits, exists on either side near the base. The lateral border of the carapace is provided with a spine at the antero-lateral angle, and a second of smaller size is placed behind the prominent cervical groove; the posterior margin is armed with two spinules. The eyes are ovate, and almost immobile, while each peduncle terminates in a very minute spinule. The merus of the external maxillipedes is short and broad, with three spines on its inner margin, which decrease in size towards the distal end. The chelipedes are slender and elongated, with the joints slightly granulated, and several spines are present on the inner surface of the merus and carpus, while the inner border of the propodus is provided with a row of short spinules; the fingers are not equal in length to the palm. The ambulatory limbs are granulated, and the margins of the meri and carpi are fringed with short spinules; the dactyli are strongly curved, and their edges are entire. The second, third, and fourth abdominal segments are transversely carinated, and provided with curved spines, of which three are present on the second segment, four on the third (arranged in two rows), and one on the fourth.

This species was taken by the "Blake," off Dominica, at a depth of 333 fathoms.

Munidopsis sigsbei (A. Milne-Edwards) (Pl. XVIII. fig. 2).

Galathodes sigsbei, A. Milne-Edwards, Bull. Mus. Comp. Zoöl., vol. viii. No. 1, p. 56, 1880.

Habitat.—Station 23, off Sombrero, West Indies; depth, 450 fathoms; bottom, Pteropod ooze. A female with ova, measuring as follows:—Breadth of carapace 9·8 mm., length of body 36 mm., of carapace (including rostrum) 20 mm., of chelipede 51 mm., of first ambulatory leg 25 mm., diameter of ova 1·5 mm.

The carapace is unarmed and comparatively smooth, the surface being merely crossed by short indistinct striæ. The gastric area is moderately convex, and the cardiac area is triangular in outline, the two being separated by a rather wide space. The rostrum is narrow, acute, and horizontal, its length being about half that of the carapace, and the upper surface is faintly carinated. The lateral borders of the carapace are parallel and unarmed, with the exception of a small spine at the antero-lateral angle. The posterior margin bears five or six spinules (three according to Milne-Edwards) situated close

[1] According to Professor Milne-Edwards, "La région gastrique porte trois petites épines disposées transversalement, l'une sur la ligne médiane, les autres latéralement." I can find no trace of this median spine in the Challenger specimens.

together. The eye-stalks are somewhat elongated, and freely movable, without terminal spines. The merus of the external maxillipedes possesses a prominent angular lobe at the proximal end of its inner margin. The chelipedes are long and slender, with several well-marked spines on the inner surface of the merus, and at the distal end of both merus and carpus. The fingers are remarkably long and slender, exceeding the palm in length, and their opposed margins are finely denticulate; there is a slight basal hiatus, and the apices have a downward curve. The ambulatory limbs are granulated, but comparatively free from spines; the dactyli are of large size, and each terminates in a yellow curved claw, while a series of spinules, gradually increasing in size towards the apex, is present on the posterior margin. The abdominal segments are smooth, though the second is carinated transversely.

This species was taken by the "Blake" at eight West Indian localities, the depths at which varied from 472 to 878 fathoms.

Munidopsis antonii (A. Milne-Edwards, MS.) (Pl. XVIII. fig. 1).

Galathodes Antonii, Filhol, La Nature, vol. xii. p. 231, fig. 2 (*sine descr.*), 1884.

Habitat.—Station 158, south-west of Australia; depth, 1800 fathoms; bottom, Globigerina ooze. A female with ova, and a young female.

Station 300, west of Valparaiso; depth, 1375 fathoms; bottom, Globigerina ooze. A young female.

The single adult specimen measures as follows:—Greatest breadth of carapace 33 mm., length of body 95 mm., of carapace (including rostrum) 50 mm., of chelipede 62 mm., of first ambulatory leg 73 mm., diameter of ova 3·5 mm.

The carapace is covered everywhere with irregular granulations, which tend to become spiny on the anterior half, more especially on the gastric area, while posteriorly they become somewhat oblong, and reach their greatest size on the cardiac area; the last-named region is lozenge-shaped and fairly convex, with a smaller area of similar shape on either side immediately behind the cervical groove. The rostrum is narrow and acute, with a decided upward inclination. The lateral margin of the carapace is armed near the antero-lateral angle with two spines of large size (including the postorbital), and a few spinules are also present; the posterior margin is raised and prominent, but unarmed. The eyes are immovably united together in the middle line beneath the rostrum, and each peduncle is prolonged into a pointed spine, continued some distance beyond the cornea, which is somewhat circular in outline, and placed on the antero-external surface. The merus of the external maxillipedes is comparatively narrow, and bears three spiniform teeth on the inner margin, in addition to a more prominent spine at the distal end of the outer border; the outer surface is granulated. The chelipedes are of moderate size, with the joints granular, and the merus and carpus are also somewhat spiny; the fingers are long, and excavated inferiorly. The ambulatory limbs are granular, and the anterior margin of the meri is spiny; the dactyli are narrow, slightly tortuous, and almost smooth. The abdominal segments are transversely carinated, and granulated towards the lateral margins; the posterior margin of the sixth segment gives rise to two prominent rounded lobes.

This species was taken by the "Talisman" in the Atlantic, off the north-west coast of Africa, at a depth of 4000 metres (2187 fathoms).

Munidopsis subsquamosa, Henderson (Pl. XVII. fig. 4).

Munidopsis subsquamosa, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 414, 1885.

Characters.—The carapace is slightly pubescent, and covered with flattened scale-like tubercles, which on the posterior half are elongated to form short transverse ridges. The gastric area is convex and distinctly circumscribed, with its rounded lateral margins formed by the cervical grooves, which pass unusually far forwards; the scale-like tubercles are well marked, and a few of those near the base of the rostrum terminate in short stout spines; the hepatic areas are flattened and depressed; the cardiac area is indistinctly mapped out, and a somewhat deep groove crosses it transversely near its middle, the short ridge-like elevations are well seen on the posterior part of this area as well as on the branchial regions. The rostrum is almost horizontal, and a little more than one-third the length of the carapace, with the upper surface granular and carinated, and the lower surface smooth; the apex is narrow and acute, but a considerable widening out takes place near the base. The lateral margin of the carapace is armed with two broadly conical yet acute spines, the second of which is almost horizontal in direction, and separated from the first (placed at the antero-lateral angle) by the cervical groove; a few spinules are situated further back on the border, and a short spine occurs on the antero-lateral margin immediately behind the antennal peduncle; the posterior margin is broad and transversely grooved, with a narrow and smooth strip of carapace in front.

The chelipedes are comparatively short, and the joints are covered with small rounded tubercles, many of which are pubescent; a few short spines also occur on the upper surface of the merus and carpus. The propodus is slightly dilated, while the fingers exceed the palm in length, and their inner surfaces are deeply excavated towards the apices. The ambulatory limbs are moderately long, the meral, carpal, and propodal joints are tuberculate, and a series of short spines occurs on their front margin; the dactyli are smooth and fairly well curved, with the lower margin denticulate, the denticulations increasing in size towards the apex.

The eyes are of moderate size and possess but slight mobility, a small free rectangular plate occurs on the ventral surface between the two; each peduncle beyond the inner margin of the cornea has a narrow acute spine. The antennal flagellum is apparently of great length though deficient in the single specimen. The merus of the external maxillipedes is rather narrow, its outer surface is faintly granular, and the inner margin is armed with a series of short irregular teeth.

The abdominal segments are granulated externally, and the second, third, and fourth are each crossed transversely by a deep central groove. The male genital organs are of large size.

This species is allied to *Munidopsis antonii* (A. Milne-Edwards), but the latter is of larger size, the elevations all over the body are granular rather than tubercular, the rostrum rises considerably above the level of the carapace, the eyes are immovably united together and to the carapace, and the ambulatory dactyli are not denticulate.

Breadth of carapace (of an adult male) 21·5 mm., length of body (including rostrum) 71 mm., of carapace (including rostrum) 39 mm., of rostrum 10 mm., of chelipede 47 mm., of first ambulatory leg 58 mm.

Habitat.—Station 237, off Yokohama; depth, 1875 fathoms; bottom, blue mud. A male specimen, and the softened remains of a second example.

Munidopsis subsquamosa, Henderson, var. *aculeata*, nov. (Pl. XVI. fig. 1).

Characters.—This variety differs from the typical form in the following respects:— The markings on the posterior half of the carapace are slightly less crowded, and show a decided tendency to become flattened; scales are absent from the gastric area, being replaced by scattered tubercles, many of which end in short conical spines. The rostrum is decidedly upturned. The eyes are less mobile, and a certain amount of fusion with the carapace has taken place. The spines on the chelipedes and ambulatory limbs are more strongly developed.

The most important feature in this variety is the absence of flattened tubercles from the gastric area of the carapace, and their replacement by short spines, though it must be borne in mind that the latter are present to a certain extent in the typical form. In some of its characters, as the elevation of the rostrum, and the partial fusion of the eyes, it approaches *Munidopsis antonii*, from which, in other respects, it is widely separated. The body (including rostrum) of the larger specimen, from Station 302, measures 89 mm. in length.

Habitat.—Station 146, between Marion Island and the Crozets; depth, 1375 fathoms; bottom, Globigerina ooze. A single specimen.

Station 302, west of Patagonia; depth, 1450 fathoms; bottom, Globigerina ooze. An adult male.

Munidopsis brevimana, Henderson (Pl. XVII. figs. 1, 2).

Munidopsis brevimana, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 414, 1885.

Characters.—The carapace is glabrous and covered with short transverse ridge-like elevations, which exist in greatest number on the posterior half; in some specimens also short hairs are sparingly met with. The gastric area is swollen, and armed in front with two prominent spines placed behind the base of the rostrum, while the short transverse ridges are comparatively few in number; the cardiac area is circumscribed, and a deep furrow crosses it transversely near the middle; the ridges are strongly marked, and lengthen out somewhat on the branchial regions. The rostrum is narrow and acute, slightly elevated towards the apex, and carinated superiorly, its length being less than half that of the carapace. The lateral margin of the carapace is armed with five spines, three of which are situated between the two divisions of the cervical groove, and the first of this trio reaches the greatest size; a single spine is placed on the antero-lateral margin behind the antennal peduncle; the posterior margin is prominent, but unarmed. The chelipedes are stout and remarkably short, with the joints pubescent, and the merus and carpus somewhat spiny above. The lower surface of the ischium is produced anteriorly, and a spinule is present near the apex of this process; the propodus is almost smooth, and dilated both from side to side and from above downwards; the fingers are short and stout, with their opposed surfaces deeply excavated, and the apical margins finely toothed; numerous short tufted hairs are present towards the apices, and the outer surface of the immobile finger carries a denticulate carina. The ambulatory limbs are of moderate length, and the posterior surfaces of the meri and carpi are tuberculate, while their anterior margins are strongly spinose; the posterior surface of the propodi is carinated; the dactyli are only curved towards the apex, and their posterior margins are denticulate, the teeth increasing in size towards the terminal claw.

The eyes still retain a certain amount of mobility, and are separated ventrally by from one to three small calcified pieces; the cornea is rounded, and the peduncle is prolonged into two slender lateral spines, the inner of which is about twice the length of the other. The antennal flagellum is more than twice the length of the body. The merus of the external maxillipedes has its inner margin irregularly dentate.

The abdominal segments are comparatively smooth, a few granulations being present merely on the posterior ones; the second, third, and fourth each bear a curved transverse sulcus, the convexity of which is directed forwards.

This species is allied to *Munidopsis reynoldsi* (A. Milne-Edwards), dredged by the "Blake" off Frederickstadt, West Indies, at the great depth of 2376 fathoms. The latter is of small size, its chelipedes are considerably shorter, and more than two spines are situated on the gastric region of the carapace.

The largest specimen (a female with ova) measures as follows:—Breadth of carapace 17·5 mm., length of body (including rostrum) 63 mm., of carapace (including rostrum) 33·5 mm., of chelipede 34 mm., of first ambulatory leg 50·5 mm., diameter of ova 2 mm. The body of the largest male specimen measures 49 mm. in length.

Habitat.—Station 191, off the Arrou Islands; depth, 800 fathoms; bottom, green mud. A young specimen (Pl. XVI. fig. 2), which differs from the adult in having the body smoother and the spines less strongly developed.

Station 218, between Papua and the Admiralty Islands; depth, 1070 fathoms; bottom, blue mud. Seven adult females, four of which bear ova; three adult males, and a number of young individuals.

Munidopsis milleri, Henderson (Pl. XVII. fig. 3).

Munidopsis Milleri, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 414, 1885.

Characters.—The carapace is glabrous, and covered, more especially the posterior half, by short transverse ridges, which give it a rugose appearance. The gastric area is swollen, and armed with two pairs of spinules; the first pair situated behind the rostrum, the second, of smaller size (occasionally absent), placed behind the first pair and nearer the middle line. The cardiac area is crossed transversely by a moderately deep sulcus, and immediately behind the well-marked gastro-cardiac groove there are three pairs of spinules, of which the two lateral pairs are situated on the boundary of the branchial area; the short transverse ridges are well developed on the posterior cardiac and branchial regions. The rostrum is short and spinulous, not exceeding the antennal peduncle; it is almost horizontal in direction, and its upper surface is carinated. The lateral margin of the carapace is armed with four spines, of which the first is of large size and placed at the antero-lateral angle, the second and third are placed on a somewhat dilated part between the two divisions of the cervical groove, and the fourth occurs about halfway back on the margin; a single spinule is also present on the antero-lateral border behind the antennal peduncle. The posterior margin of the carapace is prominent, and bears six small spinules separated by narrow intervals.

The chelipedes are narrow and elongated, with the merus and carpus spinose. The merus is faintly granulated, while two rows of spines are found on its inner surface, and one on the dorsal median line. The spines on the carpus are arranged in two dorsal rows, and a few scattered granules are also present. The propodus is more than twice the length of the carpus, and its upper surface is smooth and glabrous. The fingers are in close contact, and slightly excavated below, each being provided with a prominent angular tooth, which fits into a corresponding depression in its fellow, and numerous silky hairs are present, especially towards the apices. The ambulatory limbs are remarkably long and slender; the meri are obscurely granulated, and a few spinules are present at their distal end, and on their anterior margins, while a single spinule also occurs at the distal anterior end of the carpi. The ambulatory dactyli are almost straight, each terminating in a curved, horny claw, and a series of delicate horny spinules is present on their posterior margin.

The eyes are rounded, and firmly fused together on the ventral aspect; the peduncles are not prolonged into spines. The antennal flagellum is of moderate length. The merus of the external maxillipedes bears two prominent and subequal spines on the proximal half of its inner margin.

The second and third abdominal segments are each provided with a transverse sulcus; the remaining segments are smooth and glabrous. The size of the abdomen as a whole is unusually small, when compared with that of the cephalothorax.

I have dedicated this well-marked species to my friend and colleague, the Rev. Dr. Miller, C.I.E., Principal of the Madras Christian College.

Breadth of carapace (of a female with ova) 11 mm., length of body (including rostrum) 31 mm., of carapace (including rostrum) 16 mm., of chelipede 39·5 mm., of first ambulatory leg 33·5 mm., diameter of ova 1·3 mm. The body of the largest male specimen measures only 27 mm. in length.

Habitat.—Station 207, off Tablas Island, Philippines; depth, 700 fathoms; bottom, blue mud. A female with ova, and two males.

Munidopsis trifida, Henderson (Pl. XVI. fig. 2).

Munidopsis trifida, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 415, 1885.

Characters.—The carapace is covered with short transverse rugosities of no great size, which are best seen on the postero-lateral surface; a few short hairs are also scattered over the surface. The gastric area is moderately convex, and armed with two prominent spines placed behind the base of the rostrum, while the tubercular rugosities are somewhat rounded, and comparatively few in number; the cardiac area is indistinctly circumscribed, and a broad shallow groove crosses it transversely near the middle. The rostrum is about half the length of the carapace, with a proximal broad and flattened portion which is traversed by a median dorsal carina, and a laterally compressed, and distinctly upturned terminal spine; the margins of the flattened part are prolonged into two short spinules which, in the single specimen, are not placed in the same transverse line. The lateral border of the carapace is armed with four subequal and equidistant spines, and a spinule occurs on the oblique antero-lateral margin immediately behind the antennal peduncle; the posterior margin is prominent though unarmed, and a rather wide, smooth, band-like area occurs on the carapace in front of it.

The chelipedes are long and sub-cylindrical, with the joints spinose and faintly pubescent. The merus is armed with three conspicuous rows of spines, two on the inner surface and one on the upper surface, while the outer surface is finely tubercular; the spines on the carpus are most pronounced at the distal end; the margins of the propodus, especially the inner, are fringed with short spines, and the upper surface is smooth and glabrous. The fingers are almost straight and not equal in length to the palm, with their opposed margins minutely dentate and in contact throughout; a few teeth of larger size are, however, noticeable at the apices, and their lower surfaces, especially towards the distal end, are somewhat excavated. The ambulatory limbs are moderately long and slightly pubescent, with the merus, carpus, and propodus finely tubercular, and the first two of these joints are spinose on the anterior margin; the dactyli are almost straight, and each ends in a curved, horny claw, while a series of well-marked horny spines are present on the posterior margin, arising separately from distinct teeth.

The eyes are freely movable, and the peduncles are not prolonged into spines. The antennal flagellum is of moderate length. The merus of the external maxillipedes is tuberculate externally, and two well-marked spines are present on the proximal half of the inner margin, the first of which is considerably stouter than the second; a small spine is also present at the distal end of the outer border.

The second and third abdominal segments are crossed transversely by a sulcus, which is somewhat deeper on the former; the remaining segments are comparatively smooth.

This species is allied to *Munidopsis latifrons* (A. Milne-Edwards) and *Munidopsis tridens* (A. Milne-Edwards), in both of which the rostrum has a somewhat similar conformation, but the former is without a pair of gastric spines, and the carapace of the latter is broader, smoother, and entirely glabrous, while fewer spines are met with on its chelipedes and ambulatory legs.

Breadth of carapace 12 mm., length of body (including rostrum) 40 mm., of carapace (including rostrum) 23 mm., of chelipede 47 mm., of first ambulatory leg 32 mm.

Habitat.—Station 310, in the Sarmiento Channel, Patagonia; depth, 400 fathoms; bottom, blue mud. A female specimen.

Munidopsis pilosa, Henderson (Pl. XVII. fig. 5).

Munidopsis pilosa, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 415, 1885.

Characters.—The whole body, but especially the carapace, is covered with a short, dense pubescence. The gastric area is less convex than usual, and, like the remainder of the carapace, unarmed; a moderately deep groove passes transversely across the cardiac area. The rostrum is of moderate width and about one-third the total length of the carapace, with its apex acute and slightly upturned, and the upper surface carinated. A single spine occurs on the lateral border of the carapace at the antero-lateral angle, and a second is found on the orbital border behind the antennal peduncle; the posterior margin is prominent, but unarmed.

The chelipedes[1] are wanting in the single specimen. The ambulatory limbs are short and robust, with the various joints pubescent; both margins of the meri are armed with prominent curved spines, and three or four spines also occur on the anterior margin of the carpi; the dactyli are short and almost straight, with a well-marked, curved, horny, apical claw, and a series of minute dentations on the posterior margin.

The eyes are firmly fused with the carapace, and the corneæ are extremely rudimentary; the ocular peduncle is prolonged dorsally into a long, acute, pubescent spine, more than half the length of the rostrum, and a short prolongation occurs underneath the cornea. The antennal flagella are wanting in the single specimen. The external maxillipedes are of small size, and the inner margin of the merus is provided with a few irregular dentations.

The abdominal segments are pubescent, and the second, third, and fourth are each provided with a short transverse groove; the terminal segments are less hairy than those in front.

This very distinct species is characterised by the dense pubescence met with on its trunk and limbs, the short chelipedes, and, above all, by the rudimentary state of the eyes and the length of the ocular spine. I am unacquainted with any other Galatheid in which the eyes have become so reduced.

Breadth of carapace 7 mm., length of body (including rostrum) 23 mm., of carapace (including rostrum) 13 mm., of ambulatory leg (detached) 16 mm.

Habitat.—Station 196, near the Philippines; depth, 825 fathoms; bottom, hard ground. A male specimen.

Genus *Elasmonotus*, A. Milne-Edwards.

Elasmonotus, A. Milne-Edwards, Bull. Mus. Comp. Zoöl., vol. viii. No. 1, p. 60, 1880.
Galathopsis, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 417, 1885.
? *Anoplonotus*, S. I. Smith, Proc. U.S. Nat. Mus., vol. vi. No. 1, p. 50, 1883.

Rostrum flattened and triangular, usually of moderate length. Carapace unarmed, with the lateral margins parallel and entire. Orbito-antennal border short and transverse. Chelipedes and ambulatory limbs frequently robust, with or without spines. Eyes devoid of pigment, with the peduncle in some cases prolonged beyond the cornea. Antennal peduncle of moderate width. Anterior abdominal segments, as a rule, transversely carinated. Eggs few in number, and of large size.

The characters which separate *Elasmonotus* from *Munidopsis* are few in number, of slight importance, and liable to variation in different species, so much so that I cannot

[1] Represented in the figure, but lost while the species was being drawn. I find from my notes that they measured only 10 mm. in length.

regard the institution of the former genus as other than questionable. The two occur in similar localities and at corresponding depths. The two species which I previously placed in a separate subgenus intermediate between *Elasmonotus* and *Munidopsis*, although in some respects peculiar (as in the form of the rostrum), I have now, on second thought, referred to *Elasmonotus;* at the same time, I cannot see sufficient reason for the separation of the form which Professor S. I. Smith has designated *Anoplonotus*.

Elasmonotus armatus, A. Milne-Edwards (Pl. XIX. fig. 5).

Elasmonotus armatus, A. Milne-Edwards, Bull. Mus. Comp. Zoöl., vol. viii. No. I, p. 61, 1880.

Habitat.—Station 23, off Sombrero Island, West Indies; depth, 450 fathoms; bottom, Pteropod ooze. A female with ova, and a young individual.

Station 24, off Culebra Island, West Indies; depth, 390 fathoms; bottom, Pteropod ooze. Two females, one of which bears ova, and a male. The largest specimen (a female) measures as follows:—Length of body 23 mm., of carapace (including rostrum) 13·3 mm., of chelipede 26 mm., of first ambulatory leg 20 mm.

The surface of the carapace is faintly rugose, and two minute tubercles are present on the rather convex gastric area; the cardiac area is circumscribed, and a shallow groove passes transversely across its surface. The lateral margins of the carapace are raised, and form a prominent rounded rim on each side, which terminates anteriorly in a short acute spine. The rostrum is long, narrow, and slightly upturned, with its apex acuminate, and a slight constriction is present towards the base. The ocular peduncles are slightly elongated, but do not terminate in spines. The merus of the external maxillipedes is armed with two long and subequal spines on the proximal half of the inner margin, and the inner margin of the ischium is prolonged distally into a spine. The chelipedes are slender and elongated, with only a few short spinules present at the distal ends of the merus and carpus, and one or two on the inner surface of the merus; the fingers are stout, and excavated inferiorly, with a slight thickening towards the apices. The ambulatory limbs are slender, and provided with a single spinule at the anterior and distal end of the merus; the dactyli are of large size, and a series of horny spinules is articulated to the posterior margin. The second and third abdominal segments are strongly carinated transversely.

The "Blake" specimens were taken off Frederickstadt, West Indies, at a depth of 625 fathoms.

Elasmonotus latifrons, Henderson (Pl. XIX. fig. 1).

Elasmonotus latifrons, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 416, 1885.

Characters.—The carapace is strongly arched from side to side, and covered everywhere with tubercular granules, many of which are compound. The gastric area is convex, and provided in front with two slightly-rounded elevations which overhang the base of the rostrum; the cardiac area is circumscribed, and a moderately deep transverse groove separates a posterior triangular portion from two lozenge-shaped portions in front. The rostrum is broad, flattened, and horizontal, with the apex acute, and a notch occurs on either side of the base, into which the eye-stalk fits; the upper surface is finely granular and traversed by a faint median carina; the lower surface is smooth, and faintly carinated towards the apex, while the lateral margins are finely serrated, especially towards the apex. The lateral margin of the carapace is notched by the two divisions of the cervical groove, and a slight projection is present on the orbital border behind the antennal peduncle; the posterior margin is raised and granular.

The chelipedes are short and stout, with the joints granulated; a spine is present at the distal end of the merus on both its inner and outer surfaces, and a third exists on the inner margin near the distal end of the carpus. The propodus is rather finely granulated, but devoid of spines; the fingers are scarcely equal in length to the palm, and their surface is pubescent, while each is deeply excavated on its inner aspect towards the apex, and the apical margin is finely dentate externally. The ambulatory limbs are short and robust, with the joints granulated, and a few short blunt spines are present on the anterior margins of the meri, carpi, and propodi; the dactyli are short, and each ends in a curved, horny claw, while a few short teeth occur on their posterior margins.

The eyes are of small size, but slightly movable, and partially concealed by the sides of the rostrum; the peduncle is granulated, and prolonged a short distance beyond the rudimentary cornea in the form of a blunt spine. The basal joint of the antennular peduncle is granulated. The merus of the external maxillipedes has its inner margin armed with minute teeth, which are somewhat closely arranged on the proximal half.

The second, third, and fourth abdominal segments are transversely sulcate, with a granulated carina on either side of the groove; the lateral margins are granulated, as is also the whole surface of the posterior segments.

This species is characterised by the form of its rostrum, and the presence of tubercular granulations on most parts of the body.

Breadth of carapace (of an adult male) 11 mm., length of body (including rostrum) 34 mm., of carapace (including rostrum) 17·5 mm., of chelipede 22 mm., of first ambulatory leg 20 mm.

Habitat.—Station 218, between Papua and the Admiralty Islands; depth, 1070 fathoms; bottom, blue mud. A single specimen.

Elasmonotus marginatus, Henderson (Pl. XIX. fig. 2).

Elasmonotus marginatus, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 416, 1885.

Characters.—The carapace is moderately convex, and covered everywhere with granulations, which are slightly pubescent and in large specimens show a distinct tendency to become tubercular. The gastric area is circumscribed, and excavated towards the lateral margins, with two somewhat prominent tubercular elevations on the front margin overhanging the base of the rostrum; the cardiac area is traversed by a shallow transverse groove which separates two lozenge-shaped spaces in front from a similar one behind. The rostrum is broad and flattened, with the apex acute (in the larger specimen it is also acuminate) and bent upwards; the upper surface is granular and provided with a median carina which occurs also on the lower surface, the lateral margins are finely serrated towards the apex, and hollowed out for the ocular peduncle on either side towards the base. The lateral margin of the carapace bears in front a prominent triangular lobe, and projects considerably between the two divisions of the cervical groove to form a thin lamina, which is distinctly bent upwards; the posterior margin is raised and granular.

The chelipedes are short and stout, with the joints pubescent and spinose. The merus is trigonal, its outer surface is granulated, and the margins are armed with short stout spines; the carpus is granulated above, and the spines are most numerous on the inner margin; the propodus is more than twice the length of the carpus, its lateral margins are spinose, and a few scattered granules and spines occur on the upper surface; the fingers are deeply excavated towards the apices, and the margins of the latter are finely dentate. The ambulatory limbs are robust, with the surfaces of the joints granular, and their margins both pubescent and spinose, the spines being somewhat strongly developed on the anterior margins of the meri, carpi, and propodi; the dactyli are moderately long, and each terminates in a curved horny claw, while their posterior margins are strongly pubescent, and armed with short horny spines.

The eyes are immovably fused with the sides of the rostrum; the peduncle is granulated and prolonged both in front of and behind the rudimentary cornea. The second joint of the antennal peduncle bears a rather prominent external spine; the flagellum is of moderate length. The merus of the external maxillipedes is granulated externally, and the inner margin is irregularly dentate.

The abdominal segments are granulated externally, and the second, third, and fourth are transversely bicarinate, the anterior of the two carinæ being the more prominent. The penultimate segment has two rather well marked rounded lobes on its posterior margin.

This species bears some resemblance to the preceding, but is easily distinguished by the prominent lateral margins of the carapace, and by the armature of the chelipedes and ambulatory limbs. Two specimens are present in the collection, both females with ova, yet differing considerably in size; in the larger also the rostrum is acuminate, the granulations on the carapace are more strongly developed, and the limbs are more pubescent.

Breadth of carapace 16·5 mm., length of body (including rostrum) 50 mm., of carapace (including rostrum) 26·5 mm., of chelipede 32 mm., of first ambulatory leg 33 mm., diameter of ova 1·5 mm. The body of the smaller specimen measures 35 mm. in length.

Habitat.—Station 168, off New Zealand; depth, 1100 fathoms; bottom, blue mud.

Elasmonotus miersii, Henderson (Pl. XIX. fig. 3).

Elasmonotus Miersii, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 416, 1885.

Characters.—The surface of the carapace is finely granulated, and the regions are fairly distinct. The gastric area is convex and distinctly raised anteriorly above the level of the rostrum, where it forms two rounded elevations, each surmounted by a nipple-like projection; the cervical groove is well marked on the carapace, and forms a distinct boundary between the cardiac and gastric areas; the cardiac area is crossed by a shallow groove, and the posterior triangular portion is circumscribed, while a pitted depression is formed by the cervical groove on either side at the antero-external angle of the area. The rostrum is flattened, depressed, and of moderate width, narrowing somewhat abruptly towards the apex which is subacute; the upper surface is granulated and faintly carinated on the proximal half. The lateral margin of the carapace terminates anteriorly in a short blunt spine, and a rather deep notch is present at the point where the cervical groove passes on to the carapace, a second, though much less strongly marked one, is placed about halfway back; the posterior margin is raised and granular.

The chelipedes are elongated and of moderate width, with the joints finely granulated, though appearing smooth to the naked eye; a few short blunt spines are met with on the inner margin of the merus and at its distal end. The propodus is slightly dilated, and more than twice the length of the carpus, with its lateral margins rounded; the fingers are excavated below, and their apices are minutely dentate, some hairs also, are met with on their opposed edges. The ambulatory limbs are of moderate length, a few short blunt spines are present on both margins of the meri, and a single spine is present at the anterior and distal end of each carpus; the dactyli are slender, and the apical horny claw is but slightly curved, while a series of minute horny spinules are present on the posterior margin.

The eyes are slightly movable, and partially concealed by the sides of the rostrum; the peduncle does not appear to be prolonged beyond the cornea. A somewhat prominent spine is present on the second joint of the antennal peduncle at its outer distal end. The ischium and merus of the external maxillipedes are finely granulated externally, and the latter joint is armed with two large triangular teeth on its inner margin, one of which is placed near the distal end, while a third is present at the distal end of the outer margin.

The abdominal segments are finely granular externally, and the second, third, and fourth are each provided with two faint transverse carinæ.

This species is characterised by the comparative smoothness of its carapace and limbs, and by the form of the meral joint of the external maxillipedes. I have associated it with the name of my friend Mr. E. J. Miers, late of the British Museum staff, well known as the author of a large number of carcinological memoirs.

Breadth of carapace 5 mm., length of body (including rostrum) 15 mm., of carapace (including rostrum) 8·2 mm., of chelipede 17 mm., of first ambulatory leg 11 mm. The single specimen is a male, probably not fully grown.

Habitat.—Station 173, off Matuku Island, Fiji; depth, 315 fathoms; bottom, coral mud.

Elasmonotus asper, Henderson (Pl. XIX. fig. 4).

Elasmonotus asper, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 416, 1885.

Characters.—The carapace is remarkably flattened, and the regions are not clearly defined; the surface is dotted with irregular tubercles, some of which are subacute, and the intervening spaces are finely granular. The gastric area is but slightly raised above the surrounding level, and the tubercles are prominent (some are even compound) towards the median line; the tubercles are most numerous elsewhere towards the lateral and posterior margins of the carapace, and two of large size are situated on the cardiac area, overhanging a shallow transverse groove. The rostrum is moderately narrow, and usually about twice the length of the eye-stalks, though in some male specimens it scarcely exceeds these in length: the apex is slightly upturned, and bidentate, the upper and larger of the two teeth being in most cases again subdivided; the upper surface is finely tubercular, and in some cases a few serrations are present on the lateral margins towards the apex. The lateral margin of the carapace is irregular in outline, but without any spines of importance; a small serrated lobe is present on the orbital border behind the ocular peduncle; the posterior margin is narrow and finely tuberculate.

The chelipedes are narrow and elongated, while the joints, more particularly the meri, are armed with short tubercular spines. The propodus is about three times the length of the carpus, and its upper surface bears a median row of tubercles; the fingers are not equal in length to the palm, and slightly pubescent, their opposed margins are dentate (the dentations being more strongly marked towards the apices) and a slight basal hiatus is usually present between the two. The ambulatory limbs are of moderate length, with the joints finely tubercular above; the meri are dilated, and their anterior margins are pubescent; the dactyli are short and strongly curved, with their posterior margins entire.

The eyes are freely movable, with the corneæ subglobose and terminal in position; the peduncle is slightly elongated, but not prolonged into a spine. The antennal flagellum is not equal in length to the carapace. The ischium and merus of the external maxillipedes are faintly granular externally; the outer margin of the former is prolonged distally into an acute spine, while the inner margin of the latter is irregularly dentate, and a curved acute spine is placed at the distal end and outer border of the same joint.

The second and third abdominal segments are each provided with a prominent median tubercular elevation, the surface of which is roughened, and scattered tubercles of small size are present towards the lateral margins of the same segments. The posterior segments are perfectly smooth.

Several of the distinctive features of this species are peculiar, as for instance the flattened carapace, the bidentate rostrum, the short curved ambulatory dactyli, and the median abdominal tubercles; but they are not, in my opinion, sufficient to separate it from the genus *Elasmonotus*. Females are apparently slightly larger than males, their rostrum is more strongly developed, and their chelipedes are shorter.

Breadth of carapace (of an adult male) 8 mm., length of body (including rostrum) 24 mm., of carapace (including rostrum) 13 mm., of chelipede 31 mm., of first ambulatory leg 18 mm. The ova measure about 1 mm. in diameter. The body of the largest female measures 29 mm. in length.

Habitat.[1]—Station 311, off Port Churruca, Patagonia; depth, 245 fathoms; bottom, blue mud. Upwards of a dozen specimens, the majority of which are females with ova.

Elasmonotus lævigatus, Henderson (Pl. XVIII. fig. 3).

Galathopsis lævigata, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 417, 1885.

Characters.—The carapace is comparatively smooth, only a few very slight rugosities being present on the gastric, cardiac, and posterior branchial regions, while a slight pubescence occurs on the upper surface of the rostrum, and towards the lateral margins in front. The gastric area is strongly convex, and rises considerably above the level of the rostrum, but there is no sharply defined ridge between the two; the cardiac area is crossed by a moderately deep transverse groove. The rostrum is flattened and depressed on the whole, though the acute apex is slightly upturned; its lateral margins are thin and entire. The lateral margin of the carapace is armed with two small acute teeth, one placed at the commencement of the border, the other immediately behind the cervical groove, and a single acute triangular tooth of slightly larger size occurs on the antero-

[1] This species is erroneously recorded from Station No. 107 in my preliminary account, an error due to a mistake in the labelling of one of the specimens.

lateral margin behind the antennal peduncle; the posterior margin is raised and prominent, but unarmed.

The chelipedes are short and robust, with the joints pubescent and finely granulated; a few short conical spines are also present at the distal end of the ischium, merus, and carpus. The propodus is about twice the length of the carpus; the fingers are deeply excavated inferiorly, and their apices are broad and dentate; the immobile finger is broader than the dactylus, while its outer border is sharp and regularly serrated. The ambulatory limbs are short and stout, with the joints granulated, and their anterior margins pubescent; the distal end of the meri and carpi terminates both above and below in an acute spine, and the posterior surface of the latter joints is provided with a short median carina; the dactyli are short and broad, terminating in a strongly curved claw, with a series of acute teeth on the posterior margin, the last of which so nearly equals the terminal claw that the joint has a biunguiculate appearance.

The ocular peduncles are slightly elongated, with the corneæ rounded, and terminal in position. The merus of the external maxillipedes is short and broad, with two narrow and acute subequal spines on the inner margin.

The abdominal segments are comparatively smooth, but the second, third, and fourth are each faintly bicarinate transversely, and a transverse impression is met with on the fifth segment; the posterior segments are slightly pubescent.

This species is distinguished by its flattened acute rostrum, and the form of its carapace, ambulatory limbs, and other parts, characters which on the whole are those of the genus *Elasmonotus*, as at present constituted; at the same time the chelipedes bear a close resemblance to those of certain species of *Munidopsis* (*Munidopsis brevimana*, Henderson, and *Munidopsis pilosa*, Henderson). I do not now feel justified in placing it, as I formerly did, in a subgenus intermediate between these two genera, but refer it (as well as the next species) to the former, though I may be allowed once more to express a doubt as to whether *Elasmonotus* itself may not have to be united with *Munidopsis*.

Breadth of carapace (of a female with ova) 11 mm., length of body (including rostrum) 33 mm., of carapace (including rostrum) 17 mm., of chelipede 19 mm., of first ambulatory leg 18 mm., diameter of ova 0·9 mm.

Habitat.—Station 219, north of Papua; depth, 150 fathoms; bottom, coral mud. A single specimen.

Elasmonotus debilis, Henderson (Pl. XVIII. fig. 4).

Galathopsis debilis, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 417, 1885.

Characters.—This species is closely allied to the preceding, and as the two specimens are both in too fragmentary a condition to admit of a detailed description, I shall endeavour merely to point out its distinguishing features. The carapace is slightly more rugose than in the preceding species, and a few granulations are met with on the anterior gastric region. The denticles on the lateral margin of the carapace are obsolete, and a rounded finely serrated lobe occurs on the orbital margin behind the antennal peduncle.

The chelipedes are wanting in both specimens.[1] The ambulatory limbs are very similar to those of the last species, but the dactyli have a less obvious biunguiculate appearance.

The eyes are of small size, and partly hidden by the sides of the rostrum. The merus of the external maxillipedes is finely granulated externally, and the inner margin is bispinose; a minute spine is also present at the distal end of the outer margin.

The transverse carinæ on the second, third, and fourth abdominal segments are somewhat strongly marked (they are not represented in the figure).

Length of body (of a male) 18 mm., of carapace 10·5 mm., of chelipede 11 mm., of ambulatory leg (detached) 8 mm.

Habitat.—Station 173, off Matuku Island, Fiji; depth, 315 fathoms; bottom, coral mud. A male specimen.

Station 210, among the Philippine Islands; depth, 375 fathoms; bottom, blue mud. A male specimen.

Genus *Galacantha*, A. Milne-Edwards.

Galacantha, A. Milne-Edwards, Bull. Mus. Comp. Zoöl., vol. viii. No. 1, p. 52, 1880.

Rostrum long and spinulous, the proximal part horizontal, the apical portion upturned. Carapace broad, and convex from side to side, armed with a median spine of large size, placed near the posterior limit of the gastric area, and with an anterior gastric pair of spines and a cardiac spine of smaller size. Lateral margin of the carapace provided with two prominent flattened spines in front. Chelipedes rather stout, and exceeded in length by the ambulatory limbs. Eyes devoid of pigment, with the corneæ terminal in position. Antennal peduncle stout, the flagellum of moderate length. Second, third, and fourth abdominal segments strongly bicarinate transversely, and armed each with a prominent median spine. Male reproductive appendages of large size. Eggs few in number and of large size.

The characters of this genus as constituted above are so distinct that I cannot agree with Professor S. I. Smith's remark that it should perhaps be united with *Munidopsis*; judging from the description[2] it appears extremely doubtful whether the species which he

[1] These were apparently lost after my departure from Scotland and while the specimens were in the hands of the draughtsman, for I find from the diagnosis of the species that they measured 11 mm. in length in an individual measuring 18 mm. The chelipedes, as represented in the figure, must be regarded with suspicion, as their length (in proportion to that of the body) greatly exceeds the above measurement.

[2] "Albatross" Crustacea, Report United States Fishery Commission, 1882, p. 356.

terms *Galacantha bairdii*, upon an examination of which this belief is chiefly based, should really be included in the genus in question. Three species—all from great depths—have been recorded by Professor A. Milne-Edwards, one of which, *Galacantha rostrata*, is apparently not uncommon in deep water off the east coast of the United States.

Galacantha talismanii, A. Milne-Edwards, MS. (Pl. XX. fig. 1).

Habitat.—Station 195, off Banda; depth, 1425 fathoms; bottom, blue mud. A very young male specimen, measuring 25 mm. in total length, is referred with some uncertainty to this species.

The minute elevations on the surface of the carapace are tubercular, and scarcely tend to become spinulose. The posterior gastric spine is but slightly compressed, and is almost perpendicular; the anterior gastric spinules are more slender than the cardiac spinule, but of nearly equal length. The distal half of the rostrum is very slightly upturned, though long and slender, while the lower and distal margin of the proximal part is finely dentate. The spines on the lateral border of the carapace are of equal width, but the second is a little shorter than the first. The chelipedes and ambulatory limbs are finely granulated and almost destitute of spines. The first two abdominal spines are slender and strongly curved.

The types at Paris were taken during the voyage of the "Talisman."

Galacantha bellis, Henderson (Pl. XIX. fig. 6).

Galacantha bellis, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 418, 1885.

Characters.—The carapace is covered everywhere with small spiniform tubercles, which are more densely crowded together on the posterior half. The median gastric spine is broad and flattened, exceeding the apical portion of the rostrum in length, and placed at an angle of about fifty degrees to the carapace. The anterior gastric spinules are more slender than the cardiac spinule, and scarcely equal it in size; the latter overhangs a shallow transverse groove on the surface of which the pointed tubercles are somewhat deficient. The rostrum is comparatively short, and the apical portion is decidedly upturned, so as to be placed parallel to the median gastric spine, than which it is narrower and less flattened, while the proximal part is bidentate inferiorly and distally (occasionally unidentate); a distinct carina is continued backwards on the carapace from the base of the rostrum to the gastric spine. The lateral spines of the carapace are separated by a considerable interval, and diverge slightly; they are of almost equal width, and the second is slightly longer than the first. The orbital margin exhibits a faint raised line which is continued along the lateral margin of the first part of the rostrum; the posterior margin of the carapace is distinctly elevated, and bounded in front by a narrow transverse strip which is perfectly smooth.

The chelipedes are armed with blunt tubercular granulations, and a few short spines are placed at the distal ends of the meral and carpal joints respectively, as well as on the under surface of the ischia and meri. The fingers are broad, flattened, and considerably longer than the palm, with their apices depressed, and the lower surfaces deeply excavated; their opposed margins are furnished with short interlocking teeth, which increase in size towards the apices. The ambulatory limbs are coarsely granulated, the granules showing a tendency towards linear arrangement, and two short spines are placed, one on either side, at the distal ends of the meri. The dactyli are moderately long and fairly well curved, with a series of five dentations on the posterior margin.

The eyes are freely movable, and the corneæ are rounded, though slightly deficient internally. The joints of the antennal peduncle are devoid of spines. The merus of the external maxillipedes is granulated externally, and two spines are present on the inner proximal margin, the first of which is considerably swollen towards its base; in some cases a third spine is present, placed slightly above the middle of the margin.

The second, third, and fourth abdominal segments are strongly granulated towards their lateral margins, whereas the fifth and sixth are almost devoid of granulations. The first and second abdominal spinules are well developed and rather strongly curved.

This species is very closely allied to *Galacantha rostrata*, A. Milne-Edwards, but a careful comparison with the types of the latter has convinced me that it is distinct. In the Challenger species, the tubercles on the carapace are of larger size, and more strongly marked on the anterior half; the gastric spine is shorter and broader at its base; the rostrum also is shorter and slightly more oblique; the lateral spines are of smaller size, more nearly equal, and separated by a wider interval; the carina at the base of the rostrum is more strongly developed; and the chelipedes are decidedly more spiny.

Breadth of carapace (of an adult male) 22 mm., length of body (including rostrum) 65 mm., of carapace (including rostrum) 35 mm., of gastric spine 6·5 mm., of apical portion of rostrum 5 mm., of second lateral spine 5 mm., of chelipede 48·5 mm., of first ambulatory leg 51 mm. The largest female specimen measures 67 mm. in length, and its chelipedes only 42 mm., while the ova are about 2·8 mm. in diameter.

Habitat.—Station 300, west of Valparaiso; depth, 1375 fathoms; bottom, Globigerina ooze. Four males and two females, both of the latter with ova.

Genus *Eumunida*, S. I. Smith.

Eumunida, S. I. Smith, Proc. U.S. Nat. Mus., vol. vi. No. 1, p. 44, 1883.

Rostrum slender and styliform, with a pair of well-developed supraorbital spines on either side of its base. Chelipedes and ambulatory limbs elongated and slender.

Antennal peduncle narrow and elongated, placed under the eye-stalk, and composed of five joints, the second of which is provided with a slender movable acicle. Second abdominal segment with its lateral margin prolonged into anteriorly directed spines; all the appendages except the penultimate pair absent in the male. Telson comparatively small in size, transversely segmented, and folded under the preceding abdominal segments. Branchiæ absent from the bases of the external maxillipedes.

This remarkable genus apparently forms a connecting link between *Munida* and the genera *Ptychogaster* and *Uropytchus*; it agrees closely with the first of these in the arrangement of the frontal spines (with the exception that there is an additional pair of supraorbitals), the presence of pubescent striæ on the carapace, and the shape of the chelipedes and ambulatory limbs, while it resembles the two last in having the swimming fan somewhat rudimentary and folded under the remainder of the abdomen. In some respects it occupies a unique position among Galathodea, for, as has been pointed out by Professor Smith, the pair of rudimentary arthrobranchiæ usually present on the eighth body segment are absent, and the first five abdominal segments are without appendages in the male, while an examination of the Challenger species shows some peculiarities in the arrangement of the antennal peduncle, which I take to be of generic value.[1] The only previously described species, *Eumunida picta*, S. I. Smith, was taken by the United States Fish Commission off the south coast of New England, at a depth of from 115 to 158 fathoms.

Eumunida smithii, Henderson (Pl. XV. fig. 5).

Eumunida Smithii, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 413, 1885.

Characters.—The carapace is very slightly arched from side to side, with its surface glabrous, and crossed by about a dozen sparingly ciliated transverse striæ. The frontal spines are all slender and deflexed, but especially the rostrum, which is about one-third longer than the first supraorbital, and nearly twice the length of the second. The gastric area is flattened and circumscribed, with a slight hollowing out towards the base of the rostrum, and the transverse striæ have a tendency to become squamose, more particularly in front; the hepatic area is deeply concave, and on its upper boundary three small spinules pass in an oblique line from the base of the second supraorbital spine, the first being very minute, and the third or most posterior being slightly larger than the second; the cardiac area is circumscribed anteriorly, but like the remainder of the carapace is unarmed. The lateral margin of the carapace is armed with six curved spinules, gradually decreasing in size from before backwards, of which one is placed in front of the

[1] The presence of an additional segment may possibly be a specific and not a generic character, for I have already noticed the occurrence of a similar number in a species of *Porcellana* (*Porcellana serratifrons*, Stimpson), in which genus the normal number is four.

cervical groove, and one between its two branches; the posterior margin is unarmed, and not specially prominent.

The chelipedes are wanting in the single specimen. The ambulatory limbs are very similar to those of *Eumunida picta*, S. I. Smith; the meri are subsquamose externally, and their anterior margin as well as that of the carpi is fringed with short curved spinules, one of slightly larger size being present on either side of the distal end of the former joints; the dactyli are flattened and but slightly curved, with a well-marked series of horny spinules present on the posterior margin, a few occurring also on the same margin of the propodi.

The eyes are of moderate size and the corneæ are distinctly rounded. The ischium and merus of the external maxillipedes are subequal, and both are unarmed.

The abdominal segments are glabrous, and each is crossed by two sparingly pubescent striæ. The lateral spines of the second segment are stout and show a tendency to bifurcate.

This small species in most of its characters closely approaches *Eumunida picta*, S. I. Smith, from which it may, however, be distinguished at once by the relative size of the hepatic spinules, for in the North Atlantic form these decrease in size from before backwards, the first being considerably larger than either of the other two. I have dedicated it to the founder of the genus.

Breadth of carapace (of a male) 5 mm., length of body (including rostrum) 15 mm., of carapace (including rostrum) 9 mm., of rostrum 3·5 mm., of ambulatory leg (detached) 11·5 mm.

Habitat.—Station 192, off Little Ki Island; depth, 140 fathoms; bottom, blue mud. A single specimen.

Genus *Ptychogaster*, A. Milne-Edwards.

Ptychogaster, A. Milne-Edwards, Bull. Mus. Comp. Zoöl., vol. viii. No. 1, p. 63, 1880.

Rostrum slender and spiniform, usually upturned. Carapace narrow and somewhat ovate in shape, with its surface glabrous and usually spinose. Chelipedes and ambulatory limbs slender and greatly elongated, the basal joints of the latter not hidden by the sides of the carapace. Eye-stalks with the corneæ dilated. Antennal peduncle slender, the flagellum short. External maxillipedes narrow, the terminal joints elongated. Abdomen folded on itself, the telson (which is transversely segmented) and the last pair of appendages bent under the preceding segments, and applied to the thoracic sterna; males with the first two pairs of appendages (genital) well developed, those of the third, fourth, and fifth segments rudimentary. Eggs comparatively few in number, and of large size.

Two species belonging to this interesting deep-water genus have been previously described, viz., *Ptychogaster spinifer*, A. Milne-Edwards, taken by the "Blake" at seven stations in the West Indies, at depths varying from 123 to 183 fathoms, and *Ptychogaster formosus*, A. Milne-Edwards, dredged by the "Talisman" off the Canaries, at the great depth of 4000 mètres (2187 fathoms). The Challenger dredgings have added two new and interesting forms to the list.

Ptychogaster milne-edwardsi, Henderson (Pl. XX. fig. 2).

Ptychogaster milne-edwardsi, Henderson, Narr. Chall. Exp., vol. i. p. 900, fig. 330, 1885; Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 418, 1885.

Characters.—The carapace is narrow in front though widening out posteriorly, with its surface glabrous and covered by slender acute spines, which attain their largest size towards the middle line. The gastric area is moderately convex, and is armed with a lateral and two submedian pairs of spines, as well as with two unpaired spines which are situated in the middle line; the cardiac area is circumscribed and remarkably convex, with a pair of prominent spines placed in front of three smaller spinules; at each antero-lateral angle of the cardiac area there is a small convex elevation surmounted by a spine of large size. The spines on the branchial regions are of small size, and closely grouped together; there are, however, two submedian pairs placed behind the cardiac area which attain a considerable size. The rostrum is narrow, acute, and strongly upturned, with its length equal to more than one-third that of the carapace. The lateral margin of the carapace bears three almost equidistant spines on its anterior half, the first of which is placed at the antero-lateral angle, while the posterior half is armed with a number of closely set spinules; the epimeral suture is very distinct and situated a little below the lateral margin; the branchiostegite has considerable vertical extent and its surface is spinulose. The posterior margin of the carapace is slightly raised, and bears a number of minute spinules.

The chelipedes are narrow, subcylindrical, and of great length, with the joints uniformly covered by short slightly curved spinules, which are arranged in six or seven distinct rows on each joint; the right chelipede is considerably shorter than the left, a result perhaps due to accident. The carpus and palm are subequal in length, but both are exceeded by the merus; the fingers are nearly two-thirds the length of the palm, and are slightly curved, they are subcylindrical in shape, and gradually taper towards the pointed apices, while their opposed margins are densely setose and armed with conical teeth, which gradually decrease in size from behind forwards, and two of which near the proximal end of the fingers are considerably larger than the others. The ambulatory limbs are slender, subcylindrical, and greatly elongated, with the joints armed in a similar way to the chelipedes; the dactyli are short and flattened, being only about one-fourth the length of the propodi, and a series of long horny spines is present on their posterior margin.

The eye-stalks are slightly elongated, while the corneæ are terminal in position, globular in shape, and deeply pigmented. The basal joint of the antennular peduncle is of small size, but the two succeeding joints are elongated and subcylindrical. A small spine is present on the outer margin of the first free joint of the antennal peduncle, and the ultimate joint is nearly twice the length of the penultimate; the flagellum is scarcely equal in length to the carapace. A few spinules are met with on the outer surface of the carpus and propodus of the external maxillipedes, and a single minute spinule occurs at the distal end of the merus; the terminal joints are densely pubescent below.

The abdominal segments are uniformly covered with short stout spines arranged in transverse rows on the dorsal surface, which show a tendency to decrease in size towards the lateral margins; part of the first segment is uncovered by the carapace, forming a transverse carina which bears a single row of spines. The telson and last pair of appendages are smooth, and provided with long fringing hairs.

This fine species is distinguished at once from *Ptychogaster spinifer* by the armature of its abdomen, for in the latter all the segments are smooth; it bears a greater resemblance to *Ptychogaster formosus*, in which, however, the third, fourth, and fifth segments are devoid of spines. I have pleasure in dedicating it to Professor Alphonse Milne-Edwards, in recognition of his courteous assistance in connection with the identification of the deep-sea forms in the present collection.

Greatest breadth of carapace (of an adult male) 15·5 mm., breadth at antero-lateral angles 8 mm., length of body (including rostrum) 55 mm., of carapace (including rostrum) 22·5 mm., of left chelipede 118 mm., of chela 43·5 mm., of right chelipede 90 mm., of first ambulatory leg 90 mm.

Habitat.—Station 310, Sarmiento Channel, Patagonia; depth, 400 fathoms; bottom, blue mud. A single specimen.

Ptychogaster lævis, Henderson (Pl. XX. fig. 3).

Ptychogaster lævis, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 418, 1885.

Characters.—The carapace narrows very slightly in front, and its surface is uneven and glabrous, with only a few minute spinules present on the anterior half. The gastric area is scarcely elevated, and bears two pairs of spinules behind the base of the rostrum, (of which the external are slightly larger) as well as a spinule of very small size near the posterior limit of the area; a single minute spinule is also present on each midbranchial region behind the cervical groove. The rostrum is narrow, spinulous, and almost horizontal in direction, with a faint upward inclination. The lateral margin of the carapace is armed with five slender spines, situated on the anterior two-thirds of the border, and gradually decreasing in size from before backwards; the posterior margin is unarmed.

The chelipedes are extremely slender and closely beset with minute spinules arranged in distinct rows. The carpus is slightly longer than the palm, but the two joints are of equal width; the fingers are slender and slightly curved, with their apices acute, and their opposed margins setose, while a prominent tubercular tooth is present near the proximal end of each. The ambulatory limbs are very slender, and a few delicate spinules are present on the anterior margin of the meri and carpi, as well as two or three on the posterior margin and distal end of the propodi; the dactyli are broad, flattened, and but slightly curved, with a series of slender spines on the posterior margin, which increase in size towards the apex.

The eye-stalks are narrow and elongated, in length equalling the rostrum, with the corneæ dilated and deeply pigmented. The external maxillipedes are armed with a single spinule at the outer and distal end of the merus, and the three terminal joints are densely pubescent internally.

The abdominal segments are all smooth and glabrous externally, and their pleura are subobtuse.

This species is distinguished by its narrow and elongated eye-stalks, the comparative absence of spines from the carapace, and by its very small size.

Breadth of carapace (of a female with ova) 4 mm., length of body (including rostrum) 15 mm., of carapace (including rostrum) 6·5 mm., of chelipede 32 mm., of chela 10·2 mm., of ambulatory leg (detached) 14·5 mm., diameter of ova about 0·7 mm.

Habitat.—Station 192, off Little Ki Island; depth, 140 fathoms; bottom, blue mud. A single specimen in an imperfect state of preservation.

Genus *Uroptychus*, n. n.

Diptychus,[1] A. Milne-Edwards, Bull. Mus. Comp. Zoöl., vol. viii. No. 1, p. 61, 1880.

Rostrum flattened and acute, resembling that of *Galathea*. Carapace somewhat ovate in shape, with its surface glabrous and usually devoid of spines. Chelipedes elongated and of varying width; the ambulatory limbs slender. Eye-stalks short and stout, the corneæ scarcely dilated. Antennal peduncle slender, the first free joint provided with a flattened and acute acicle or movable spine; the flagellum never of great length, and in some cases remarkably short. External maxillipedes comparatively smooth, with the terminal joints elongated, more especially the propodus, which is considerably longer than any of the other joints. Abdomen smooth and glabrous externally, folded on itself; the telson (which is transversely segmented and of very small size), as well as the last pair of appendages, bent under the preceding segments and applied to the thoracic sterna; males with the first two pairs of appendages (copulatory organs)

[1] As this name has been previously used in Zoology to designate a genus of Cyprinoid Fishes, I have altered it to that given above.

fairly well developed, those of the third and fourth segments rudimentary, of the fifth absent; females with two pairs of ovigerous appendages on the third and fourth segments, those of the other segments (with the exception of the penultimate) absent. Eggs comparatively few in number, and of large size.

The species are mostly of small size, and characterised by the shining polished surface of their body and limbs. They are widely distributed, occurring at depths of about 100 to 700 fathoms, and many of the species appear to live among the branches of Corals, their limbs being specially adapted for clinging. The atrophy of the caudal swimming fin is carried to a greater extent than in either *Ptychogaster* or *Eumunida*, and it is probable that the folding in of that part is a result of this condition in all three genera. In one respect *Uroptychus* differs from all other Galatheids, viz., in the presence of a distinct movable aciele on the first free (in reality the second) joint of the antennal peduncle, an important and primitive character, but it must be remembered that a similar process, though of very small size, is present also in *Eumunida*. In those species which I have examined, the fifth arthrobranchia, counting from before backwards, is not of larger size than the others, whereas in most of the Galathodea it is distinctly enlarged. Professor A. Milne-Edwards has made known five species from the West Indies, dredged during the "Blake" expedition, and more recently another species from the "Talisman" dredgings in the North Atlantic.

Uroptychus nitidus (A. Milne-Edwards) (Pl. XXI. fig. 6).

Diptychus nitidus, A. Milne-Edwards, Bull. Mus. Comp. Zoöl., vol. viii. No. 1, p. 62, 1880.

Habitat.—Station 23, off Sombrero Island, West Indies; depth, 450 fathoms; bottom, Pteropod ooze. Two males, and a female with ova; all of small size.

Station 24, off Culebra Island, West Indies; depth, 390 fathoms; bottom, Pteropod ooze. An adult male (figured), the body of which measures 34 mm. in length, and the chelipedes 69 mm.

The carapace is perfectly smooth and glabrous, with a single spinule placed on each lateral margin at the antero-lateral angle. The rostrum is about twice the length of the eye-stalks, with its margins entire, and it is slightly upturned towards the apex (this last character being liable to considerable variation in different specimens). The chelipedes are broad, flattened, and of great length, with their surface smooth and shining; the merus narrows very considerably towards its proximal end, and a few ill-defined granules occur, in some specimens at least, on its inner surface, while a minute spinule is found on the upper surface and at the distal end of the ischium; the fingers are excavated inferiorly, and their surfaces are clad with delicate silky hairs; two unequal teeth are met with on the inner margin of the dactylus, and an ill-defined projection occurs on the corresponding border of the immobile finger. The ambulatory limbs are slender, and like the chelipedes glabrous, with a series of delicate spines articulated to the posterior margin of the propodi; the dactyli are short and strongly curved, with numerous spinules on the posterior margin, which increase in size and are separated by wider intervals towards the apex of the joint, in some cases also the dactyli are pubescent. The antennal acicle extends slightly beyond the tip of the eye-stalk, and almost to the end of the antennal peduncle; the flagellum is not equal in length to the carapace. The joints of the external maxillipedes are smooth. The abdominal segments are smooth and glabrous externally.

From the dredgings of the "Blake" it would appear that this species is common in the West Indies, it having been taken by that vessel at no less than eighteen stations, in depths varying from 88 to 734 fathoms. It was found in most of these cases adhering to Corals of the genus *Chrysogorgia*.

Uroptychus insignis, Henderson (Pl. XXI. fig. 1).

Diptychus insignis, Henderson, Ann. and Mag. Nat. Hist., ser 5, vol. xvi. p. 419, 1885.

Characters.—The surface of the carapace is smooth and glabrous, with a moderate convexity from side to side. The gastric area is crossed in front by a transverse row of short, stout spinules, chiefly arranged in two groups one on either side of the middle line; the remaining areas are unarmed. The rostrum is about four times the length of the eye-stalks, and its apical half is slightly upturned; two minute spinules are present on each lateral margin towards the apex, and the whole lower surface as well as the distal end of the upper surface bears a median carina. The lateral margin of the carapace is armed with two spines of moderate size on its anterior half, one being situated at the antero-lateral angle, and the other opposite the gastric row of spinules, with a few spines of smaller size intervening, while the posterior half is provided with a regular series, decreasing gradually in size from before backwards, and continued almost to the posterior limit. The posterior margin is regularly convex, with the convexity directed forwards. A few minute spinules occur on the anterior pterygostomial region.

The chelipedes are robust and of moderate length, with the proximal joints tuberculate and spiny. The merus and carpus are both armed with prominent spines at their distal ends, as also is the inner surface of the former joint, while their surfaces, but especially the upper one, are roughened by somewhat pointed tubercles which are mostly arranged in rows. The propodus is glabrous, and its upper surface is provided with indistinct tubercles, chiefly towards the proximal end; the fingers are more than half the length of the palm, their apices cross one another and are acute, while each in addition to having its inner margin finely serrated bears a single ill-defined tooth of moderate size. The ambulatory limbs are rather stout, and comparatively smooth, a few indistinct spinules being merely present on the anterior margin of the meral and carpal joints, and a rounded projection occurs at the distal inferior end of the propodi, to which from eight to ten horny spines are articulated; the dactyli are short and strongly curved, with nine or ten spinules gradually increasing in size towards the apex, present on the inferior margin.

The eyes are of small size, and partially concealed in orbits, with the corneæ not dilated. The antennal acicle is elongated, being more than twice the length of the eye-stalks, and extending almost to the end of the antennal peduncle. A few ill-defined spinules occur on the inner margin and at the distal end of the merus of the external maxillipedes.

The abdominal segments are smooth and glabrous externally, with their pleura subacute; the pleuron of the second segment is bilobed, a feature common to most members of the genus, and the rounded anterior lobe overlaps the postero-external angle of the carapace.

This fine species is distinguished by the armature of its carapace, chelipedes, and ambulatory limbs, and the small size of its eyes. With the exception of *Uroptychus nitidus* (A. Milne-Edwards), it is the largest known species belonging to the genus.

Breadth of carapace (of an adult male) 12·4 mm., length of body (including rostrum) 34 mm., of carapace (including rostrum) 17·5 mm., of chelipede 45 mm., of chela 19·5 mm., of first ambulatory leg 29 mm. Females appear to equal the males in size, but their chelipedes are more slender; the ova have a diameter of nearly 1 mm.

Habitat.—Station 145A, off Prince Edward Island; depth, 310 fathoms; bottom, volcanic sand. Two males, four females (one bearing ova), and several young specimens.

Uroptychus spinimarginatus, Henderson (Pl. XXI. fig. 2).

Diptychus spinimarginatus, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 419, 1885.

Characters.—The carapace is glabrous, though its surface is roughened posteriorly and towards the lateral margins by very minute granulations, and in some specimens also the same parts are pubescent; no spines are met with anywhere on the surface. The rostrum is about four times the length of the eye-stalks, and three-fourths that of the remainder of the carapace; it is horizontal in direction, its lower surface bears a median carina, and two or three minute spinules are present on each lateral margin towards the apex. The posterior half of the lateral border of the carapace is armed with five large and prominent spines, the first of which reaches a larger size than any of the others, the second and third being subequal, as are also the fourth and fifth; the anterior half bears three or four spines of small size, including that at the antero-lateral angle. The pterygostomial region terminates anteriorly in a short acute spine.

The chelipedes are elongated and extremely slender, with the proximal joints finely tubercular and armed with a few short spines. A spine is placed at the upper distal end of the basis, a second at the lower distal end of the ischium, and two on the inner distal end of the merus, while the minute tubercles are best marked on the merus and carpus. The propodus is glabrous, and its surface is minutely punctate; the fingers are scarcely half the length of the palm, with their surface slightly pubescent, and a single ill-defined tooth is present on the inner margin of each. The ambulatory limbs are slender, more particularly the first, and the joints are glabrous, though slightly pubescent; the meral joints are finely tubercular, and numerous distinct spinules are present on their anterior margin; the propodi, as well as the dactyli, are slightly curved, and a series of minute horny spinules is present on the posterior margin of the latter.

The eyes are of small size and partially concealed in orbits, with the corneæ but slightly dilated. The antennal acicle is of very small size, only reaching the end of the eye-stalk, and scarcely the middle of the last joint of the antennal peduncle. The external maxillipedes are smooth, one or two minute spinules being alone present at the distal end of the merus.

The abdominal segments are glabrous externally, though minutely punctate, and the fifth and sixth are in addition pubescent in some specimens; their pleura are subobtuse.

This species agrees with the West Indian *Uroptychus armatus* (A. Milne-Edwards) in having the carapace armed laterally with prominent spines, but in the latter species from seven to eight of these are present, and the ambulatory limbs are in addition smooth.

Breadth of carapace, not including spines (of a female with ova from Station 170) 7 mm., length of body (including rostrum) 22 mm., of carapace (including rostrum) 11 mm., of chelipede 29 mm., of chela 12 mm., of first ambulatory leg 13 mm., diameter of ova about 1 mm.

Habitat.—Station 170, off the Kermadec Islands; depth, 520 fathoms; bottom, volcanic mud. A female with ova, and a young male.

Station 214, south of the Philippines; depth, 500 fathoms; bottom, blue mud. Two females, both with ova.

Uroptychus parvulus, Henderson (Pl. XXI. fig. 3).

Diptychus parvulus, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 420, 1885.

Characters.—The carapace is slightly more convex than usual, and is everywhere smooth and glabrous, though a few minute punctations are visible on its surface. The rostrum is about half the length of the carapace, or four times the length of the eye-stalks, and slightly depressed, with its upper surface hollowed out from side to side, and the margins entire. The lateral border of the carapace is armed with a series of very minute spinules which are best marked towards the posterior limit. The pterygostomial region is provided with a few scattered granules.

The chelipedes are elongated and of moderate width, with the proximal joints finely spinose. The merus and carpus are each armed with numerous rows of short spinules.

which at the distal end of both joints become distinct spines. The propodus is slightly swollen in both its diameters and its surface is perfectly smooth; the fingers are more than half the length of the palm and their surface is pubescent, the apices are curved, the dactylus folding under the immobile finger, and a single tooth is present on the inner margin of each. The ambulatory limbs are of moderate width, and with the exception of a row of minute spinules on the anterior border of the meri (and in some cases also of the carpi) are smooth, a series of distinct horny spinules also occurs on the posterior margin of the propodi; the dactyli are more than half the length of the propodi and strongly curved, with from six to eight stout horny spinules articulated to the posterior margin of each, the apical one being of small size.

The eyes are of small size, with the corneæ subglobose and deeply pigmented. The antennal acicle is long and acuminate, extending slightly beyond the end of the peduncle, the last joint of which is prolonged inferiorly into an acute spine, and its basal portion is rather broad; the flagellum is remarkably short, not reaching the end of the rostrum, and consisting of scarcely half a dozen joints. The external maxillipedes are almost completely smooth, one or two minute spinules being found only at the distal end of the merus.

The abdominal segments are smooth and glabrous externally, with the pleura subacute, those of the third segment and the posterior part of the second segment being narrow and attenuated. The telson and last pair of appendages are of very small size.

This small species is distinguished by the form of its rostrum, and the armature of the chelipedes, as well as by the remarkable characters of the external antennæ.

Breadth of carapace of the largest specimen (a female with ova) 6 mm., length of body (including rostrum) 16 mm., of carapace (including rostrum) 9 mm., of chelipede 20 mm., of chela 9 mm., of first ambulatory leg 12 mm., diameter of ova about 0·8 mm. Males are of somewhat smaller size than the above (as are also the other females with ova) but their chelipedes are considerably stouter.

Habitat.—Station 310, Sarmiento Channel, Patagonia; depth, 400 fathoms; bottom, blue mud. About thirty specimens, including both males and females, several of the latter with ova.

Uroptychus politus, Henderson (Pl. VI. fig. 2).

Diptychus politus, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol xvi. p. 420, 1885.

Characters.—The carapace is moderately convex from side to side, and everywhere perfectly smooth and glabrous, the margins even being entire, with the exception of a minute denticle at the antero-lateral border. The rostrum is horizontal and placed very slightly below the level of the highest part of the carapace, in length it exceeds the eyestalks by a small part of its extent, and it narrows somewhat abruptly towards the apex, the basal portion being of considerable breadth. The pterygostomial region is smooth but bears a slight depression near its centre.

The chelipedes are of moderate length, and the joints are everywhere perfectly smooth and glabrous, with the exception of a small spine at the upper and distal end of the ischium. The palm is slightly dilated, and equal in length to the carpus; the fingers are somewhat curved, and in male specimens a distinct hiatus exists between the two, a pair of conical teeth, the second of which is the larger, occur on the inner and proximal margin of the dactylus, with corresponding depressions on the inner margin of the immobile finger. The ambulatory limbs are slender and smooth, with the exception of the usual horny spinules on the posterior margin of the propodi; the dactyli are strongly curved, and more than half the length of the penultimate joints, with a series of short horny spines on their posterior margin.

The eyes are of moderate size, with the corneæ slightly dilated and of a light brown colour. The antennal acicle is not more than half the length of the peduncle, and narrows rather abruptly towards the apex; the flagellum is about twice the length of the peduncle. The external maxillipedes are perfectly smooth and glabrous, with the exception of the usual hairs.

The abdominal segments are smooth and glabrous externally, and their pleura are subobtuse.

This species is distinguished by its almost complete smoothness, and by the form of the fingers, more especially in male specimens.

Breadth of carapace (of a female with ova) 5·5 mm., length of body (including rostrum) 18 mm., of carapace (including rostrum) 8 mm., of chelipede 24 mm., of chela 9·5 mm., of ambulatory leg (detached) 12 mm., diameter of ova about 1·2 mm. In the male specimen (which is of slightly smaller size), the chelipedes are proportionately longer and stouter, and a hiatus exists between the fingers.

Habitat.—Station 171, near the Kermadec Islands; depth, 600 fathoms; bottom, hard ground. A female with ova, and a male.

Uroptychus australis, Henderson (Pl. XXI. fig. 4).

Diptychus australis, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 420, 1885.

Characters.—The carapace is everywhere smooth and glabrous, only a single small tooth being present at each antero-lateral angle. The gastric area is slightly swollen and raised above the level of the rostrum, with in some cases two very minute denticles present on its anterior margin. The rostrum is horizontal in direction, and extends for about one-fourth of its length beyond the apices of the eye-stalks; it is of considerable breadth towards the base, but gradually narrows towards the acute apex. The pterygostomial region terminates anteriorly in a very minute spinule, and a depression is visible towards its middle.

The chelipedes are slender and elongated, with the joints smooth and glabrous. A row of four or five small tubercles occurs on the inner proximal end of the merus, and a few tubercles of smaller size are sometimes found on the inner surface of the ischium, while a small spine is present on the upper and distal end of the same joint; in some specimens all the tubercles are nearly obsolete. The palm is but slightly dilated, and not equal in length to the carpus; the fingers are pubescent and excavated inferiorly, and a single prominent tooth occurs on the inner margin of the dactylus. The ambulatory limbs are smooth, with the exception of a few delicate spines on the posterior margin of the propodi; the dactyli are strongly curved, and about half the length of the penultimate joints, with a series of minute horny spinules on their posterior margin.

The eyes are of moderate size, and the corneæ are light brown in colour. The antennal acicle is slightly curved, and tapers gradually towards the acute apex, which reaches almost to the end of the peduncle; the flagellum is scarcely twice the length of the peduncle (it is represented of too great a length in the figure). The external maxillipedes are unarmed.

The abdominal segments are smooth and glabrous externally, and their pleura are subobtuse.

This species is closely allied to *Uroptychus politus*, from which it differs in the following respects:—The gastric region of the carapace is more swollen in the former, the rostrum is broader towards its apex, the chelipedes are more elongated, and finely tubercular towards their bases, while there is no hiatus between the fingers, and the antennal acicle is longer, more curved, and acuminate.

The largest specimen (a female from Station 164) gives the following measurements:—Breadth of carapace 7 mm., length of body (including rostrum) 21 mm., of carapace (including rostrum) 10·5 mm., of chelipede 39 mm., of chela 15·5 mm., of first ambulatory leg 18 mm. Diameter of ova, taken from another specimen, about 1 mm.

Habitat.—Station 164B, off Port Jackson; depth, 410 fathoms; bottom, green mud. Two adult females, one with ova, and a young male.

Station 170, off the Kermadec Islands; depth, 520 fathoms; bottom, volcanic mud. A female with ova.

Station 171, near the Kermadec Islands; depth, 600 fathoms; bottom, hard ground. A female with ova.

Station 194A, off Banda; depth, 360 fathoms; bottom, volcanic mud. A female with ova, and two young individuals.

Uroptychus gracilimanus, Henderson (Pl. XXI. fig. 5).

Diptychus gracilimanus, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 420, 1885.

Characters.—The carapace is smooth and glabrous as in the last two species, and armed only with a single small tooth at each antero-lateral angle. The gastric area is slightly raised above the level of the rostrum, but is without any definite anterior margin. The rostrum is horizontal, and extends for about one-third of its length beyond the ends of the eye-stalks; it is rather narrow at the base, and tapers gradually towards the acute apex. The pterygostomial region presents a slight depression towards its centre.

The chelipedes are remarkably long and slender, and there is no trace of armature, the joints being everywhere smooth and glabrous. The palm is only about three-fourths the length of the carpus and but slightly dilated; the fingers are pubescent, slightly curved, and rather deeply excavated below, while a compound tooth of considerable size exists on the proximal and inner margin of the dactylus. The ambulatory limbs are slender and elongated, with a few horny spines on the posterior margin of the propodi; the dactyli are strongly curved and scarcely half the length of the penultimate joint, while a series of short horny spinules occurs on their posterior margin.

The eyes are of rather small size, and the corneæ are deep brown in colour. The antennal acicle is acuminate, and scarcely reaches the end of the peduncle; the flagellum is but slightly longer than the peduncle. The external maxillipedes are unarmed.

The abdominal segments are smooth and glabrous externally, and their pleura are subobtuse.

This species is distinguished from *Uroptychus australis* by the great length and tenuity of its chelipedes, and the absence of minute tubercles from their basal joints. It may possibly be only a variety of the last species, but in none of the female specimens of the latter do the chelipedes assume so slender a form, and the material at my disposal therefore makes me inclined to regard it as distinct.

Breadth of carapace 8 mm., length of body (including rostrum) 22 mm., of carapace (including rostrum) 10·5 mm., of chelipede 50 mm., of chela 19·5 mm., of first ambulatory leg 19 mm., diameter of ova about 1 mm.

Habitat.—Station 164B, off Port Jackson; depth, 410 fathoms; bottom, green mud. A female with ova.

Uroptychus tridentatus, Henderson (Pl. VI. fig. 1).

Diptychus tridentatus, Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi. p. 421, 1885.

Characters.—The carapace is smooth and glabrous, and its surface is unarmed. The rostrum is about one and a half times the length of the eye-stalk, and slightly depressed, with its apex tridentate, and the upper surface hollowed out from side to side. The lateral margin of the carapace has three prominent spines on its middle third, and a few spines of smaller size are situated between the first of these and the antero-lateral angle. A few minute spinules occur on the anterior part of the pterygostomial region.

The chelipedes and ambulatory limbs are wanting in the single specimen.

The eyes are of small size, and somewhat wider at the base than at the free end; the corneæ are minute but deeply pigmented. The antennal acicle is broad and acuminate. slightly exceeding the peduncle in length; the terminal joint of the peduncle is prolonged on one side into a delicate spine; the flagellum is absent on both sides of the body. The carpal joint of the external maxillipedes is of smaller size than usual, and the outer and distal end of the merus is prolonged into a minute denticle.

The abdominal segments are smooth and glabrous externally, while their pleura are subacute.

Although the collection contains but a single specimen, and that in a very imperfect state of preservation, the characters are in some respects so striking that I have felt justified in making it the type of a new species. It may be distinguished at once from all the other known species of *Uroptychus* by the form of its rostrum.

Breadth of carapace 4·3 mm., length of body (including rostrum) 12 mm., of carapace 5·5 mm., diameter of ova about 0·6 mm.

Habitat.—Amboina. The label gives the depth as 15 fathoms, but from what is known of the bathymetrical distribution of the genus it is probable that the specimen came from one of the deeper dredgings in that locality.

GEOGRAPHICAL DISTRIBUTION.

LIST OF STATIONS,

SHOWING THE PHYSICAL CONDITIONS AND THE SPECIES OF ANOMURA OBTAINED AT EACH.

STATION VIIP. Off Tenerife, Canaries, February 10, 1873; lat. 28° 35′ N., long. 16° 5′ W.; depth, 78 fathoms; bottom, volcanic sand; surface temperature, 64°. Dredged.

Pagurus calidus, Risso.
Spiropagurus elegans, Miers.
Anapagurus pusillus, n. sp.
Galathea dispersa, Spence Bate.

"Label lost, probably Madeira." More probably Bay of Biscay, in deep water.

Eupagurus excavatus (Herbst), var. *meticulosa*, Roux.

STATION 23. Off Sombrero, West Indies, March 15, 1873; lat. 18° 24′ N., long. 63° 28′ W.; depth, 450 fathoms; bottom, Pteropod ooze; surface temperature, 76°. Dredged.

Munida sp.
Munidopsis sigsbei (A. Milne-Edwards).
Elasmonotus armatus, A. Milne-Edwards).
Uroptychus nitidus (A. Milne-Edwards).

St. Thomas, West Indies, shallow water.

Hypoconcha sabulosa (Herbst).
Porcellana sayana (Leach).

STATION 24. Off Culebra Island, West Indies, March 25, 1873; lat. 18° 38′ 30″ N., long. 5° 65′ 30″ W.; depth, 390 fathoms; bottom, Pteropod ooze; surface temperature, 76°. Dredged.

Porcellana robertsoni, n. sp.
Munida microphthalma, A. Milne-Edwards.
Elasmonotus armatus, A. Milne-Edwards.
Uroptychus nitidus (A. Milne-Edwards).

Bermuda, on the sandy shore and in shallow water.

Remipes scutellatus (Fabricius). | *Petrolisthes armatus* (Gibbes).

Station 49. South of Halifax, Nova Scotia, May 20, 1873; lat. 43° 3′ N., long. 63° 39′ W.; depth, 85 fathoms; bottom, gravel, stones; surface temperature, 40°·5; bottom temperature, 35°. Dredged.

Eupagurus pubescens (Kröyer), var. *kroyeri*, Stimpson.

Station 56. Off Bermuda, May 29, 1873; lat. 32° 8′ 45″ N., long. 64° 54′ 35″ W.; depth, 1075 fathoms; bottom, coral mud; bottom temperature, 38°·2; surface temperature, 72°·5. Dredged.

Parapagurus abyssorum, A. Milne-Edwards. | *Munidopsis serratifrons* (A. Milne-Edwards).

Station 68. Between Bermuda and the Azores, June 24, 1873; lat. 38° 4′ N., long. 39° 19′ W.; depth, 2175 fathoms; bottom, Globigerina ooze; bottom temperature, 36°·2; surface temperature, 70°. Trawled.

Parapagurus abyssorum, A. Milne-Edwards, var. *scabra*, nov.

Station 73. West of the Azores, June 30, 1873; lat. 38° 30′ N., long. 31° 14′ W.; depth, 1000 fathoms; bottom, Pteropod ooze; bottom temperature, 39°·4; surface temperature, 69°. Dredged.

Pagurodes (?) sp.

Station 75. Off Fayal, Azores, July 2, 1873; lat. 38° 38′ 0″ N., long. 28° 28′ 30″ W., depth, 50–90 fathoms; bottom, volcanic mud; surface temperature, 70°·2. Dredged.

Anapagurus pusillus, n. sp. | *Galathea* sp.

St. Vincent, Cape Verde Islands.

Remipes scutellatus (Fabricius).
Pagurus callidus, Risso.
Eupagurus excavatus (Herbst), var. *meticulosa*, Roux.
Galathea sp.
Pachycheles barbatus, A. Milne-Edwards.

Station 78. South of San Miguel, Azores, July 10, 1873; lat. 37° 26′ N., long. 25° 13′ W.; depth, 1000 fathoms; bottom, volcanic mud; surface temperature, 71°. Dredged.

Lithodes agassizii, S. I. Smith.

STATION 106. South-west of Sierra Leone, August 25, 1873; lat. 1° 47′ N.; long. 24° 26′ W.; depth, 1850 fathoms; bottom, Globigerina ooze; bottom temperature, 36°·6; surface temperature, 78°·8. Trawled.

Parapagurus abyssorum, A. Milne-Edwards.

St. Paul's Rocks; depth, 10 to 60 fathoms.

Munida sancti-pauli, Henderson.

STATION 113A. Off Fernando Noronha, September 2, 1873; lat. 3° 47′ 0″ S., long. 32° 24′ 30″ W.; depth, 7 to 25 fathoms; bottom, volcanic sand and gravel; surface temperature, 78°. Dredged.

Munida spinifrons, Henderson.

STATION 122. Off Pernambuco, September 10, 1873; lat. 9° 5′ S., long. 34° 50′ W.; depth, 350 fathoms; bottom, red mud; surface temperature, 77°·5. Trawled.

Eupagurus occlusus, n. sp.
Paguristes visor, n. sp.
Parapagurus gracilis, n. sp.
Munida stimpsoni, A. Milne-Edwards.
Munida miles, A. Milne-Edwards.
Munidopsis erinacea (A. Milne-Edwards).

Off Bahia; depth, 7 to 20 fathoms.

Dromidia antillensis, Stimpson.
Hypoconcha panamensis, S. I. Smith.
Zanclifer caribensis (de Fréminville).
Petrolisthes serratus, n. sp.
Petrolisthes sp.

STATION 133. Near Tristan da Cunha, October 11, 1873; lat. 35° 41′ S., long. 20° 55′ W.; depth, 1900 fathoms; bottom, Globigerina ooze; bottom temperature, 35°·4; surface temperature, 58°. Trawled.

Parapagurus abyssorum, A. Milne-Edwards.

STATION 135C. Off Nightingale Island, Tristan da Cunha, October 17, 1873; lat. 35° 25′ 30″ S., long. 12° 28′ 30″ W.; depth, 110 fathoms; surface temperature, 54°. Dredged.

Eupagurus tristanensis, n. sp.
Parapagurus dimorphus (Studer).

Simon's Bay, Cape of Good Hope; depth, 5 to 20 fathoms.

Dromidia spongiosa, Stimpson.
Pseudodromia latens, Stimpson.
Diogenes brevirostris, Stimpson.
Pagurus granulatus, Olivier.
Anapagurus pusillus, n. sp.
Porcellana streptocheles, Stimpson.
Galathea labidolepta, Stimpson (?).
Galathea sp.

STATION 142. Off Cape Agulhas, December 18, 1873; lat. 35° 4′ S., long. 18° 37′ E.; depth, 150 fathoms; bottom, green sand; bottom temperature, 47°; surface temperature, 65°·5. Dredged.

Dromidia bicornis, Studer.
Eudromia frontalis, n. gen. et. sp.
Parapagurus dimorphus (Studer).

STATION 145A. Off Marion Island, December 27, 1873; lat. 46° 41′ S., long. 38° 10′ E.; depth, 85 to 310 fathoms; bottom, volcanic sand; surface temperature, 41°·5. Dredged.

Lithodes murrayi, n. sp.
Paralomis aculeatus, n. sp.
Parapagurus dimorphus (Studer).
Munida spinosa, Henderson.
Uroptychus insignis, Henderson.

STATION 146. Near Marion Island, December 29, 1873; lat. 46° 46′ S., long. 45° 31′ E.; depth, 1375 fathoms; bottom, Globigerina ooze; bottom temperature, 35°·6; surface temperature, 43°. Trawled.

Pagurodes inarmatus, n. sp.
Munidopsis subsquamosa, Henderson, var. *aculeata*, nov.

STATION 158. South-west of Australia, March 7, 1874; lat. 50° 1′ S., long. 123° 4′ E.; depth, 1800 fathoms; bottom, Globigerina ooze; bottom temperature, 33°·5; surface temperature, 45°. Trawled.

Munidopsis antonii (A. Milne-Edwards).

STATION 161. Off Port Philip, April 1, 1874; lat. 38° 22′ 30″ S., long. 144° 36′ 30″ E.; depth, 33 fathoms; bottom, sand; surface temperature, 63°·5. Trawled.

Eupagurus lacertosus, n. sp., var. *nana*, nov.

STATION 162. Off East Moncœur Island, Bass Strait, April 2, 1874; lat. 30° 10′ 30″ S., long. 146° 35′ E.; depth, 38 fathoms; bottom, sand and shells; surface temperature, 63°·2. Dredged.

Dromia ciliata, n. sp.
Cryptodromia lateralis (Gray).
Clibanarius stringimanus (White).
Eupagurus lacertosus, n. sp., var. *nana*, nov.
Munida subrugosa (White), var. *australiensis*, nov.

STATION 163A. Off Twofold Bay, Australia, April 4, 1874; lat. 36° 59′ S., long. 150° 20′ E.; depth, 150 fathoms; bottom, green mud; surface temperature, 71°. Trawled.

Cryptodromia lateralis (Gray).
Cryptodromia incisa, n. sp.
Latreillia australiensis, n. sp.
Glaucothöe carinata, n. sp.
Pylocheles spinosus, n. sp.
Galathea pusilla, Henderson.
Munida haswelli, Henderson.

Port Jackson, April 1874; depth, 2 to 10 fathoms.

Cryptodromia lateralis (Gray).
Cryptodromia nodulifera, n. sp.
Diogenes custos (Fabricius).
Anapagurus australiensis, n. sp.

STATION 163B. Off Port Jackson, June 3, 1874; lat. 33° 51′ 15″ S., long. 151° 22′ 15″ E.; depth, 35 fathoms; bottom, hard ground; bottom temperature, 63°; surface temperature, 69°. Dredged.

Latreillia australiensis, n. sp.
Lyreidus tridentatus, De Haan.
Pagurus sp.
Eupagurus lacertosus, n. sp., var. *nana*, nov.

STATION 164B. Off Port Jackson, June 13, 1874; lat. 34° 13′ S., long. 151° 38′ E.; depth, 410 fathoms; bottom, green mud; surface temperature, 69°·0. Trawled.

Uroptychus australis, Henderson.
Uroptychus gracilimanus, Henderson.

STATION 166. West of New Zealand, June 23, 1874; lat. 38° 50′ S., long. 169° 20′ E.; depth, 275 fathoms; bottom, Globigerina ooze; bottom temperature, 50°·8; surface temperature, 58°·5. Trawled.

Eupagurus lacertosus, n. sp.
Munida gracilis, Henderson.

STATION 167. West of New Zealand, June 24, 1874; lat. 39° 32′ S., long. 171° 48′ E.; depth, 150 fathoms; bottom, blue mud; surface temperature, 58°·5. Trawled.

Paguristes subpilosus, n. sp.
Parapagurus latimanus, n. sp.

STATION 167A. Near Wellington, New Zealand, June 27, 1874; lat. 41° 4′ S., long. 174° 19′ E.; depth, 10 fathoms; bottom, mud; surface temperature, 51°·5. Dredged.

Paguristes pilosus (H. Milne-Edwards).
Parapagurus latimanus, n. sp.

STATION 168. East of New Zealand, July 8, 1874; lat. 40° 28′ S., long. 177° 43′ E.; depth, 1100 fathoms; bottom, blue mud; bottom temperature, 37°·2; surface temperature, 57°·2. Trawled.

Pagurodes inarmatus, n. sp. | *Elasmonotus marginatus*, Henderson.

STATION 169. East of New Zealand, July 10, 1874; lat. 37° 34′ S., long. 179° 22′ E.; depth, 700 fathoms; bottom, blue mud; bottom temperature, 40°; surface temperature, 58°·2. Trawled.

Eupagurus rubricatus, n. sp.

STATION 170. Off the Kermadec Islands, July 14, 1874; lat. 29° 55′ S., long. 178° 14′ W.; depth, 520 fathoms; bottom, volcanic mud; bottom temperature, 43°; surface temperature, 65°. Trawled.

Uroptychus spinimarginatus, Henderson. | *Uroptychus australis*, Henderson.

STATION 171. North of the Kermadec Islands, July 15, 1874; lat. 28° 33′ S., long. 177° 50′ W.; depth, 600 fathoms; bottom, hard ground; bottom temperature, 39°·5; surface temperature, 66°·5. Trawled.

Munida microphthalma, A. Milne-Edwards. | *Uroptychus politus*, Henderson.
Uroptychus australis, Henderson.

STATION 172. Off Nukalofa, Tongatabu, July 22, 1874; lat 28° 58′ S., long. 175° 9′ W.; depth, 18 fathoms; bottom, coral mud; surface temperature, 75°. Dredged.

Pagurus euopsis, Dana. | *Petrolisthes unilobatus*, n. sp.
Galathea aculeata, Haswell.

STATION 172A. Off Nukalofa, Tongatabu, July 22, 1874; lat. 26° 56′ S., long. 175° 11′ W.; depth, 240 fathoms; bottom, coral mud; surface temperature, 75°. Dredged.

Munida tuberculata, Henderson.

STATION 173. Off Matuku, Fiji, July 24, 1874; lat. 19° 9′ 35″ S., long. 179° 41′ 50″ E.; depth, 315 fathoms; bottom, coral mud; surface temperature, 76°. Dredged.

Munida normani, Henderson. | *Munida tuberculata*, Henderson.
Munida granulata, Henderson. | *Elasmonotus miersii*, Henderson.
Munida militaris, Henderson. | *Elasmonotus debilis*, Henderson.

Reefs at Levuka, Fiji Islands.

Catapagurus australis, n. sp.

Kandavu, Fiji Islands, from the shore.

Cœnobita rugosa, H. Milne-Edwards. | *Cœnobita perlata*, H. Milne-Edwards.

STATION 174D. Off Ngaloa, Kandavu, Fiji Islands, August 3, 1874; lat. 19° 5′ 50″ S., long. 178° 16″ 20″ E.; depth, 210 fathoms; bottom, coral mud; surface temperature, 77°·7. Dredged.

Lyreidus tridentatus, De Haan. | *Munida spinicordata*, Henderson.

Api, New Hebrides, from the shore.

Cœnobita rugosa, H. Milne-Edwards. | *Cœnobita perlata*, H. Milne-Edwards.

STATION 186. Flinder's Passage, Cape York, North Australia, September 8, 1874; lat. 10° 30′ S., long. 142° 18′ E.; depth, 8 fathoms; bottom, coral mud; surface temperature, 77°·2. Dredged.

Mastigochirus quadrilobatus, Miers. | *Petrolisthes annulipes* (White) Miers.
Pagurus imbricatus, H. Milne-Edwards. | *Pachycheles pulchellus* (Haswell).
Polyonyx obesulus (White) Miers.

Torres Strait.

Spiropagurus spiriger (De Haan).

STATION 187. Cape York, North Australia, September 9, 1874; lat. 10° 36′ S., long. 141° 55′ E.; depth, 6 fathoms; bottom, coral mud; surface temperature, 77°·7.

Diogenes guttatus, n. sp.

STATION 188. Arafura Sea, south of Papua, September 10, 1874; lat. 9° 59′ S., long. 139° 42′ E.; depth, 28 fathoms; bottom, green mud; surface temperature, 78°·5. Dredged and trawled.

Spiropagurus spiriger (De Haan). | *Catapagurus australis*, n. sp.
Pachycheles pulchellus (Haswell).

STATION 190. Arafura Sea, south of Papua, September 12, 1874; lat. 8° 56′ S., long. 136° 5′ E.; depth, 49 fathoms; bottom, green mud; surface temperature, 79°·2. Trawled.

Spiropagurus spiriger (De Haan). | *Galathea australiensis*, Stimpson.

Wokan Dobbo, Arrou Islands, from the shore.

Cœnobita rugosa, H. Milne-Edwards.

Station 191. Off the Arrou Islands, September 23, 1874; lat. 5° 41′ 0″ S., long. 134° 4′ 30″ E.; depth, 800 fathoms; bottom, green mud; bottom temperature, 39°·5; surface temperature, 82°·2. Trawled.

Munidopsis brevimana, Henderson.

Station 192. Off Little Ki Island, September 26, 1874; lat. 5° 49′ 15″ S., long. 132° 14′ 15″ E.; depth, 140 fathoms; bottom, blue mud; surface temperature, 82 Trawled.

Homola orientalis, n. sp.
Notopoides latus, n. sp.
Notopus ovalis, n. sp.
Clibanarius (?) sp.
Munida scabra, Henderson.
Munida militaris, Henderson.
Eumunida smithii, Henderson.
Ptychogaster lævis, Henderson.

Arafura Sea.

Pagurodes piliferus, n. sp. (?).
Porcellana serratifrons, Stimpson.

Station 194a. Off Banda, September 29, 1874; lat. 4° 31′ 0″ S., long. 129° 57′ 20″ E.; depth, 360 fathoms; bottom, volcanic mud; surface temperature, 82°·5. Trawled.

Galathea inconspicua, Henderson.
Uroptychus australis, Henderson.

Station 195. Off Banda, October 3, 1874; lat. 4° 21′ S., long. 129° 7′ E.; depth, 1425 fathoms; bottom, blue mud; bottom temperature, 38°; surface temperature, 82°. Trawled.

Parapagurus abyssorum, A. Milne-Edwards.
Galacantha talismanii, A. Milne-Edwards.

Amboina; depth, 15 fathoms.

Raninoides personatus (White) Henderson.
Cosmonotus grayii, Adams and White.
Munida spinulifera, Miers.
? *Uroptychus tridentatus*, Henderson.

Amboina; depth, 100 fathoms.

Munida militaris, Henderson.

STATION 196. Near the Philippines, October 13, 1874; lat. 0° 48′ 30″ S., long. 126° 58′ 30″ E.; depth, 825 fathoms; bottom, hard ground; bottom temperature, 36°·9; surface temperature, 83°. Trawled.

Homologenus (?) sp. | *Munidopsis pilosa*, Henderson.

Ternate, October 15, 1874.

Remipes testudinarius, Latreille. | *Birgus latro* (Linné).

STATION 200. Off Samboangan, Philippines, October 23, 1874; lat. 6° 47′ N., long. 122° 28′ E.; depth, 250 fathoms; bottom, green mud; surface temperature, 85°·5. Trawled.

Munida incerta, n. sp. | *Munida militaris*, Henderson, var. *curvirostris*, nov.

STATION 201. Off Samboangan, Philippines, October 26, 1874; lat. 7° 3′ N., long. 121° 48′ E; depth, 82 fathoms; bottom, stones, gravel; surface temperature, 83°. Trawled.

Eupagurus sp.

Philippine Islands.

Birgus latro (Linné).

Reefs at Zebu, Philippine Islands.

Pagurus striatus, Latreille.

STATION 204A or 204B. Off Panay Island, Philippines, November 2, 1874; lat. 12° 43′ N., long. 122° 9′ E.; depth, 100 or 115 fathoms; bottom, green mud; surface temperature, 84°. Trawled.

Pagurus striatus, Latreille. | *Pagurodes piliferus*, n. sp.
Eupagurus spinulentus, n. sp. | *Paguropsis typicus*, n. sp.
Galathea subsquamata, Stimpson.

STATION 205. Off Luzon, Philippines, November 13, 1874; lat. 16° 42′ N., long. 119° 22′ E.; depth, 1050 fathoms; bottom, blue mud; bottom temperature, 37°; surface temperature, 82°. Trawled.

Parapagurus abyssorum, A. Milne-Edwards.

Hong Kong; depth, 10 fathoms.

Spiropagurus spiriger (De Haan). | *Porcellana serratifrons*, Stimpson.
Raphidopus ciliatus, Stimpson.

STATION 207. Off Tablas Island, Philippines, January 16, 1875; lat. 12° 21′ N., long. 122° 15′ E.; depth, 700 fathoms; bottom, blue mud; bottom temperature, 51°·6; surface temperature, 80°. Trawled.

Munidopsis milleri, Henderson.

STATION 208. Among the Philippines, January 17, 1875; lat. 11° 37′ N., long. 123° 31′ E.; depth, 18 fathoms; bottom, blue mud; surface temperature, 81°. Trawled.

Spiropagurus spiriger (De Haan).
Paguristes hians, n. sp.
Paguristes sp.
Galathea aculeata, Haswell.

STATION 209. Off Zebu, Philippines, January 22, 1875; lat. 10° 14′ N., long. 123° 54′ E.; depth, 95 fathoms; bottom, blue mud; bottom temperature, 71°; surface temperature, 81°. Dredged and trawled.

Homola orientalis, n. sp.
Latreillopsis bispinosa, n. sp.
Latreillia valida, De Haan.
Galathea grandirostris, Stimpson.

STATION 210. Off Mindanao, Philippines, January 25, 1875; lat. 9° 26′ N., long. 123° 45′ E.; depth, 375 fathoms; bottom, blue mud; bottom temperature, 54°·1; surface temperature, 80°·2. Dredged and trawled.

Munida militaris, Henderson, var. *curvirostris*, nov.
Elasmonotus debilis, Henderson.

STATION 212. Off Samboangan, Philippines, January 30, 1875; lat. 6° 54′ N., long. 122° 18′ E.; depth, 10 fathoms; bottom, sand; surface temperature, 83°. Dredged and trawled.

Albunea microps (White) Miers.
Pagurus similimanus, n. sp.
Porcellanella triloba, White.
Galathea elegans, White.

STATION 214. Off the Meangis Islands, February 10, 1875; lat. 4° 33′ N., long. 127° 6′ E.; depth, 500 fathoms; bottom, blue mud; bottom temperature, 41°·8; surface temperature, 80°·5. Trawled.

Parapagurus affinis, n. sp.
Pagurodes limatulus, n. sp.
Uroptychus spinimarginatus, Henderson.

STATION 218. North of Papua, March 1, 1875; lat. 2° 33′ S., long. 144° 4′ E.; depth, 1070 fathoms; bottom, blue mud; bottom temperature, 36°·4; surface temperature, 84°. Trawled.

Parapagurus abyssorum, A. Milne-Edwards.
Munidopsis brevimana, Henderson.
Elasmonotus latifrons, Henderson.

STATION 219. Off Nares Harbour, Admiralty Islands, March 10, 1875; lat. 1° 54′ 0″ S., long. 146° 39′ 40″ E.; depth, 150 fathoms; bottom, coral mud; surface temperature, 84°. Trawled.

Munida squamosa, Henderson.
Munida proxima, Henderson.
Munida inornata, Henderson.
Elasmonotus lævigatus, Henderson.

Wild Island, Admiralty Islands.

Cœnobita clypeata (Herbst).
Cœnobita rugosa, H. Milne-Edwards.

Tracy Island, Nares Harbour, Admiralty Islands.

Cœnobita rugosa, H. Milne-Edwards.

Admiralty Islands; depth, 16 to 25 fathoms.

Pagurus dearmatus, n. sp.
Spiropagurus spiriger (De Haan).

Off Yokoska, Japan; depth, 5 to 20 fathoms.

Cryptodromia japonica, n. sp.

Off Yokohama, Japan.

Eupagurus constans, Stimpson.

STATION 237. South of Japan, June 17, 1875; lat. 34° 37′ N., long. 140° 32′ E.; depth, 1875 fathoms; bottom, blue mud; bottom temperature, 35°·3; surface temperature, 73°. Trawled.

Parapagurus abyssorum, A. Milne-Edwards.
Munidopsis subsquamosa, Henderson.

Tahiti, Society Islands, near the reefs, September 28, 1875.

Cœnobita rugosa, H. Milne-Edwards.
Calcinus tibicen (Herbst).

Reefs at Papiete, Society Islands.

Pagurus deformis, H. Milne-Edwards.

STATION 285. Mid South Pacific, October 14, 1875; lat. 32° 36′ S., long. 137° 43′ E.; depth, 2375 fathoms; bottom, red clay; bottom temperature, 35°; surface temperature, 65°. Trawled.

Tylaspis anomala, Henderson.

Valparaiso Beach, November 1875.

Petrolisthes violaceus (Guérin).
Petrolisthes validus (Dana).

STATION 300. Off Juan Fernandez, December 17, 1875; lat. 33° 42′ S., long. 78° 18′ W.; depth, 1375 fathoms; bottom, Globigerina ooze; bottom temperature, 31°·5; surface temperature, 92°·5. Trawled.

Parapagurus abyssorum, A. Milne-Edwards.
Munidopsis antonii (A. Milne-Edwards).
Galacantha bellis, Henderson.

STATION 302. Off Patagonia, December 28, 1875; lat. 42° 43′ S., long. 82° 11′ W.; depth, 1450 fathoms; bottom, Globigerina ooze; bottom temperature, 35°·6; surface temperature, 55°. Trawled.

Munidopsis subsquamosa, Henderson, var. *aculeata*, nov.

STATION 304. Port Otway, Patagonia, December 31, 1875; lat. 46° 53′ 15″ S., long. 75° 12′ 0″ W.; depth, 45 fathoms; bottom, green sand; surface temperature, 51°·2. Dredged.

Munida subrugosa (White).
Parapagurus abyssorum, A. Milne-Edwards.

STATION 305A. In the Messier Channel, Patagonia, January 1, 1876; lat. 47° 48′ 30″ S., long. 74° 47′ 0″ W.; depth, 125 fathoms; bottom, blue mud; surface temperature, 55°. Trawled.

Munida subrugosa (White).

Messier Channel, January 1876.

Petrolisthes validus (Dana).

Gray's Harbour, Patagonia; from the stomach of a fish.

Munida subrugosa (White).

STATION 308. Tom Bay, Patagonia, January 5, 1876; lat. 50° 8′ 30″ S., long. 74° 41′ 0″ W.; depth, 175 fathoms; bottom, blue mud; surface temperature, 51°·7. Trawled.

Eupagurus comptus (White), var. *jugosa*, nov.

STATION 310. In the Sarmiento Channel, Patagonia, January 10, 1876; lat. 51° 27′ 30″ S., long. 74° 3′ 0″ W.; depth, 400 fathoms; bottom, blue mud; bottom temperature, 46°·5; surface temperature, 50°·5. Trawled.

Munidopsis trifida, Henderson.
Ptychogaster milne-edwardsi, Henderson.
Uroptychus parvulus, Henderson.

STATION 311. Off Port Churruca, Patagonia, January 11, 1876; lat. 52° 45′ 30″ S., long. 73° 46′ 0″ W.; depth, 245 fathoms; bottom, blue mud; bottom temperature, 46°; surface temperatnre, 50°. Trawled.

Parapagurus dimorphus (Studer).
Elasmonotus asper, Henderson.

STATION 312. Port Famine, Patagonia, January 13, 1876; lat. 53° 37′ 30″ S., long. 70° 56′ 0″ W.; depth, 9 fathoms; bottom, blue mud; surface temperature, 49°·8. Dredged.

Munida subrugosa (White).

Port Stanley, Falkland Islands.

Paralomis verrucosus (Dana).

STATION 315. Port William, Falkland Island, January 26, 1876; lat. 51° 40′ S., long. 57° 50′ W.; depth, 12 fathoms; bottom, sand, gravel; surface temperature, 50°. Dredged.

Eupagurus comptus (White), var. *jugosa*, nov.
Porcellanella triloba, White.
Munida subrugosa (White).

STATION 316. Port Louis, Falkland Islands, February 3, 1876; lat. 51° 32′ S., long. 58° 6′ W.; depth, 4 fathoms; bottom, mud; surface temperature, 51°·2. Dredged.

Paralomis verrucosus (Dana).

STATION 320. Off Monte Video, February 14, 1876; lat. 37° 17′ S., long. 53° 52′ W.; depth, 600 fathoms; bottom, green sand; bottom temperature, 37°·2; surface temperature, 67°·5. Trawled.

Paralomis formosus, n. sp. | *Munida subrugosa* (White).
Munida spinosa, Henderson.

STATION 335. Near Tristan da Cunha, March 16, 1876; lat. 32° 24′ S., long. 13° 5′ W.; depth, 1425 fathoms; bottom, Pteropod ooze; bottom temperature, 37°; surface temperature, 73°·5. Dredged.

Parapagurus abyssorum, A. Milne-Edwards.

STATION 343. Off Ascension Island, March 27, 1876; lat. 8° 3′ S., long. 14° 27′ W.; depth, 425 fathoms; bottom, volcanic sand; bottom temperature, 40°·3; surface temperature, 80°·8. Dredged.

Munida microphthalma, A. Milne-Edwards.

THE CHIEF GEOGRAPHICAL AREAS WITH THE SPECIES OF ANOMURA OBTAINED IN EACH.

In order to facilitate the distributional study of the species collected during the Expedition, I have thought it advisable to group them according to the special areas in which they were found. In doing so I have followed the arrangement adopted by Mr. E. J. Miers in his Report on the Challenger Brachyura, which is in part founded on that originally proposed by Professor Dana. As regards the distribution of the littoral and shallow-water forms of higher Crustacea, he believes that four great regions can be recognised, viz.:—(1) The Arctic or Boreal Circumpolar Region; (2) the Antarctic or Austral Circumpolar Region; (3) the Atlantic Region; and (4) the Indo-Pacific or Oriental Region.

Of the Circumpolar Regions much remains to be learnt, but so far as is known their Crustacean fauna is a scanty one when compared with that of the other two divisions; in some respects they appear to gradually merge with the latter, for it has been shown that certain characteristic genera, *e.g.*, *Lithodes*, extend almost to the tropics, but are then found only in deep water where the temperature conditions are favourable. No part of the Arctic Region was visited by the Challenger, but I have followed Mr. Miers by including in the Antarctic Region all those species taken to the south of 40° S. latitude, an arrangement which has at least the merit of being convenient.

The Atlantic and Indo-Pacific Regions stand clearly apart from one another, each containing many species with a wide range of distribution, though if the deep-water forms be excluded a comparatively small number are common to both. Each of these great regions may be subdivided into a number of provinces, all of which are characterised by the presence of distinct species, and in most cases also of distinct genera. The following arrangement will be found on the whole consistent with the distribution of other groups of marine animals, and the nomenclature is in many respects similar to that adopted by Mr. Hoyle in his Report on the Challenger Cephalopoda:—

Atlantic Provinces.

1. *Scandinavian.*[1]
2. New England.
3. West Indian.
4. Lusitanian.
5. *Mediterranean.*
6. West African.
7. South African.

[1] The provinces printed in *italics* were not visited by the Challenger.

Indo-Pacific Provinces.

1. *Mascarene* or *East African.*	6. *Californian.*
2. *Red Sea.*	7. Australian.
3. Indo-Malayan.	8. Nova Zeylanian.
4. Japanese.	9. Pacific.
5. *Columbian.*	10. Peruvian.

In no instance can the boundaries of these provinces be sharply defined, and in all cases many species are found common to adjacent provinces. The abyssal forms (taken at greater depths than 500 fathoms) are provisionally included in the nearest province, though as a result of the more uniform conditions met with at great depths, their distribution is not limited as in the case of shallow-water species.

The number of species recorded from each province bears a ratio to the amount of dredging done, rather than affords an index to the comparative prevalence of Anomura; and during the first part of the cruise, some allowance must perhaps be made for the fact that methods of capture were only undergoing development. Thus but few species are recorded from the North Atlantic or West Indies, while the investigations of the "Blake" have shown that the deep-water of the latter district is tenanted by a wonderfully rich Crustacean fauna.

An asterisk placed before a species indicates that it is abyssal, and one or more numbers after indicate the other provinces in which it was taken.

THE ATLANTIC REGION.

I. The New England Province.

This province extends from the Gulf of St. Lawrence, or possibly as far north as the coast of Labrador, to the coast of Carolina.

Eupagurus pubescens (Kröyer), var. *kroyeri*, Stimpson.

II. The West Indian Province.

The Gulf of Mexico and the West Indian Islands form the centre of this province, but its fauna creeps along the South American coast possibly as far south as the Rio de la Plata. In the north it includes the American shores from Florida to Carolina, as well as the Bermudas.

Dromidia antillensis, Stimpson.
Hypoconcha sabulosa (Herbst).
,, *panamensis*, S. I. Smith.
Zanclifer caribensis (de Freminville).
Remipes scutellatus (Fabricius), IV.
Eupagurus occlusus, n. sp.
Paguristes visor, n. sp.
**Parapagurus abyssorum*, A. Milne-Edwards, III., V., VI., VII., XI.
,, *gracilis*, n. sp.
Petrolisthes armatus (Gibbes).
,, *serratus*, n. sp.
,, sp.
Porcellana sayana (Leach).
,, *robertsoni*, n. sp.
Munida stimpsoni, A. Milne-Edwards.
Munida miles, A. Milne-Edwards.
,, *microphthalma*, A. Milne-Edwards, IV., X.
,, *sancti-pauli*, n. sp.
,, *spinifrons*, n. sp.
,, sp.
Munidopsis erinaceus (A. Milne-Edwards).
,, *sigsbei* (A. Milne-Edwards).
* ,, *serratifrons* (A. Milne-Edwards).
Elasmonotus armatus, A. Milne-Edwards.
Uroptychus nitidus (A. Milne-Edwards).

III. The Lusitanian Province.

Extends from the south coast of the British Islands to the Canaries, and includes the Azores. Towards its southern limit there is a decided admixture of Mediterranean and West African species.

**Lithodes agassizii*, S. I. Smith.
Pagurus calidus, Risso, IV.
Eupagurus excavatus (Herbst), var. *meticulosa*, Roux., IV.
Spiropagurus elegans, Miers.
Anapagurus pusillus, n. sp., V.
**Parapagurus abyssorum*, A. Milne-Edwards, var. *scabra*, nov.
**Pagurodes* (?) sp.
Galathea dispersa, Spence Bate.
,, sp.

IV. The West African Province.

This province extends along the west coast of Africa from the Canaries probably to the Tropic of Capricorn, and includes the islands of Ascension and St. Helena. The fauna of the Cape Verde Islands (which I include in this section) shows a decided Lusitanian facies.

Remipes scutellatus (Fabricius), II.
Pagurus calidus, Risso, III.
Eupagurus excavatus (Herbst), var. *meticulosa*, Roux, III.
Pachycheles barbatus, A. Milne-Edwards.
Munida microphthalma, A. Milne-Edwards, II., X.

V. The South African Province.

Includes the south-west coast of Africa from the Tropic of Capricorn to Cape Agulhas, and the Tristan da Cunha group.

Dromidia spongiosa, Stimpson.
,, *bicornis*, Studer.
Eudromia frontalis, n. gen. et sp.
Pseudodromia latens, Stimpson.
Diogenes brevirostris, Stimpson.
Pagurus granulatus, Olivier.
Eupagurus tristanensis, n. sp.
Anapagurus pusillus, n. sp., III.
Parapagurus dimorphus (Studer), XII.
* ,, *abyssorum*, A. Milne-Edwards, II., III., VI., VII., XI.
Porcellana streptocheles, Stimpson.
Galathea labidolepta, Stimpson (?).
,, sp.

THE INDO-PACIFIC REGION.

VI. The Indo-Malayan Province.

This province is one of considerable extent. It includes the Malay Archipelago, the north coast of Australia, and extends in a northerly direction so as to take in the greater part of the Chinese seas, while it also comprises the coasts of India and Ceylon.

Homola orientalis, n. sp.
**Homologenus* (?) sp.
Latreillopsis bispinosa, n. gen. et sp.
Latreillia valida, De Haan.
Raninoides personatus (White), Henderson.
Notopoides latus, n. gen. et sp.
Notopus ovalis, n. sp.
Cosmonotus grayii, Adams and White.
Remipes testudinarius, Latreille.
Mastigochirus quadrilobatus, Miers.
Albunea microps (White), Miers.
Birgus latro (Linné).
Cœnobita clypeata (Herbst).
,, *rugosa*, H. Milne-Edwards, X.
Diogenes guttatus, n. sp.
Pagurus striatus, Latreille.
,, *imbricatus*, H. Milne-Edwards.
,, *dearmatus*, n. sp.

Pagurus similimanus, n. sp.
Clibanarius (?) sp.
Eupagurus spinulentus, n. sp.
,, sp.
Spiropagurus spiriger (De Haan).
Catapagurus australis, n. sp., X.
Paguristes hians, n. sp.
,, sp.
**Parapagurus abyssorum*, A. Milne-Edwards, II., III., V., VII., XI.).
* ,, *affinis*, n. sp.
**Pagurodes limatulus*, n. sp.
,, *piliferus*, n. sp.
Paguropsis typicus, n. sp.
Petrolisthes annulipes (White), Miers.
Porcellana serratifrons, Stimpson.
Porcellanella triloba, White, XII.
Raphidopus ciliatus, Stimpson.
Pachycheles pulchellus (Haswell).
Polyonyx obesulus (White), Miers.
Galathea elegans, White.
,, *australiensis*, Stimpson.
,, *subsquamata*, Stimpson.
,, *grandirostris*, Stimpson.
Galathea aculeata, Haswell, X
,, *inconspicua*, n. sp.
Munida spinulifera, Miers.
,, *incerta*, n. sp.
,, *squamosa*, Henderson.
,, *scabra*, Henderson.
,, *proxima*, Henderson.
,, *militaris*, Henderson, X
,, var. *curvirostris*, Henderson.
,, *inornata*, Henderson.
**Munidopsis brevimana*, Henderson.
* ,, *milleri*, Henderson.
* ,, *pilosa*, Henderson.
Elasmonotus lævigatus, Henderson.
,, *debilis*, Henderson.
**Galacantha talismanii*, A. Milne Edwards.
Eumunida smithii, Henderson.
Ptychogaster lævis, Henderson.
**Uroptychus spinimarginatus*, Henderson, X.
,, *australis*, Henderson, VIII., X.

VII. The Japanese Province.

The Crustacean fauna of the Japanese seas is in many respects so peculiar that there can be little doubt that they are entitled to rank as a distinct province.

Cryptodromia japonica, n. sp.
Eupagurus constans, Stimpson.
**Parapagurus abyssorum* (A. Milne-Edwards), II., III., V., VI., XI.
**Munidopsis subsquamosa*, Henderson.

VIII. The Australian Province.

This includes Tasmania and the whole Australian continent with the exception of the northern coast.

Dromia ciliata, n. sp.
Cryptodromia lateralis (Gray).
,, *nodulifera*, n. sp.
,, *incisa*, n. sp.
Latreillia australiensis, n. sp.
Lyreidus tridentatus, De Haan, X.
Diogenes custos (Fabricius).
Pagurus sp.
Clibanarius strigimanus (White).
Eupagurus lacertosus, n. sp., var. *nana*, nov.
Anapagurus australiensis, n. sp.
Glaucothöe carinata, n. sp.
Pylocheles spinosus, n. sp.
Galathea pusilla, n. sp.
Munida rugosa (White), var. *australiensis*, nov.
,, *haswelli*, n. sp.
Uroptychus australis, n. sp., VI., X.
,, *gracilimanus*, n. sp.

IX. The Novo-Zeylanian Province.

This province, which includes only the islands of New Zealand, is fairly distinct from the last, though there is a considerable number of species common to both.

Eupagurus lacertosus, n. sp.
,, *rubricatus*, n. sp.
Paguristes pilosus (H. Milne-Edwards).
,, *subpilosus*, n. sp.
Parapagurus latimanus, n. sp.
**Pagurodes inarmatus*, n. sp., XII.
Munida gracilis, n. sp.
**Elasmonotus marginatus*, n. sp.

X. The Pacific Province.

This province is one which extends over a large area, and at the same time its boundaries are by no means clearly defined. It comprises the shores of the various groups of islands throughout the Pacific.

Lyreidus tridentatus, De Haan, VIII.
Cœnobita rugosa, H. Milne-Edwards, VI.
,, *perlata*, H. Milne-Edwards.
Pagurus deformis, H. Milne-Edwards.
Pagurus euopsis, Dana.
Calcinus tibicen (Herbst).
Catapagurus australis, n. sp., VI.
**Tylaspis anomala*, n. gen. et sp.
Petrolisthes unilobatus, n. sp.

Galathea aculeata, Haswell, VI.
**Munida microphthalma*, A. Milne-Edwards, II., IV.
,, *normani*, Henderson.
,, *granulata*, Henderson.
,, *militaris*, Henderson, VI.
,, *tuberculata*, Henderson.
,, *spinicordata*, Henderson.
Elasmonotus miersii, Henderson.
,, *debilis*, Henderson.
**Uroptychus spinimarginatus*, Henderson, VI.
* ,, *australis*, Henderson, VI., VIII.
,, *politus*, Henderson.

XI. The Peruvian Province.

This includes the coasts of Chili and Peru; possibly it extends further north than the boundary of the latter country.

**Parapagurus abyssorum*, A. Milne-Edwards, II., III., V., VI., VII.
Petrolisthes violaceus (Guérin).
,, *validus* (Dana), XII.
**Munidopsis antonii* (A. Milne-Edwards), XII.
**Galacantha bellis*, n. sp.

THE ANTARCTIC REGION.

XII.

As already indicated, this region is held to include all these species taken to the south of 40° S. latitude. I have, however, comprised certain Antarctic forms taken at Station 320, off the Rio de la Plata.

Lithodes murrayi, n. sp.
Paralomis verrucosus (Dana).
,, *aculeatus*, n. sp.
* ,, *formosus*, n. sp.
Eupagurus comptus (White), var. *jugosa*, nov.
Parapagurus dimorphus (Studer), V.
**Pagurodes inarmatus*, n. sp., IX.
Petrolisthes validus (Dana), XI.
Porcellanella triloba, White, VI.
Munida subrugosa (White).
**Munida spinosa*, Henderson.
Munidopsis antonii (A. Milne-Edwards), XI.
* ,, *subsquamosa*, Henderson, var. *aculeata*, nov.
,, *trifida*, Henderson.
Elasmonotus asper, Henderson.
Ptychogaster milne-edwardsi, Henderson.
Uroptychus insignis, Henderson.
,, *parvulus*, Henderson.

BATHYMETRICAL DISTRIBUTION.

In the following tables the species are grouped according to the bathymetrical zones in which they occurred. I have thought it unnecessary to incorporate the results of other and later deep-sea expeditions, for so far as is known from what has already been published on the subject, these do not add materially to the results obtained by a study of the Challenger collection.

I have followed Professor A. Agassiz in considering all depths beyond 500 fathoms as abyssal, but this limit must be regarded as a somewhat arbitrary one. There is less difficulty in deciding where the littoral fauna ceases and the deep-water forms make their appearance, and as regards the Anomura at least, the 100 fathom line marks approximately the boundary between the two.

The Anomura, it may be stated generally, occupy an intermediate position between the Macrura and the Brachyura, in regard to the limit of depth at which they are found. The more highly specialised forms are like the Brachyura found in shallow-water and moderate depths, whereas the more primitive Macruran types extend to the abysses of the ocean. Mr. Miers has pointed out that the Brachyura obtained from the greatest depths are essentially those most nearly related to the Anomura.

The tables, in addition to affording a list of the species taken at different depths, indicate the relative proportion of new species obtained in each vertical zone. It will be seen that a large proportion of the deep-water and abyssal forms belong to previously undescribed species—indeed all of the latter, with a single exception, were taken for the first time by the Challenger; though in the long interval that has elapsed since the return of the expedition, subsequent deep-sea investigations have resulted in the rediscovery of several.

One or more numbers placed after any species indicate that it was also obtained from the corresponding zones.

Terrestrial Species.

Birgus latro (Linné).
Cœnobita clypeata (Herbst).
Cœnobita rugosa, H. Milne-Edwards.
,, *perlata*, H. Milne-Edwards.

Littoral and Shallow-water Species.

I. From between tide-marks to 20 fathoms.

Cryptodromia lateralis (Gray), II., IV.
,, *japonica*, n. sp.
,, *nodulifera*, n. sp.
Dromidia antillensis, Stimpson.
,, *spongiosa*, Stimpson.
Pseudodromia latens, Stimpson.
Hypoconcha sabulosa (Herbst).
,, *panamensis*, S. I. Smith.
Raninoides personatus (White), Henderson.
Cosmonotus grayii, Adams and White.
Zanclifer caribensis (de Freminville).
Remipes testudinarius, Latrielle.
,, *scutellatus*, Fabricius.
Mastigochirus quadrilobatus, Miers.
Albunea microps (White), Miers.
Paralomis verrucosus (Dana).
Diogenes custos (Fabricius).
,, *brevirostris*, Stimpson.
,, *guttatus*, n. sp.
Pagurus striatus, Latrielle, IV.
,, *granulatus*, Olivier.
,, *calidus*, *Risso*, III.
,, *deformis*, H. Milne-Edwards.
,, *imbricatus*, H. Milne-Edwards.
,, *euopsis*, Dana.
,, *dearmatus*, n. sp.
,, *similimanus*, n. sp.
Calcinus tibicen (Herbst).
Eupagurus excavatus (Herbst), var. *meticulosa*, Roux.
Eupagurus comptus (White), var. *jugosa*, nov., IV.
Eupagurus constans, Stimpson.
Spiropagurus spiriger (De Haan), II.
Anapagurus pusillus, n. sp., III.
,, *australiensis*, n. sp.
Catapagurus australis, n. sp., II.
Paguristes pilosus (H. Milne-Edwards).
,, *hians*, n. sp.
,, sp.
Parapagurus latimanus, n. sp.
Petrolisthes violaceus (Guérin).
,, *validus* (Dana).
,, *armatus* (Gibbes).
,, *annulipes* (White), Miers.
,, *unilobatus*, n. sp.
,, *serratus*, n. sp.
,, sp.
Porcellana sayana (Leach).
,, *streptocheles*, Stimpson.
,, *serratifrons*, Stimpson.
Porcellanella triloba, White.
Raphidopus ciliatus, Stimpson.
Pachycheles barbatus, A. Milne-Edwards.
,, *pulchellus* (Haswell). II.
Polyonyx obesulus (White), Miers.
Galathea elegans, White.
,, *labidolepta*, Stimpson (?).
,, *aculeata*, Haswell.
,, sp.
Munida subrugosa (White), II., IV., VI.
,, *spinulifera*, Miers.
,, *spinifrons*, Henderson.

II. From 20 to 50 fathoms.

Dromia ciliata, n. sp.
Cryptodromia lateralis (Gray), I., IV.
Latreillia australiensis, n. sp., IV.
Lyreidus tridentatus, De Haan, V.
Pagurus sp.
Clibanarius strigimanus, White.
Eupagurus lacertosus, n. sp., var. *nana*, nov.
Spiropagurus spiriger (De Haan), I.
Catapagurus australis, n. sp., I.
Pachycheles pulchellus (Haswell), I.
Galathea australiensis, Stimpson.
Munida subrugosa (White), I., IV., VI.
,, ,, (White), var. *australiensis*, nov.

III. From 50 to 100 fathoms.

Homola orientalis, n. sp., IV.
Latreillopsis bispinosa, n. sp.
Latreillia valida, De Haan.
Pagurus calidus, Risso, I.
Eupagurus pubescens (Kröyer), var. *kroyeri*, Stimpson.
Eupagurus (?) sp.
Spiropagurus elegans, Miers.
Anapagurus pusillus, n. sp., I.
Galathea grandirostris, Stimpson.
,, *dispersa*, Spence-Bate.
,, sp.
Munida sancti-pauli, Henderson.

DEEP-WATER SPECIES.

IV. From 100 to 200 fathoms.

Cryptodromia lateralis (Gray), I., II.
,, *incisa*, n. sp.
Dromidia bicornis, Studer.
Eudromia frontalis, n. sp.
Homola orientalis, n. sp., III.
Latreillia australiensis, n. sp., II.
Notopoides latus, n. sp.
Notopus ovalis, n. sp.
Pagurus striatus, Latreille, I.
Clibanarius (?) sp.
Eupagurus tristanensis, n. sp.
,, *comptus* (White), var. *jugosa*, nov.
,, *spinulentus*, n. sp.
Paguristes subpilosus, n. sp.
Glaucothoë carinata, n. sp.
Parapagurus dimorphus (Studer), V.
Pagurodes piliferus, n. sp.
Paguropsis typicus, n. sp.
Pylocheles spinosus, n. sp.
Galathea subsquamata, Stimpson.
,, *pusilla*, Henderson.
Munida subrugosa (White), I., II., VI.
,, *squamosa*, Henderson.
,, *scabra*, Henderson.
,, *proxima*, Henderson.
,, *militaris*, Henderson, V.
,, *haswelli*, Henderson.
,, *inornata*, Henderson.
Elasmonotus lævigatus, Henderson.
Eumunida smithii, Henderson.
Ptychogaster lævis, Henderson.

V. From 200 to 500 fathoms.

Lyreidus tridentatus, De Haan, II.
Lithodes murrayi, n. sp.
Paralomis aculeatus, n. sp.
Eupagurus lacertosus, n. sp.
,, *ocelusus*, n. sp.
Paguristes visor, n. sp.
Parapagurus dimorphus (Studer), IV.
,, *gracilis*, n. sp.
Porcellana robertsoni, n. sp.
Galathea inconspicua, Henderson.
Munida stimpsoni, A. Milne-Edwards.
,, *miles*, A. Milne-Edwards.
,, *microphthalma*, A. Milne-Edwards, VI.
,, *spinosa*, Henderson, VI.
,, *normani*, Henderson.
,, *incerta*, n. sp.
,, *granulata*, Henderson.
,, *militaris*, Henderson, IV.
,, *militaris*, Henderson, var. *curvirostris*, nov.
,, *gracilis*, Henderson.
Munida tuberculata, Henderson.
,, *spinicordata*, Henderson.
,, sp.
Munidopsis erinacea (A. Milne-Edwards).
,, *sigsbei* (A. Milne-Edwards).
,, *trifida*, Henderson.
Elasmonotus armatus, A. Milne-Edwards.
,, *miersii*, Henderson.
,, *asper*, Henderson.
,, *debilis*, Henderson.
Ptychogaster milne-edwardsi, Henderson.
Uroptychus nitidus (A. Milne-Edwards).
,, *insignis*, Henderson.
,, *parvulus*, Henderson.
,, *australis*, Henderson, VI.
,, *gracilimanus*, Henderson.

ABYSSAL SPECIES.

VI. From 500 to 1000 fathoms.

Homologenus (?) sp.
Paralomis formosus, n. sp.
Eupagurus rubricatus, n. sp.
Parapagurus affinis, n. sp.
Pagurodes limatulus, n. sp.
Munida subrugosa (White), I., II., IV.
,, *microphthalma*, A. Milne-Edwards, V.
Munida spinosa, Henderson, V.
Munidopsis brevimana, Henderson. VII.
,, *milleri*, Henderson.
,, *pilosa*, Henderson.
Uroptychus spinimarginatus, Henderson.
,, *politus*, Henderson.
,, *australis*, Henderson, V.

VII. From 1000 to 1500 fathoms.

Lithodes agassizii, S. I. Smith.
Parapagurus abyssorum, A. Milne-Edwards, VIII.
Pagurodes inarmatus, n. sp.
,, sp. (?).
Munidopsis serratifrons (A. Milne-Edwards).
,, *antonii* (A. Milne-Edwards), VIII.
Munidopsis subsquamosa, Henderson. var. *aculeata*, nov.
,, *brevimana*, Henderson. VI.
Elasmonotus latifrons, Henderson.
,, *marginatus*, Henderson.
Galacantha talismanii, A. Milne-Edwards.
,, *bellis*, Henderson.

VIII. From 1500 to 2000 fathoms.

Parapagurus abyssorum, A. Milne-Edwards, VII.
Munidopsis antonii, A. Milne-Edwards, VII.
Munidopsis subsquamosa, Henderson.

IX. From 2000 to 2500 fathoms.

Tylaspis anomala, Henderson.
Parapagurus abyssorum, A. Milne-Edwards, var. *scabra*, nov.

SUMMARY.

The Challenger collection contains 161 species, or well-marked varieties, of Anomura, referable to 52 different genera, and of these 86 species and 7 genera are described as new to science.

The large proportion of new species is scarcely to be wondered at when the nature of the Challenger dredgings is borne in mind. Prior to 1873 scarcely any deep-water investigations had been made in the seas visited by the Expedition, and the abysses of the ocean practically remained a sealed book to naturalists; hence it is not surprising that slightly more than three-fourths of the total number of new species were taken beyond the one hundred fathom line.

In some respects the collection is disappointing, a few of the shallow-water groups being but poorly represented, while many well-known and widely distributed species are conspicuous by their absence. The interest and value of the collection is, however, by no means confined to the deep-water forms, for the careful manner in which the locality and conditions of existence were noted at the time of capture has disclosed many important facts, and added materially to our knowledge of the distribution of shallow-water species. The main interest, however, centres in the Paguridea and the Galatheidea—two great groups which extend to abyssal depths.

The more highly specialised Anomura, *i.e.*, the Dromidea, Raninidea, and Hippidea, are less fully represented in the collection than the Macruran forms, and, like the Brachyura, they appear to be almost confined to shallow water. With the exception of *Homologenus*, founded by Alphonse Milne-Edwards for the reception of a West Indian species, to which a young Homolid taken by the Challenger is doubtfully referred, none of the Dromidea are known to occur beyond the five hundred fathom line, though several genera are found in comparatively deep water. So far as is known the Raninidea are even more completely restricted to shallow water, and few of the species in all probability occur at greater depths than 200 fathoms. The deepest water in which any Raninid has been found is 210 fathoms, at which depth specimens of the rare Japanese *Lyreidus tridentatus*, De Haan, were taken off the Fiji Islands. The Hippidea are represented by only four species, all of which have been previously described, though two belong to rare and little known forms. There is every reason to believe that the members of this group are strictly littoral, and most if not all occur from between tide-marks to a depth of not more than a few fathoms.

Two of the new genera in the above-mentioned groups are of special interest. *Latreillopsis*, of which a single species was taken off the Philippines, forms an interesting connecting link between *Homola* and *Latreillia*, inasmuch as it combines the body of the former, with the attenuated limbs and eye-stalks of the latter, thus showing the necessity of placing all three in a single family. The genus *Zanclifer* has been established for a curious Raninid taken in shallow water off Bahia, which possesses some interesting structural peculiarities. Originally discovered in the West Indies, upwards of fifty years ago, it was described in a very imperfect manner by its discoverer, de Freminville, who referred it to the fossil genus *Eryon*. The manifest inaccuracy of this description led to its being ignored by most subsequent writers, and the species was apparently lost sight of till rediscovered by the Challenger. It is sharply distinguished from all other Raninidea by certain prominent features, and more especially by the form of the eyes, which are so extremely rudimentary as to be scarcely recognisable at first sight. It seems probable that in this case partial loss of vision has been brought about by the animal taking up its abode in subterranean burrows.

The Paguridea and Galatheidea comprise more than four-fifths of the total number of species in the collection, and the facts connected with their bathymetrical distribution are among the most important discussed in the Report.

Three new species of Lithodea were taken, all of them in the southern hemisphere. The members of this group were formerly believed to occur only in the shallow water of the northern and southern temperate regions, but deep-sea dredgings, more especially those of the "Talisman," have shown that they extend to the tropics, in which case they are confined to deep water (some of the species reaching a depth of over 1000 fathoms), where the temperature conditions are doubtless favourable to their existence. As Professor A. Milne-Edwards has pointed out, this unexpected feature in their distribution is not without interest, inasmuch as it shows the possibility of certain forms spreading from the one circumpolar region to the other, and accommodating themselves to the altered environment, in order to obtain the necessary conditions of temperature.

The Pagurodea, or Hermit Crabs, extend to a depth of more than 2000 fathoms. A few of the characteristic shallow-water genera, *e.g.*, *Eupagurus* and *Paguristes*, extend to deep water, but the majority of the abyssal species belong to genera which have either recently, or in the preceding pages, been described as new. In nearly all cases the branchiæ of the deep-water forms, while retaining their normal arrangement, exhibit a puzzling modification of structure. The two collateral rows of flattened leaflets met with on each branchial stem in the gills of the ordinary Pagurids are replaced by a double row of rounded filaments; in other words, there is a departure from the phyllobranchiate to the trichobranchiate type. It so happens that this condition is the reverse of what might be expected, for it is known that the supply of oxygen is diminished at great depths, and in many other deep-sea animals the respiratory surface is apparently increased with the object as it were of counterbalancing this diminution in the supply. I am, therefore, led to the conclusion that this character is an ancestral one, and that certain at least of the Pagurodea are the descendents of Macrura in which the gills were trichobranchiate. This view is partly supported by the fact that in *Pylocheles*, A. Milne-Edwards, a deep-water genus which is represented by a single species in the collection, and retains to a remarkable extent the primitive Macruran characteristics, the gills have essentially this structure.

The other structural modifications met with in the deep-water Pagurids are comparatively few and unimportant. The eyes as a rule are slightly reduced in size, but in all cases they are pigmented and apparently functional, a fact which would lead us to suppose that the Pagurodea have spread more recently into deep water than the Galathodea. The most characteristic genus is *Parapagurus*, S. I. Smith, the species of which appear to live invariably in a state of commensalism with an Anemone, which exerts a solvent action on the shell originally taken possession of by the Hermit, so that in many cases the latter is merely protected by its clinging messmate. I have failed to detect a single instance in which a shell had not apparently been present at one time. In all the females which I have examined the genital opening of the right side is apparently absent, a peculiarity which doubtless coincides with a deficiency in the internal reproductive organs, though I have been unable to satisfy myself on this point. One of the species, *Parapagurus abyssorum*, A. Milne-Edwards, appears to be almost universally distributed at great depths, affording a noticeable instance of the greatly extended distribution enjoyed by many abyssal species.

The Pagurid which I have described under the name of *Tylaspis*, and which occurred at a depth of more than 2000 fathoms, is remarkable chiefly for the fact that its gills have essentially the ordinary phyllobranchiate structure, though the characters of the carapace and abdomen are also sufficiently marked. *Pagurops is*, another of the new genera, also presents several features of extreme interest. It is distinguished by the large size of its eyes, and by two characters in which it stands apart from all other Pagurids, viz., the last two pairs of thoracic legs are subdorsal in position, and the unpaired abdominal appendages occur on the right side.

It is, however, among the Galatheidea that the largest proportion of deep-water forms is found.

The Porcellanodea, or more highly specialised Galatheids, are almost confined to shallow water, but a new species (*Porcellana robertsoni*) was taken in the West Indies at a depth of 390 fathoms, which in all probability marks approximately the extreme vertical limit of the group.

The Galathodea, on the other hand, are found abundantly to a depth of about 2000 fathoms. Most of the abyssal species are blind, and the eyes have undergone a process of degeneration which is tolerably uniform in all. The eye-stalk is frequently prolonged in the form of a short spine, while the visual portion is pale in colour and absolutely devoid of pigment. A distinct corneal surface is always present, though in one species (*Munidopsis pilosa*, Henderson) it is remarkably reduced; and in nearly all cases the degenerative changes have taken place without any marked reduction in the size of the eye as a whole. Some of the blind species are remarkable for the great length of their antennæ, rendering it probable that the loss of sight is partially compensated by an increased development of the tactile sense. The puzzling fact that certain deep-water species are blind, while in others belonging to the same group and found at similar depths the eyes are well developed, has been frequently commented on, and the explanation that the former have probably migrated into deep water at an earlier period, and have consequently had sufficient time to undergo modification, appears to be the most satisfactory one. The blind Galatheids share so many features in common, and the most widely separated types are so frequently connected by intermediate forms, that the retention of certain of the genera which have been founded for their reception must, I hold, be regarded as questionable. Since the return of the expedition other naturalists have instituted five new genera, all of which are represented in the Challenger collection.

A very conspicuous feature is the prevalence of species of *Munida*. They are found almost everywhere in deep water, though but few reach a depth of 1000 fathoms, which appears to represent their bathymetrical limit. Prior to the Challenger investigations not more than half a dozen species were known to science, but recent deep-sea dredgings have increased the number to upwards of thirty; no less than fifteen of the species in the present collection are described as new. In none of them—with a single exception—do we meet with any striking modification, though in most cases the eyes are slightly enlarged, a feature commonly observed in those deep-sea animals in which the visual organs are still functional. The exception referred to is that of a species named *Munida microphthalma* by A. Milne-Edwards in his Preliminary Report on the "Blake" Crustacea, which was taken by the Challenger in both the Atlantic and the Pacific. In this species signs of commencing degeneration are apparent, the eyes being remarkably reduced in size, and the corneæ of a light brown colour.

In the majority of the deep-water Galatheids—with the exception of those belonging to the genus *Munida*—the eggs carried by the female are few in number and of remarkably large size. It may be inferred from this that in the deep sea enemies are fewer, and the chances of each individual egg undergoing its full development therefore relatively greater, the result being diminished production on the part of the parents; while the large size of the ova perhaps indicates a protracted embryonic existence.

Two well-marked genera, *Ptychogaster* and *Uroptychus*, and to a lesser extent a third, *Eumunida*, are distinguished by a curious modification in the form of the abdomen, which, unlike that of other Galatheids, has become twice folded on itself. Some of the species appear to dwell in the branches of Gorgoniæ, &c., and the rudimentary nature of the terminal swimming fan points to their leading a sedentary life, which has resulted in the abdomen becoming folded, as there is now no need for keeping it semi-extended. These forms are thus assuming to a slight extent the main feature of the Brachyura.

Numerous instances occur of abyssal species with a greatly extended range of distribution, and of these we may cite what is perhaps the most striking. *Munidopsis antonii* (A. Milne-Edwards), which was captured by the "Talisman" off the north-west coast of Africa, was taken by the Challenger in the Southern Ocean and off the island of Juan Fernandez, South America.

An examination of the deep-sea forms in the collection does not afford any insight into the colour which they possessed during life, for long immersion in alcohol has reduced them all to a dull white. It is known, however, that red is the prevailing colour at great depths, and it appears that, in some cases at least, shallow-water species assume this colour when they pass into deeper water. In the summer of 1885, when dredging in Loch Fyne, on the west coast of Scotland, along with Mr. John Murray and other naturalists, we captured at a depth of 105 fathoms a large number of examples of the shrimp *Pandalus annulicornis*, Leach, in which the colour was a bright red, whereas specimens from shallow water on the same coast are invariably of the same pale greyish hue as the sandy bottom on which they are usually found.

In conclusion, it may be stated that the collection of Anomura reported on in the preceding pages is one of the most valuable which has ever been brought together during a single voyage. It has indeed furnished a knowledge of the bathymetrical distribution of the Anomura which previous to the dispatch of the Challenger was almost entirely wanting, and last, though not least, it has very materially added to the number of known species in the group.

APPENDIX.

Two species of Anomura, taken in shallow water, off Bahia, were received too late for satisfactory identification and insertion in the Report. One is a *Hypoconcha*, of small size, though an adult female bearing eggs, which is perhaps referable to *Hypoconcha panamensis*, S. I. Smith, while the other is a species of *Petrolisthes*.

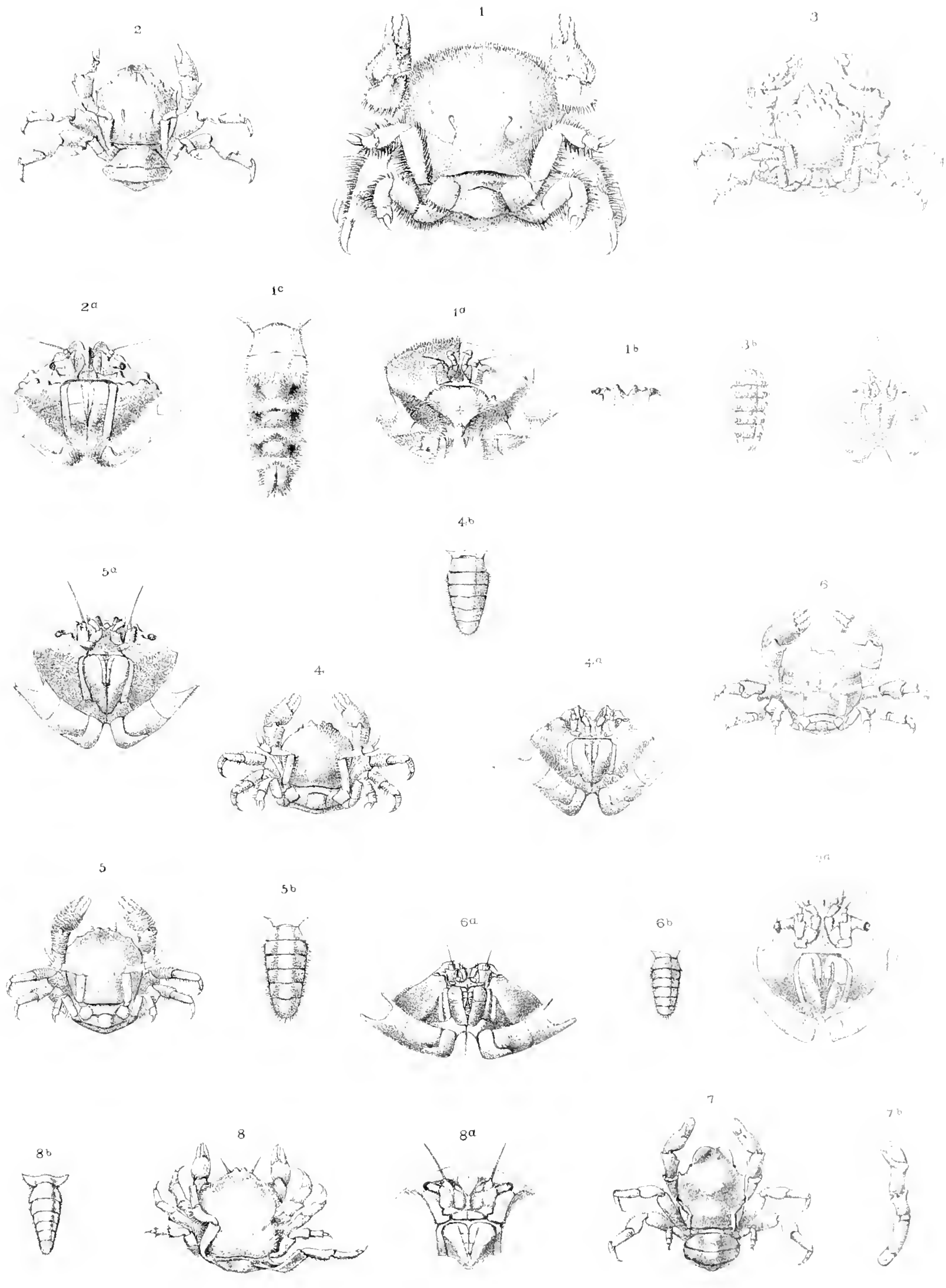
INDEX.

Note.—Synonyms are printed in *Italics*. The more important pages are indicated by darker type.

PLATE I.

PLATE I.

	Diam.	Page
Fig. 1. *Dromia ciliata*, n. sp.,	× 1	3
a. Cephalic region (with the hairs removed on the left side),	× 1	
b. Fronto-orbital region (with hairs removed),	× 1	
c. Abdomen of male,	× 1	
Fig. 2. *Cryptodromia japonica*, n. sp.,	× 1	6
a. Cephalic region,	× 2	
Fig. 3. *Cryptodromia nodulifera*, n. sp.,	× 2	8
a. Cephalic region,	× 2	
b. Abdomen of male,	× 2	
Fig. 4. *Cryptodromia incisa*, n. sp.,	× 1	10
a. Cephalic region (with the hairs removed on the left side),	× 2	
b. Abdomen of female,	× 1	
Fig. 5. *Dromidia antillensis*, Stimpson,	× 1	12
a. Cephalic region,	× 2	
b. Abdomen of female,	× 1	
Fig. 6. *Dromidia spongiosa*, Stimpson,	× 1	12
a. Cephalic region,	× 2	
b. Abdomen of male,	× 1	
Fig. 7. *Eudromia frontalis*, n. gen. et sp.,	× 1	14
a. Cephalic region,	× 2	
b. Left chelipede of female,	× 1	
Fig. 8. *Pseudodromia latens*, Stimpson (with the fifth right leg drawn back),	× 1	16
a. Cephalic region,	× 2	
b. Abdomen of male,	× 1	



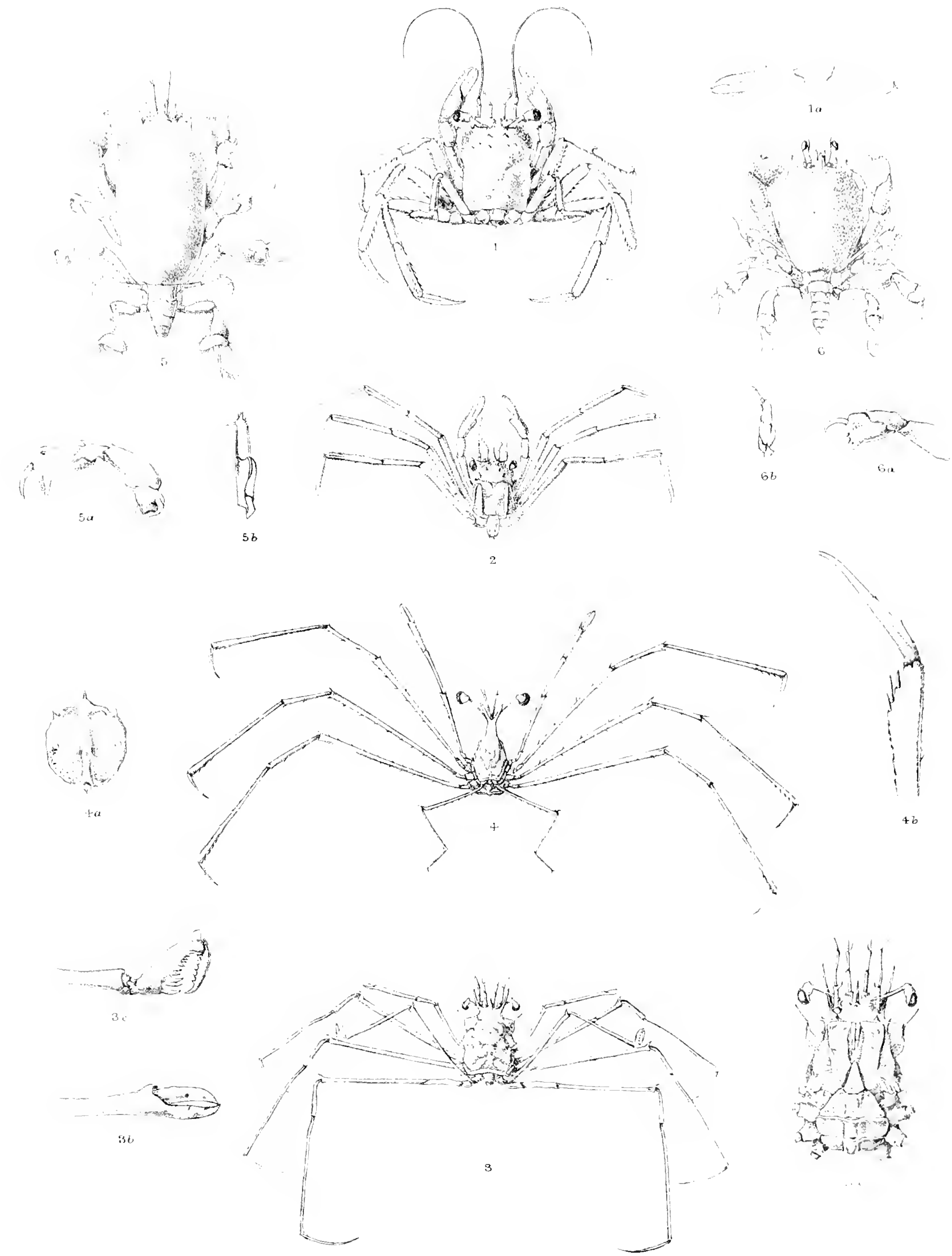
Geo. West & Sons lith. et imp.

DROMIA, CRYPTODROMIA, DROMIDIA, EUDROMIA, PSEUDODROMIA

PLATE II.

PLATE II.

	Diam.	Page
Fig. 1. *Homola orientalis*, n. sp.,	× 1	19
a. Left chelipede of female,	× $1\frac{1}{2}$	
Fig. 2. *Homologenus*, sp. (?), juv.,	× 2	21
Fig. 3. *Latreillopsis bispinosa*, n. gen. et sp.,	× 1	22
a. Under surface of trunk,	× 2	
b. Right chela of female,	× 4	
c. Terminal joints of fifth right leg,	× 4	
Fig. 4. *Latreillia australiensis*, n. sp.,	× 1	24
a. Abdominal plate of female,	× 2	
b. Apex of fourth left leg,	× 4	
Fig. 5. *Raninoides personatus*, White, MS.,	× $1\frac{1}{2}$	27
a. Left chelipede of male,	× 2	
b. Left external maxillipede,	× 2	
Fig. 6. *Notopus ovalis*, n. sp.,	× 2	31
a. Left chelipede of female,	× $2\frac{1}{2}$	
b. Left external maxillipede,	× 2	

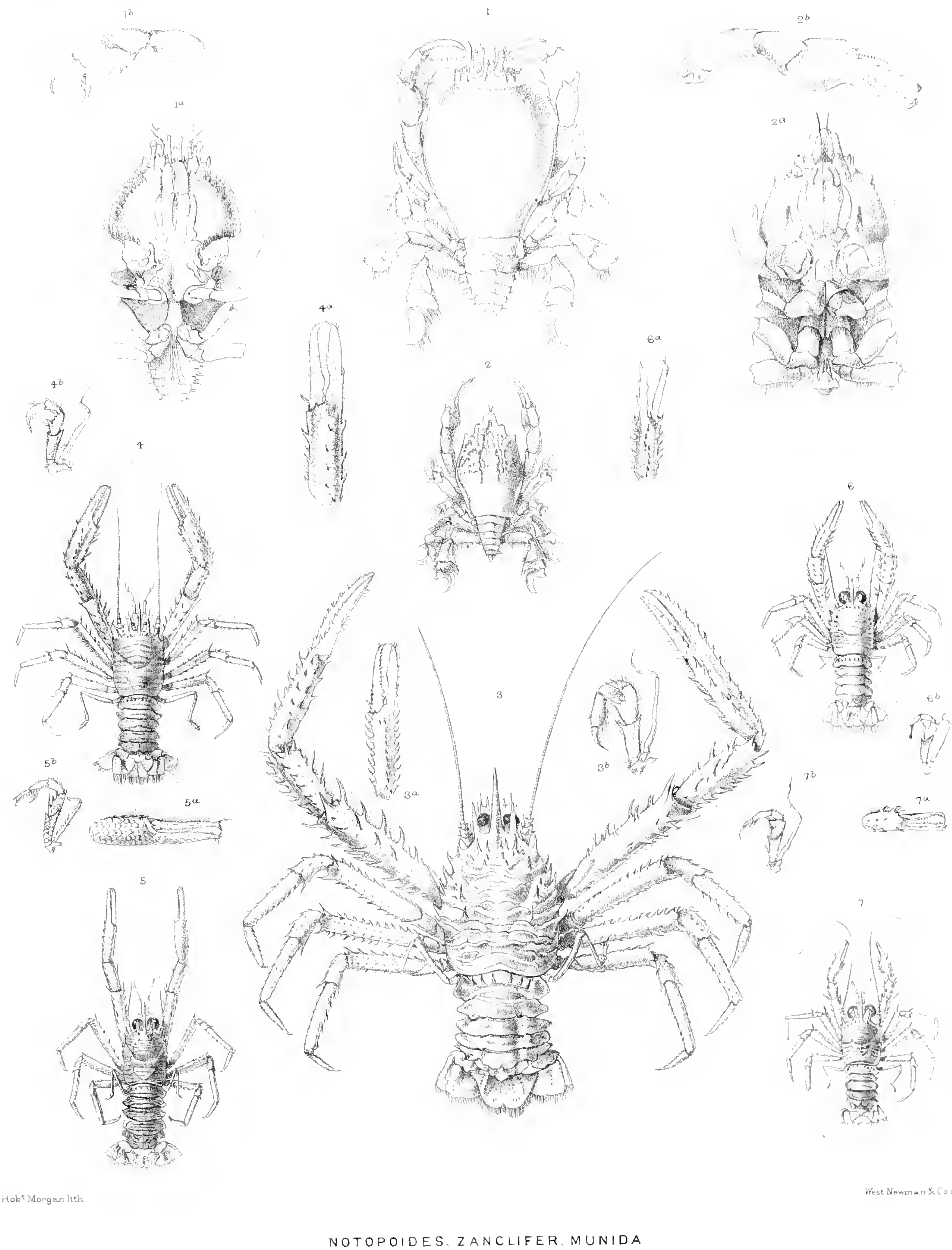


HOMOLA, HOMOLOGENUS, LATREILLOPSIS, LATREILLIA,
RANINOIDES, NOTOPUS

PLATE III.

PLATE III.

	Diam.	Page
Fig. 1. *Notopoides latus*, n. gen. et sp.,	× 1	29
a. Under surface,	× 1	
b. Left chelipede of male,	× 1	
Fig. 2. *Zanclifer caribensis* (de Freminville),	× 1	34
a. Under surface,	× 2	
b. Right chelipede of male,	× 2	
Fig. 3. *Munida spinosa*, Henderson,	slightly enlarged	128
a. Right chela of male,	× 1	
b. Left external maxillipede,	× 2	
Fig. 4. *Munida microphthalma*, A. Milne-Edwards,	× 1	127
a. Right chela of male,	× 2	
b. Left external maxillipede,	× 2	
Fig. 5. *Munida haswelli*, Henderson,	× 1	139
a. Right chela of female from Station 173, doubtfully referred to this species,	× 2	
b. Left external maxillipede,	× 2	
Fig. 6. *Munida sancti-pauli*, Henderson,	× 1	142
a. Right chela of female,	× 2	
b. Left external maxillipede,	× 2	
Fig. 7. *Munida militaris*, Henderson, var. *curvirostris*, Henderson,	× 1	139
a. Right chela of female,	× 2	
b. Left external maxillipede,	× 2	



Robt Morgan lith.

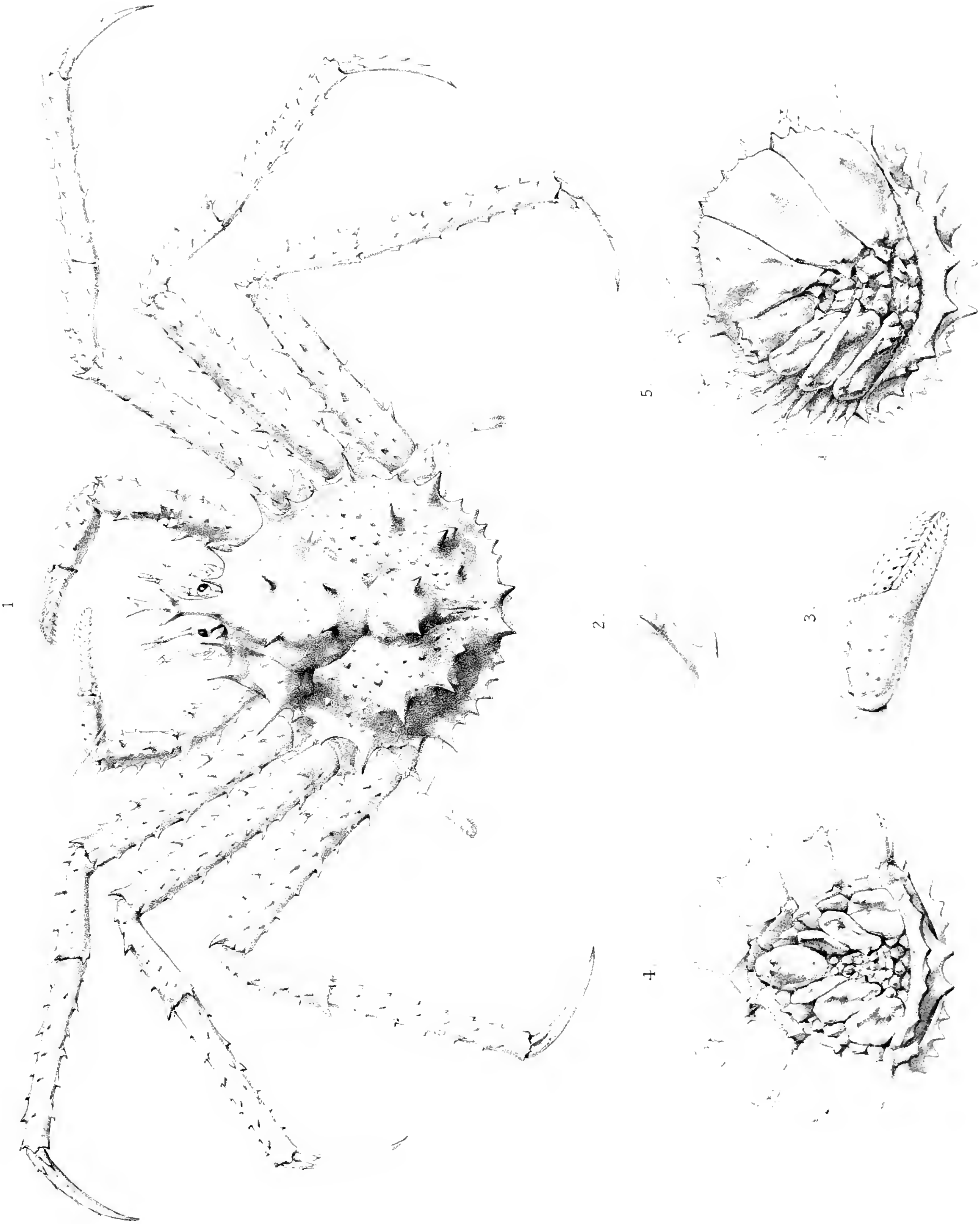
West Newman & Co imp.

NOTOPOIDES, ZANCLIFER, MUNIDA

PLATE IV.

PLATE IV.

	Diam.	Page
Figs. 1–5. *Lithodes murrayi*, n. sp., ...	× about $\frac{2}{3}$	43
Fig. 2. Side view of rostrum, ...	× 1	
Fig. 3. Right chela of male, ...	× 1	
Fig. 4. Abdomen of male, . . .	× about $\frac{2}{3}$	
Fig. 5. Abdomen of female, ...	× about $\frac{2}{3}$	



F. Huth Jr. del.

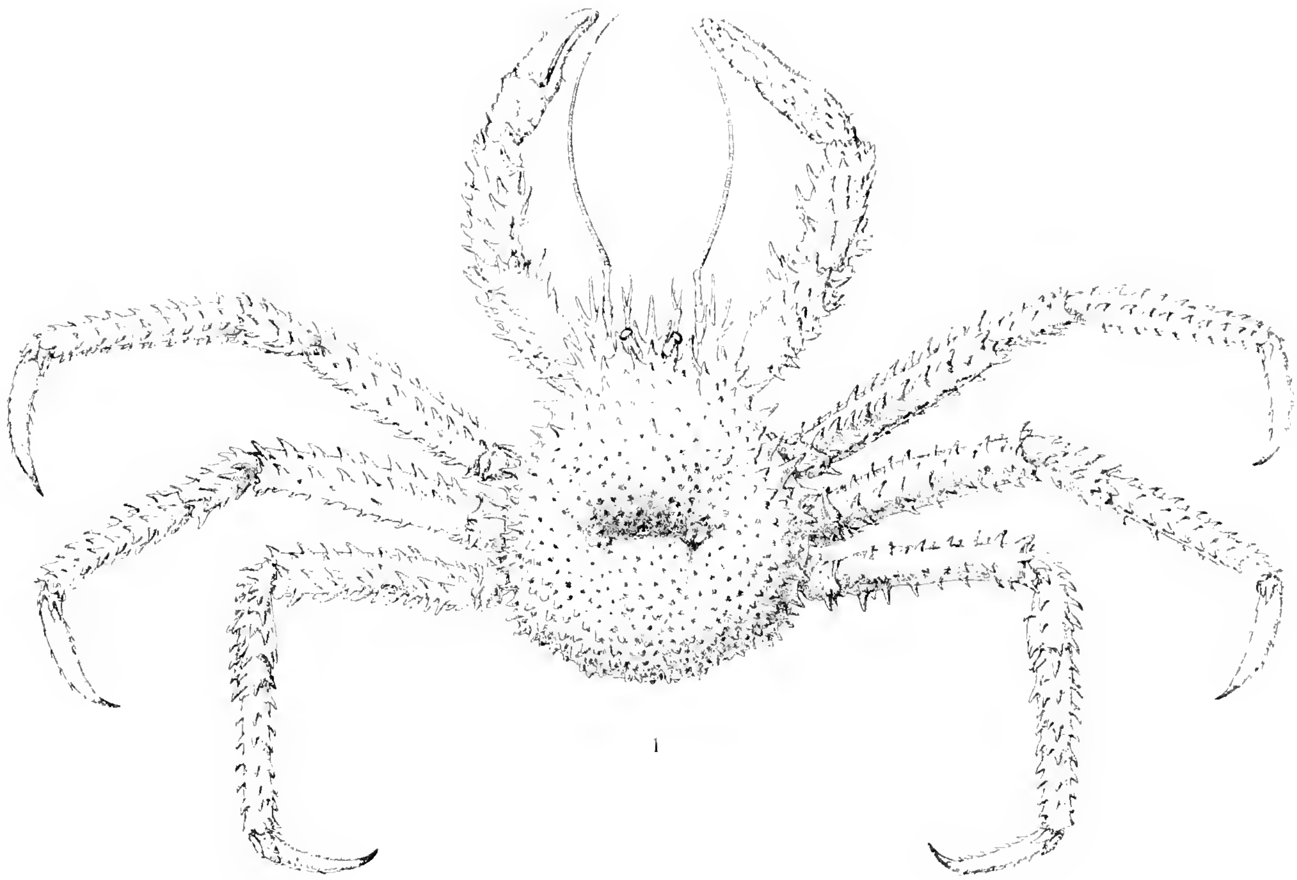
F. Huth Lith.r Edin.r

LITHODES.

PLATE V.

PLATE V.

		Diam.	Page
Fig. 1. *Paralomis aculeatus*, n. sp.,	. . . . .	× 1	45
a. Side view of carapace,	. . . . .	× 1	
b. Side view of rostrum of male,	. . . . .	× 2	
c. Abdomen of male,	. . . . .	× 1	
Fig. 2. *Paralomis formosus*, n. sp.,	. . . . .	× 1	46
a. Side view of carapace,	. . . . .	× 1	
b. Antennal peduncle, from above,	. . . .	× 4	

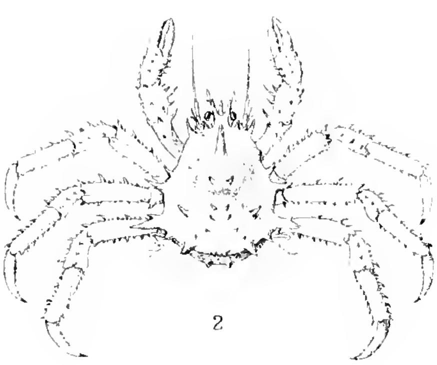


1

2 a

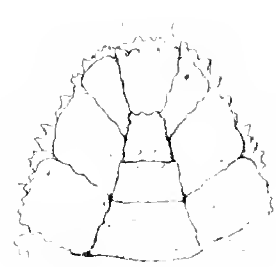
1 a

1 b



2

2 b



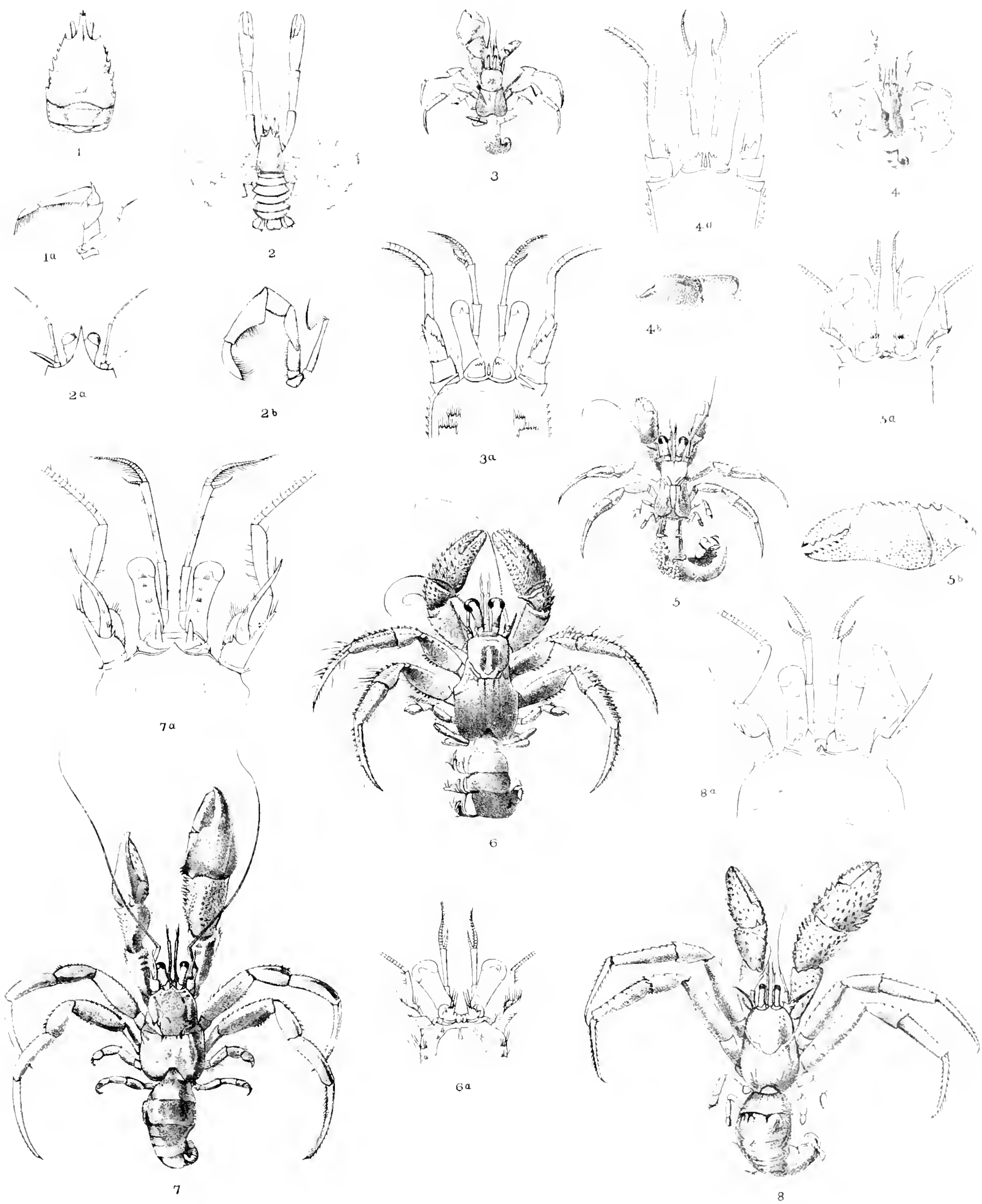
1 c

PARALOMIS.

PLATE VI.

PLATE VI.

	Diam.	Page
Fig. 1. *Uroptychus tridentatus*, n. sp., ...		181
Dorsal surface of trunk, ...	× 3	
a. Left external maxillipede, ...	× 5	
Fig. 2. *Uroptychus politus*, n. sp., ...	× 1	178
a. Frontal region, ...	× 3	
b. Left external maxillipede, ...	× 5	
Fig. 3. *Diogenes brevirostris*, Stimpson, ...	× 1	53
a. Frontal region, ...	× 5	
Fig. 4. *Diogenes guttatus*, n. sp., ...	× 1	54
a. Frontal region, ...	× 6	
b. Left chela of male, ...	× 2	
Fig. 5. *Pagurus dearmatus*, n. sp., ...	× 1	58
a. Frontal region, ...	× 3	
b. Left chela of female, ...	× 3	
Fig. 6. *Pagurus similimanus*, n. sp., ...	× 1	59
a. Frontal region, ...	× 2	
Fig. 7. *Eupagurus lacertosus*, n. sp., ...	× 1	63
a. Frontal region, ...	× 3	
Fig. 8. *Eupagurus constans*, Stimpson, ...	× 1	67
a. Frontal region, ...	× 3	



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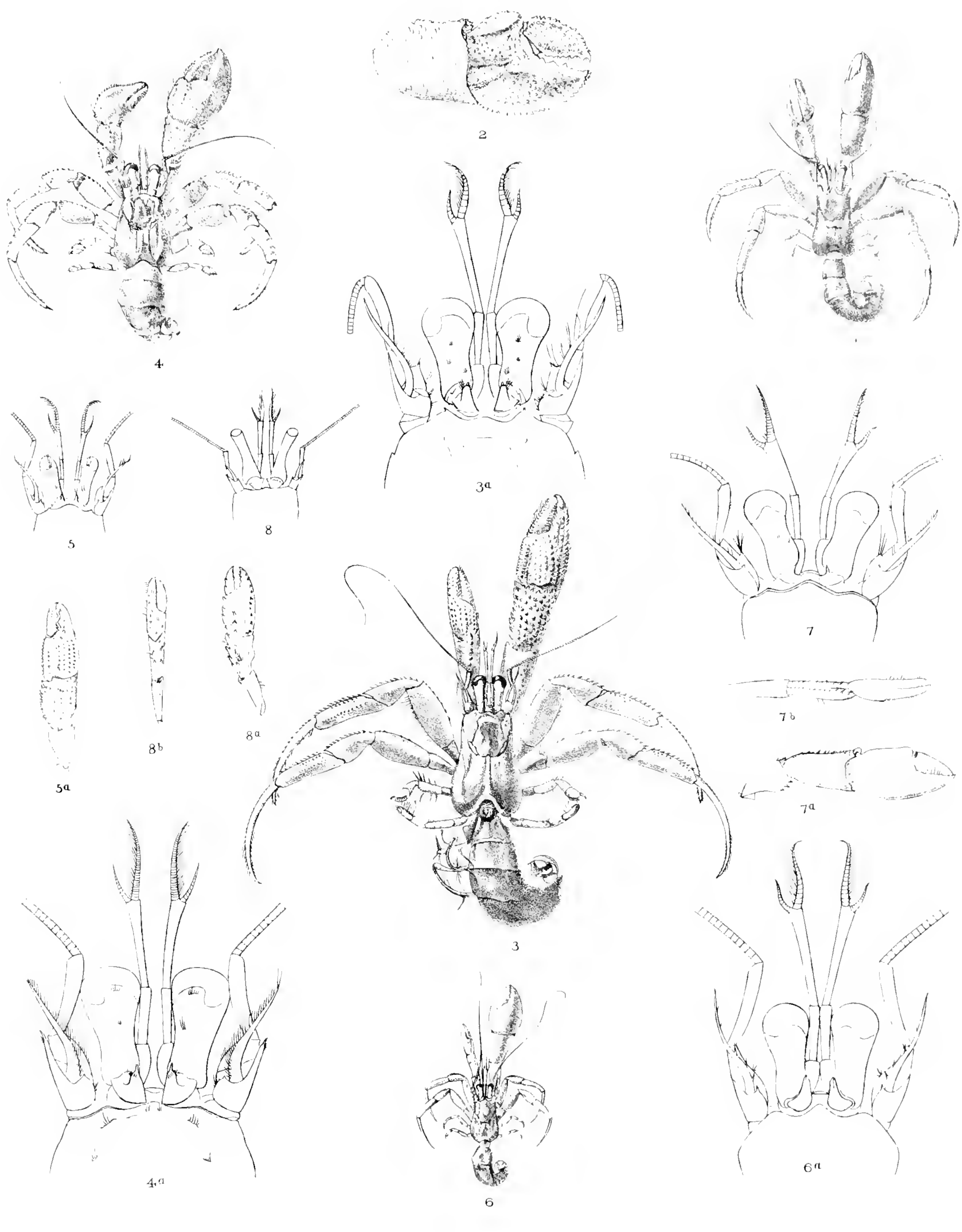
UROPTYCHUS, DIOGENES, PAGURUS, EUPAGURUS.

PLATE VII.

PLATE VII.

	Diam.	Page
Fig. 1. *Eupagurus lacertosus*, n. sp., var. *nana*, nov.,	× 2	64
Fig. 2. *Eupagurus comptus* (White), var. *jugosa*, nov.,		67
Right chela of male,	× 3	
Fig. 3. *Eupagurus spinulentus*, n. sp.,	× 1	68
a. Frontal region,	× 3	
Fig. 4. *Eupagurus rubricatus*, n. sp.,	× 1	69
a. Frontal region,	× 4	
Fig. 5. *Eupagurus tristanensis*, n. sp.,		66
Frontal region,	× 4	
a. Right chelipede of male,	× 3	
Fig. 6. *Eupagurus occlusus*, n. sp.,	× 1	70
a. Frontal region,	× 5	
Fig. 7. *Anapagurus pusillus*, n. sp.,		73
Frontal region,	× 9	
a. Right chelipede of male,	× 5	
b. Left chelipede of male,	× 5	
Fig. 8. *Anapagurus australiensis*, n. sp.,		74
Frontal region,	× 6	
a. Right chelipede of male,	× 5	
b. Left chelipede of male,	× 6	



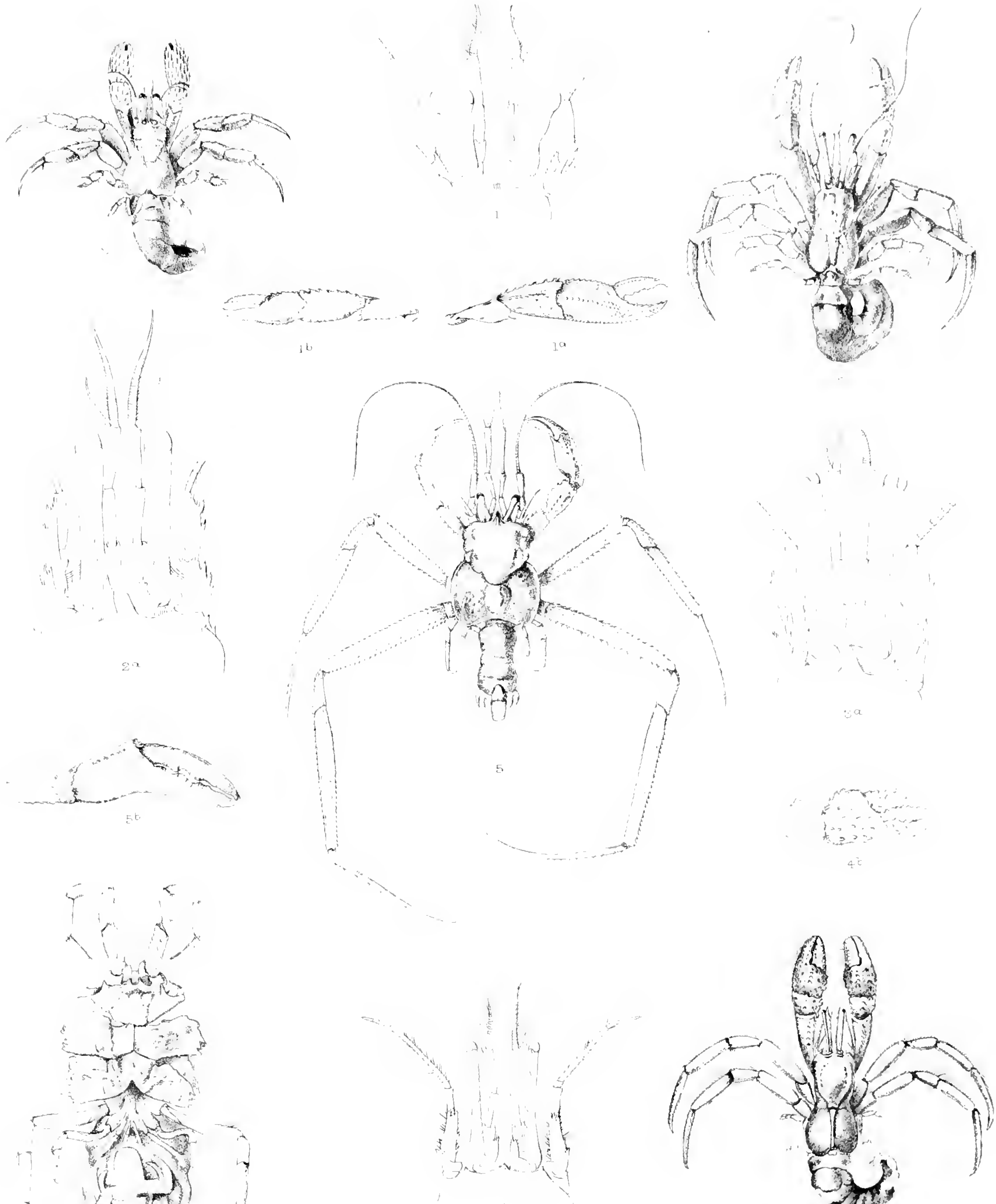
Geo West & Sons lith et imp

EUPAGURUS, ANAPAGURUS.

PLATE VIII.

PLATE VIII.

	Diam.	Page
Fig. 1. *Catapagurus australis*, n. sp., ...	.	76
Frontal region, ...	× 7	
a. Right chelipede of male, ...	× 4	
b. Left chelipede of male, ...	× 4	
Fig. 2. *Paguristes subpilosus*, n. sp., ...	× 1	77
a. Frontal region, ...	× 6	
Fig. 3. *Paguristes visor*, n. sp., ...	× 1	78
a. Frontal region, ...	× 3	
Fig. 4. *Paguristes hians*, n. sp., ...	× 2	79
a. Frontal region, ...	× 6	
b. Right chela of male, ...	× 3	
Fig. 5. *Tylaspis anomala*, n. gen. et sp., ...	× 2	81
a. Under surface, ...	× 4	
b. Right chela of male, ...	× 3	

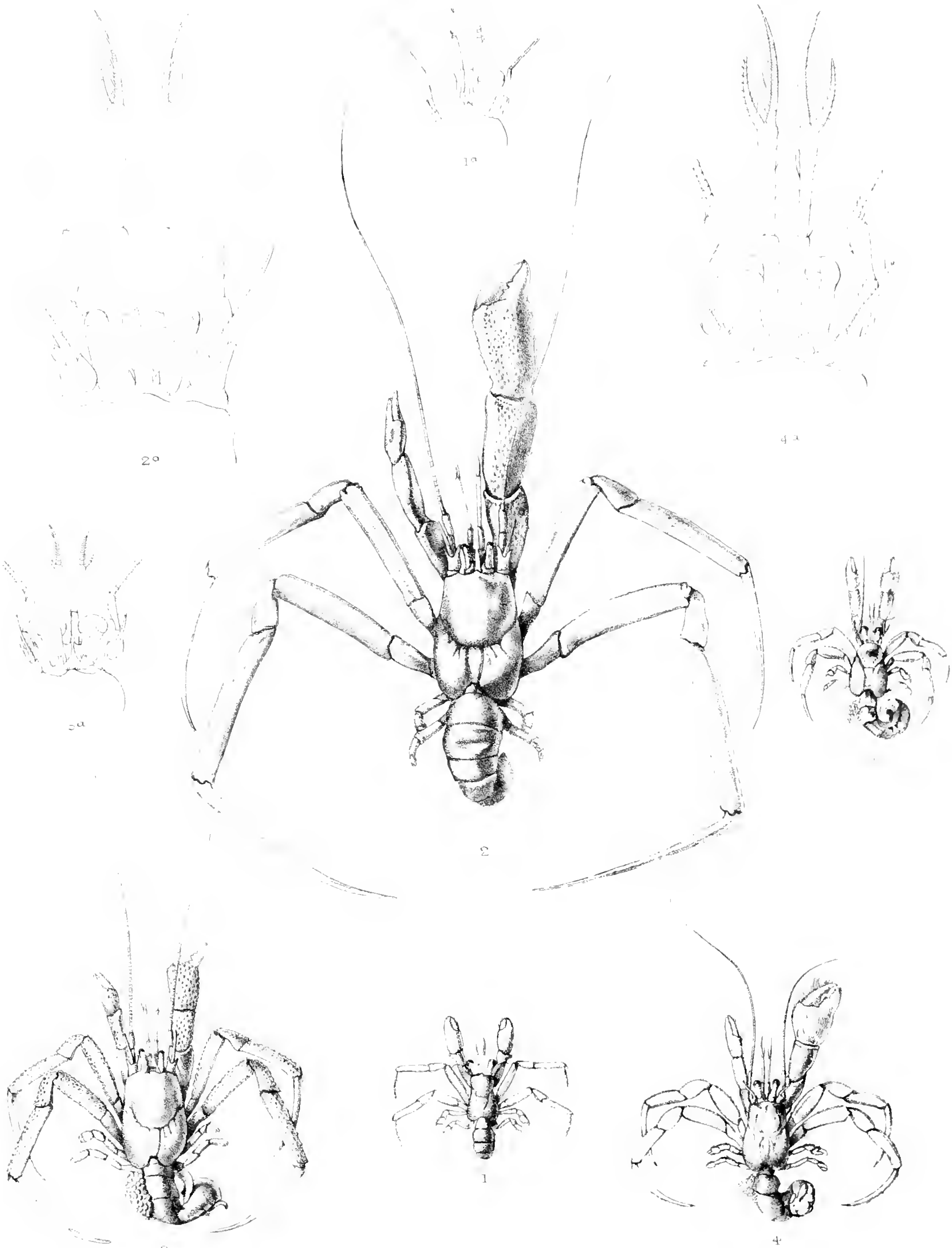


CATAPAGURUS, PAGURISTES, TYLASPIS

PLATE IX.

PLATE IX.

		Diam.	Page
Fig. 1. *Glaucothoë carinata*, n. sp.,	.	× 2	84
a. Frontal region,	.	× 6	
Fig. 2. *Parapagurus abyssorum* (A. Milne-Edwards),	.	× 1	87
a. Frontal region,	.	× 2	
Fig. 3. *Parapagurus abyssorum* (A. Milne-Edwards), var. *scabra*, nov.,		× 1	89
Fig. 4. *Parapagurus affinis*, n. sp.,	.	× 1	90
a. Frontal region,	.	× 4	
Fig. 5. *Pagurodes piliferus*, n. sp.,	.	× 1	96
a. Frontal region,	.	× 3	



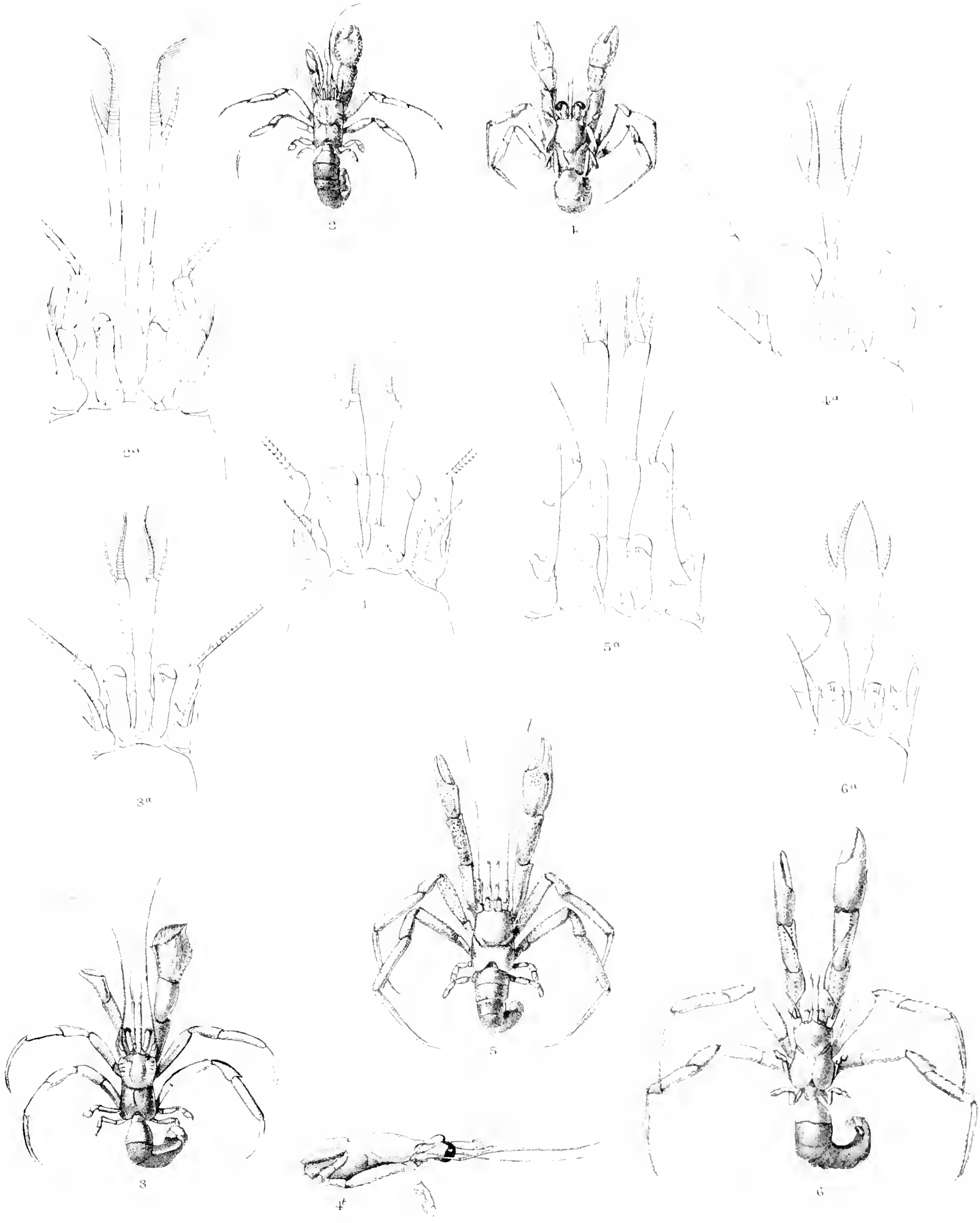
Hanh^t Morgan lith

GLAUCOTHOË, PARAPAGURUS, PAGURODES

PLATE X.

PLATE X.

	Diam.	Page
Fig. 1. *Parapagurus dimorphus* (Studer).	× 3	86
Fig. 2. *Parapagurus latimanus*, n. sp.,	× 1	91
a. Frontal region,	× 6	
Fig. 3. *Parapagurus gracilis*, n. sp.,	× 2	92
a. Frontal region,	× 6	
Fig. 4. *Paguropsis typicus*, n. gen. et sp.,	× 1	99
a. Frontal region,	× 5	
b. Side view of carapace,	× 2	
Fig. 5. *Pagurodes inarmatus*, n. gen. et sp.,	× 1	94
a. Frontal region,	× 5	
Fig. 6. *Pagurodes limatulus*, n. sp.,	× 2	97
a. Frontal region,	× 6	



Rob^t Morgan, lith

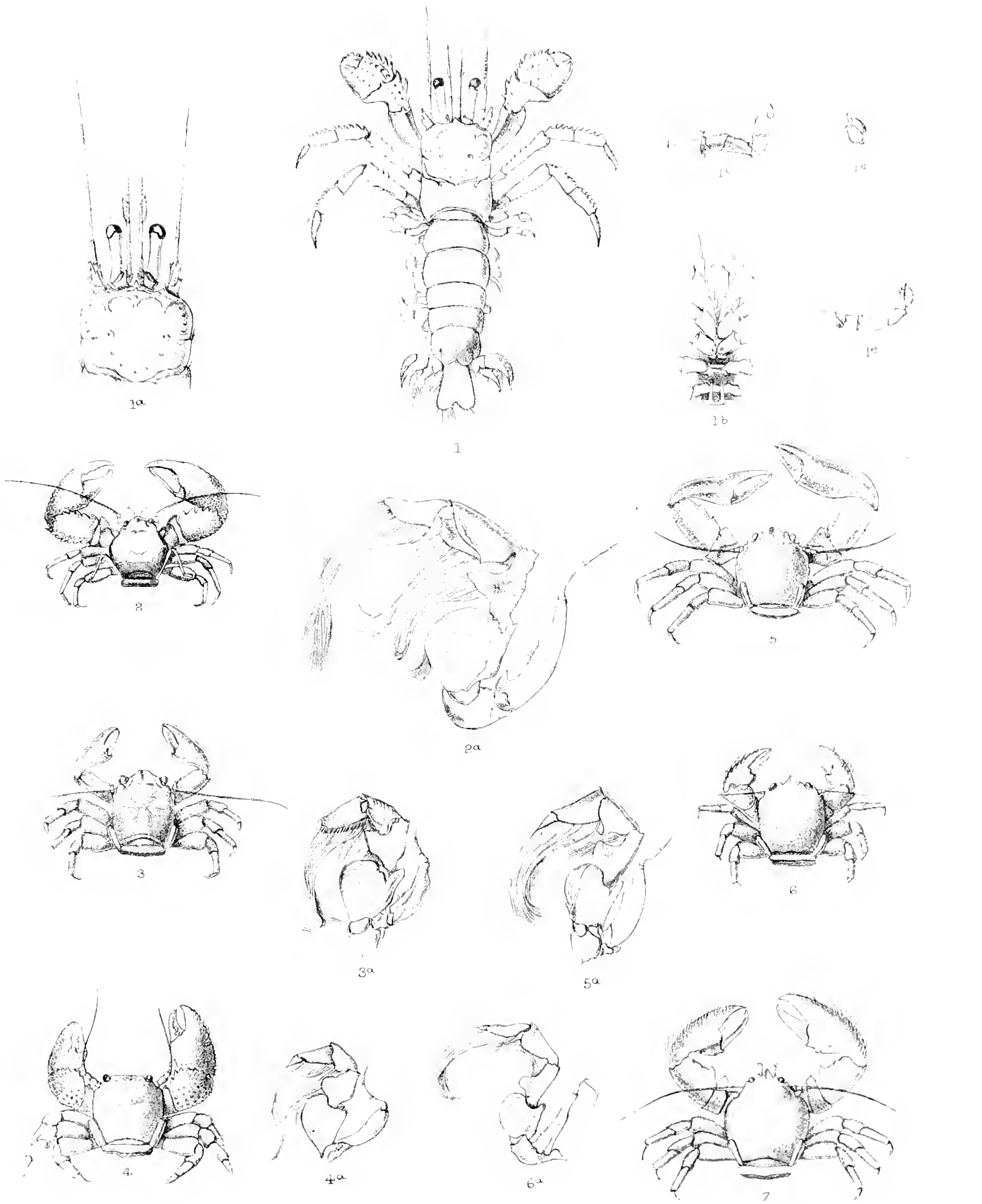
West Newman & Co imp

PARAPAGURUS, PAGUROPSIS, PAGURODES.

PLATE XI.

PLATE XI.

	Diam.	Page
Fig. 1. *Pylocheles spinosus*, n. sp., ...	× 2	101
a. Frontal region, ...	× 3	
b. Under surface of thorax, ...	× 2	
c. Fourth left leg (from below and in front), . . .	× 3	
d. Apex of fourth left leg (from above), ...	× 3	
e. Fifth left leg (from below and behind), ...	× 3	
Fig. 2. *Petrolisthes serratus*, n. sp., . . .	× 1	107
a. Left external maxillipede, ...	× 5	
Fig. 3. *Petrolisthes unilobatus*, n. sp., ...	× 2	106
a. Left external maxillipede, ...	× 5	
Fig. 4. *Pachycheles barbatus*, A. Milne-Edwards (?), . . .	× 3	114
a. Left external maxillipede, ...	× 7	
Fig. 5. *Porcellana serratifrons*, Stimpson, ...	× 2	110
a. Left external maxillipede, ...	× 6	
Fig. 6. *Porcellana robertsoni*, n. sp., ...	× 3	111
a. Left external maxillipede, ...	× 7	
Fig. 7. *Porcellana platycheles* (Pennant), . . .	× 3	112
(Young specimen from Millport, Firth of Clyde.)		



Robt Morgan, lith

West, Newman & Co imp

PYLOCHELES, PETROLISTHES, PACHYCHELES, PORCELLANA

PLATE XII.

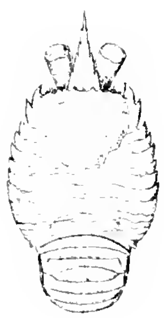
PLATE XII.

	Diam.	Page
Fig. 1. *Galathea pusilla*, Henderson,	× 5	121
a. Right chelipede of male,	× 3	
b. Left external maxillipede,	× $5\frac{1}{2}$	
Fig. 2. *Galathea inconspicua*, Henderson,	× 5	122
Fig. 3. *Galathea grandirostris*, Stimpson (?),	× 5	119
Fig. 4. *Galathea subsquamata*, Stimpson (?),	× 3	118
Fig. 5. *Galathea australiensis*, Stimpson (?),	× 3	118
Fig. 6. *Galathea dispersa*, Spence Bate (?),	× 2	119
a. Left external maxillipede,	× 5	

1a

1

1b



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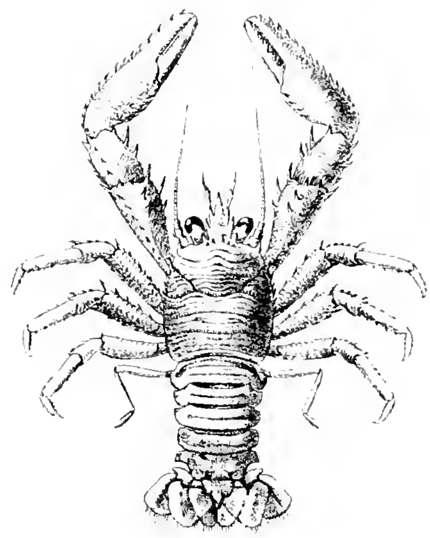
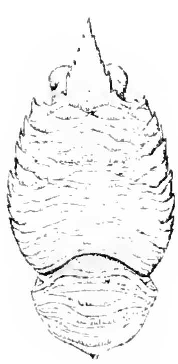


6

6a



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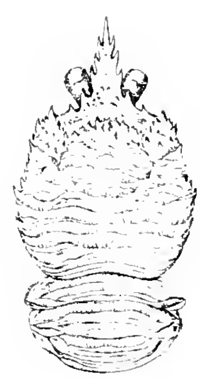

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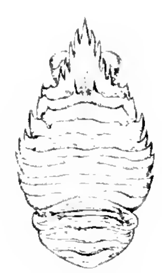


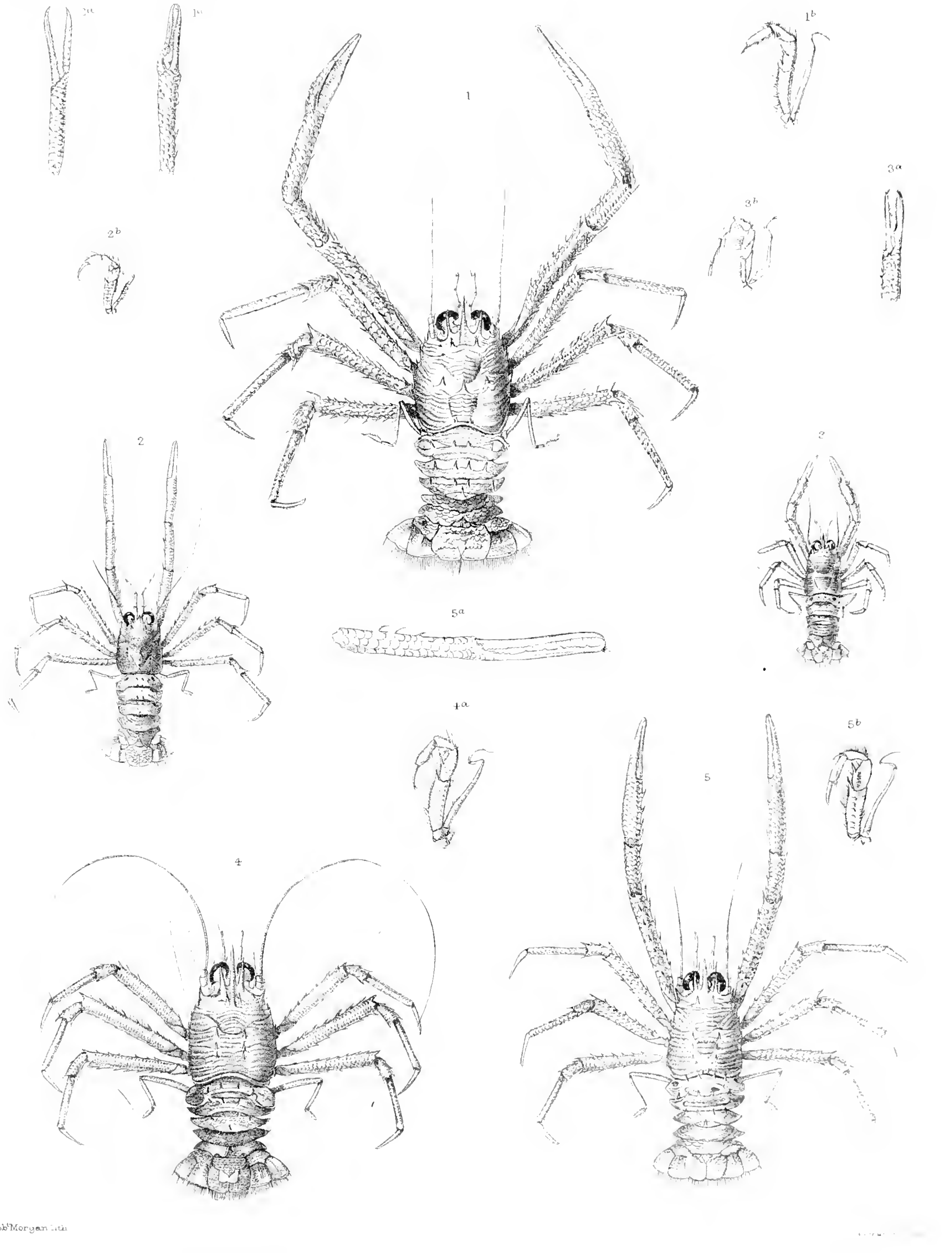
5

GALATHEA.

PLATE XIII.

PLATE XIII.

	Diam.	Page
Fig. 1. *Munida squamosa*, Henderson,	× 1	131
a. Right chela of male,	× 1	
b. Left external maxillipede,	× 2	
Fig. 2. *Munida proxima*, Henderson,	× 1	135
a. Right chela of female,	× 2	
b. Left external maxillipede,	× 2	
Fig. 3. *Munida subrugosa*, White, var. *australiensis*, nov.,	× 1	125
a. Right chela of male,	× 3	
b. Left external maxillipede,	× 3	
Fig. 4. *Munida incerta*, n. sp.,	× 1	130
a. Left external maxillipede,	× 2	
Fig. 5. *Munida normani*, Henderson,	× 1	129
a. Right chela of male,	× 2	
b. Left external maxillipede,	× 2	



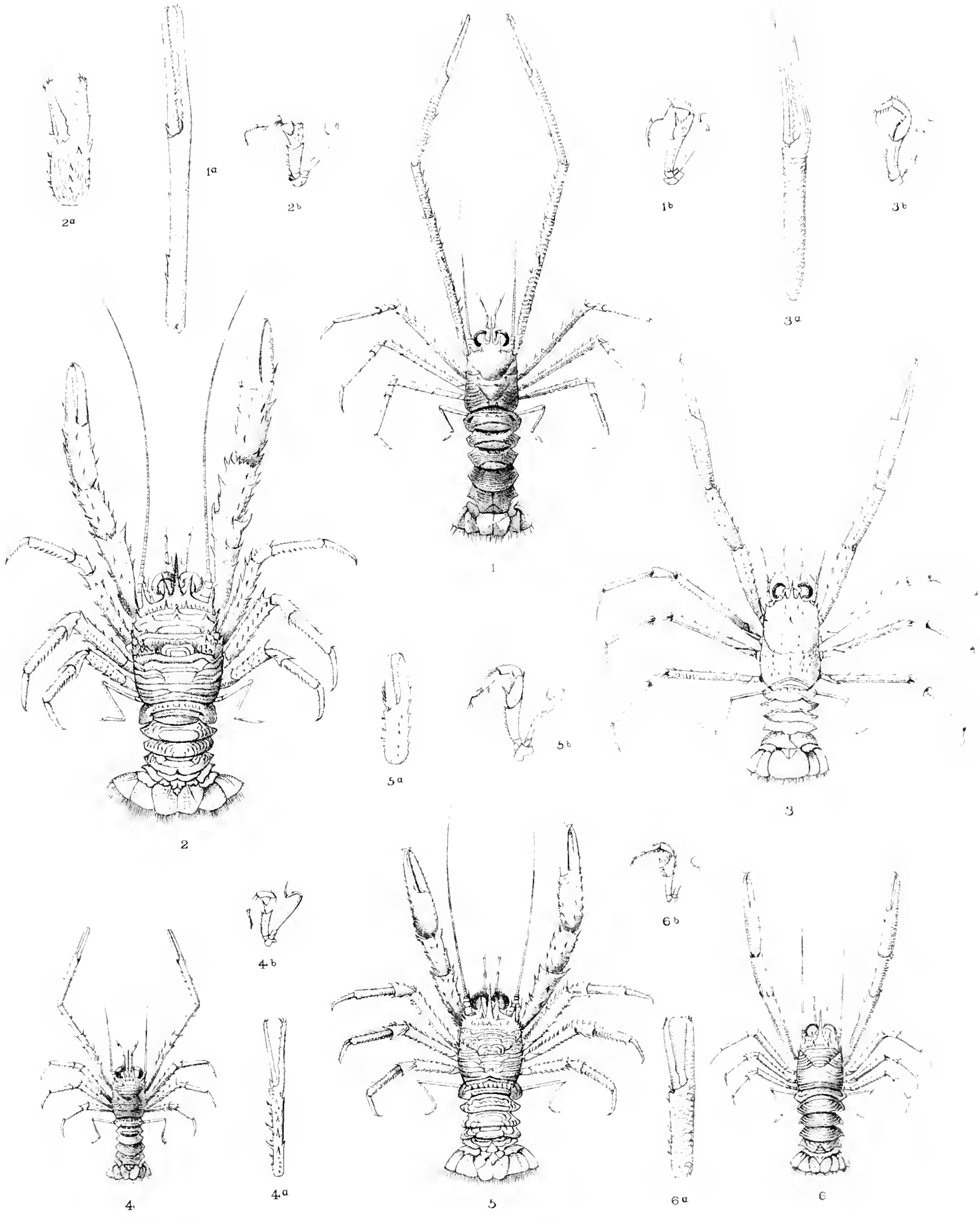
Robt Morgan lith.

MUNIDA.

PLATE XIV.

PLATE XIV.

	Diam.	Page
Fig. 1. *Munida stimpsoni*, A. Milne-Edwards,	× 1	126
a. Right chela of male,	× 2	
b. Left external maxillipede,	× 2	
Fig. 2. *Munida militaris*, Henderson,	× nearly 2	137
a. Right chela of female,	× 2	
b. Left external maxillipede,	× 2	
Fig. 3. *Munida granulata*, Henderson,	× 1	133
a. Right chela of male,	× 2	
b. Left external maxillipede,	× 2	
Fig. 4. *Munida gracilis*, Henderson,	× 1	143
a. Right chela of female,	× 2	
b. Left external maxillipede,	× 2	
Fig. 5. *Munida militaris*, Henderson,	× 1	137
a. Right chela of male,	× 1	
b. Left external maxillipede,	× 2	
Fig. 6. *Munida inornata*, Henderson,	× 1	140
a. Right chela of male,	× 2	
b. Left external maxillipede,	× 2	



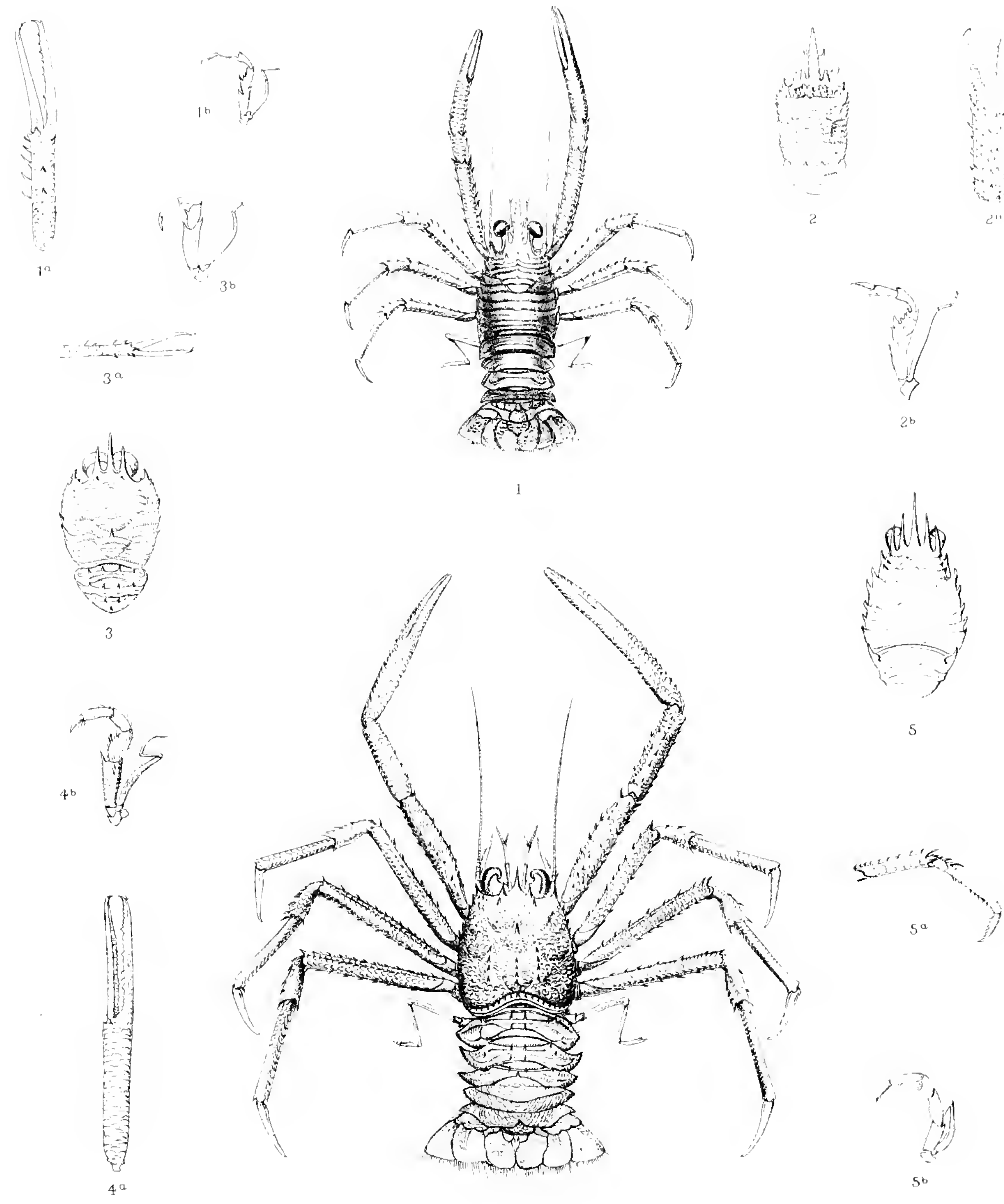
Geo West & Sons lith et imp

MUNIDA

PLATE XV.

PLATE XV.

	Diam	Page
Fig. 1. *Munida spinifrons*, Henderson,	× 2	144
a. Right chela of female,	× 3	
b. Left external maxillipede,	× 3	
Fig. 2. *Munida tuberculata*, Henderson,	× 3	145
a. Right chela of male,	× 5	
b. Left external maxillipede,	× 5	
Fig. 3. *Munida spinicordata*, Henderson,	× 3	146
a. Right chela of male,	× 3	
b. Left external maxillipede,	× 5	
Fig. 4. *Munida scabra*, Henderson,	× 1	134
a. Right chela of male,	× 2	
b. Left external maxillipede,	× 2	
Fig. 5. *Eumunida smithii*, Henderson,	× 3	169
a. Third right ambulatory limb,	× 3	
b. Left external maxillipede,	× 5	

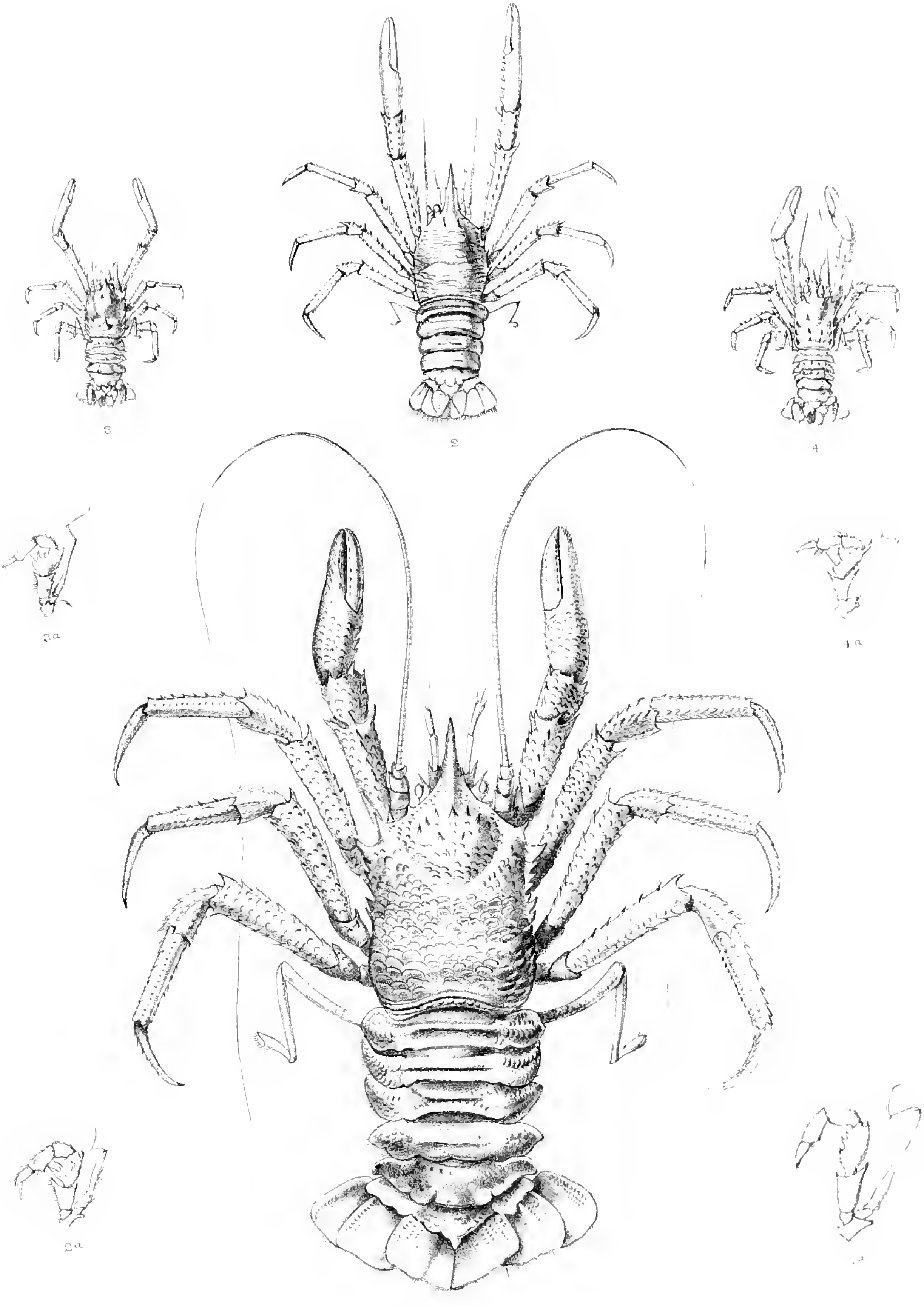


MUNIDA, EUMUNIDA

PLATE XVI.

PLATE XVI.

		Diam.	Page
Fig. 1. *Munidopsis subsquamosa*, Henderson, var. *aculeata*, nov.,	×	1	153
a. Left external maxillipede,	×	$1\frac{1}{2}$	
Fig. 2. *Munidopsis trifida*, Henderson,	×	1	156
a. Left external maxillipede,	×	2	
Fig. 3. *Munidopsis serratifrons* (A. Milne-Edwards),	×	1	149
a. Left external maxillipede,	×	3	
Fig. 4. *Munidopsis erinacea* (A. Milne-Edwards),	×	1	149
a. Left external maxillipede,	×	3	



Robt Morgan lith.

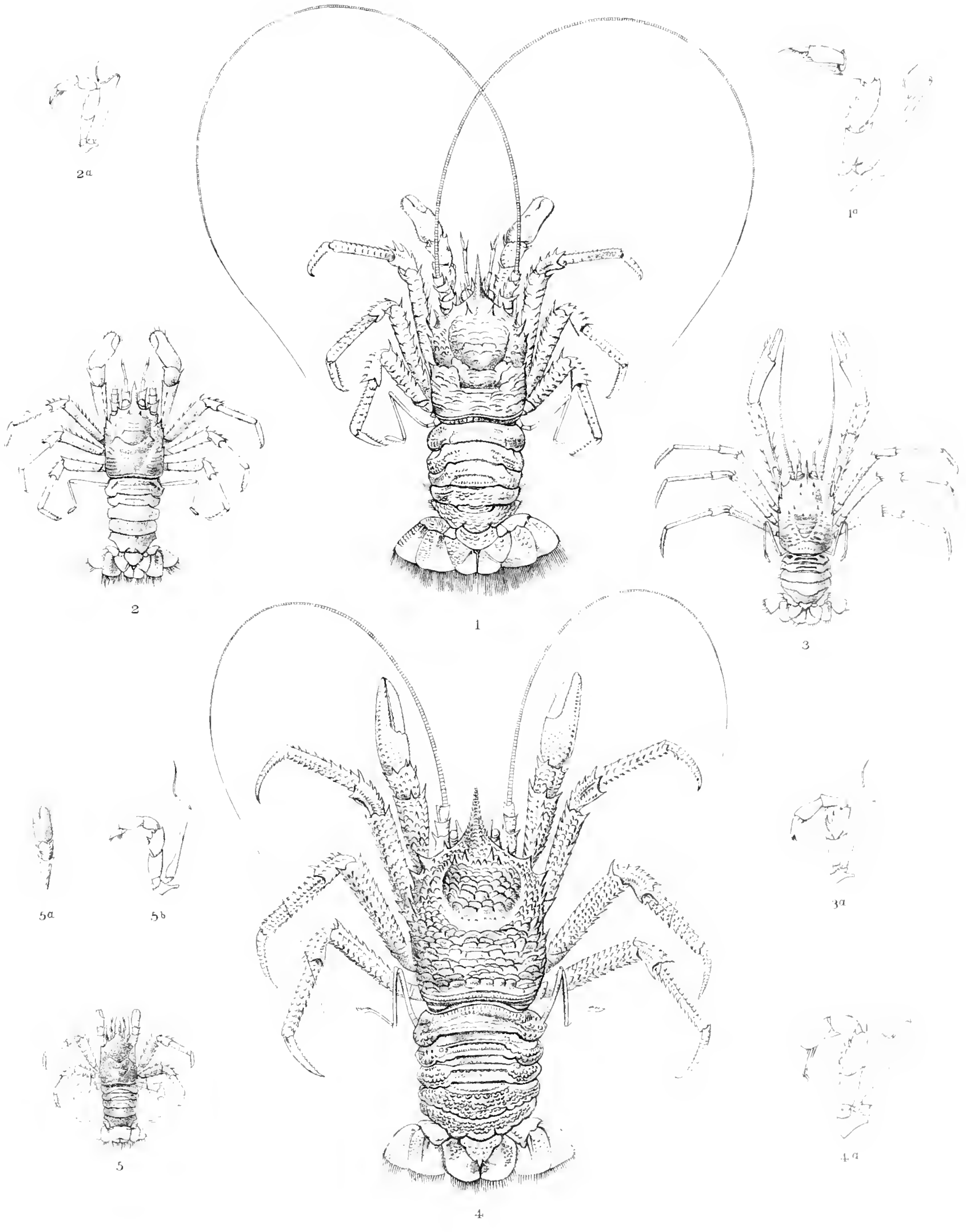
MUNIDOPSIS.

[illegible]

PLATE XVII.

PLATE XVII.

		Diam.	Page
Fig. 1.	*Munidopsis brevimana*, Henderson,	× 1	154
	a. Left external maxillipede,	× 3	
Fig. 2.	*Munidopsis brevimana*, Henderson (*juv.*),	× 2	155
	a. Left external maxillipede,	× 5	
Fig. 3.	*Munidopsis milleri*, Henderson,	× 1	155
	a. Left external maxillipede,	× 3	
Fig. 4.	*Munidopsis subsquamosa*, Henderson,	slightly enlarged	152
	a. Left external maxillipede,	× 2	
Fig. 5.	*Munidopsis pilosa*, Henderson,	× 1	157
	a. Right chelipede from above,	× 2	
	b. Left external maxillipede,	× 4	



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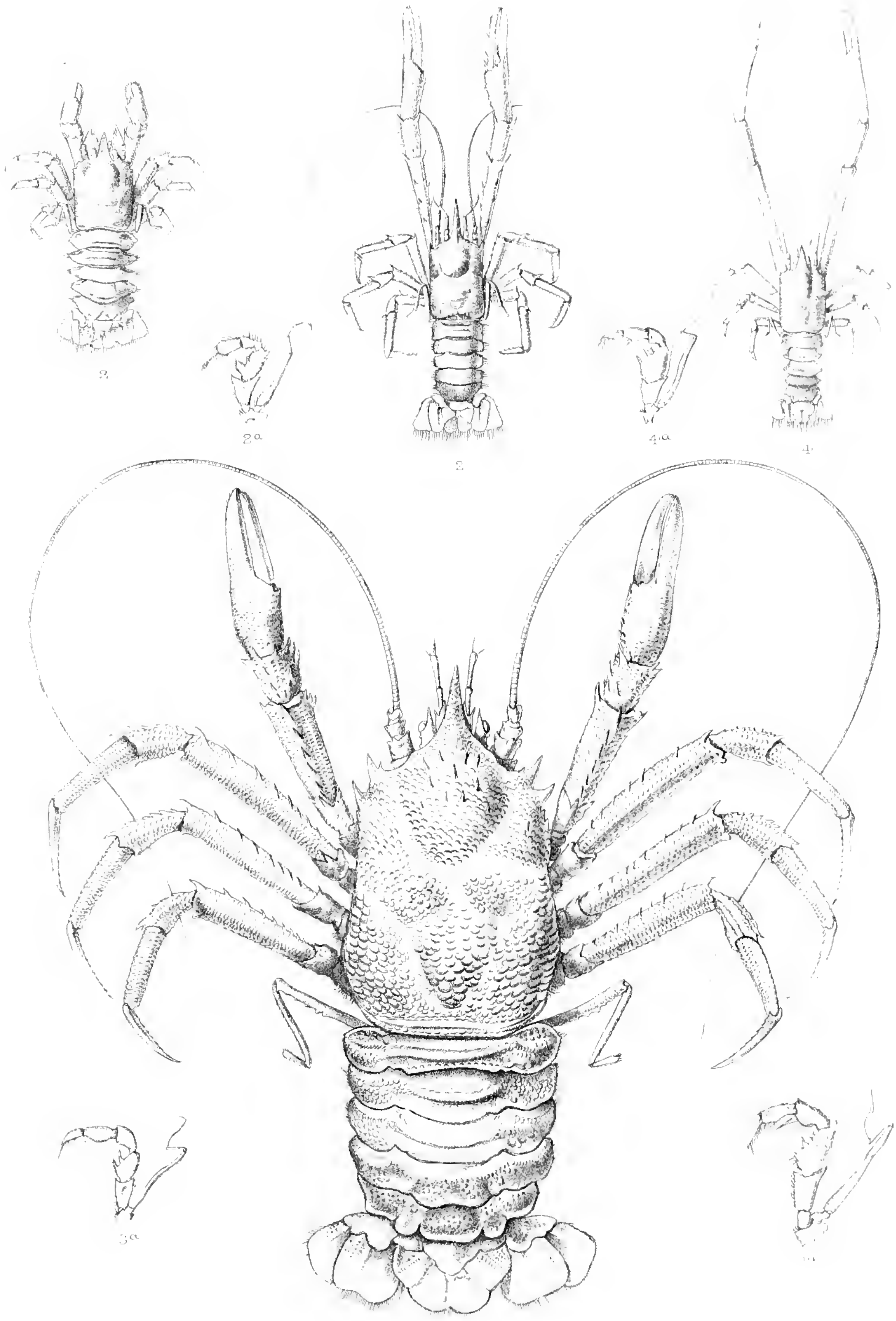
MUNIDOPSIS

PLATE XVIII.

PLATE XVIII.

	Diam.	Page
Fig. 1. *Munidopsis antonii* (A. Milne-Edwards),	slightly enlarged	151
a. Left external maxillipede, ...	× $1\frac{1}{2}$	
Fig. 2. *Munidopsis sigsbei* (A. Milne-Edwards), . . .	× 1	150
a. Left external maxillipede, ...	× 2	
Fig. 3. *Elasmonotus lævigatus*, Henderson, ...	× 1	164
a. Left external maxillipede, ...	× 3	
Fig. 4. *Elasmonotus debilis*, Henderson, ...	× 2	165
a. Left external maxillipede, ...	× 5	



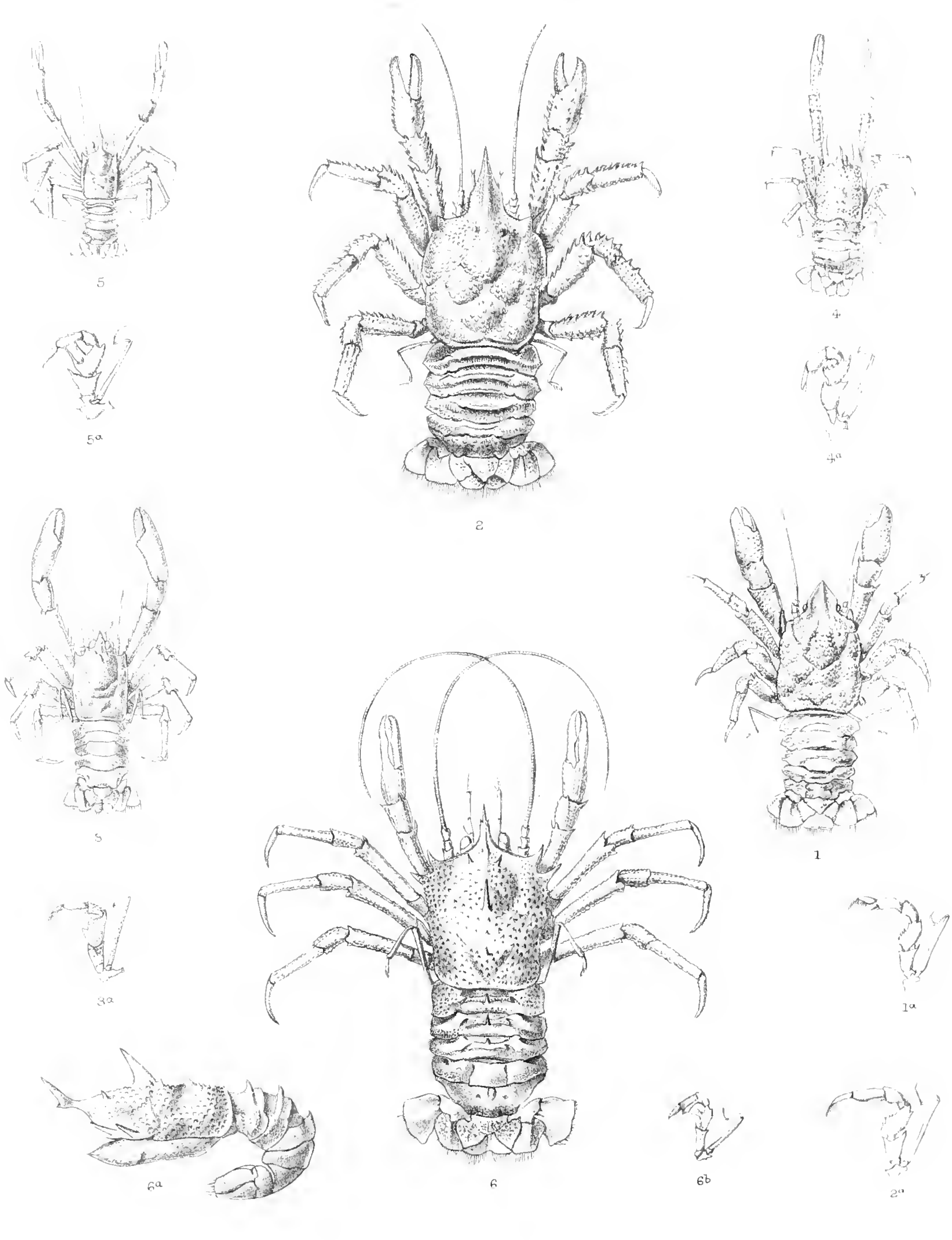
Robt Morgan lith

MUNIDOPSIS. ELASMONOTUS.

PLATE XIX.

PLATE XIX.

	Diam.	Page
Fig. 1. *Elasmonotus latifrons*, Henderson,	slightly enlarged	160
a Left external maxillipede,	× 3	
Fig. 2. *Elasmonotus marginatus*, Henderson,	slightly enlarged	161
a. Left external maxillipede,	× 2	
Fig. 3. *Elasmonotus miersii*, Henderson.	× 2	162
a. Left external maxillipede,	× 5	
Fig. 4. *Elasmonotus asper*, Henderson.	× 1	159
a. Left external maxillipede,	× 3	
Fig. 5. *Elasmonotus armatus*, A. Milne-Edwards,	× 1	159
a. Left external maxillipede,	× 3	
Fig. 6. *Galacantha bellis*, Henderson,	× 1	167
a. Side view of trunk,	× 1	
b. Left external maxillipede,	× 1	



Robt Morgan, lith.

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ELASMONOTUS, GALACANTHA

PLATE XX.

PLATE XX.

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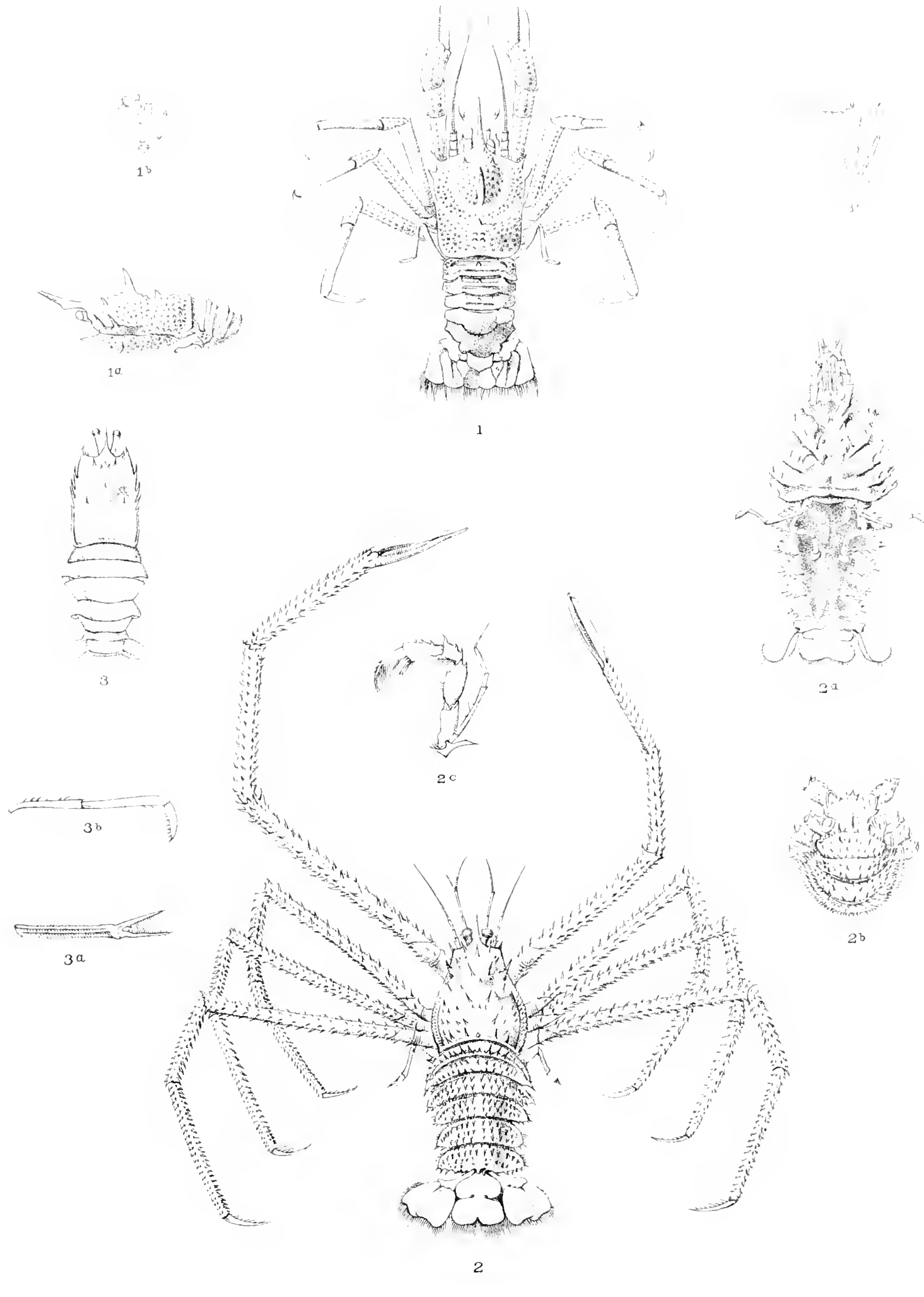
b. Portion of the third left ambulatory leg,	× $4\frac{1}{2}$	
c. Left external maxillipede,	× 4	



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GALACANTHA, PTYCHOGASTER

PLATE XXI.

PLATE XXI.

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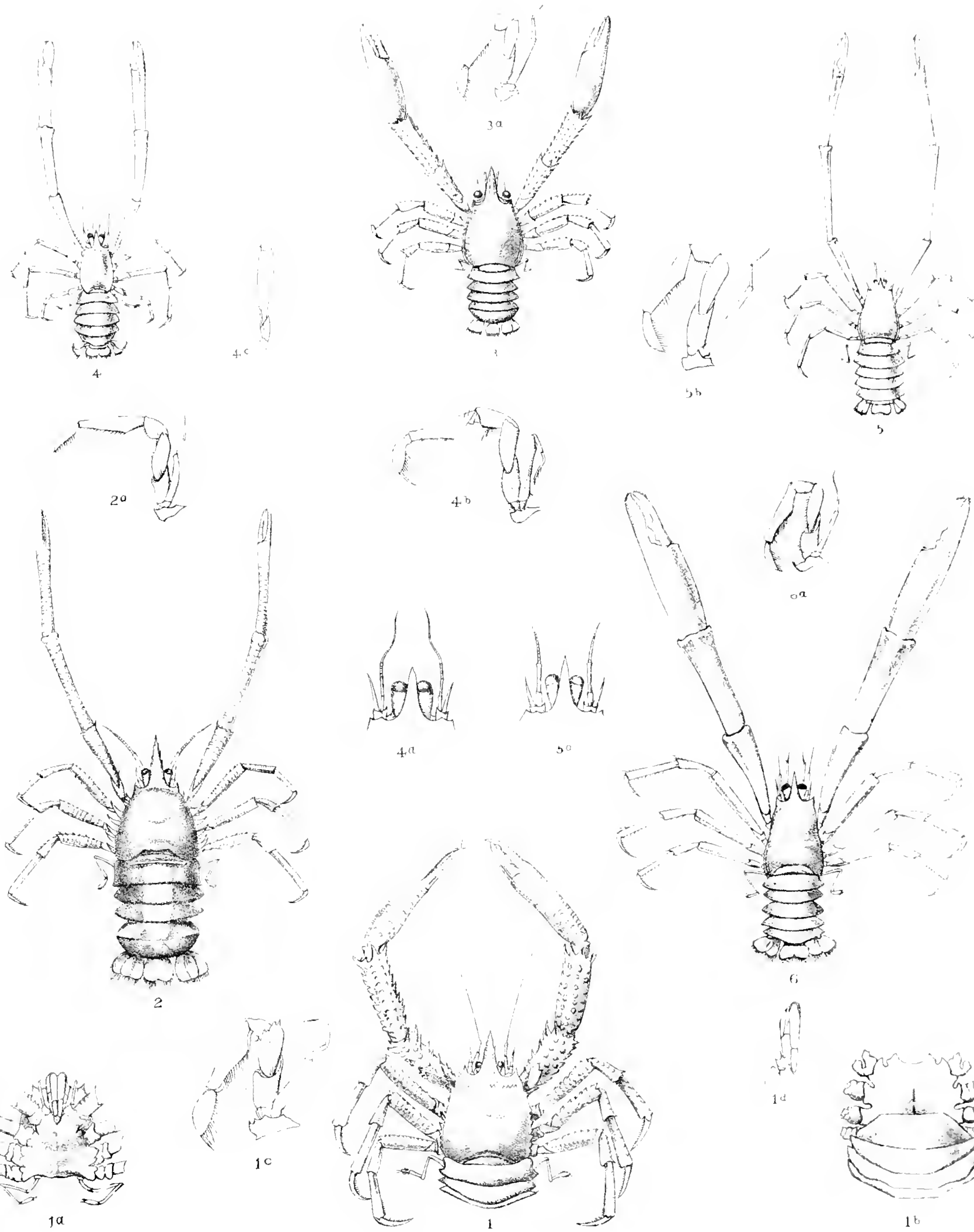
a. Left external maxillipede,	× 2	



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UROPTYCHUS.

THE

VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY.

REPORT on the ANATOMY of the DEEP-SEA MOLLUSCA collected by H.M.S. CHALLENGER in the years 1873–76, by PAUL PELSENEER, D.Sc., Professor in the Normal School, Bruges.

A REPORT on the Anatomy of the Deep-sea Mollusca collected by the Challenger was projected many years ago,[1] but Mr. Murray was unable to place the material in the hands of a naturalist till the systematic Reports had been completed. It was only recently, on the completion of my Report on the Pteropoda, that the examination of the material collected was entrusted to me.

This material consisted exclusively of Gastropoda (not including Isopleura or Amphineura), of Scaphopoda, and of Pelecypoda. There was no great wealth either of species or of specimens.

In studying the collection I had a twofold purpose.

1st, To note the interesting peculiarities in the structure of the new or unfamiliar Molluscs from the deep sea.

2nd, To compare the structure of these Challenger Molluscs with that of other known forms, and especially with those from the littoral zone, or from the lesser depths; to elucidate as far as possible by such comparisons what modifications may have been produced in the structure of the different parts; to consider the state of the sense organs (and especially the eyes) in the absence of light, and of the respiratory organs and associated structures in conditions of considerable pressure, etc.

I have therefore restricted my study of the Challenger specimens to those obtained from depths greater than are usually reached. I have not had to do with forms collected from a hundred or two hundred fathoms, which are more frequently obtained, and consequently better known.

[1] Narr. Chall. Exp., vol. i. part ii. p. 1072.

I am bound to add that my investigations have not been pursued as far as I had desired.

1. This is, in the first place, due to the unsatisfactory state of some of the specimens, either in consequence of prolonged preservation, or because the soft parts had been somewhat injured in the removal of the shell.

2. Furthermore, certain forms were represented only by single specimens, the rarity of which made it necessary to retain them as intact as possible.

Finally, the short space of time allowed for the accomplishment of my work forced me to hurry on with the direct examination, and to defer certain accessory researches which would have increased the interest and completeness of the results.

I.—STUDY OF THE STRUCTURE OF VARIOUS DEEP-SEA MOLLUSCS.

I. GASTROPODA.

VOLUTIDÆ.

1. *Guivillea alabastrina*, Watson. Station 147; 1600 fathoms.

A single male specimen, mutilated, the entire visceral sac absent, and probably left in the recess of the shell. Only the cephalic region, the foot, and the anterior margin of the mantle were left, but nothing of the gill.

I refer, in part, to the description given by Watson,[1] and can entirely confirm his statement that *Guivillea* is "a typical *Voluta*" (Pl. I. fig. 1). The foot (*e*), the proboscis (*a*), the pallial respiratory siphon (*h*), with its appendage (*j*), the cephalic velum (*b*), bearing the two tentacles (*c*), and with the penis (*f*) at its right extremity, have indeed the same characters as in *Voluta*.

The integument, especially on the head and tentacles, is tuberculated.

The eyes, said by Watson to be absent, are present (*d*), but uncoloured, that is, without any pigment. They form two symmetrical projections at the external base of the tentacles, and are distinguished by their size from the integumentary tubercles.

In fact, these eyes are in structure quite rudimentary, and could not be functional.

Transverse sections cut across these organs reveal the following structure (Pl. I. fig. 2):—

The general epithelium of the cephalic region (*a*) is continued across the ocular prominence, but is more delicate than on the surrounding parts. Below the epithelium the entire optic prominence is covered by a homogeneous structureless layer (*b*), more transparent than the surrounding tissues. This layer is separated by reticulated connective tissue (*c*) from the central portion, which forms the principal part of the optic prominence.

This central mass (*e*) is homogeneous, structureless, staining but slightly with reagents, and is continued with the same characters into the depth of the cephalic

[1] Zool. Chall. Exp., part lvii. p. 261.

velum by a narrower cylindrical portion (*f*), which only lay in part within the plane of the sections. This connecting portion, changing its direction, could be followed across the muscular mass throughout the whole of the adjacent portions which I felt justified in removing for the purpose of making sections.

The central mass and its prolongation are surrounded by a layer which exhibits numerous nuclei, is especially delicate in front of the central mass, and forms a sheath which completely separates the latter from the surrounding tissues, that is, from the muscular mass (*g*) of the cephalic velum.

How, then, are we to interpret these different parts of the eye of *Guivillea*, especially the homogeneous sub-epithelial layer and the central mass with its prolongation? for the epithelium and the reticulated connective tissue which separates the central mass from the more superficial tissues do not at first sight present anything special or inexplicable.

1. The sub-epithelial homogeneous layer. This is the sub-epithelial connective tissue, which, like the epithelial portion which covers the eye in Molluscs, has become transparent, and forms the layer to which Hensen gave the name "pellucida." It surrounds the whole ocular mass in front and at the sides, and forms the deep portion of the cornea.

2. The central mass and its prolongation. There can be no doubt as to the import of the prolongation which is given off from the central portion of the eye, and is continued with a constant diameter into the depths of the cephalic mass; it is the optic nerve.

The central mass, continuous with this last, is the retina, whose anterior margins have joined after the complete disappearance of the refractive parts (the crystalline and the vitreous body). This is a modification somewhat similar to that which has taken place in *Proteus*.[1]

Finally, the common envelope (*d*) of the central mass and its prolongation is simply the sheath of the optic nerve continued round the ball of the eye to form a "choroid."

The non-functionality of the organ of sight has quite changed the structure of these parts of the eye of *Guivillea*. The cellular elements have completely disappeared from the mass of the retina, and the transformation of the latter has extended to the adjoining portion of the optic nerve, in which the fibrillar structure no longer exists. The percipient elements then have entirely disappeared, both from the retina and from the terminal portion of the optic nerve; the connective substance between these elements alone persists, and forms the entire homogeneous and structureless mass of that part of the organ of sight in *Guivillea*.

[1] Semper, Die natürliche Existenzbedingungen der Thiere, Bd. i. fig. 20, p. 96; transl. Animal Life, Internat. Sci. Series, p. 78

It may be said, therefore, that the rudimentary character of this "eye" consists—

1st, In the disappearance of the refractive media.

2nd, In the disappearance of pigment.

3rd, In the change of structure in the nervous elements.

Trochidæ.

2. *Trochus infundibulum*, Watson. Station 146; 1375 fathoms.

This *Trochus*, drawn out from its shell (Pl. I. fig. 3), at once exhibits a characteristic which distinguishes it from all other animals of the same genus and of the same group; the head bears on each side of the mouth (*a*) a large labial palp (*b*), analogous to the tentaculiform appendages of *Ampullaria* and *Jeffreysia*.

Otherwise the head is formed as in other species of *Trochus*. The tentacles (*c*) are strong and still long, though a little contracted.

The eye is by no means rudimentary. It is situated at the base of the tentacle, on the outer side, and is borne on a short stalk. Neither in size nor form is it distinguished from the corresponding organ in the other allied species. Finally, it is much pigmented. It is thus situated and formed like that of the littoral *Trochus*.

The foot (*g*) and the epipodium also exactly resemble the corresponding parts in the littoral species.

As in the latter, the epipodium includes an anterior portion formed by a cervical lobe (*h*) and a less prominent posterior epipodial line extending to the operculum, and bearing five tentacles (*i*). These last are large and rather long. This epipodium is therefore similar to that seen in all the Trochoids, and, as in these, its pedal nature cannot be doubted.

The pallial cavity (*e*) scarcely differs from that of the littoral species of *Trochus*. The gill is well developed, and is exactly similar to that of species found in lesser depths. So also with the hypobranchial gland, the osphradium, and the kidney. The anus (*f*) opens a little farther forward than is usual among known species.

It would be interesting to find out whether other species of the same genus, or of the same group, obtained from great depths, possess the same labial palps as *Trochus infundibulum*. With this end in view I have examined (1) *Trochus rhina*, (2) *Turbo transenna*.

3. *Trochus rhina*, Watson. Station 75; 450 fathoms.

This species possesses no appendages corresponding to the labial palps of *Trochus infundibulum*. Its structure is analogous to that of littoral species. The eyes are pigmented and well developed; the gill is normal.

4. *Turbo transenna*, Watson. Station 235; 565 fathoms.

This *Turbo* has no labial palps either: in this, therefore, as in all the other points examined, it agrees with the already known forms of *Turbo*. The eyes are pigmented.

It seems, then, that the presence of labial palps is not general among Trochoids from great depths, and that *Trochus infundibulum* is, as far as we know, the only one provided with them.

As I have already said, among the Streptoneural Gastropods (= Prosobranchs), *Ampullaria* and *Jeffreysia*[1] have two buccal appendages of the same kind as the two labial palps of *Trochus infundibulum*.

It may be asked what these structures are, and to what they correspond.

At first sight we might suppose, as certain authors have done, that they correspond to the two anterior tentacles of the four-tentacled Gastropods, that is to say, of the great majority of Euthyneura (Pulmonates and Opisthobranchs). This is, however, not the case.

The fact is, that labial palps analogous to those of *Trochus infundibulum* and of *Ampullaria* exist also at different degrees of development in certain forms of four-tentacled Gastropods; as among the Pulmonates, in *Helix*, *Bulimus*,[2] *Achatina*, and especially *Glandina*;[3] among the Opisthobranchs, in *Dolabella neapolitana* (Pl. I. fig. 6), *Phyllaplysia*.[4]

The labial palps are therefore not anterior tentacles. Their origin is to be found simply in the development and lengthening of the two lateral extremities of the snout, which are thus developed for the purpose of adding a sensory organ, and especially an organ of exploration, to that part of the body. Proof of this is found in animals allied to *Jeffreysia* and *Rissoia*, where the snout exhibits, on each side of the mouth, a little projection representing the first appearance of the appendages so much developed in *Ampullaria* for instance.

In the four-tentacled Gastropods, the nerve of the labial palp springs from a common root with the nerve of the anterior tentacle,[5] while in the Gastropods with two tentacles (Prosobranchs and aquatic Pulmonates (*Limnæa*), in which the labial palps are represented by the "velar area" of Ray Lankester[6]) this nerve springs from a distinct root.[7]

It is in this last way that the labial palps of *Trochus infundibulum* are innervated. In *Trochus*, as in all the Rhipidoglossa, a ventral portion of each cerebral ganglion

[1] Jeffreys, British Conchology, vol. iv. pl. i. fig. 3.

[2] Férussac, Histoire Naturelle des Mollusques Terrestres, pl. cxlvii. fig. 1.

[3] Leidy, Special Anatomy of the Gastropoda of the United States, pl. xiv. fig. 1, 7 (as "external tentacles").

[4] Fischer, Manuel de Conchyliologie, figs. 330, 331, p. 569.

[5] Leidy, *loc. cit.*, pl. xiv. fig. 1, 10 (*Glandina*). Sarasin, Ueber drei Sinnesorgane und die Fussdrüse einiger Gastropoden, *Arb. Zool. Inst. Würzburg*, 1883, pl. ix. fig. 10.

[6] Mollusca, Encyclop. Brit., 9th edition, vol. xvi. fig. 70, p. 660.

[7] Bouvier, *loc. cit.*, pl. v. fig. 19.

is differentiated and forms a distinct mass (labial projection, Bouvier), from which spring the nerves supplying the probably gustatory parts (Pl. I. fig 5, *e*).

In *Trochus infundibulum* each of these labial projections gives off, distally, two nerves, of which the greater (*i*) is the special nerve of the lips of the mouth, while nearer the cerebral ganglion properly so called, there arises a large nerve (*h*) which goes directly to the labial palp.

The labial palps of *Trochus infundibulum* are connected below the alimentary canal, forming an infra-œsophageal commissure, as in *Patella* (this does not exist in the *Trochus* figured by Haller[1]) and in all the Diotocardia, according to Bouvier.[2]

There can be no doubt as to the nature and use of these appendages (labial palps); they are organs of sense, more tactile than the anterior tentacles. When greatly developed (*Ampullaria, Trochus infundibulum, Glandina*, etc.) they become important exploring organs. In *Bulimus* (according to Férussac) these palps exhibit on their anterior surface a series of minute regular projections, the structure of which has not, to my knowledge, yet been studied.

Besides the forms hitherto enumerated, I have been able to study several other species of Gastropods from great depths collected by the Challenger Expedition. But, as was the case with the preceding species, I have only been able to examine the anterior portions of the body, since the visceral mass had remained in the shells, which were not to be destroyed. The most interesting point resulting from the examination of these forms relates to the state of the organ of sight.

Pleurotomatidæ.

5. *Pleurotoma lepta*, Watson. Station 157; 1950 fathoms.

The head, the proboscis, and the tentacles are quite normal, except that the last are entirely devoid of eyes: they exhibit neither a pigmented spot, nor even, like *Guivillea*, a projection indicating a rudimentary eye.

As in all the other animals of the group, the roof of the pallial cavity exhibits a false gill (osphradium) (here very large) to the left of the functional gill. Watson is mistaken in his description of its position.[3]

6. *Pleurotoma brychia*, Watson. Station 106; 1850 fathoms.

This species is in the same condition as the preceding one as far as the tentacles are concerned: no trace of an eye can be found on them.

[1] Untersuchungen über Marine Rhipidoglossen, i., *Morph. Jahrb.*, t. ix. (1884) pl. ii. fig. 3.

[2] Système nerveux, morphologie générale et classification des Gastéropodes Prosobranches, *Ann. Sci. Nat.* (Zool.), sér. 7, t. iii. p. 481.

[3] Zool. Chall. Exp., part lvii. p. 335.

7. *Fossarus cereus*, Watson. Station 184; 1400 fathoms.

This animal does not possess cervical lobes; it is therefore unlikely that it is a true *Fossarus*. Eyes are entirely wanting.

Fissurellidæ.

8. *Puncturella brychia*, Watson. Station 47; 1340 fathoms.

As in the preceding forms, there are no visible eyes.

II. PELECYPODA.

The internal structure of the Pelecypoda does not generally vary much in its essential features (alimentary canal and its adjuncts, circulatory and excretory apparatus, genital organs, nervous system). On the other hand, the external organs, such as the gills, the mantle, the foot, having more direct connection with the surrounding medium, are much more variable in form, because of the immediate action of external conditions, and because of their adaptation to the diverse life conditions of the Pelecypoda.

We shall therefore devote special attention here to the form and modification of these latter organs.

Arcacea.

Four different genera of this group are represented in the collection entrusted to me: *Malletia*, *Yoldia*, *Limopsis*, *Arca*.

1. *Malletia pallida*, Smith. Station 137; 2550 fathoms.

A single specimen slightly damaged.

The *mantle* is quite open, except behind, where its internal fold forms two siphons joined together. In the anterior portion the mantle is not separate from the visceral mass, and the visceral glands extend to it (Pl. I. fig. 7, *e*).

The siphons are not separate from each other. The ventral one (inhalent), which is the shorter, is open ventrally all its length; it does not form a closed tube, like that of the other Pelecypoda with two siphons, but resembles the rudimentary open branchial siphon of *Modiolaria nigra*, and the funnel of the *Nautilus*. In *Yoldia* (see later *Yoldia isonota*) this inhalent siphon forms a completely closed tube, like that of the other Pelecypoda with two siphons.

This open siphon cannot be compared to the open pseudo-siphon of *Leda*.[1] The

[1] Deshayes, Histoire Naturelle des Mollusques (Exploration Scientifique de l'Algérie), pl. cxv. fig. 2, *c*.

latter, indeed, is formed by the edge of the mantle itself, while the open inhalent siphon in *Malletia* is formed by the internal fold of the mantle, just like the exhalent siphon to which it is attached.

At the base of the inhalent siphon, where the retractor muscle of the siphons is inserted, there exists, ventrally, and at the left side only, a long extensile tentacle (*j*).

In *Malletia obtusa*, Sars (*Yoldia*), G. O. Sars has already noted the presence of pallial tentacles;[1] but, according to his description, each lobe of the mantle bears one ("tentaculis singulis").

Brooks was the first to point out that this appendage was not paired in *Yoldia*,[2] but he speaks of it as existing on the right side. I have examined *Yoldia isonota* on this point, and have ascertained that this tentacle is situated sometimes on the left lobe of the mantle, sometimes on the right, but that it is never paired. This may possibly be the case in *Malletia*, but I cannot say so positively, as I had only one specimen for examination.

Does there exist among other Pelecypods any organ comparable to this tentacle in *Malletia* and *Yoldia?* I have nowhere discovered any notice of similiar structure. I may therefore call attention to an organ which I observed in *Macoma balthica*, L. sp. (*Tellina*), but not in all the species bearing the name of *Tellina*, during my first stay at the Marine Zoological Laboratory in Wimereux (1884),[3] and which I have seen again since. As this arrangement has never been described, to my knowledge, I represent it here (Pl. I. fig. 9, *j*).

It is an organ in the form of a tuft, composed of a considerable number of small, short, cylindrical tentacles radiating from the same point; it is situated at the base of the inhalent siphon, on the retractor muscle of the siphons; and is always present on each half of the mantle, the left as well as the right.

The situation of these tufts in *Tellina balthica* resembles that of the tentacle in *Yoldia* and *Malletia*. The innervation is also similar; the nerve springing from the visceral ganglion, and taking its course to the margin of the mantle, gives rise to a cord which terminates in a ganglionic swelling at the base of the tuft in *Tellina*, or exhibits this swelling on its course at the base of the tentacle, in *Yoldia*[4] and *Malletia*.

As to the use of these tufts, Brooks attributes a sensory function to the tentacle in *Yoldia*. There can, indeed, be no doubt about this point, either with regard to *Yoldia* or *Tellina* and *Malletia*, when we find a ganglionic swelling, in which a nerve terminates, at the base of the organs in question.

[1] On some Remarkable Forms of Animal Life, i. (1872) p. 25, pl. iii. fig. 20, *c*.

[2] On an organ of special sense in Lamellibranchiate genus Yoldia, *Proc. Am. Ass. Adv. Sci.* for 1874, t. xxiii. (1875) part i. p. 81.

[3] It gives me pleasure to thank Professor A. Giard, director of this laboratory, for the cordial and hospitable manner in which he has repeatedly welcomed me there.

[4] Brooks, *loc. cit.*, p. 82.

The situation of these organs at the base of the inhalent siphon, and near the gill, makes it probable that their function is to test the quality of the water which comes through the siphon to bathe the gills. They may therefore be compared to the osphradium (the olfactory organ of Spengel) of Gastropods. The ganglion at the base of the tuft in *Tellina balthica*, and of the tentacle in *Yoldia* and *Malletia*, really corresponds exactly to the "siphonal" ganglion observed in many other siphonate Pelecypoda (*Cytherea*,[1] *Solen*,[2] *Mya*,[3] *Lutraria*[4]), and more or less separated from the visceral ganglion.

This "siphonal" ganglion is the osphradial ganglion of Gastropoda and of *Nautilus*. In the Pelecypoda without siphons (*Arca*, &c.), the sensory epithelium is situated directly above the visceral ganglia.[5] This has led Ray Lankester wrongly to conclude that the latter are the osphradial ganglia ("olfactory"), and that the supra-œsophageals are cerebro-pleuro-visceral ganglia.[6] But in the siphonate Pelecypoda the sensory epithelium is situated above the siphonal ganglion, and in certain forms (*Malletia*, *Tellina*) this special organ is complicated by the presence of a large tentacle or a tuft of small ones.

The foot is similar to that of the allied forms already known,—*Yoldia*, *Leda*, *Nucula*,—and presents a ventral plantar surface greatly resembling the creeping foot of Gastropods. The posterior retractor muscle of the foot extends from the posterior adductor muscle to the visceral mass.

The mouth has two lips, which are continued in well-developed labial palps (*b*) stretching behind the foot. The situation and aspect of these palps, in the whole group of Nuculidæ, have led to their being taken for gills, as, for instance, by Sars in his *Yoldia obtusa*,[7] and Thiele in *Nucula*,[8] where he has mistaken anterior for posterior. The two palps on each side possess a common posterior appendage (*c*), very long, but contracted and rolled up in the figure.

The gills of *Malletia*, and of the whole group of Nuculidæ, have a structure different from that of typical Pelecypoda, as Mitsukuri first pointed out in *Nucula* and *Yoldia*.[9]

In *Malletia* the structure of the gill is even simpler than in *Yoldia*, the lamellæ being much less numerous and less compressed.

[1] Duvernoy, Mémoires sur le système nerveux des mollusques acéphales, *Mém. Acad. Sci. Paris*, t. xxiv. (1853), pl. xi. xii. fig. 3, *g'*.

[2] Blanchard, Observations sur le système nerveux des mollusques acéphales testacés ou Lamellibranches, *Ann. Sci. Nat.* (Zool.), sér. 3, t. iii., pl. xii. fig. 1.

[3] Duvernoy, *loc. cit.*, pl. xi. xii. fig. 5, *g'*.

[4] *Ibid.* pl. xi. xii. fig. 6, *g'*.

[5] Spengel, Die Geruchsorgane und das Nervensystem der Mollusken, *Zeitschr. f. wiss. Zool.*, Bd. xxxv. p. 374, pl. xvii. fig. 13.

[6] Mollusca, Encycl. Brit., 9th ed. vol. xvi. p. 693.

[7] On some Remarkable Forms of Animal Life, i., pl. iii. fig. 20, *e*.

[8] Die Mundlappen der Lamellibranchiaten, *Zeitschr. f. wiss. Zool.*, Bd. xli., pl. xvii. fig. 17, *k*.

[9] On the Structure and Significance of some aberrant forms of Lamellibranchiate gills, *Quart. Journ. Micr. Sci.*, vol. xxi., 1881, p. 595.

In the gill of *Malletia* (Pl. I. fig. 8) we no longer see the binary character of typical Pelecypoda (except Tellinacea, Lucinacea, and Anatinacea). The branchial axis (containing the two afferent and efferent vessels, and fixed to the visceral sac and to the dorsal side of the mantle), as in *Nucula* and *Yoldia*, bears lamellæ (or large branchial filaments) on each side, *but in the same longitudinal plane*. Here, as also in *Nucula*,[1] the lamellæ or filaments of one side make an obtuse angle with the plate formed by the lamellæ of the other. In the allied forms, *Arca*, *Pectunculus*, *Limopsis* (Pl. II. fig. 2), the two plates formed by the filaments are parallel, and almost touching each other; that is, they exhibit the typical binary arrangement of the gills of Pelecypoda.

On the other hand, the gill of *Malletia* has all its lamellæ or filaments in the same plane, right and left of the axis, and it presents an aspect similar to that of the gill of Cephalopoda and Gastropoda (*Fissurella* and *Haliotis*). The gill of *Malletia*, therefore, well represents a primitive gill, from which all the gill-forms of the Pelecypoda may be derived by successive specialisation.

The great development of the labial palps, and the presence of appendages to these organs, in *Malletia* and all Nuculidæ, is in direct correlation to the structure of the gills. These do not form the large plates, with ciliated surfaces, which play so large a part in nutrition, by conveying the food towards the mouth in the currents which they produce. The gills being exclusively respiratory organs, and having nothing to do with nutrition as they have in other Pelecypoda, the latter function is performed by the palps alone, and it is therefore quite natural that they should be so greatly developed.

What can be seen, without dissection, of the rest of the structure agrees with that existing in *Yoldia*.

2. *Yoldia isonota*, von Martens. Kerguelen Island; 95–110 fathoms.

I have used this species to compare with *Malletia pallida*. The structure of the genus *Yoldia* being better known, I shall confine myself to pointing out the following facts:—

The branchial siphon (inhalent) is not open ventrally.

The siphonal tentacle (probably osphradium) is placed sometimes to the right, sometimes to the left. The presence of pallial tentacles, properly so called (on the posterior edge of the mantle), does not appear to be constant.

Finally, the gill (as in other species of *Yoldia* already studied) is less simple than that of *Malletia*, the lamellæ being more numerous and more closely pressed together; that is to say, they already resemble in their arrangement those of *Nucula*.

[1] Mitsukuri, *loc. cit.*, pl. xxxiv. fig. 5.

Limopsis.

3. *Limopsis minuta*, Philippi. Station 75; 450 fathoms.
4. *Limopsis pelagica*, Smith. Station 106; 1850 fathoms.
5. *Limopsis lata*, Watson. Station 169; 700 fathoms.

The animal of *Limopsis* has not yet been described in detail. For the most part it resembles that of *Pectunculus.*

One point is remarkable about the gill. Here, as in all the Arcidæ, there are two branchial plates formed by the filaments corresponding to the lamellæ of the Nuculidæ. But, as in these last (*Nucula*, *Yoldia*, *Malletia*), the branchial axis is fixed by a supporting membrane to the mantle near its posterior extremity.

In *Limopsis*, on the contrary, as in all the other Arcidæ, the axis is free over all the part of it posterior to the posterior adductor muscle (Pl. II. fig. 1, *h*). This axis, which is thus the support of the gill, becomes comparatively solid and resisting, and in *Limopsis* much more than in *Arca* and *Pectunculus* it is greatly developed in size (Pl. II. fig. 1).

In this figure representing *Limopsis pelagica*, Smith, the axis and the whole gill are greatly contracted. In Pl. II. fig. 2, a sketch of *Limopsis minuta*, Philippi, shows these organs very nearly as they are arranged in the living animal. The branchial support in *Limopsis* is chiefly formed by muscular fibres.

Arca.

Several species from great depths have been examined, notably—

6. *Arca pteroessa*, Smith. Station 246; 2050 fathoms.

Their structure is like that of the littoral species, especially as regards the form of the gills.

Pectinacea.

The littoral species have pigmented ocelli on the edge of the mantle. It would be interesting to know whether these organs are present in the deep-sea species.

Two genera have been examined, *Pecten* and *Amusium.*

Pecten.

7. *Pecten philippii*, Recluz. Station 75; 450 fathoms.
8. *Pecten subhyalinus*, Smith. } Station 310; 400 fathoms.
9. *Pecten vitreus*, Chemnitz. }

In the three species there exist pigmented ocelli of proportionately the same size as in the littoral species. The gills are similar to those of the latter.

Amusium.

10. *Amusium lucidum*, Jeffreys. Station 78; 1000 fathoms.
11. *Amusium meridionale*, Smith. Stations 146, 158 and 302; 1375, 1800 and 1450 fathoms respectively.

These forms have no pigmented ocelli. It must be noticed that they live at much greater depths than the above-mentioned *Pecten;* the difference can therefore be easily explained.

The absence of pigmented ocelli confirms the observation made by Dall about *Amusium dalli*, Smith.[1] Dall affirms, however, that this form has only a single gill on each side; the species which I have examined have two branchial plates of recurrent filaments similar to those of *Pecten*.

I have examined a certain number of Pelecypoda, which presented nothing remarkable, and have therefore led to only negative results. Such are—

12. *Myrina coppingeri*, Smith. Station 184; 1400 fathoms.

The arrangement and form of the gills exactly resemble those of the allied littoral forms (Mytilidæ) already known.

13. *Venus mesodesma*, Quoy and Gaimard. Station 135E; 1000 fathoms.

The gills are normal, and the labial palps very small, as in the littoral species of the same genus.

LUCINACEA.

14. *Cryptodon moseleyi*, Smith. Station 133; 1900 fathoms.

The mantle is quite open ventrally, as in the other Lucinacea. The margin of the two lobes (circumpallial muscle) is very thick in its anterior portion, and the interior surface of this margin is tuberculated and papillary. This is probably what Semper[2] has called "mantle-gills" (Pl. II. fig. 4, *j*).

As in *Lucina*, the anterior adductor muscle does not come into contact with the circumpallial muscle, but is separate from it, and is carried back to some distance inwards (Pl. II. fig. 3, *l*).

The two lobes of the mantle are only united at a single point (*r*), and consequently only form one pallial (anal) aperture, as in *Ungulina*, instead of two, as in *Lucina*. This aperture (*k*) is absolutely sessile, and does not form a siphon, properly so called.

The foot (*d*), even taking the rather feeble contraction into account, is short, and

[1] Report on the Mollusca, *Bull. Mus. Comp. Zoöl.*, vol. xii. p. 210.
[2] Die natürliche Existenzbedingungen der Thieren, Bd. i. p. 208, fig. 48, *a*; Animal Life, pp. 169, 170.

differs from the cylindrical, claviform, posteriorly-directed foot of the Lucinidæ. Here the principal part of the foot is directed forwards, swollen, and terminating in a point; behind this part is a byssal aperture (Pl. II. fig. 4, *e*).

The mouth (*a*) is bordered anteriorly and posteriorly by two rather narrow lips (*b*), which are continued on each side in small, bifid, labial palps (Pl. II. figs. 3, 4, *c*).

There is only one branchial plate (*g*) on each side, as in *Lucina*. This organ is triangular in form, and has no dorsal "appendage." It is fixed by its anterior edge, and by the beginning of its dorsal edge, to the base of the dihedral angle formed by the union of the mantle with the visceral sac.

Behind the foot the recurrent or internal laminæ of the two gills are united to each other by a membrane (Pl. II. fig. 4, *h*), which joins their dorsal edges. The common posterior extremity of the two gills is united at the separation of the anal aperture from the great branchio-pedal aperture (Pl. II. fig. 3, *r*), so that the pallial cavity is divided into two distinct spaces,—a large, ventral, infra-branchial space (the branchial chamber, properly so called); and a small, dorsal, posterior, supra-branchial space (anal chamber), into which the anus opens, and which communicates with the exterior by the anal aperture; while the inferior or branchial chamber communicates with the exterior by the great pallial, ventral, branchio-pedal aperture.

This division of the pallial cavity is present in a certain number of other Pelecypoda; but in several of these, such as *Mya*, *Pholas*, *Pliodon*,[1] &c., the separation is absolute, while in others (*Unio*, *Anodonta*,[2] those with one siphon like "*Cryptodon*" *moseleyi*, *Myochama*,[3] &c.) there persists between the posterior portion of the visceral mass and the gills a narrow opening by which the two chambers communicate with each other.

In the same way, in the "*Cryptodon*" alluded to above, one can pass a probe introduced at the anal aperture through a similar opening into the ventral chamber (Pl. II. fig. 4, *k*).

It may be remarked, that in many forms with two siphons this division into two chambers does not exist, and that, as the posterior extremity of the gills does not become united to the partition between the two siphons, these both open into the great undivided pallial cavity (Tellinidæ, Donacidæ, Psammobiidæ, &c.).

Deshayes[4] makes out that the gills of *Lucina*, which are similar to those of "*Cryptodon*" *moseleyi*, have two laminæ, corresponding to the two branchial plates of the typical Pelecypoda. The gill of *Lucina* and *Cryptodon moseleyi* does indeed

[1] Paul Pelseneer, Notice sur les Mollusques recueillis par M. le Capitaine Storms dans la région du Tanganyka, *Bull. Mus. Roy. Hist. Nat. Belgique*, t. iv. p. 117.

[2] Woodward, A Manual of the Mollusca (1856), fig. 171, *b*; Ray Lankester, Mollusca, Encycl. Brit., 9th ed., vol. xvi. p. 686, fig. 124, 5, *g*.

[3] Hancock, On the Animal of Myochama Anomioides, *Ann. Mag. Nat. Hist.*, ser. 2, vol. xi., pl. xi. fig. 1, *f*.

[4] Remarques sur l'organisation des Lucines, *Comptes rendus*, t. xx. (1845) p. 1794; Traité élementaire de conchyliologie, t. i. part 2, p. 767.

possess two laminæ, but they correspond to the two laminæ of *one* branchial plate in the Pelecypoda,—a direct and a recurrent or reflected lamina. Thus the gill of *Lucina* and that of *Cryptodon moseleyi* correspond to only *one* of the branchial plates of other Pelecypoda,—the inner one, as we shall see later (Pl. IV. fig. 4).

As to the "pallial gills" mentioned by Semper, we have seen above that these are probably only the thickened edges of the mantle.

15. *Cryptodon luzonicus*, Smith. Station 205; 1050 fathoms.

The structure of this species is exactly similar to that of the preceding, especially as regards the foot, the gill, and the mantle, this last having also only one posterior anal aperture (Pl. II. fig. 5).

Smith[1] has expressed his doubts as to the synonymy of the two names *Axinus* and *Cryptodon*,—a synonymy admitted, one may say, by all authors.

Axinus was used in 1821 by J. Sowerby for a fossil, *Lucina angulata*, whose structure is, of course, unknown.

Cryptodon was created in 1822 by Turton for a living Pelecypod, *Lucina flexuosa*, Montagu, which all writers have since placed in the above-named genus *Axinus*, implying the synonymy of the generic names given by Sowerby and Turton.

I have unfortunately been unable to procure a specimen of the animal of "*Axinus*" *flexuosus*, so that I could not study it for myself. But Jeffreys[2] has already pointed out that this form possesses "two gills on each side;" and the structure of the genus *Axinus* or *Cryptodon* is particularly well known through the work of Sars,[3] who has studied in detail *Axinus sarsi*, Philippi, a species allied to *Axinus flexuosus*.

Sars confirms Jeffreys' statement, that there exist two gills on each side, similar to those of the typical Pelecypoda.[4]

In *Axinus sarsi*, the visceral glands (hepatic and genital) form a projection outside the pedal muscular wall, and their ramifications extend freely into the visceral cavity on each side of the foot (an arrangement which I have hitherto observed only in *Montacuta ferruginosa*, which I was able to study in great abundance in Prof. Giard's laboratory at Wimereux). The foot is filiform, very long, and directed backwards. There is only one pallial aperture, with no siphon, and the gills do not become united to the pallial commissure separating the anal from the great branchio-pedal aperture.

These animals (*Axinus flexuosus* and *Axinus sarsi*) differ entirely from our "*Cryptodon*" in regard to the gills, the foot, and the arrangement of the visceral

[1] Zool. Chall. Exp., part xxxv. p. 187.
[2] British Conchology, vol. ii. p. 245.
[3] Malacozoologiske Jagttagelser, i. Om Dyret af Cryptodon Sarsii (Axinus), Philippi, *Forhandl. Vidensk. Selsk. Christiania*, 1864, pl. iv. fig. 11.
[4] Sars, *loc. cit.*, pl. iv. fig. 4, *h*.

glands, &c. And as the name *Cryptodon* was created specially for *Lucina flexuosa*, our species cannot remain in this genus, and a new name must be invented for them.

After what I have said above, there can be no such doubts as Fischer has expressed[1] regarding the systematic position of the genus *Axinus* (= *Cryptodon*, properly so called). Since it has two branchial plates on each side, this genus ought to be placed in the family Ungulinidæ; and it has, besides (according to Sars), only one siphonal aperture.

The characteristic of a single siphonal aperture, which Fischer emphasises for the Ungulinidæ, will not hold good (if this family is adhered to), because the *Diplodonta* have two posterior apertures. I must add that *Axinus flexuosus* should be studied in detail, for Forbes and Hanley[2] say that it has two apertures, and no tube; while according to the brothers Adams,[3] *Axinus* has a single tubular, siphonal aperture, and Woodward[4] attributes to it a long anal tube.

The new genus established for our "*Cryptodon*" should be placed, then, in the "family" Lucinidæ, though it has only one siphonal aperture like *Ungulina*.

The comparative study of these two "families," Lucinidæ and Ungulinidæ, shows that the Pelecypoda cannot be classified according to the number of their branchial plates. A classification based on this characteristic would be quite artificial, since it would separate all those animals in which the rest of the structure, and even the *structure* of the gills, is very similar, and which, taken together, would form such a natural group, *Lucina*, "*Cryptodon*," *Diplodonta*, *Axinus*, *Ungulina*.

We shall see later that this classification, based on the number of branchial plates, has no real basis.

Tellinacea.

Semele (= *Syndesmya*, Recluz).

16. *Semele profundorum*, Smith. Station 244; 2900 fathoms.

I have figured (Pl. II. fig. 6) a specimen of this species to show the relative proportions of the labial palps and the gills. In the littoral species of this genus the palps are never so large as the gills. Here, on the other hand, we see the gill (*e* and *e'*) greatly reduced and much smaller than the palps (*b*), which have preserved their normal size.

17. *Semele longicallus*, Scacchi. Station 75; 450 fathoms.

In this species the arrangement is exactly the same as in *Semele profundorum*.

[1] Manuel de Conchyliologie, p. 1098.
[2] History of the British Mollusca and their Shells, vol. ii. p. 469.
[3] The Genera of Recent Mollusca, t. ii. p. 56.
[4] A Manual of the Mollusca (1856), p. 293.

Anatinacea.

Lyonsiella.

The only anatomical knowledge we possess about this genus is due to the researches of Sars,[1] who was the first, and hitherto almost the only, investigator of the structure of deep-sea Molluscs.

There are two species belonging to this genus in the Challenger collection, *Lyonsiella jeffreysi*, Smith, and *Lyonsiella papyracea*, Smith.

18. *Lyonsiella jeffreysi*, Smith. Station 106; 1850 fathoms.

The mantle has three openings, an anterior, of moderate size (pedal), a large posterior, ventral (branchial), and a small posterior (anal).

The anal aperture forms a short siphon which is invaginated in the only existing specimen (Pl. II. fig. 7, *p*). The branchial aperture bears a crown of papilla-like tentacles, somewhat similar to those figured by Sars (*loc. cit.*, pl. iii. fig. 40) from *Lyonsiella abyssicola*. This aperture is continued inwards by a circular membranous fold projecting into the pallial cavity, and probably with a valvular function.

The foot contracted in the specimen is cylindrical and rather narrow; near its base is a projection, ventral to which is the aperture of the byssus.

The mouth (*a*) has neither palps nor lips in the strict sense of these words. That is to say, there is no distinction possible between lips and palps. The mouth is encircled by a fold more expanded in front (the part corresponding to the anterior palps) than behind. A gill arises from each side of the posterior portion of this fold.

This gill is delicate, and seems to be formed of a single plate. But, as in the other Anatinacea (I do not include *Solenomya* in this group), there are two branchial plates turned in contrary directions, like the two halves of an open book. The dorsal or outer plate (the so-called "appendage") is somewhat reduced, and has only one (the direct) lamina. The ventral plate has two laminæ, but the reflected lamina is already reduced, and its most distal portion is no longer in folds.

The greater portion of the gill is free. The anterior portion of the dorsal plate is united to the mantle, for a short distance, by its dorsal edge. But the right and left gills are not united to each other behind the foot, so that the pallial cavity is not divided into two chambers definitely separated by the gills.

But this division into two chambers can be effected in the following manner: a fold arising between the two posterior pallial apertures (Pl. II. fig. 7, *h*) stretches into the pallial cavity to the distal extremity of the gills, with which, however, it does not unite, and is continued from each side, over the mantle, to the point where the gill and

[1] On some Remarkable Forms of Animal Life, i. p. 27 (1872).

the mantle are joined. Thus the gills, being in juxtaposition to each other behind the foot (by the reflected lamina of the inner or ventral plate), and to this fold (by their posterior extremity, and the dorsal edge of their dorsal or external plate), effect a complete separation between the two chambers.

Dorsally to the gill there is on the mantle a glandular swelling, comparable in its position to the hypobranchial gland of Gastropoda.

19. *Lyonsiella papyracea*, Smith. Station 157; 1950 fathoms.

As in the preceding species, the mantle has three apertures. The largest of these is the branchial aperture, which here also is surmounted by a crown of tentacles, larger and less numerous than in the above (Pl. II. fig. 8, *q*), and which is continued inwards by an annular membranous valve similar to but more extended than that in *Lyonsiella jeffreysi* (*k*). This aperture is separated from the pedal aperture by a pallial commissure of considerable extent, as far as *j*.

The mouth (*a*) is encircled by a fold (corresponding to the lips and palps), specially developed anteriorly, where it stretches over the anterior adductor muscle.

The foot (*d*) is cylindrical and obtuse at its distal extremity; it has a simple byssal groove on its posterior surface.

The gill consists, as in *Lyonsiella jeffreysi*, of two plates, of which the dorsal or outer (*e′*) has only one lamina, while the ventral (*e*) has two. But here the gill is thicker, the lamellæ more dilated, and pressed close together, so as to give the organ an almost fleshy appearance.

The outer plate is joined to the mantle, all along its external margin, by means of a membrane (*h*). This union is complete from the anterior adductor (*l*) to the posterior adductor (*m*). In addition, the two gills are united to each other behind the foot by the ventral margin of their ventral plate, and their posterior extremity is joined, by the same membrane (*h*), to the division between the two siphonal apertures, so that they form a great partition through which the foot passes, the reflected lamina of the ventral plates forming a fold round it.

We find, therefore, that the pallial cavity is divided into two chambers morphologically similar to those which I have already had occasion to describe in *Cryptodon moseleyi*. But here the "anal" chamber is very much larger, for it extends to the anterior adductor, that is, in front of the foot, of which the greater part is contained within it.

The pallial wall of the anal chamber exhibits on each side, as in *Lyonsiella jeffreysi*, a glandular thickening, which I have compared to the hypobranchial gland of Gastropoda.

These two species of *Lyonsiella* differ remarkably in regard to the arrangement of the gills, and the existence of well-divided pallial "chambers." While in *Lyonsiella* *jeffreysi* the gills are free and the pallial cavity almost undivided, in *Lyonsiella papyracea* the gills are united to the mantle and to each other, and are disposed as in *Lyonsia* (Pl. II. fig. 9), except that the anal chamber is larger, ventrally as well as anteriorly.

But my astonishment was still greater when, on studying two specimens of the typical species *Lyonsiella abyssicola*, Sars (which were sent to the Challenger Office by Professor G. O. Sars), I ascertained that the smaller of the two specimens (about 2 mm. in length) exhibited the arrangement observed in *Lyonsiella jeffreysi*, and that the larger (about 4 mm. in length) was similar in this respect to *Lyonsiella papyracea* (compare Pl. II. figs. 8, 10, and Pl. III. figs. 1, 2).

From the very succinct description given by Sars, and from his figure (*loc. cit.*, Pl. III. fig. 42), one cannot make out whether the gills are free, as in *Lyonsiella jeffreysi*, or united to form a partition, as in *Lyonsiella papyracea*. As, except in the arrangement of the pallial "chambers," the structure of the two specimens of *Lyonsiella abyssicola* which I have studied is exactly similar, I shall here complete Sars' account by giving two figures (Pl. II. fig. 10, and Pl. III. fig. 2), and a short description of the larger specimen.

The mantle is formed as in the preceding species. The pallial commissure separating the pedal and branchial apertures is very delicate. As in *Lysonia*, there is a small, very short retractor muscle of the siphons at each side.

The fold surrounding the mouth is so disposed that one can observe a more marked separation between "lips" and "palps." In fact, it forms four lateral lobes corresponding to palps (Pl. III. fig. 2, *b* and *c*); an anterior pair, more developed, and a posterior pair (*c*), extending on each side of the foot (*d*).

The gill (*e* and *e'*) arises between the two lobes on each side. It extends from the anterior adductor to the division between the two posterior apertures (branchial, *q*, and anal, *p*). The two gills are situated almost in the same longitudinal plane (see Pl. II. fig. 10, *e*). Their outer plate (Pl. III. fig. 2, *e'*) is less developed than the inner one.

The two gills are joined together behind the foot. They are united to the mantle on each side and posteriorly, at the separation of the two siphons, by the membrane (*h*). Thus an "anal" chamber (Pl. II. fig. 10, *o*) is formed, dorsal to the partition made by the gills and the membrane (*h*).

As I have not been able to examine a larger number of specimens of the genus *Lyonsiella*, I can only suppose, from the four individuals studied, that the arrangement observed in the large specimen (described and figured) of *Lyonsiella abyssicola* does not exist in the young stage; and that certain species of the genus (*Lyonsiella jeffreysi*) always preserve the arrangement of the young stage, while others have two entirely separated pallial chambers in the adult stage.

20. *Verticordia tornata* (Jeffreys). Station 106; 1850 fathoms; a single specimen.

The mantle is almost quite open ventrally; only a short pallial commissure separates the branchial from the pedal aperture (from *q* to *j*, Pl. III. fig. 3). The two posterior orifices are surrounded by a common crown of tentacles arranged in a single row (*r*) and of an odd number; one of them being alone on the dorsal side, and seven others, of different sizes, on each side.

The anal aperture has a short siphon (Pl. III. fig. 3, *p*). The branchial aperture is sessile. But it possesses, internally, a large tubular valve, incompletely closed (cut open on the ventral side) (Pl. III. fig. 3, *k*), which certainly cannot be externally evaginated.

The foot (*d*), retracted in the specimen, must be very long in its extended state; it has a byssal groove on its posterior surface (Pl. III. fig. 4, *d'*).

The buccal aperture (*a*) has two pairs of labial palps, the anterior (*b*) greatly developed, the posterior (*c*) somewhat reduced.

There is no gill, or, at least, no structure like the respiratory organs of other known Pelecypoda. We have seen in *Lyonsiella* (Pl. II. fig. 10, *e*) that the gills form a partition separating the pallial cavity into two great chambers, and traversed by the foot.

Here a similar partition exists (*e*). But it is muscular throughout its entire length, and is entirely different in structure and aspect from the branchial partition of *Lyonsiella*. It only exhibits on each side two groups of transverse lamellæ, very slightly projecting (*g* and *g'*), between which narrow slits establish communication between one chamber and the other. These groups of lamellæ exhibit three longitudinal stays on the inner surface of the partition (see Pl. III. fig. 5, *e*).

The muscular partition extends from the anterior adductor to behind the foot, which traverses it without uniting with it. Behind the foot it is continued, without interruption, by a thinner portion (*h*), which forms the division between the two siphons.

The relation and position of this partition place it beyond doubt that it is homologous with the branchial partition in *Lyonsiella* (see Pl. II. fig. 10, *e*). We have thus here to do with a very remarkable rudimentary respiratory apparatus. The two groups of transverse lamellæ on each side (*g* and *g'*) seem to me to represent a portion of the branchial lamellæ which has been preserved.

The muscular partition is united to the mantle over all its circumference; at several points on each side there are muscular bundles, which attach it to the shell: an anterior, beside the retractor muscle of the foot; a second, dorsal and rather large; and a third, posterior, long and delicate (Pl. III. fig. 4, *h*), which is inserted near the posterior retractors of the foot. These last (*n*) are remarkable because they are only distinct at their insertion, and arise from a common trunk. The muscles of the partition probably serve to make it contract in order to expel, through the slits between the plates (*g*, *g'*), some of the water contained in the anal or dorsal chamber.

The dorsal chamber is not entirely filled by the visceral mass, between which and the partition there is a considerable space.

According to Dall,[1] *Verticordia* resembles in its structure the *Lyonsiella* (*abyssicola*) described by Sars. It may be seen, however, by comparing the descriptions given above, and the figures of *Lyonsiella abyssicola* and *Verticordia tornata*, that there is a considerable difference between the two forms, especially in regard to the gills.

As I had a relatively large amount of material at my disposal in my researches among the Anatinacea, I was able to study comparatively almost an entire group of that order. In this group I studied the genus *Poromya*,[2] and I am able to affirm that between it and *Verticordia tornata* there exists a striking resemblance.

In fact, as we shall see, the structure of *Poromya granulata* (Pl. III. fig. 7) is almost exactly similar to that of "*Verticordia tornata*." This genus, *Poromya*, was first described in its fossil state by a conchologist of my country, H. Nyst, and has since been found alive; but its organization is still little known. I shall therefore describe very briefly the principal points of its structure, in order to show how much it resembles that of "*Verticordia tornata*."

The mantle is open almost all along its ventral surface, from the anterior adductor muscle to (*j*) near the branchial aperture. The posterior apertures are surrounded by a common crown of tentacles (*q*), rather long, and odd in number (seventeen on the specimen I examined), not eighteen or twenty, as Gwyn Jeffreys[3] says. The number of these tentacles must necessarily be odd, because, as in "*Verticordia*" *tornata*, there is a single dorsal one.

The anal aperture has a short siphon (*p*); the branchial aperture has a large valve inside (*h*), exactly similar in structure and position to that in the preceding species.

The foot (*d*) is long and linguiform; it is extended in the specimen figured.

The mouth is surrounded with palps, just like those in "*Verticordia*" *tornata*; a large anterior pair (*b*), and a small posterior pair (*c*).

From the anterior adductor muscle (*l*) to the division between the two posterior apertures (*h*) there stretches a partition (*e*) traversed by the foot. This partition forms two chambers in the pallial cavity, a dorsal and a ventral, similar to those in the preceding species. On the ventral surface of the partition, on each side, are two groups (*g*, *g′*) of lamellæ, separated by linear slits. This partition is therefore disposed precisely like that of "*Verticordia*" described above; it has the same dorsal muscles attaching it to the shell.

[1] Report on the Mollusca, *Bull. Mus. Comp. Zoöl.*, vol. xii. p. 286.

[2] I have to thank Prof. Anton Dohrn for an opportunity of investigating a specimen of this species.

[3] British Conchology, vol. iii. p. 45.

We may therefore confirm Dall's opinion,[1] and conclude without hesitation that *Verticordia tornata* is a *Poromya*.

Silenia.[2]

21. *Silenia sarsi*, Smith. Station 157; 1950 fathoms; and Station 325; 2650 fathoms; two specimens.

On lifting up one of the lobes of the mantle (Pl. III. figs. 8, 9) of a *Silenia*, we see an arrangement similar to the one observed in the *Poromya* just described.

The great pallial ventral (pedal) aperture extends to (*j*), that is, to near the branchial aperture. The posterior apertures are surrounded by a series of tentacles, fifteen in number, of which one is dorsal (*q*). The anal aperture is prolonged by a small projecting siphon (*p*); the branchial aperture has the same large internal tubular valve as the *Poromya* (*k*).

The mouth (*a*) has two pairs of labial palps; the anterior very large (*b*), the posterior (*c*) small.

The foot (*d*) is rather long and linguiform, but has no byssal groove.

The essential difference is in the aspect of the partition (*e*). It is disposed just as in *Poromya*; that is, it extends from the anterior adductor muscle (*l*) to the division between the two posterior apertures. It is crossed by the foot, and, dorsal to it, there is a chamber not entirely filled by the visceral mass (*f*). This partition has also special muscles attaching it to the shell.

But instead of the two groups of lamellæ, separated by long slits, which we saw on each side in *Poromya granulata* and *Poromya tornata*, we find here that the slits piercing the partition are comparatively short, and that the lamellæ have disappeared to become the lips of the two apertures which they separate (see Pl. III. fig. 10).

Besides, these apertures do not form two groups on each side, as in the preceding genus; they form three: an anterior (*g*), comprising five apertures in one specimen (Station 325), and six apertures in the other (Station 157); a second group (*g′*) towards the middle of the partition, and behind the foot (*g″*), comprising five apertures; and finally, a third posterior group, consisting of three apertures.

The two anterior groups are longitudinal, with the apertures transverse; the last group, on the other hand, is transverse (without being continuous, however, with the corresponding group on the other side), and its apertures are longitudinal. The last group (*g″*) is situated on a rather large projection which the partition forms between the foot and the division between the siphons.

[1] Report on the Mollusca, *Bull. Mus. Comp. Zoöl.*, t. xii. p. 281.

[2] This title, due to Smith, ought to be altered, for it has been already used, in 1873, by Mulsant, for a coleopterous insect.

Cuspidaria (= *Neæra*).

The structure of the genus *Cuspidaria* was till recently unknown. In 1886, in a query to Nature,[1] Mr. Wm. H. Dall, conchologist to the Washington National Museum, asked that facts which he had observed in the structure of this genus should be tested on European specimens. He thought it had neither gills nor labial palps. The reservations with which he stated these facts arose from his not having made his observations on specimens in a perfect state of preservation.

The query remained unanswered until I took up the question.[2]

Meanwhile, Dall had republished his statement in greater detail, but still with the same reservations: "If the writer has not been misled by contraction of the parts under the action of alcohol;"[3] "if confirmed by the study of fresh specimens."[4]

It would, however, be interesting to test the facts mentioned by Dall in his paper, especially as Gwyn Jeffreys[5] attributes to *Cuspidaria* (*Neæra*) "pink gills." It was therefore with great satisfaction that I found three specimens, each representing a different species of the genus *Cuspidaria*, in the Challenger collection entrusted to me.

22. *Cuspidaria curta*, Jeffreys. Station 75; 450 fathoms.
23. *Cuspidaria fragilissima*, Smith. Station 145; 300 fathoms.
24. *Cuspidaria platensis*, Smith. Station 320; 600 fathoms.

The structures which I shall describe and figure are based on the study of the three specimens already mentioned, and of specimens of *Cuspidaria rostrata*, Spengler, obtained from the Zoological Station at Naples,[6] that is to say, the best prepared specimens which can be found. Indeed, so well are they preserved by the clever conservator Salvator Lo Bianco, that one can cut sections and work with them as with fresh specimens.

It follows, therefore, that my examination has included a certain number of species, and several specimens of one of these species. What I have observed, then, does not constitute an individual variation or a monstrosity, but a normal, invariable disposition which is not peculiar to certain forms, but common to the entire genus. The different species resemble each other closely, and I shall not describe them separately.

The mantle is closed ventrally, in the posterior half of its length at least, and even a little more in certain species, as in *Cuspidaria curta*; the pedal aperture is therefore normal enough. The two pallial lobes are excessively delicate and transparent, as was already known.

[1] Vol. xxxiv. p. 122.
[2] Sur des Pélécypodes sans branchies, *Comptes rendus*, t. cvi. p. 1029.
[3] Report on the Mollusca, *loc. cit.*, p. 293. [4] *Ibid.*, p. 302.
[5] British Conchology, vol. iii. p. 49.
[6] I have to thank Professor Anton Dohrn, who kindly sent me these specimens.

The two pallial posterior apertures are prolonged by two siphons joined along their whole length, except towards the distal extremity, where they are slightly separated (Pl. IV. fig. 6, *s*, *t*); at this point they are surrounded by a common sheath (*w*). The extremity of the branchial siphon bears, ventrally, two pairs of claviform tentacles; the anal siphon has only three of these organs. The base of the branchial siphon is closed by a partition, in which is a linear aperture (*k*) of small extent.

The pallial cavity is divided into a dorsal and a ventral chamber (Pl. IV. fig. 6, *h*, *i*) by a muscular partition (*e*), extending from one adductor to the other, and joined to the mantle on each side by a more delicate membrane (Pl. IV. fig. 3, *h*). The foot issues near the middle of this partition, which has been considered as the body-wall.

The foot (*d*), which is rather delicate and linguiform, has a byssal groove on its posterior surface. Its posterior retractor muscle (Pl. IV. fig. 6, *n'*) is very delicate, single, and only bifurcated near its insertion on the shell, as in the two preceding genera (*Poromya* and *Silenia*).

The mouth (*a*) is rather widely open. According to Dall,[1] it has no labial palps. In reality it has two pairs, but these organs are much reduced, and would scarcely be visible in badly preserved specimens (Pl. IV. fig. 5). The anterior pair rest on the anterior adductor muscle; the posterior pair are carried far backwards on each side of the foot, as in *Solen*. In *Cuspidaria fragilissima* and *Cuspidaria curta* even the anterior pair are very slightly developed (Pl. IV. fig. 2).

The muscular partition (*e*), of which we have spoken above, is attached to the shell by two large muscular bundles in front of the posterior adductor, and by two others behind the anterior adductor, so that, seen from the side (Pl. IV. figs. 1, 4), the partition seems to form a curved mass, which Jeffreys,[2] looking through the transparent mantle, took for "pink gills."

The visceral mass lies in the chamber dorsal to the partition, and fills the greater part of it. Between the visceral mass (*f*) and the posterior retractor muscle of the foot (*n'*) is a delicate sagittal partition (*p*). On the wall of the visceral mass there is no trace of gills any more than on the muscular partition. This partition is absolutely homologous with the "branchial" partition in *Poromya* and *Silenia*, and consequently represents the gills of Pelecypoda.

Instead of the three groups of apertures observed in *Silenia* (Pl. III. figs. 8, 9), we only find here four separate apertures, arranged in the same manner in all the species (Pl. IV. figs. 1–4), and situated near the median line. Except for these apertures, and the little lips which border them, the whole surface of the partition is uniform. In *Cuspidaria fragilissima* (Pl. IV. fig. 1) and *Cuspidaria curta* (Pl. IV. fig. 2) there are two pairs of apertures behind the foot, while in *Cuspidaria rostrata* (Pl. IV. figs. 3, 4) and *Cuspidaria platensis* there is only one.

[1] Nature, vol. xxxiv. p. 122.

[2] British Conchology, vol. iii. p. 45.

The structure of this branchial partition is entirely muscular; at the point where the apertures occur it is somewhat less thick. The epithelium of the ventral surface of the partition is continued on the lips of the apertures; it is ciliated there, but has no special modification.

As in *Poromya* and *Silenia*, the muscular partition has, on its outer borders, delicate muscular bundles which are attached to the shell (Pl. IV. figs. 1, 3, 4, *r*).

Summary on the Genera Poromya, "Silenia," and Cuspidaria.

A. *Classification.*—The genus "*Silenia*" is placed by Smith [1] among the Anatinidæ, and by Fischer,[2] doubtfully, among the Lyonsiidæ. But the structure of the gills in these two families is absolutely unlike that observed in *Silenia*.

Among recent authors Jeffreys,[3] Sars,[4] and Smith[5] range *Poromya* and *Cuspidaria* (=*Neæra*) among the Corbulidæ, and Fischer [6] classes *Poromya* in the Anatinidæ. But here, again, the gill-structure of *Poromya* and *Cuspidaria* is quite different from that of the Corbulidæ and Anatinidæ.

What strikes us first in the three genera cited, is the presence of a muscular partition extending from one adductor to the other, and taken by previous authors for the body-wall. We have shown that this partition is formed by the gills, which have lost the structure habitual to these organs in the Pelecypoda, and, consequently, form an arrangement quite unique among them.

Among the Anatinacea, where the three genera in question are ranged, they form a sub-group quite different from the other Pelecypoda beside which they have been placed. These others (Anatinacea, *s. str.*) are true "Lamellibranchia;" that is to say, they have gills of the typical, normal structure. I propose, therefore, to designate this abnormal sub-group Septibranchia.

The structure of this group remained unknown, in consequence of the habit the majority of conchologists have of not troubling themselves about the soft portions. In the present instance this has resulted in the classifying of the forms in question as described above; a fact which shows that we need expect little assistance from the shell in determining the systematic position of a mollusc.

I have been able to study the structure of each of the three genera, and I have proved that *Poromya* and "*Silenia*" are more nearly allied to each other than to *Cuspidaria*. In the former the apertures in the partitions are in groups; the

[1] Zool. Chall. Exp., part xxxv. p. 75.
[2] Manuel de Conchyliologie, p. 1164.
[3] British Conchology, vol. iii. pp. 45, 47.
[4] Mollusca regionis arcticæ Norvegiæ, pp. 85, 96.
[5] Zool. Chall. Exp., part xxxv. pp. 35, 54.
[6] Manuel de Conchyliologie, p. 1172.

pallial, posterior apertures are surrounded by a common ring of tentacles; the anal aperture is prolonged in a short siphon; the branchial aperture has a large internal valve; finally, there is a very large anterior pair of labial palps, and a small posterior pair.

In *Cuspidaria* the characteristics are different and very special. There are four separate pairs of apertures on the branchial partition; the two pallial posterior orifices are prolonged by siphons united throughout all their length; the labial palps are all much reduced.

We may therefore classify the three genera as follows:—

I. Apertures of the branchial partition arranged in groups.
  1. Two groups of apertures on each side. . . . . *Poromya.*
  2. Three groups of apertures on each side. . . . . *Silenia.*
II. Separate apertures, to the number of four pairs. . . . . . . *Cuspidaria.*

For the first two genera we may employ the family name created by Dall, Poromyidæ; for the third we must form a special family, Cuspidariidæ, taken from the same author.

B. *Phylogeny.*—We have seen that a "branchial" partition pierced with apertures, so that the two pallial chambers communicate with each other, is a common characteristic of the three genera we have been considering. But, if we compare them with each other, we shall easily discover different successive stages of retrogression in the branchial apparatus.

In *Lyonsiella*, a genus belonging to the group Anatinacea (*sensu latiore*), the gills are also united to the mantle along their entire length, to each other behind the foot, and to the division between the two siphons. They thus form two great pallial chambers, corresponding exactly to the two chambers of the Septibranchia. Here, then, we have the starting-point of the strange arrangement which characterises this latter group.

But in *Lyonsiella abyssicola* (see Pl. II. fig. 10) the structure of the gills is preserved, and the branchial lamellæ cover the partition from the anterior adductor to the division between the siphons.

The first stage of reduction is seen in *Poromya*, in which the partition has already become muscular, but has retained two groups of lamellæ on each side (Pl. III. fig. 7).

The reduction is still greater in "*Silenia*," in which the plates have disappeared, and only form the lips on each side of the apertures in the three pairs of groups (Pl. III. fig. 10).

The reduction is extreme in *Cuspidaria*, in which there are only four pairs of apertures. If we wish, then, to arrange these four genera according to their mutual affinities, we may do so in a straight line, thus :—

Cuspidaria.
|
"*Silenia.*"
|
Poromya.
|
Lyonsiella.

II.—COMPARATIVE PART.

I. GASTROPODA.

We have seen that in the majority of the Gastropoda from great depths, the organs of visions are very rudimentary or even completely absent.

But, on the other hand, adjacent species (as for *Pleurotoma brychia*, *Pleurotoma lepta*, *Fossarus cereus*, and *Puncturella brychia*) and allied genera (as in the case of *Guivillea*) may possess well-developed and normal eyes. The state of these organs in the Gastropods from the depths cannot therefore be regarded as a zoological characteristic of their group, which has been retained in a new habitat. It is rather a modification impressed upon these organs by the conditions of abyssal life.

In fact, there are other Gastropods, which are, as regards their eyes, in the same condition as those from the deep sea.

The Gastropods in which the eyes are wholly absent are not numerous. The instance of *Vermetus*, quoted by Gegenbaur,[1] is wholly erroneous: very evident eyes are to be seen in *Vermetus triqueter*, where they have been observed by Lacaze-Duthiers, and in *Vermetus gigas*, as I have myself noted, &c.

In the group formed by *Neomenia* and *Chætoderma*, designated Aplacophora, the organs of vision are absent. As to the Polyplacophora (or Chitons), though they have numerous dorsal eyes, as H. N. Moseley has shown, they do not *possess in their adult life* organs homologous to the two cephalic eyes of the Anisopleural Gastropods. It is therefore a distinct character of the entire group of Isopleura, that they have no cephalic eyes.

It is inaccurate, however, to say, as Claus[2] does, that "cephalic eyes are absent only in the Chitons," for some other Gastropoda are reputed to be without visual organs. But in these cases the absence of visual organs is not, as in the Isopleura, a general

[1] Grundriss der vergleichenden Anatomie (1878), p. 373.
[2] Grundzüge der Zoologie (1882), Bd. ii. p. 31.

character of an entire group of some extent, but is merely the result of a special adaptation of some restricted division.

I ought to mention at the outset that among the Gastropod Molluscs which have been cited as devoid of eyes, there are several which have not been subjected to sufficiently complete investigation, and which have been credited with blindness without special research, when the fact was that the eyes were only in some degree rudimentary. The conclusion was simply based on the observation that the head did not exhibit pigmented spots visible externally. Such are, for example,—

On the one hand, (A) a certain number of Bulloidea[1] (*Scaphander*, *Philine*, *Doridium*, &c.) and also Naticidæ, in which the eye really exists and is pigmented, but is covered by a tegumentary and muscular layer of some thickness. The latter is the result of adaptation to the burrowing habits of the animals. Through the tegumentary layer the above animals can still appreciate different degrees of light and darkness. It is possible that in certain forms of *Natica* the eye does not persist, but is altogether absent. (B) *Phyllirhoe*, reputed to be blind by von Siebold,[2] possesses pigmented eyes;[3] but these are again covered by integument, and situated directly upon the nervous system, as is also the case (C) in certain Nudibranchs, such as *Doris*, *Eolis*, *Scyllæa*, *Tethys*, &c. In all these animals the rudimentary character of the eye consists solely in its being concealed below the integument, and in a moderate reduction of its dimensions.

On the other hand, (D) in *Guivillea*, and in certain other Gastropods afterwards mentioned, the eye still exists, but has been subjected to important modifications of structure, and has lost its pigment, as we have noted above.

I have unfortunately been unable, for lack of time, to corroborate, by personal examination, all the cited cases of Anisopleural Gastropods said to have no eyes, or to have visual organs atrophied in some way or other. It is therefore possible that in regard to some of the forms reputed to be "blind," some reservations may have to be made, as in the above cases.

Among these forms, perhaps the most astonishing are two large species of *Auricula* (*Auricula auris judæ* and *Auricula auris midæ*), for in these animals there does not seem to be any apparent reason for the atrophy of eyes; while in the cases to be mentioned below, the rudimentary nature or total disappearance of these organs is the result of a special and perfectly definite adaptation. It is evident that the primitive Anisopleura all possessed eyes, but that these organs may become rudimentary under the influence of special external conditions.

[1] Krohn, Fernere Beiträge zur Kenntniss des Schneckenauges, *Arch. f. Naturgesch.*, 1839, p. 335.
[2] Lehrbuch der vergleichenden Anatomie der Wirbellosen Thiere, p. 316.
[3] Souleyet, Voyage de la Bonite, Zoologie, t. ii. p. 410.

1. In several forms one may observe an exaggeration of the first exception cited above, that is to say, rudimentary condition, in consequence of the concealment of the eyes under organs which completely cover them. All such organisms are burrowers, like the Naticidæ and Bulloidea referred to above.

A. *Diphyllidia.*[1]
B. Several species of *Terebra.*[2]
C. Certain Olividæ : *Agaronia,*[3] *Olivella,*[4] *Ancillaria.*[5]
D. *Bulla.*[5]

2. It is well known that the eyes of pelagic animals have a tendency to become very perfectly developed, or, on the contrary, to become rudimentary, and to disappear. As an example of the former specialisation, one might cite Heteropods among Molluscs, *Alciope* among Annelids, &c. As to the second direction, we have already seen the tendency to atrophy exhibited by Gastropods, *e.g.* in *Phyllirhoe* cited above. But the tendency to become rudimentary may become still more marked.

A. In certain pelagic Nudibranchs, such as *Glaucus* (where the eye is situated on the central nervous system, and has become quite microscopic).[6]

B. Among "Pteropods," several forms (such as *Pneumonoderma, Clione*) exhibit the rudiment of an eye which does not appear to be any longer functional. Certain forms of *Clio* (*Creseis*) still possess two pigmented spots, bearing several minute refractive bodies. The other forms no longer exhibit any trace of an organ of vision.

C. In *Janthina*, the older authorities, Lesson, Rang, d'Orbigny, assert the presence of eyes, but they are not agreed even in regard to the position of these organs. On the other hand, all the other authorities, Quoy et Gaimard, Delle Chiaje,[7] Clark,[8] the brothers Adams,[9] Gwyn Jeffreys,[10] von Jhering,[11] Bouvier,[12] and myself, are agreed on this point, that no organs of vision were to be found in any of the different forms examined.

[1] Siebold, *loc. cit.*, p. 316; Souleyet, *loc. cit.*, Mollusques, pl. xxiv. E, figs. 16, 17.

[2] Woodward, A Manual of the Mollusca (1856), p. 111; Bronn (Keferstein), Die Klassen und Ordnungen des Thierreichs, Bd. iii. p. 1046; Bouvier, Système nerveux, morphologie générale et classification des Gastéropodes Prosobranches, *Ann. Sci. Nat.* (Zool.), sér. 7, t. iii. p. 322.

[3] Woodward, *loc. cit.*, p. 117.

[4] Fischer, Manuel de Conchyliologie, p. 599.

[5] A. and H. Adams, The Genera of Recent Mollusca, t. i. p. 112.

[6] Bergh, Anatomiske Bidrag til Kundskab om Aeoliderne, *K. Dansk. Vidensk. Selsk. Skriv.*, t. vii. (1864) p. 265; Vayssière, Observations sur l'anatomie du Glaucus, *Ann. Sci. Nat.* (Zool.), sér. 6, t. i. p. 15, pl. x. fig. 6, *s*.

[7] Descrizione e notomia degli Animali senza vertebre, pl. 67, 68.

[8] On the Janthinæ, Scalariæ, Naticæ, Lamellariæ, and Velutinæ, *Ann. Mag. Nat. Hist.*, ser. 2, vol. xi. p. 48.

[9] The Genera of Recent Mollusca, t. ii. p. 85.

[10] British Conchology, vol. iv. p. 82.

[11] Vergleichende Anatomie des Nervensystemes und Phylogenie der Mollusken, p. 108.

[12] Contributions à l'étude des Prosobranches Pténoglosses, *Bull. Soc. Malacol. France*, 1886, p. 81.

3. In many animals belonging to various groups living in the absence of light, it has been observed that the eye is rudimentary and without vision, or that it has entirely disappeared.

Among the anisopleural Gastropods which are in this condition we may cite,—

A. The species of *Cæcilianella* (for example, *Cæcilianella acicula*, O. F. Müller, sp.), which live concealed in the ground. In these the absence of pigmented eyes has been known since Nilsson's investigation.[1] In the species of *Testacella*, the eye, although very minute and almost rudimentary, is still distinct and pigmented; and this not unnaturally, since this Mollusc has not an exclusively subterranean existence.

On the other hand, it is well known that a certain number of animals, including both terrestrial and fresh-water forms (Amphibians, Fishes, Insects, Arachnids, Crustaceans, Molluscs, &c.), live in caves absolutely shut off from the light. They form the "cave fauna" of Carniola, Falkenstein, of the mammoth cave of Kentucky, of Cuba, &c. Among the anisopleural Gastropods which are found blind in such environment, we may mention,—

B. The species of *Zospeum*, allied to *Pupa*.[2]

C. *Helix hauffeni*, F. Schmidt.[3]

D. *Bithinella pellucida*, Hauffen, sp.

The last species, investigated by Wiedersheim[4] and de Rougemont,[5] exhibits at the base of the tentacles an unpigmented tubercle, like that of *Guivillea*.[6]

Among the Gastropods of the cave fauna there appear to be some forms which still retain normal or approximately normal eyes. Such, for example, is a species of *Zonites* described by Dall.[7] These are forms in which adaptation to a life in dark caves has not yet been so old-established or so complete as that of the species above mentioned.

4. Finally, there are certain marine animals (Fishes, Crustaceans, Molluscs, &c.) which live in depths so great that the light is feeble or nil, apart from that produced by phosphorescent forms. These also exhibit marked modifications in the organs of vision.

[1] Historia Molluscorum Sueciæ, 1823.

[2] Frauenfeld, Besuch einiger Krainenhöhlen, *Verh. d. k. k. zool.-bot. Vereins Wien*, Bd. iv. p. 64, 1854; Frauenfeld, Die Gattung Carychium, *ibid.*, p. 75.

[3] Schmidt, Beschreibung neuer Höhlenthiere, *Verh. d. k. k. zool.-bot. Vereins Wien*, Bd. v., 1855, p. 4.

[4] Beitrage zur Kenntniss der Württembergischen Höhlenfauna, *Verh. d. Phys. Medic. Ges. Würzburg*, Neue Folge, Bd. iv., 1873.

[5] Étude sur la faune des eaux privées de lumière (1876).

[6] Wiedersheim, *loc. cit.*, p. 210, pl. vii. fig. 14, *b*.

[7] Packard, On a new cave fauna in Utah, *Bull. U. S. Geol. and Geogr. Survey of the Territories*, vol. iii., 1877, p. 163.

Among Crustaceans, modifications occur in the two directions mentioned above in respect to pelagic animals in general, that is, towards atrophy and towards hypertrophy. An example of the latter is furnished by *Cystisoma neptuni*, Guérin; and such modifications are probably useful for the perception of luminous rays which would be imperceptible to normal eyes, either on account of their feeble intensity, or because of their special chemical character. Examples of such modification are not, however, numerous, and there is no instance of a Gastropod from the great depths in which the visual organs have undergone such a change.

In all Gastropods from that habitat the eyes have been markedly atrophied (as in *Guivillea*), or have totally disappeared, as in the other species discussed after *Guivillea* (*Pleurotoma lepta*, *Pleurotoma brychia*, *Fossarus* (?) *cereus*, *Puncturella brychia*). Some other instances of the latter condition are already known in species from various depths, and I am convinced that further researches will greatly increase the list.

A. *Pleurotoma nivale*, Lovén,[1] of which G. O. Sars has made a special genus, under the title *Typhlomangilia*,[2] lives at about 170 fathoms.

B. *Fusus abyssorum*, Fischer,[3] collected from between 1300 and 2800 fathoms.

C. *Eulima stenostoma*, Jeffreys,[4] lives at about 90 fathoms.

D. *Tectura fulva*, O. F. Müller, sp.

E. *Lepeta s. str.*

F. *Propilidium.*

The markedly rudimentary character of the eyes of the subterranean or abyssal Molluscs is produced in an entirely different fashion from that which we have noticed in certain Gastropods (burrowers, some Nudibranchs, &c.), where the organs are concealed under the skin, and undergo diminution in size. In the present instances the eyes remain on the surface and do not become reduced in size, but lose successively certain of their constitutent portions, or altogether disappear.

Among the Gastropods from great depths, as among the subterranean forms, there are several (*Trochus infundibulum*, *Trochus rhina*, *Turbo transenna*, &c.) which still retain well-pigmented eyes, like those of littoral species. Like some of the cave forms above referred to, they are instances of more recent and still incomplete adaptation. It is certain none the less that abyssal Gastropods, as well as the subterranean forms, have a general tendency to become rudimentary and to lose their eyes.

[1] Jeffreys, British Conchology, vol. iv. p. 389.

[2] Mollusca regionis arcticæ Norvegiæ, p. 241.

[3] Fischer, Sur les espèces de Mollusques arctiques trouvées dans les grandes profondeurs de l'Océan Atlantique intertropical, *Comptes rendus*, xcvii. p. 1498.

[4] Jeffreys, British Conchology, vol. iv. pp. 207, 208.

The facts and instances above referred to may be summed up in the following table :—

Anisopleural Gastropods with rudimentary organs of vision.				*Auricula auris-judæ*, *Auricula auris-midæ*.
	From habit.	Burrowers.		*Diphyllidia*. Some *Terebræ*. *Olivella*. *Agaronia*. *Ancillaria*. *Bullia*.
		Pelagic.		"Pteropoda." *Glaucus*. *Janthina*.
	From the absence of light.	Subterranean (Cave fauna).	Pulmonate.	*Cæcilianella*. *Helix hauffeni*. *Zospeum*.
			Fresh water.	*Bithinella pellucida*.
		Abyssal.		*Pleurotoma nivale*. —— *lepta*. —— *brychia*. *Fusus abyssorum*. *Guivillea*. *Eulima stenostoma*. *Fossarus ? cereus*. *Tectura fulva*. *Lepeta s. str.* *Propilidium*. *Puncturella brychia*.

II. PELECYPODA.

The arrangement of the gills in *Malletia*, in the "*Cryptodon*" of the Challenger, and in the entire group of "Anatinacea" formed by *Poromya*, *Silenia*, and *Cuspidaria*, prompted me to study their structure in a large number of other Pelecypoda. I shall here summarise the results of my comparative investigation.

It has been already indicated that among all the known gills of Pelecypoda, those of *Malletia* have the simplest structure, and most closely approach the gills of Cephalopods and Gastropods (such as *Fissurella* and *Haliotis*). They may be regarded, then, as the type most closely resembling the primitive gill of Pelecypoda.

It is possible, in fact, to derive from this type all the other forms of gill found in the group. One can readily understand that with further specialisation, that is to say, with increase of surface for blood exposure, these organs must needs have their gill-lamellæ elongated into filaments. But the two rows of lamellæ being then compressed between the mantle and the visceral mass, they must, in order to elongate and become transformed into filaments, extend towards the ventral side, parallel to one another. This is what occurs in the animals allied to *Malletia* (Pl. IV. fig. 10 BB), in the entire group of Arcidæ.

One remarkable exception to this rule is found in the forms of *Solenomya*. In these Molluscs the gills apparently retain the simple structure characteristic of *Malletia*, but the lamellæ are elongated, and one row extends towards the dorsal, and the other towards the ventral surface.

In *Nucula* (Pl. IV. fig. 10, B) the beginning of the elongation of the lamellæ may be already observed. A more advanced stage, showing the two rows of filaments (elongated lamellæ) simple and perfectly parallel, is not represented by any modern forms. *Solenomya* would approximately represent this phase, if the two series of lamellæ, instead of remaining in the same plane (turned in opposite directions), were both turned ventrally, that is to say, if the dorsal row were folded between the mantle and the ventral series. But among the other extant Pelecypoda no form retains the stage with simple filaments (Pl. IV. fig. 10, C).

In fact, in the gills which are least removed from those of *Nucula*, these filaments become recurrent. Elongated to increase their surface of hæmatosis, and not being able to extend farther in a ventral direction, the filaments are turned upon themselves in a dorsal direction, growing towards the point of origin of the axis, and exhibiting in transverse section the form of an elongated V. Such is the structure of the gill in the Arcidæ (Pl. IV. fig. 10, D). The two series of filaments then form two branchial plates. According to Dall,[1] *Arca cetomata* possesses only one of these plates; but the fact seems to me to demand corroboration.

In the Arcidæ these filaments are still entirely free and perfectly distinct from one another. But in a more advanced stage of specialisation all the filaments of one half plate or lamina (*a* or *a'*, for example, in Pl. IV. fig. 10), though not fused to one another, are nevertheless united by perpendicular bridges, while transverse bridges connect the two branches of the same filament. This is the state of affairs in *Mytilus*.

In a more elaborated union and completer fusion, the filaments come to form four laminæ, of which the two internal and the two external are united to one another by longitudinal contact, leaving between them "interbranchial" tubular spaces, and by transverse septa. In this way the gill consists of an external plate (with two laminæ) and of an internal plate (also with two laminæ).

The surface of the plates may then become folded, and exhibit the most general type of gill in the Pelecypoda (Pl. IV. fig. 10, E). This type may be further modified by enlargement or by reduction.

Thus in a large number of Pelecypoda, as, for example, in *Cardium* (Pl. IV.

[1] Report on the Mollusca, *Bull. Mus. Comp. Zoöl.*, xii. p. 244. According to Dall, *Dimya* (*ibid.*, p. 232) and *Amusium* (p. 210) have also only a single gill on each side; but I have shown that in the Challenger species of *Amusium* there were two normal gills on each side.

fig. 10, F), the external lamina of the outer plate extends dorsally, so as to form the beginning of a third lamella. This is what is called an "appendage."

On the other hand, the whole of the outer plate may be reduced and directed dorsally, as, for instance, in *Tellina* (Pl. IV. fig. 10, G). This portion is then also called an "appendage." But it is in nowise comparable, as Fischer believed, to the appendage of *Cardium*, or of other Pelecypoda with two branchial plates of which the outer is appendiculate. For in the latter cases the appendage corresponds to the entire outer plate of the typical gill (E).

It is by regarding this appendage of *Cardium* and of other Pelecypoda with two branchial plates, as a structure homologous with the so-called "appendage" of *Tellina*, that Fischer[1] has come to consider the ventrally directed branchial plate of *Tellina* as homologous with the outer plate of the Pelecypoda which he designates as "Tetrabranch."

But this branchial plate of *Tellina* has its recurrent or reflected lamina *internal*. If the plate were external, its recurrent lamina would also be *external*. It therefore represents surely the internal branchial plate of the other Pelecypoda mentioned above.

This arrangement of the gill seen in *Tellina* occurs in the greater number of the members of Fischer's group Anatinaceæ (in which Hancock[2] has also previously supposed that the ventrally directed plate corresponded to the outer plate of other Pelecypoda), and in the family Clavagellidæ which he includes in his group. But in these groups the outer plate of the gill (Fischer's "appendage"), very much reduced in *Pandora*, only possesses the internal lamina (Pl. IV. fig. 10, I, *a*), the "direct" lamina of Lacaze-Duthiers; the external or recurrent lamina is absent.[2]

I cannot for a moment suppose that this disposition of the gills (G and I) of Tellinidæ, Anatinacea, Clavagellidæ (that is to say, the "Appendiculate Dibranchs" of Fischer), could be derived from the arrangement found in *Solenomya* (BB), where the two branchial plates are also directed in opposite directions, the one ventrally and the other dorsally (the dorsal plate being for Fischer the "appendage"), but where neither of the plates exhibits any recurrent or reflected portion.

I would regard the gill arrangement of *Tellina*, &c., as a modification of the typical disposition ("Tetrabranch") (E). For each of the groups cited, one may find among the "Tetrabranchs" neighbouring forms which hardly differ, except in the arrangement of the outer plate of the gill.

[1] Manuel de Conchyliologie, p. 1141.

[2] Hancock, On the animal of Chamostrea albida, *Ann. and Mag. Nat. Hist.*, ser. 2, vol. xi. p. 109; Hancock, On the animal of Myochama anomioides, *ibid.* p. 289; Lacaze-Duthiers, Morphologie des Acéphales, *Arch. de Zool. Expér.*, sér. 2, t. i. p. 715, pl. xxxvii. fig. 4 (*Aspergillum*).

In the Lucinidæ of Fischer, and in the species of *Cryptodon* of the Challenger (II), the outer plate of the gill is not transformed into a dorsally directed "appendage," but has altogether disappeared. For here again, as in *Tellina*, the branchial plate directed ventrally is homologous with the internal plate of the typical gill (E). In fact, its recurrent or reflected lamina is internal. The embryological facts also show, according to Lacaze-Duthiers,[1] that this plate is indisputably the internal.

From what has been said, it is not necessary to conclude, as Dall[2] has done, that the gills cannot be employed for purposes of classification. They may be so used, but in so doing we attend, as Ray Lankester[3] has shown, to their structure, and not, as Fischer did, to their number. All the Pelecypoda have, in fact, on each side only a single gill, each plate of which corresponds to half of the gill of Gastropod or Cephalopod. This can be very clearly seen in primitive gills like those of *Malletia*. But this single gill may be greatly modified in the great majority of Pelecypoda, either by enlargement or by reduction. Thus, as has been already explained, the gills come to have an appearance quite different from those of other Molluscs.

In a preceding publication[4] I was not in a position definitely to discuss Fischer's classification, which was not then fully published. But since the publication of Fischer's Manual, and my recent examination of a large number of Pelecypoda, I have become convinced that his classification is unnatural. It tends, that is to say, to separate forms so closely allied as *Lucina* and *Ungulina*, *Tellina* and *Psammobia*, *Aspergillum* and *Fistulana*, &c., to place *Malletia*, *Yoldia*, and *Nucula* among Tetrabranchs, and *Solenomya* among Dibranchs, though the gills in all cases are formed in essentially similar fashion; and, finally, to rank genera so peculiar as those of the "Anatinacea," studied above, which are destitute of true gills (*sensu stricto*), among the "Dibranchs," in which the gills are well developed.

The supposed parallel classification of Dibranchs and Tetrabranchs, which Fischer[5] suggests, shows nothing more than that the same reduction of gill may occur in different groups.

Apart from the two great works of Poli[6] and of Deshayes,[7] of which the former is already very old, the general morphology of the Pelecypoda has not been the subject of works extending over the entire group, or even over the greater part of it. Of late years it has been rather to the physiology of these organisms that investigation has been

[1] Mémoire sur le développement des branchies des Mollusques Acéphales Lamellibranches, *Ann. Sci. Nat.* (Zool.), sér. 4, t. v. p. 46.

[2] Report on the Mollusca, *Bull. Mus. Comp. Zoöl.*, t. xii. p. 281.

[3] Mollusca, Encycl. Brit., 9th ed. t. xvi. p. 691.

[4] Notice sur les Mollusques recueillis par M. le Capitaine Storms dans la région du Tanganyka, *Bull. Mus. Roy. Hist. Nat. Belg.*, t. iv., 1886, p. 120.

[5] Manuel de Conchyliologie, p. 1141.

[6] Testacea utriusque Siciliæ.

[7] Histoire naturelle des Mollusques (Exploration de l'Algérie).

specially directed; the circulation, the entrance of water into the blood, pori aquiferi, and the like, have mainly occupied attention. Thus it is that our notions of the mutual relations of the different groups of Pelecypoda are still very imperfect.

In order to reach a completer view of the class, it would be necessary to have material from all parts of the world, and representative of all the principal types, and then in such a museum to resume the labours of Poli and Deshayes with the light of the phylogenetic conceptions which were unknown to them.

But although there are great lacunæ in our knowledge of the morphology of Pelecypoda, I do not think that it is necessary to abstain from already seeking to discover the mutual relations of the different groups, or, in other words, to sketch their phylogenetic or natural classification.

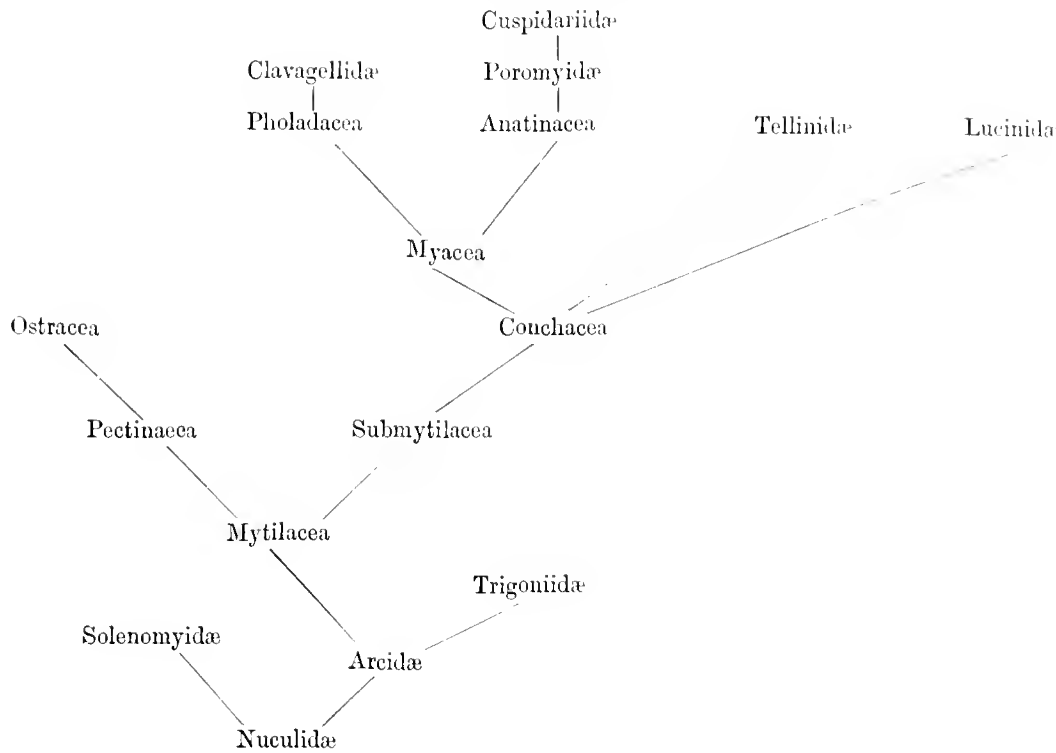
Indeed, however imperfect the result of any such endeavour may be, it cannot but be of use in attracting discussion and criticism, and thereby suggesting new researches. From this point of view one cannot help regretting that there are so few synthetic works among the multitude of analytic or descriptive memoirs which see the light, and so few ideas amid so many accumulated facts. For every new idea is a progress; and even when synthetic attempts or theoretical ideas are pushed to an extreme, as, for example, in the great work of von Jhering on the nervous system of Molluscs, they do not by any means remain barren of results, even if they only serve to incite to research and to provoke discussion.

But even von Jhering has not attempted to sketch the phylogenetic classification of the Pelecypoda. The only attempt of the kind, and that from an exclusively conchological and palæontological point of view, is due to Neumayr.[1]

While I share the opinion of Fischer[2] as to the limited value of the hinge in classification, I cannot, on the other hand, ignore the work of Neumayr, or the results of his conchological and palæontological researches. For although Professor Gaudry has described Palæontology as "grandeur et misère," it must be allowed that as regards Mollusca (except from some points of view in respect to Cephalopods), Palæontology is hardly anything but "misère." In spite of the perfect fossils that remain, nothing of the real structure is revealed beyond certain peculiarities of the mantle.

Therefore I limit myself here simply to the living Pelecypoda, and exclusively to the study of their soft parts. In the following table, only the great groups are indicated. Except in the case of a few important families, I have omitted the smaller groups which gravitate round the larger. It must be noted, furthermore, that this table is only a sketch, designed especially to indicate the successive modifications of the gills, and to summarise the facts which have been discussed above.

[1] Zur Morphologie des Bivalvenschlosses, *Sitzungsb. d. k. k. Akad. Wiss. Wien*, Bd. lxxxviii. p. 413.
[2] Une nouvelle Classification des Bivalves, *Journ. de Conchyl.*, t. xxxii. p. 121.



In this table the branch proceeding from Mytilacea to Ostracea corresponds to the Dysodonta of Neumayr; the branch from Submytilacea to Tellinidæ and Lucinidæ represents Neumayr's Heterodonta, and the Myacea with the two branches which rise from them are his Desmodonta.

It will be noticed that the above table differs in several points from that of Professor Neumayr (*loc cit.*, p. 413). In fact, I regard his Palæoconcha as arising from the Taxodonta (Arcacea), rather than as giving origin to them. It is possible that these Palæoconcha represent the origin of the Solenomyidæ.

And again, I regard the Trigoniidæ as the direct derivatives of the Arcacea. The nature of their mantle, of their foot, and of their gills, which consists each of two plates of filaments,[1] afford strong evidence in favour of this interpretation.

As to the Monomyaria (Ostracea and Pectinacea) and the Heteromyaria (Mytilacea), I am in entire agreement with the opinion of Neumayr, which is shared, I believe, by all malacologists, that the first are derived from the second, of which they merely constitute a "sedentary" specialisation. The Heteromyaria find their origin in the Arcacea, through forms belonging to the Aviculidæ, and more especially to the Pterineinæ (such as *Macrodon* and *Pterinea*).

As regards the Desmodonta and Heterodonta, it will be seen that I do not regard

[1] Huxley, Description of the animal of Trigonia, *Proc. Zool. Soc. Lond.*, 1859, p. 31.

them as great separate groups of distinct origin. Neumayr seems almost alone in this opinion. On the contrary, I regard the Desmodonta as derived from certain Heterodonta, and the close resemblance in the structure of the two series prevents me from separating them.

Finally, it will be seen that the forms with rudimentary gills belong to the terminal groups: Clavagellidæ, Cuspidariidæ, Poromyidæ, Tellinidæ, Lucinidæ, which is contrary to the opinion of Von Jhering, who regarded the latter as primitive.[1] But these terminal groups have distinct origins, as the phylogenetic table suggests, and cannot possibly be united in any natural classification.

III.—CONCLUSIONS.

As the subject is still new, and hitherto but little investigated, we cannot yet presume to formulate general and final conclusions. But few deep-sea Molluscs have as yet been studied, and many researches must still be undertaken before definite generalisations can be ventured.

Having made these reservations, I think, nevertheless, that in order to sum up the facts discussed above it is necessary to attempt to formulate certain results. From the observations which I have made on the Mollusca[2] from the deep sea, I conclude :—

1. An organ of special sense, the organ of vision, may atrophy and disappear, in consequence of the absence of sufficient light in the great depths: *Guivillea* and certain forms of *Pleurotoma*, *Fossarus* (?), and *Puncturella*, among Gastropoda; *Amusium* among Pelecypoda.

2. Correlatively, the organs of general sense may multiply and acquire a high degree of development: labial palps of *Trochus infundibulum;* siphonal tentacles of varied structure in the deep-sea Anatinacea and in *Malletia*.

3. The respiratory activity may diminish and the gills become rudimentary in various ways (certain Anatinacea: Poromyidæ, Cuspidariidæ; *Cryptodon*), or may retain great simplicity of structure (*Malletia*).

[1] Vergleichende Anatomie des Nervensystemes und Phylogenie der Mollusken, p. 64.

[2] These results, especially the first and second, agree with what has been observed of other animals from the deep sea, such as Crustaceans and Fishes.

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PLATE I.

Figs. 1, 2. *Guivillea alabastrina*, Watson.

Fig. 1. Anterior portion seen from the right side.

a, Proboscis; *b*, cephalic veil; *c*, left tentacle; *d*, rudimentary right eye; *e*, foot; *f*, penis; *g*, mantle; *h*, pallial siphon; *i*, entrance to the pallial chamber; *j*, appendage of the siphon.

Fig. 2. Sagittal section of the rudimentary eye.

a, Epithelium; *b*, pellucida; *c*, subcutaneous connective tissue; *d*, common sheath of the optic nerve and of the ball of the eye (choroid); *e*, homogeneous retinal mass; *f*, beginning of the optic nerve; *g*, muscular mass of the cephalic veil.

Figs. 3–5. *Trochus infundibulum*, Watson.

Fig. 3. Anterior portion and foot, seen from the ventral side and slightly to the left.

a, Buccal aperture; *b*, right labial palp; *c*, left tentacle, with the eye at its base; *d*, mantle; *e*, pallial cavity; *f*, anus; *g*, foot; *h*, anterior epipodial lobe; *i*, epipodial tentacles.

Fig. 4. Head from the dorsal aspect.

a, Buccal aperture; *b*, labial palp; *c*, tentacle; *d*, eye; *e*, "palmette."

Fig. 5. Anterior portion of the nervous system, seen from the right side.

a, *a′*, Cerebral ganglia; *b*, cerebral commissure; *c*, cerebro-pleural connective; *d*, cerebro-pedal connective; *e*, "labial prominence" of the cerebral ganglion; *f*, proboscideal nerves; *g*, tentacular nerve; *h*, nerve of the labial palp; *i*, nerves of the lips; *j*, origin of the sub-œsophageal "labial commissure."

Fig. 6. *Dolabella neapolitana*, Delle Chiaje.

Fig. 6. Anterior portion and foot, seen from the ventral side, and slightly to the left.

a, Buccal aperture; *b*, labial palp; *c*, anterior tentacle; *d*, posterior tentacle, with the eye at its base; *e*, foot.

Figs. 7, 8. *Malletia pallida*, Smith.

Fig. 7. The animal is viewed from the left side, and the pallial lobe of that side has been removed, with the exception of the retractor muscle of the siphons.

a, Buccal aperture; *b*, left labial palps; *c*, their appendage contracted; *d*, foot; *e*, visceral mass; *f*, right lobe of the mantle; *g*, left gill; *h*, branchial siphon; *i*, anal siphon; *j*, siphonal tentacle; *k*, left retractor muscle of the siphons; *l*, anterior adductor muscle; *m*, posterior adductor muscle; *n*, posterior retractor muscle of the foot.

Fig. 8. Left gill, seen from the outer side.

a, Branchial axis; *b*, outer row of lamellæ; *c*, inner row of lamellæ.

Fig. 9. *Macoma balthica* (L.) (*Tellina*).

Fig. 9. Posterior portion, seen from the left side, with the mantle removed from that side to the line *x*—*x′*.

d, Foot; *f*, right lobe of the mantle; *g*, left gill; *h*, branchial siphon; *i*, anal siphon; *j*, siphonal tentacular tuft; right retractor muscle of the siphons; *l*, posterior adductor muscle; *m*, posterior retractor muscle of the foot; *o*, muscle of the pallial commissure.

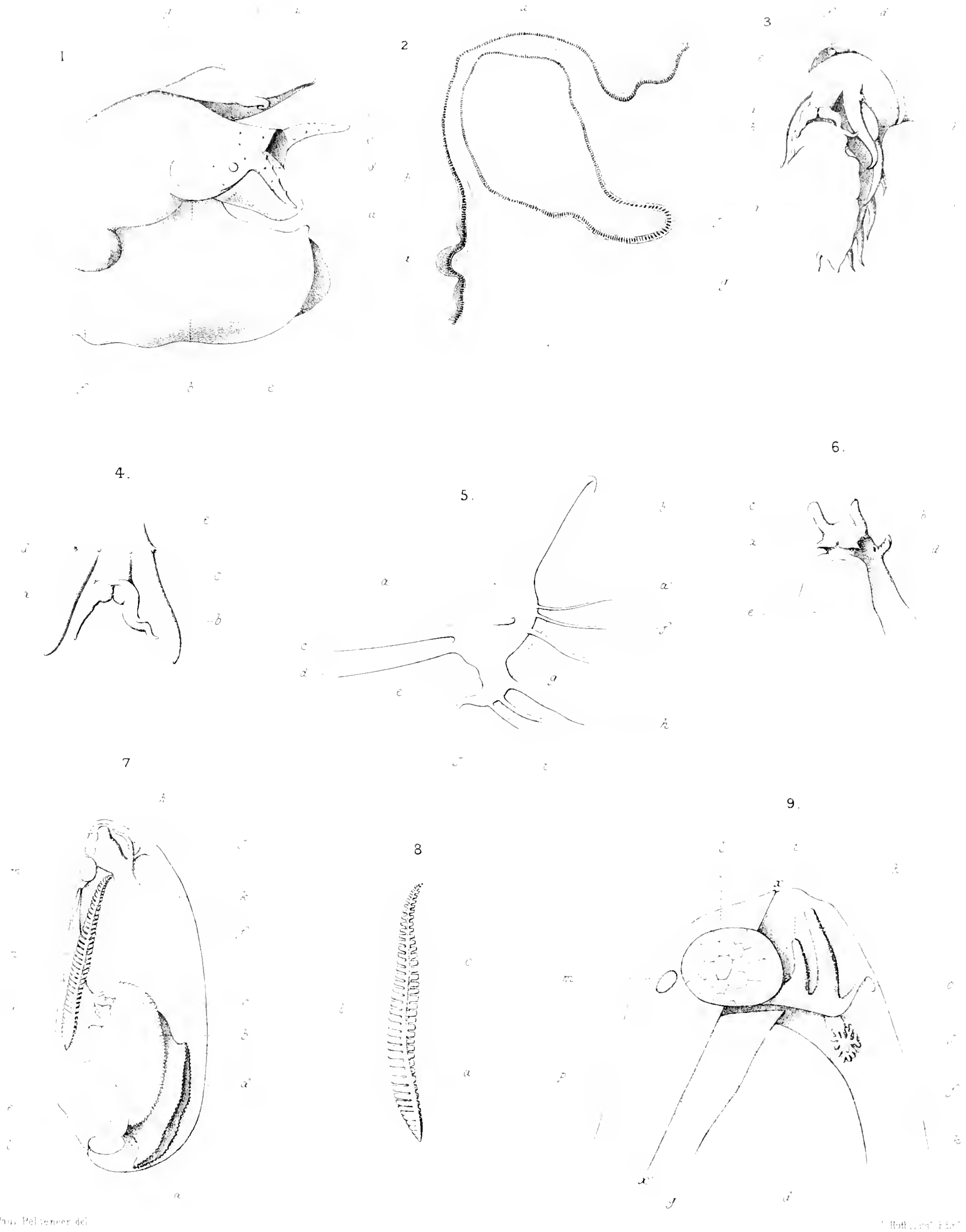

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PLATE II.

PLATE II.

Fig. 1. *Limopsis pelagica*, Smith.

Fig. 1. Seen from the left side, the mantle having been removed from that side.

a, Buccal aperture; *b*, anterior lip; *c*, posterior lip; *d*, foot; *e*, visceral mass; *g*, gill; *h*, branchial support; *i*, right lobe of the mantle; *k*, anterior adductor muscle; *l*, posterior adductor muscle; *m*, anterior retractor muscle of the foot; *m'*, posterior retractor muscle of the foot; *n*, heart; *o*, intestine; *p*, anus.

Fig. 2. *Limopsis minuta*, Philippi.

Fig. 2. Seen from the left side, the mantle having been removed from that side.

a—e, As in the preceding figure; *f*, internal plate of the gill; *g*, external plate; *h*, branchial support; *i*, right lobe of the mantle; *j*, point where the two lobes of the mantle unite posteriorly; *k*, anterior adductor muscle; *l*, posterior adductor muscle; *m*, posterior retractor muscle of the foot; *n*, heart.

Figs. 3, 4. "*Cryptodon*" *moseleyi*, Smith.

Fig. 3. From the left side, from which the mantle has been removed from the anterior adductor muscle to the anal aperture, all along its adhesion to the gill.

b, Anterior lip; *c*, left posterior palp; *d*, foot; *g*, gill; *i*, right lobe of the mantle; *j*, thickening of the anterior margin of the mantle; *k*, anal aperture; *l*, anterior adductor; *m*, posterior adductor; *n*, posterior retractor of the foot; *o*, heart; *p*, intestine; *q*, genital gland; *r*, point where the two lobes of the mantle are united posteriorly.

Fig. 4. Ventral aspect, the two lobes of the mantle having been thrown aside.

a, Buccal aperture; *b*, posterior lip; *c*, anterior left labial palp; *e*, byssal orifice; *f*, visceral mass; *h*, membrane uniting the recurrent laminæ of the gills; *n*, cerebral ganglion. The other letters as in fig. 3.

Fig. 5. "*Cryptodon*" *luzonica*, Smith.

Fig. 5. Posterior aspect of the mantle margin.

a, Free margin of the left lobe of the mantle; *b*, posterior adductor muscle; *c*, large branchio-pedal orifice; *d*, anal aperture.

Fig. 6. *Semele profundorum*, Smith.

Fig. 6. Sketch of the animal, seen from the left side, from which the mantle has been removed.

b, Anterior labial palp; *d*, foot; *e*, ventral plate of the gill; *e'*, dorsal plate; *f*, visceral mass; *l*, anterior adductor; *m*, posterior adductor; *n*, posterior retractor of the foot; *o*, anal siphon; *p*, branchial siphon; *q*, right retractor muscle of the siphons.

Fig. 7. *Lyonsiella jeffreysi*, Smith.

Fig. 7. The animal is seen from the left, after the removal of the mantle from that side.

a, Buccal aperture; *b*, fold surrounding the mouth; *d*, foot; *d'*, byssus; *e*, ventral plate of the gill (external lamina); *e'*, dorsal plate of the gill; *e''*, ventral plate of the gill (reflected or recurrent lamina); *f*, visceral mass; *g*, visceral ganglia; *h*, pallial fold; *i*, free margin of the mantle (pedal orifice); *j*, point where the two lobes of the mantle are united behind the pedal orifice; *k*, internal fold of the branchial orifice; *l*, anterior adductor; *m*, posterior adductor; *p*, anal aperture; *q*, tentacles of the branchial aperture; *r*, point where the gill (dorsal plate) ceases to be fused to the mantle.

Fig. 8. *Lyonsiella papyracea*, Smith.

Fig. 8. The animal viewed from the left side, from which the mantle has been removed up to the line along which it adheres to the gill.

a, Buccal aperture; *b*, anterior portion, and *c*, posterior portion of the fold surrounding the mouth; *d*, foot; *e*, ventral plate of the gill; *e'*, dorsal plate of the gill; *f*, visceral mass; *g*, pallial gland; *h*, membrane uniting the gills to the mantle, and to the separation of the siphons; *i—m*, as in the preceding figure; *n*, posterior retractor of the foot; *o*, heart; *p*, anal aperture; *q*, tentacles of the branchial aperture.

Fig. 9. *Lyonsia*, sp.

Fig. 9. The animal viewed from the left side, from which the mantle has been removed.

b, Anterior palp; *c*, posterior palp; *d*, foot; *d'*, byssus; *e*, ventral plate of the gill; *e'*, dorsal plate; *f*, visceral mass; *g*, membrane of the hinge; *h*, membrane joining the gills to the separation of the siphons; *j*, point where the two lobes of the mantle unite behind the pedal orifice, which has bere become the byssal orifice, and exhibits an internal fold; *l*, anterior adductor; *m*, posterior adductor; *n*, anus; *o*, anal chamber; *p*, anal aperture; *q*, branchial aperture.

Fig. 10. *Lyonsiella abyssicola* (Sars).

Fig. 10. The animal seen from the left side, from which the mantle has been removed from the anterior adductor to the branchial siphon.

a, Buccal aperture; *b*, anterior labial palp; *c*, posterior palp; *d*, foot; *e*, gill; *f*, visceral mass; *g*, visceral ganglia; *h*, membrane uniting the gills to the mantle and to the separation of the siphons; *i*, free margin of the mantle (pedal orifice); *j*, point where the two lobes of the mantle unite behind the pedal orifice; *l*, anterior adductor; *m*, posterior adductor; *n*, posterior retractor of the foot; *o*, anal chamber; *p*, anal siphon; *q*, invaginate tentacles of the branchial aperture.

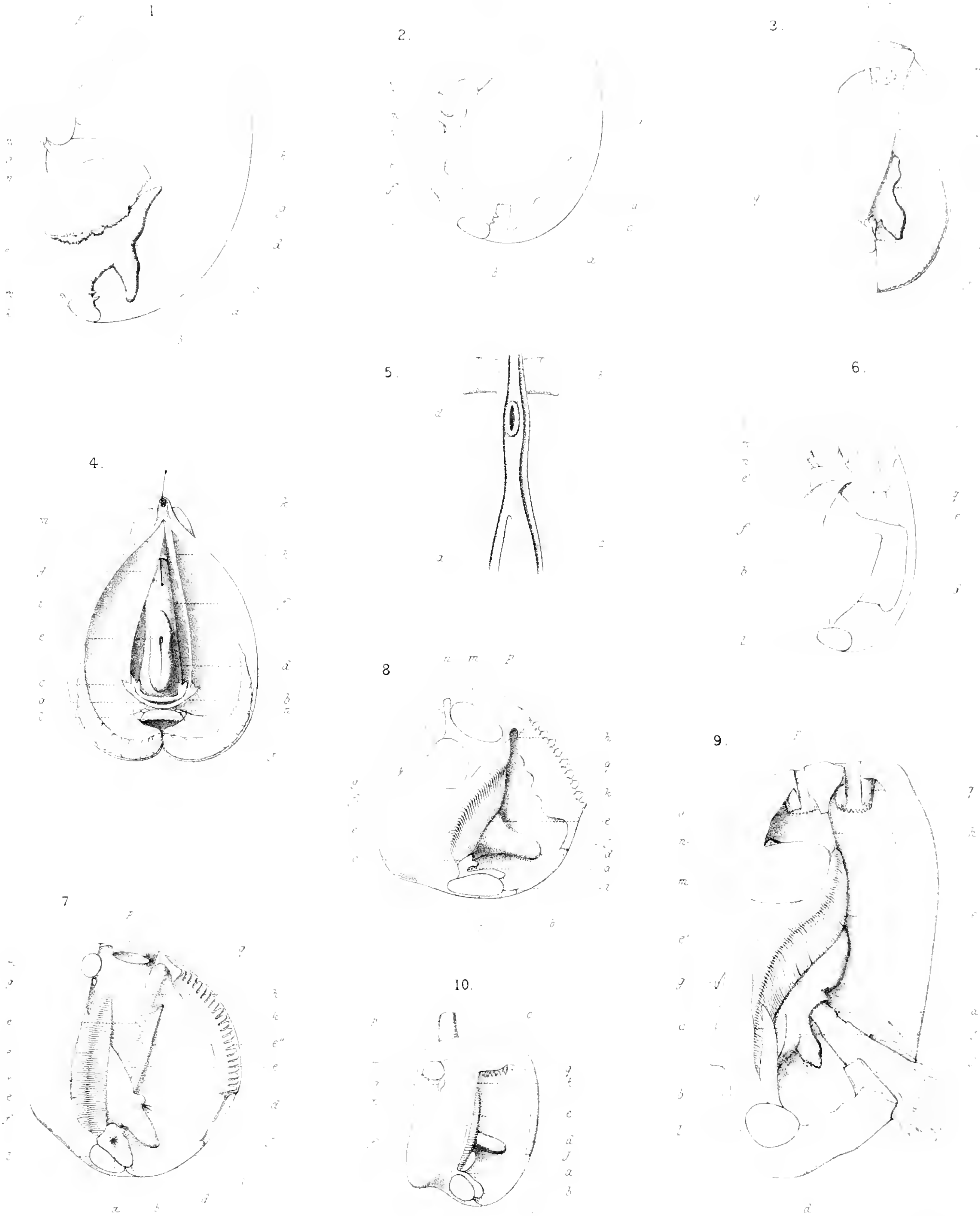

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PLATE III.

PLATE III.

Fig. 1. *Lyonsiella papyracea*, Smith.

Fig. 1. The animal seen from the ventral aspect, the pallial commissure between the pedal and branchial apertures having been cut, and the two lobes of the mantle thrown to the side.

a, Mouth; *b*, *c*, fold which surrounds the mouth; *d*, foot; *e*, ventral plate of the gill; *e'*, dorsal plate of the gill; *h*, membrane uniting the gills to the separation of the siphons; *i*, free margin of the mantle (pedal aperture); *j*, point where the two lobes of the mantle unite behind the pedal aperture; *k*, valvular fold within the branchial aperture; *l*, anterior adductor; *q*, tentacles of the branchial aperture.

Fig. 2. *Lyonsiella abyssicola* (Sars).

Fig. 2. The animal seen from the ventral aspect, the two lobes of the mantle having been removed up to the line along which they are united to the gills.

a, Buccal aperture; *b*, anterior "palp;" *c*, posterior "palp;" *d*, foot; *e*, ventral plate of the gill; *e'*, dorsal plate of the gill; *h*, membrane uniting the gills to the mantle and to the separation of the siphons; *p*, anal siphon; *q*, tentacles of the invaginated branchial siphon.

Figs. 3–6. *Poromya tornata* (Jeffreys).

Fig. 3. The animal viewed from the left side, from which the mantle has been removed, except behind the line *m*—*q*.

a, Mouth; *b*, anterior palp; *c*, posterior palp; *d*, foot; *e*, branchial partition; *f*, visceral mass (liver); *g*, anterior group of lamellæ; *g'*, posterior group; *h*, thick membrane uniting the branchial partition at the separation of the posterior apertures; *i*, free margin of the mantle; *j*, point where the two lobes of the mantle unite behind the pedal aperture; *k*, valve of the branchial aperture; *l*, anterior adductor; *m*, posterior adductor; *n*, posterior retractor of the foot; *o*, intestine; *p*, heart; *r*, tentacles of the posterior apertures.

Fig. 4. The animal seen from the ventral aspect, the mantle having been wholly removed, as well as the membrane *h* of the preceding figure.

d', Byssal groove; *h*, lateral muscle of the branchial partition. The other letters as in fig. 3.

Fig. 5. The left anterior group of plates.

a, One plate; *b*, space between two plates; *c*, longitudinal bridges.

Fig. 6. The two posterior apertures.

a, Branchial aperture; *b*, anal aperture; *c*, tentacles.

Fig. 7. *Poromya granulata*, Nyst.

Fig. 7. The animal seen from the left side, from which the mantle has been wholly removed up to the line where it joins the branchial partition.

a—*n*, As in fig. 3; *f'*, genital gland; o, heart; *p*, anal siphon; *q*, tentacles.

Figs. 8–10. "*Silenia*" *sarsi*, Smith.

Fig. 8. The animal seen from the left side, from which the mantle has been removed.

a—*f*, As in fig. 3; *g*, anterior group of apertures; *g'*, middle group; *g''*, posterior group. The other letters as in fig. 7.

Fig. 9. The animal from the ventral aspect, the mantle having been removed from the left side.

Letters as in fig. 8.

Fig. 10. The middle and posterior groups of apertures, much enlarged.

a, The last two apertures of the anterior group; *b*, the middle group; *c*, the posterior group; *d*, foot.

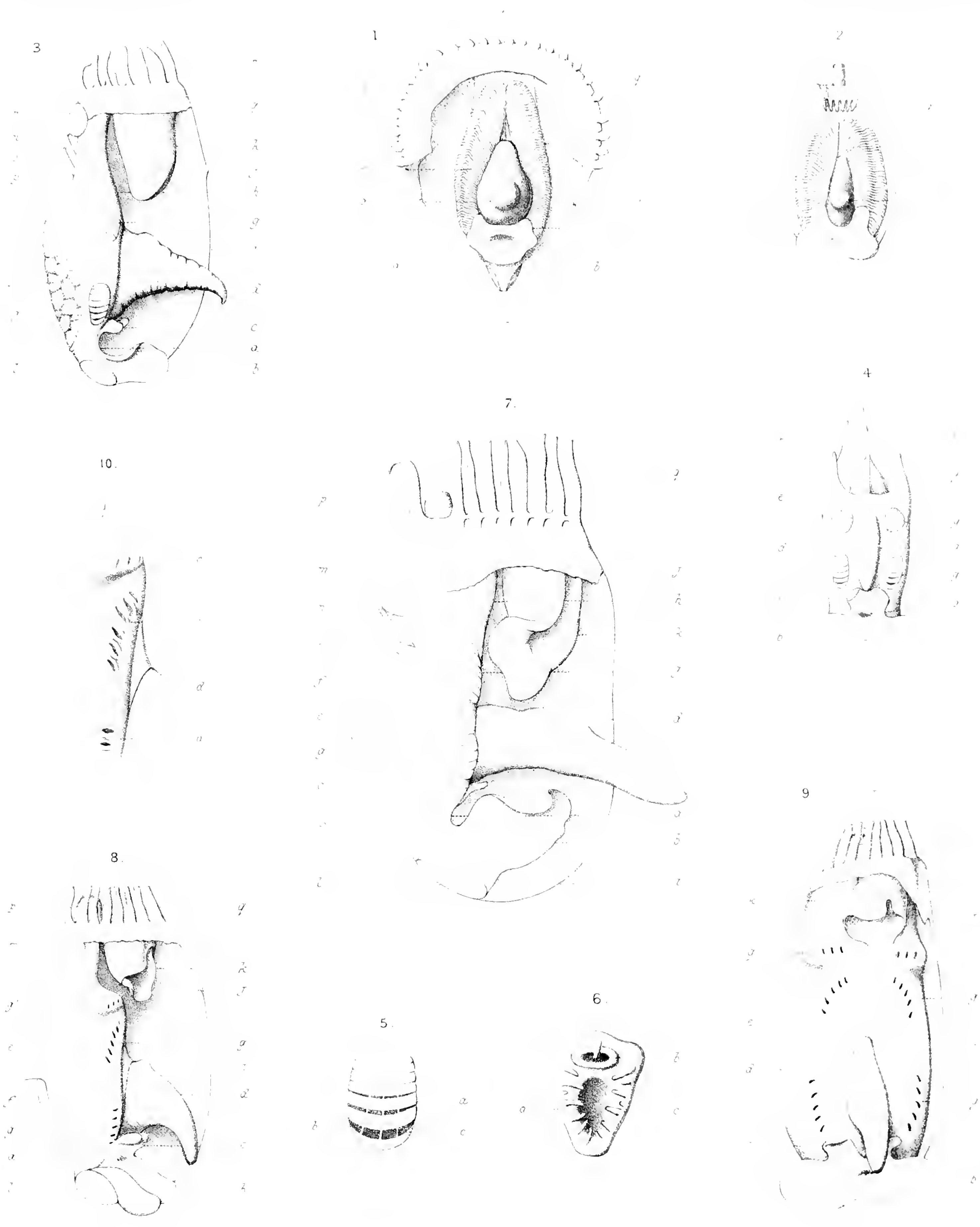

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PLATE IV.

PLATE IV.

Fig. 1. *Cuspidaria fragilissima*, Smith.

Fig. 1. The animal seen from the right side, the mantle having been removed up to its union with the branchial partition.

b, Anterior palp ; *d*, foot ; *e*, branchial partition ; *f*, visceral mass ; *g*, orifice in the partition ; *i*, free margin of the mantle (pedal orifice) ; *j*, point where the two lobes of the mantle are united posteriorly to the pedal aperture ; *l*, anterior adductor ; *m*, posterior adductor ; *p*, siphons ; *r*, lateral muscles of the branchial partitions.

Fig. 2. *Cuspidaria curta*, Jeffreys.

Fig. 2. The muscular partition seen ventrally.

a, Buccal aperture ; other letters as in fig. 1.

Figs. 3, 4. *Cuspidaria rostrata*, Spengler.

Fig. 3. The animal seen from the ventral aspect, the mantle having been removed from both sides.

h, Membrane uniting the muscular partition to the mantle ; *k*, internal aperture of the branchial siphon ; the other letters as in the figures above.

Fig. 4. The animal seen from the right side, the mantle having been removed up to its union with the branchial partition.

c, Posterior palp ; *n*, posterior retractor of the foot ; the other letters as in the figures above.

Fig. 5. *Cuspidaria platensis*, Smith.

Fig. 5. Labial palps seen ventrally.

Letters as in the preceding figures.

Fig. 6. *Cuspidaria*.

Fig. 6. Diagrammatic sagittal section, passing through the median plane.

h, Cerebral ganglion ; *n*, anterior retractor of the foot ; *n'*, posterior retractor of the foot ; *o*, heart ; *p*, sagittal partition of the dorsal chamber ; *q*, anus ; *r*, kidney ; *s*, branchial siphon ; *t*, anal siphon ; *u*, partition separating the two siphons ; *v*, free end of the anal siphon ; *w*, common sheath of the two siphons ; the other letters as above.

Fig. 7. *Lyonsiella jeffreysi*, Smith.

Fig. 7. Diagrammatic transverse section.

a, Mantle ; *b*, pedal aperture ; *c*, foot ; *d*, visceral mass ; *e*, gill ; *h*, dorsal or anal chamber ; *i*, ventral chamber.

Fig. 8. *Lyonsiella abyssicola* (Sars).

Fig. 8. Diagrammatic transverse section.

f, Membrane uniting the gill to the mantle, and forming along with it the branchial partition ; other letters as in fig. 7.

Fig. 9. *Cuspidaria*.

Fig. 9. Diagrammatic transverse section.

e, Muscular portion of the branchial partition ; *g*, orifice which pierces it ; other letters as in figs. 7, 8.

Fig. 10. *Gills of Pelecypoda*.

Fig. 10. Diagrammatic transverse sections of the right gill of different types of Pelecypoda :—

A, *Malletia ;* *B*, *Nucula ;* *BB*, *Solenomya ;* *C*, A hypothetical type, really unknown ; *D*, *Arca ;* *E*, *Unio ;* *F*, *Cardium ;* *G*, *Tellina ;* *H*, *Lucina ;* *I*, *Lyonsia.*

a, Direct lamina of the outer plate ; *a'*, reflected lamina of the outer plate ; *a''*, appendage ; *b*, direct lamina of the inner plate ; *b'*, reflected lamina of the inner plate ; *c*, point of attachment of the gill.


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THE

VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY.

REPORT on PHORONIS BUSKII,[1] n. sp., dredged during the Voyage of H.M.S. Challenger, 1873–76. By Professor W. C. M'INTOSH, M.D., LL.D., F.R.S., etc., University of St. Andrews.

INTRODUCTION.

THE interest connected with this remarkable genus warrants a few general remarks on the history of the subject — in order to bring the leading features in view before proceeding to consider the structure of the comparatively large examples procured by the Challenger.

The genus *Phoronis*[2] was first introduced by that acute and patient naturalist, Dr. Strethill Wright,[3] of Edinburgh, one of the many instances of the brotherhood that has always existed between biological science and medicine.[4] He had received some specimens of *Caryophyllia* from Ilfracombe, and found this new type (*Phoronis*) in its membranous tube deeply buried in the stone to which the coral was attached. He does not indicate the nature of the stone, but in all probability it was calcareous. This species, which he termed *Phoronis hippocrepia*, was about 6–10ths of an inch in length by 1–100th of an inch in diameter, and possessed a crown of sixty simple ciliated tentacles, united by a web at the base. Shortly afterwards he found an allied species (perhaps immature) with eighteen tentacles—forming an ovoid crown, but without a web at the base, on an oyster-shell (which the tubes penetrated) dredged

[1] In remembrance of the late George Busk, F.R.S., V.P.L.S., etc., who more than once gave his experienced advice to students of *Phoronis* in connection with its structure and relationships.

[2] One of the Egyptian divinities, wife of Osiris, and the mother of Horus.

[3] *Edin. New Phil. Journ.*, N.S., vol. iv. p. 313, pl. vii., 1856.

[4] *Vide* Introductory Lecture by Professor Allman, *Edin. Med. Journ.*, vol. i. p. 575, 1855.

from the Forth near Inchkeith. This observer, besides giving a faithful account of the external appearance of the animals, described more or less completely the integumentary, muscular, vascular, and alimentary systems, as will be more particularly alluded to under each of these heads.

Next year Professor Allman[1] figured and described an example received from the former author. His account of the structure corresponds generally with Dr. Wright's. Moreover, while pointing out the affinities of *Phoronis* in certain aspects with the Polyzoa, he was inclined to view it as Annelidan (Gephyrean) in its relationships.

Dr. T. S. Cobbold in 1857[2] procured in the Forth, near Portobello, a species of *Actinotrocha* (the larva of *Phoronis*, compare p. 22). This he seems at first to have associated with the Polyzoa, from its prominent cephalic lobe (his epistome) and the lophophore, though certain structural objections were pointed out by Professor Allman. The late Dr. Carpenter also, who had found *Actinotrocha* abundantly off the Isle of Arran, drew the author's attention to J. Müller's original description.[3] Dr. Cobbold found that his species, which differed from Müller's, adhered by the larval posterior extremity.

In the following year Prof. P. J. Van Beneden described a *Phoronis* allied to *P. hippocrepia* under the name of *Crepina gracilis*.[4] He gave a general account of its structure—noting that the skin of both body and tentacles is covered with palpocils but has no cilia; that the perivisceral space has fluid but no corpuscles; that the vascular system has contractile vessels and nucleated red corpuscles. In each tentacle he recognised only one blood-vessel; and he observed the reproduction of the whole tentacular crown. He overlooked the flexure of the alimentary canal, and thought it was simple and straight, with a terminal anus. He considered *Crepina* (*Phoronis*) a tubicolar, non-bristled Annelid, allied to the Cephalobranchiates. His specimens occurred in oyster-shells, along with other boring forms.

Dr. A. Krohn[5] next published an interesting account of the structure and further development of *Actinotrocha*, in which he corrects certain interpretations of Gegenbaur's, and shows that it is the larval form of a worm (probably a Sipunculid), with tentacles like one of the Terebellaceæ, and with a body like *Echiurus* or *Thalassema*, that is, without bristles, and that its blood is red and corpusculated.

In 1859 Dr. F. D. Dyster of Tenby published notes on *Phoronis hippocrepia*, with figures.[6] His examples occurred in tubes (probably bored by themselves) in hard limestone. He somewhat extended the description of the organs given by Dr. Strethill Wright, and appears to have been one of the earliest to observe the discharge of the ova, which issue from the oviducts into the space arched over by the inner tentacles—where they form a compact and adherent white mass by aid of a glutinous secretion. Moreover, he was enabled to watch the development of the ova, though it is probable

[1] Fresh-water Polyzoa, p. 55.
[2] *Quart. Journ. Micr. Sci.*, vol. vi. p. 50, pl. iv. figs. 10–12, 1858.
[3] *Vide* p. 22.
[4] *Ann. d. Sci. Nat.*, sér. 4, tom. x. pp. 11–23, pl. v. figs. 1–7, 1858.
[5] *Müller's Archiv f. Anat. u. Physiol.*, p. 293, 1858.
[6] *Trans. Linn. Soc. Lond.*, vol. xxii. p. 251, pl. xliv., 1859.

his figures (pl. xliv. figs. 12 and 13) represent the embryos inverted, unless they very much differ from anything hitherto described. Mr. Busk gave him the benefit of his great experience in considering the affinities of the animal.

Dr. Anton Schneider[1] a few years later published a historical account of *Actinotrocha branchiata*, and also some careful original observations with figures on this and another species (*Actinotrocha pallida*), both from Heligoland, where the larval form was first discovered by J. Müller. He mentions the test or tube in which the "worm" (produced by the transformation of the Actinotrocha) lives, and gives a general account of its development and anatomy under the heads of the larval sac, circulatory system, alimentary canal, tentacles, and lastly its metamorphosis into a Sipunculid.

Kowalewsky, again, in his Inaugural Dissertation in 1867[2] first clearly pointed out the relationship between the foregoing larval form (Actinotrocha) and *Phoronis*. Unfortunately the original paper, which is in Russian, has not been seen, but Leuckart's student, Oulianin, has given a digest of it in his (Leuckart's) Bericht for 1867.[3] Kowalewsky found that the larval form (Actinotrocha) abounded in March, whereas *Phoronis*—from September to April—was without eggs. In the early larval condition the alimentary canal and body-wall consist of a single cellular coat, but in the body-cavity is another cellular layer and a muscular coat with fatty bodies. The umbrella-shaped præoral lobe next appears at the anterior end, and overhangs the mouth; while rudiments of the arms occur in the shape of three and then five warts. The embryo soon bursts the egg-capsule and swims freely in the water, an anus meanwhile appearing, and the body increasing in length. E. Claparède shortly afterwards mentions that Actinotrocha is the young of *Phoronis*, and that he had met with the latter in the Clyde.[4]

An able paper on the development of *Phoronis*, by Elias Metschnikoff,[5] was issued in 1871. He describes the growth from an early larval stage to the assumption of the adult outline—in specimens procured from Odessa, Trieste, Naples, Messina, and Spezia. These he carefully compares with Kowalewsky's descriptions and accurate figures, and amongst other things he notes the presence of a nerve-cord in connection with the so-called ventral furrow.

A paper by E. B. Wilson appeared in 1881[6] on the metamorphosis of an Actinotrocha which was found in Chesapeake Bay. The author was enabled to corroborate the observations of Krohn, Schneider, and Metschnikoff, and to carry on the development to a later stage, until, indeed, the adult form was assumed. He describes the blood-corpuscles as developed in solid masses adhering to the stomach-wall near the base of the tentacles, probably in the cavity of a sinus, and asserts that they never float freely in the perivisceral space. The masses break up during the metamorphosis, and are carried into the vessels, an opinion which will be alluded to under its proper head.

[1] *Reichert und Du Bois-Reymond's Archiv*, p. 47, Taf. i. u. ii., 1862.
[2] St. Petersburg, 1867, 41 pp. 2 pls.
[3] *Archiv f. Naturgesch.*, Jahrg. xxxiii. Bd. ii. pp. 236–238, 1867.
[4] Annél. Chétop. Naples, p. 409, note, 1868.
[5] *Zeitschr. f. wiss. Zool.*, Bd. xxi. p. 214, Taf. xix. and xx.
[6] *Quart. Journ. Micr. Sci.*, pp. 202–218, pls. xiv. xv., 1881.

He considers *Phoronis* a true Gephyrean, and that the flexure of the alimentary canal (which resembles that habitually assumed by *Sabellaria*) is the result of the coalescence of the parts—of a primitively straight form—thus approximated by the exigencies of its life. Further, he explains how this metamorphosis came to be carried out abruptly, mainly from its great advantages to the form.

In the same year a preliminary account of the large species procured by the Challenger was communicated by the author to the Royal Society of Edinburgh.[1]

Dr. Haswell next noted[2] the occurrence of a closely allied form, somewhat less in size, inhabiting the semi-gelatinous investment of the remarkable Actinia—*Cerianthus*. In his own words, "The present species, which I propose to name *Phoronis australis*, was obtained on two occasions during the dredging work carried on under the auspices of the Trustees of the Australian Museum, at a depth of fifteen fathoms, off Ball's Head, in Port Jackson. . . . A number of individuals inhabit a large irregular semi-gelatinous sac, about six inches long and three or four wide, and open at both ends. The walls of the sac, which range from $\frac{1}{4}$ to $\frac{1}{2}$ an inch in thickness, and are tolerably tough, are composed of numerous fine threads closely felted together, and in these walls, in wide irregular species among the felted threads, lie the worms, the head projecting externally; the inner surface of the sac is lined by a dense glistening layer of the same material as the rest. The whole substance of the sac is of a purple colour." This description was drawn up before the identity of the tube was recognised, but Dr. Haswell afterwards found *Cerianthus* inside, and was good enough to forward several examples to me. He has also subsequently mentioned that the larval forms (Actinotrocha) are obtained by the tow-net on the surface throughout the greater part of the year.

The following year (1883) Mr. Caldwell presented a preliminary note on the structure, development, and affinities of *Phoronis* to the Royal Society.[3] This is an able and comprehensive contribution on the subject, the observations and conclusions arrived at by the author being noticed under the several heads in the body of this paper.

In his remarks on the metamorphoses of some Bryozoa, Dr. Jules Barrois[4] especially refers to the comparison instituted by Sydney Harmer and Ostrooumoff between the evagination of the internal sac of the Bryozoa and the ventral tube of Actinotrocha. Ostrooumoff groups the Bryozoa into three great types: (1) in which the skin of the adult is formed mainly by the evaginated sac (*e.g. Phoronis*); (2) in which the skin is formed by the aboral face enveloping the rest (*Vesicularia*); and (3) in which the skin is formed in part by both faces (Chilostomata). Barrois himself reduces them to two great types, viz. (1) those characterised by the predominance of the ventral face, and the reduction of the dorsal to the terminal region of the body; and (2) those distinguished by the predominance of the aboral face (the cephalic of the trochosphere) which envelopes the oral (somatic).

[1] *Proc. Roy. Soc. Edin.*, vol. xi. pp. 211–217, 1880–82.
[2] *Proc. Linn. Soc. N.S.W.*, vol. vii. p. 606.
[3] *Proc. Roy. Soc.*, vol. xxxiv. pp. 371–383.
[4] *Ann. d. Sci. Nat.*, t. i. pp. 83–86, 1886.

ANATOMICAL DESCRIPTION.

Class POLYZOA, J. V. Thompson.
Section VERMIFORMIA, E. R. Lankester.
Genus *Phoronis*, Strethill Wright.

Phoronis buskii, M'Intosh.

Phoronis sp., M'Intosh, Proc. Roy. Soc., Edin., vol. xi. pp. 211–217, May 1881.

Amongst the peculiar forms confounded with the Annelida was a large *Phoronis* (Pl. I. fig. 1), which in outline somewhat resembled an example of the Sabellidæ or Eriographididæ. The size of this species, indeed, had apparently led to its being overlooked, for Dr. R. von Willemoes-Suhm observes: "We have been particularly looking out for *Phoronis*, but have never been able to find it, and feel now nearly sure that it does not inhabit, as a rule, the great depths."[1] At the request of the late Sir Wyville Thomson I undertook its description, and a preliminary account appeared in 1881. The specimens were dredged at Station 212, south of the Philippine Islands, on the 30th January 1875, lat. 6° 54′ N., long. 122° 18′ E., at a depth varying from ten to twenty fathoms, on a sandy bottom. The surface temperature was 83°.

Distribution.—Though the genus was thus rarely met with in the Expedition of H.M.S. Challenger, there is no special reason why it should be so uncommon. In our own country, for instance, since its discovery by Dr. Strethill Wright simultaneously at Tenby and in the Firth of Forth, it has been found by Professor Kölliker at Millport in Cumbrae, by Dr. Dyster again at Tenby, and by E. Claparède in the Clyde district. The larval stages (Actinotrocha) have frequently been met with off the Firth of Forth,[2] at the mouth of the Mersey, and other parts.

Tube.

The species forms a somewhat tough hyaline and often semi-translucent tube (evidently a secretion of the glandular hypoderm) for itself in the sand—as in other forms having a similar habitat. In section this tube is finely and concentrically striated,—layer upon layer of the hypodermic secretion entering into its composition. Moreover, even the most translucent portions show many minute sponge-spicules, diatoms, fragments of silex or accumulations of coarser sand-grains—all more or less

[1] *Proc. Roy. Soc.*, vol. xxiv. p. 573, March 16, 1876.
[2] See *Nature*, vol. xxxiv. pp. 361, 387, 439, and 468, 1886.

adherent. In no case, however, do these form a regular layer. The tenacity of this secretion is considerable: thus, when a young example is attached to the tube of an adult, it is almost impossible to remove it without rupture of the contained animal.

The habit of this species, therefore, differs considerably from the Australian form described by Dr. Haswell, which seems, in vast numbers, to find sufficient protection in the thick semi-gelatinous case or tube of *Cerianthus*, composed as it is almost entirely of the large ovoid thread-cells of the Actinia—the threads in most cases having escaped, though a few are still in the interior of the cysts. The only other constituents of this remarkable blackish felt are a few sponge-spicules and grains of muddy sand.

Tubes have been found in almost all the species of *Phoronis* hitherto described, the hypodermic secretion being mingled with mud or sand. Schneider makes the curious statement, that the tube in his form had in it Fungi and Infusoria. No author seems to have connected the presence of these tubes in holes in limestone and other rocks, and in shells with the power of perforation; but it seems to me that in future this genus will in all probability have to be included in this interesting group.

External Form.

The total length of *Phoronis buskii* (Pl. I. fig. 1) is about 52 mm., with a variable diameter of about 2 mm. at the blackish anterior region, and 4 or 5 mm. at the enlarged posterior part. The tentacular or branchial region has a length of 6 or 7 mm. The species thus exceeds in size any hitherto described, and is even considerably longer and more bulky than the Australian form. Observers, as a rule, have worked with specimens—like those of Kowalewsky's at Naples—measuring about 14 lines in length.

The body (Pl. I. fig. 1) is elongate, smoothly rounded to the naked eye, and generally thrown into several constrictions and enlargements, as in *Phascolosoma*, or in certain examples of *Cerianthus* and *Edwardsia*, the bulbous posterior end (devoid of all transverse wrinkles) of many making the resemblance to the latter all the more striking. On the other hand, the double branchial fan and general appearance approach the contour of the Eriographididæ and Sabellidæ amongst the Annelids. The anterior third of the body, which is tinted of a blackish hue (it may be somewhat purplish during life), with a slight metallic lustre—fading posteriorly, is most minutely marked by fine transverse lines—as in the massive muscular proboscis of *Lepidonotus* and *Aphrodita*. These circular striæ are much finer in front, and gradually widen towards the posterior part of the coloured or anterior region, which in almost all the specimens is firmly contracted, from the peculiar structure of the body-wall. The dorsal (Pl. I. fig. 1) is distinguished from the ventral surface (Pl. I. fig. 2) by a longitudinal furrow—on each side of the median line—cutting off a ridge or fold, underneath which the rectum passes. This feature was formerly noticed in the smaller specimens by Schneider. In many the body gradually dilates toward the end of the anterior region, and an enlarged pale bladder-like part often occurs—marked by a close series of longitudinal bands—as well as crossed externally by fine transverse striæ, so that the region has a tessellated appearance. Such an aspect, of course, diverges very much from the eight longitudinal bands in *Edwardsia* and *Cerianthus*, though, as will afterwards be noticed, there is a certain structural resemblance between the muscles of the diverse groups. Even in the somewhat narrower region of *Phoronis*, behind the latter part, traces of these longitudinal bands (the muscular fasciculi) are visible. These are much more distinct than in the smaller species,—though in the latter they were at once recognised and well figured by Professor Allman in his remarks on *Phoronis hippocrepia* in the Fresh-Water Polyzoa. Finally, the body ends in a more or less clavate or bulbous region, which is generally devoid of such markings.

Body-Wall.

a. *Cuticle and Hypoderm.*
b. *Basement-Tissue.*
c. *Muscular System.*

Cuticle and Hypoderm.—The contracted anterior region of the body, after its special muscles are fully formed (Pl. I. fig. 3),[1] presents externally in transverse section the delicate cuticula which envelopes the entire animal with the exception apparently of certain parts of its branchial system. The hypoderm (*hp*) underneath—even in fine sections of this region—is almost opaque from the deposit of blackish pigment. This layer seems to have the same intimate structure as in the Annelids and Nemerteans, viz. an areolar stroma with gland-cells and granules. In transverse section it is somewhat regularly and closely streaked vertically. In longitudinal sections, again, it is thrown into a series of closely arranged ridges—each composed of a central area and a somewhat radiate or foliate arrangement of marginal cells. This condition is doubtless due to the very elastic nature of the subjacent basement-tissue, which adapts itself more readily to the muscular contractions, while the less facile hypoderm is thrown into numerous wrinkles. In the posterior or dilated region the hypodermic tissue is somewhat more areolar and lax; and in young specimens it is proportionally thicker all over than in the adults. In those in which the peculiar posterior gland with its external channel is well developed, the hypoderm of the region is massive. This coat, then, is uniformly on a much larger scale than in the smaller Australian or the ordinary European species, and conforms to the type seen in the Annelids and Nemerteans rather than to anything known in the Gephyrea or Polyzoa.

Basement-Tissue.—Beneath the foregoing is a translucent and highly elastic

[1] I am indebted to Mr. John Wilson, Demonstrator of Zoology and Lecturer on Botany in the University of St. Andrews, for his kind aid in making sections of *Phoronis*, and, along with Mr. E. E. Prince, for valued assistance in drawing some of the figures.

basement-tissue (*bt*) of considerable thickness. This basement-tissue anteriorly forms the skeletogenous layer in the tentacles,—as described in the preliminary account,—and at the base of these it first appears in mass on the neural side of the inner whorl, beneath the pigmented hypoderm of the part. Moreover, considerable thickening of the basement-tissue occurs towards the central region of the fans; indeed, it forms a strong ridge to which their muscles are attached. The basement-tissue gradually extends round the whorl as we proceed backward, but it becomes less massive in the region first mentioned, viz. on the neural convexity of the inner whorl. A little further backward the tissue has also largely increased on the inner free margin of the whorl, and the hypodermic pigment from the former region is continuous all round the whorl to the posterior projecting fold with the furrow to its outer side. This thickening of the basement-tissue soon supports the great nervous mass which is superficial to it, and an increase is also apparent in the furrow on the posterior aspect; moreover, it generally stains more deeply than the hypodermic nerve-tissue. It thus specially supports the nerve-centre and posterior short trunks. Then it forms a massive central pillar for the muscles of the base of the fans, stretches all round the bases of the double row of branchial channels, the thickest parts occurring in the inner row laterally and posterior to the oral region (Pl. III. fig. 1, in longitudinal section).

When the anus enters into the line of section, and the nephridia have become quite posterior in position so as to project externally, this skeletogenous tissue presents a complex arrangement, its main masses being in the centre of the lateral fans, and supporting the vascular lacunæ and the various canals of the region (Pl. II. fig. 1). With the termination of the nephridial canals the process of basement-tissue on the inner side ceases, while the outer trends away to the blood-channel on the lateral wall of the body, and finally merges into the special layer in the latter on the disappearance of the space. On the whole, the skeletogenous tissue of the anterior region is much more largely developed in the adult than in the young examples.

Behind the tentacular region the basement-tissue forms a layer all round the body, beneath the hypoderm, and sends processes inward ventrally to form the mesenteries enclosing the rectum. Thereafter the chief feature of note is the thicker layer of the tissue on each lateral arch, the central (or neural) having a thinner layer, a disposition which partly accounts for its prominent condition. As, however, the layer becomes of uniform thickness posteriorly, it would appear that the attachments of the mesenteries and radial muscles are also concerned in these modifications of the body-wall. The density of this layer anteriorly probably gives the region its characteristic rigidity. Posteriorly it becomes considerably thinner, especially in the terminal dilatation, though just at the tip it again assumes greater bulk, and supports the peculiar glandular organ of the region.

This basement-tissue thus performs all the functions of an internal skeleton for the support of the softer tissues of the body, and especially for maintaining the shape of the vascular spaces anteriorly, and protecting the nervous masses. Its various concentrations as well as its delicate expansions are admirably adapted for the functions of the parts, and it is apparently of considerable elasticity. By its greater development it affords a contrast with the condition in *Rhabdopleura* and *Cephalodiscus*, as well as with *Loxosoma* and other members of the Entoprocta. It has not hitherto, perhaps, received that attention which it merits; indeed some, including Mr. Caldwell, refer to it only incidentally in connection with other parts as the homogeneous basement "membrane."

Muscular System.—Anteriorly the main concentrations of the muscular system take place in the centre of the whorls (Pl. III. figs. 1 and 2), the fibres radiating outward from the skeletogenous axial support, and thus readily controlling the volutions of the branchial fans. In longitudinal sections these muscles often present a scalariform appearance (Pl. III. fig. 1), being ranged in somewhat regular series one above another—each radiate series to its own branchial whorl. At the base of the latter, that is, when both branchial fans have amalgamated, the radiate muscles still occupy the centre, having at each side internally (*i.e.* towards the median line) the skeletogenous tissue, and externally the vascular space.

As soon as the body-wall is distinctly formed, a layer of circular muscular fibres (*cm*) is found within the basement-tissue, and these fibres subsequently attain greater development. In the region just mentioned, the radiate fibres, which pass from the body-wall between the pennate portions of the next coat to the alimentary canal, apparently perform the main contractile functions. The circular fibres continue to the posterior end, and aid, by amalgamation with others, in closing the body-wall there.

The next or longitudinal coat (*lpm*) is anteriorly (*i.e.* immediately behind the tentacles) rather irregularly arranged, being grouped as somewhat massive fasciculi, with or without intervening radiate fibres from the basement-tissue, or assuming the form of isolated bands—the precursors of the pennate fasciculi. As soon as the body-wall has a median neural ridge and two lateral, the longitudinal muscular layer forms a series of elongate and somewhat pennate fasciculi in transverse section (Pl. I. fig. 4), many being separated by the radiate fibres especially along the ventral curve. The intermediate radiate bands are often of considerable strength, and pass from the circular coat inward to the wall of the alimentary canal, and it is the arrangement of these that gives the somewhat sinuous outline to the ventral curve. A very strong band (*rm*) occurs on each side of the intestinal mesentery, and thus prominence is given to the intermediate region of the body-wall; and a similar disposition of the parts causes the lateral elevation on each side, that on the right containing a large vascular trunk. Proceeding backwards, the pennæ become less elongate in transverse section, the somewhat constricted external region or base presenting a pair of large fibres, while the ovate leaf-like general mass is composed of smaller fibres in somewhat pinnate rows, the central region having a larger amount of translucent myolemma (Pl. I. fig. 5). Moreover, between each ovate mass a smaller bundle of longitudinal fibres exists, the tip apparently being prolonged into the radiate strands which occupy the usual position. In the succeeding part of the body the muscular layers diminish in proportionate bulk, and towards the posterior end the pennate arrangement of the longitudinal fibres disappears, and they form a comparatively thin layer under the basement-tissue, the circular fibres being internal. The arrangement of these longitudinal fibres in this region is peculiar—little spaces or lacunæ often appearing on their inner aspect (Pl. I. fig. 6). Terminally again they form a closely interwoven series, as shown in Pl. III. fig. 4, *dm*.

It is interesting to note the gradations existing between the lax pinnate arrangement of the longitudinal muscular bands in *Peachia*, the somewhat coarse pennate system in *Phoronis*, and the more finished plan of the muscles in the Eriographididæ.

In young examples the radiate muscles anteriorly are more perfectly seen than in the adult, and they fill up the body-cavity of the region to a considerable extent.

Strethill Wright was of opinion that the muscular system of *Phoronis* consists of a layer of flat longitudinal bands immediately beneath the integument, while within these a series of fine circular fibres could with difficulty be traced. He had thus probably misinterpreted the arrangement in optical section. Schneider, again, observes that the larval sac (which becomes the elongated "body" of the adult) before extrusion shows a cellular layer with nuclei, then a longitudinal coat and apparently a few small cells, followed by a transverse or circular layer. The inner coat, the future epidermis, was indistinct. Kowalewsky mentions under the epithelial layer of the body a circular coat, and an inner layer of longitudinal muscular fibres—a structure which corresponds generally with the typical condition.

A feature of considerable importance in the group is the presence of a peculiar glandular apparatus, seen in section in Pl. II. figs. 3–5, communicating with the exterior by a definite channel with well-formed walls. This structure lies quite behind the alimentary system as well as the mesenterial septa. Anteriorly it seems to end in a mass of tissue having no very definite environment in some of the preparations, and apparently having a granular glandular structure, the greater part of the area being coarsely granular, with numerous opaque bodies like folds or wrinkles towards the centre of the mass. In others, again, it leads to the posterior end of the reproductive organs. As we proceed backward, this peculiar streaked glandular region is differentiated from an outer and somewhat coarsely granular layer. The inner region then presents larger gland-cells with nuclei and granules, and the wall becomes more definite. In the condition shown in Pl. II. fig. 3, the outer surface is covered with the granular mass (probably consisting of the perivisceral corpuscles and endothelium) which is found coating the inner surface of the body-wall. Beneath are some definite circular fibres, then a series of meshes, basement-tissue of considerable thickness, and, lastly, the glandular coat, which fills the whole interior. The structure is now joined to the diminishing fundus of the body-cavity, but is wholly separated from the thick basement-tissue of the body-wall, which forms a continuous ring. The next section (Pl. II. fig. 4) presents a junction between the basement-tissue of the body-wall and that of the special organ now under consideration, and a lumen appears in the chamber of the latter. The channel then gets outside the basement-tissue of the body-wall, which is incurved to suit the circumstances, and presents, from the arrangement of the tissues, a somewhat reticulated appearance on each side of the latter just as it leaves the body-cavity. It then passes to the exterior at the tip of the body in the form of a duct, having an inverted Λ shape (Pl. II. fig. 5), the inner lining of the canal being smooth in section, from the closely arranged cylindrical epithelium, while the surrounding region is composed of the more lax hypoderm of the body-wall.

In longitudinal sections of those in which the reproductive organs are well developed, the strands of this apparatus lead to the posterior end of the alimentary canal, near which are the masses of the reproductive organs. No distinct lumen exists internally, but such may, of course, appear at intervals.

The exact nature of this remarkable organ is unknown, further than that it appears to be glandular, and in close relation with the reproductive system ; and it presents a new character in the morphology of the group. Its position would correspond with the pit of the sac, the condition of which is so marked a feature during development (*i.e.* when the Actinotrocha becomes vermiform). It is possible that it may form an accessory channel for the issue of the ova. The hollow cup-like surface formed by the thickened hypoderm of this surface in some specimens would seem to indicate its use for fixation.

Tentacles.

The tentacles or branchiæ arise from the slightly enlarged cephalic end by a somewhat firm basal web which is entire ventrally, but is widely split dorsally (Pl. I. fig. 1), so as to present the aspect of a double fan, as in the Sabellidæ. Indeed, viewed from this surface, each fan or volution is supported on its own basis, which, moreover, is oblique—elevated in the centre, and sloping downward and outward externally. The basal web remains entire for about a third of the total length of the tentacular arrangement, and then breaks up into a multitude of simple slightly tapering filaments, which are pale throughout the greater part of their length, but tinted of a dark-brownish hue toward the tip. Externally the surface of each is densely coated with cilia, which are somewhat longer toward the tip of the process. As ordinarily seen in the preparations, the branchial fan performs about three volutions. The skeletal elements of the apparatus[1] commence on the sides of the anterior region of the body as a series of

[1] Professor Ray Lankester, in his article "Polyzoa" in the Encyclopædia Britannica, attributes the original description of these to Mr. Caldwell.

simple longitudinal expansions of the basement-tissue, which stain more deeply than the basement-tissue itself. They appear at first like a series of V-shaped processes along its inner border. The limbs of the V gradually separate and enclose a canal which traverses the whole region of the basement-tissue (that is, extends from its outer to its inner border). Proceeding distally (anteriorly), the chitinous skeleton becomes much more complex, from the fact that it develops tubes for the transmission of the circulatory fluid, extends round the whole circumference of the body, except a limited region at the neural hiatus, and, moreover, splits into two or more rows. In the formation of the circulatory channels, the chitinous longitudinal processes would first seem to form a thin arch with two dilated pillars, and then a complete ring with much thinner walls. Before complete separation of the basal folds of the web occurs, the sections show a double row of these channels, one being on the outer edge of the volution and the other on the inner—a basement-layer separating the former row and its spongy vascular tissue from the latter. A line intersecting the coils would thus (before separation occurs) pass through four complete series of these channels, and in certain positions (involving the central volution) through six. At the base the inner row at the margin of the central coil is incomplete, but by and by the vessels form a continuous series round the edge. The structure of one of these double basal rows is as follows:—Externally is the cuticular layer (Pl. III. fig. 3), which, however, in the preparations does not seem to be well differentiated, since it forms only a definite boundary to the hypoderm. This feature is probably related to the branchial functions of the region. Within is a layer of hypoderm, which varies in thickness and colour according to the level of the section. Its structure agrees with that of the body-wall, and accords with the same tissue in the Annelids and Nemerteans. Directly under it are the elastic arches of the outer row of channels, which are incomplete internally,—each debouching into a large vascular space, which with connective tissue fills up the area between the outer row and the line of basement-tissue separating the two series. In transverse section the basement-tissue shows the thickened sides formerly alluded to, and is often finely streaked, but the latter is probably only an optical peculiarity. Within the line of basement-tissue are the inner series of channels, which have complete walls (and the outer row would thus seem to be less developed at a given level than the inner); and in transverse section present a noteworthy uniformity in appearance, viz. with a dumb-bell shaped outline of the inner wall, from the thickening of the median region on each side, while the lines of the outer wall laterally are nearly parallel. The outer and inner arches of the vessel are thinner. Only a slight quantity of connective-tissue separates each chitinous channel from the septum or line of basement-tissue, while the other arch has a thick coat of hypoderm, which soon (as we proceed distally) becomes grouped in a series of fan-shaped masses. The inner surface of the channels (of basement-tissue) is furnished with an epithelial lining; and since in section the arch next the septum has a rounded opaque mass of the circulating fluid, surmounted in many by a granular band, as if from a fine wall, it is possible that it represents the vessel (or at least a division or septum) with its contents. Proceeding distally, both sets of channels (in the double rows) become complete, and the hypoderm covers both the outer and inner edges of each—the somewhat spongy vascular tissue having disappeared. Then each row becomes more individualised, having a thin layer of hypoderm on the inner or concave edge, and a prominent pennate mass (in section)—several times thicker—on the outer. The rings are bound together only by a little connective-tissue in the middle, and they soon become free (Pl. I. figs. 7 and 8—in transverse section), the outer layer of hypoderm still remaining thicker, while that on the sides (where the densest portion of the chitinous ring exists) is less developed. When viewed longitudinally, this peculiar wall of basement-tissue has a series of very bold and rather regular transverse folds or wrinkles; and an included vessel and its contents are apparent. The presence of but a single well-marked vessel is of moment in connection with Professor Allman's remark that the blood-stream returned by the same vessel in the tentacle, though it entered the vein at the bottom.

A special arrangement of the branchial apparatus occurs at the mouth (Pl. III. fig. 3). The oral surface of the region being formed of a continuous web at the base of the branchiæ presents a great contrast to the anal, which has a large median hiatus between the two fans. The second whorl on the oral side, however, is formed of two halves, with a median slit, each half springing from a free edge with short tentacles. If the animal be placed with the anal hiatus between the fans uppermost, then the left whorl, with its short tentacles and sense-organ, is in front, the right free edge with its tentacles being behind the former.

The skeletal elements in the branchial apparatus of this form thus show a further development of the homologous tissue in *Cephalodiscus* and *Rhabdopleura*. The most elementary type is observed in the latter, in which no vascular spaces occur in connection with the bases of the lophophoral plumes. *Cephalodiscus* again is further differentiated, very considerable vascular channels being present at the base of the apparatus, and the central region of each plume having apparently reticulate tissue capable of transmitting fluid. The degree of specialisation, however, attained by *Phoronis* in this respect much exceeds that in *Cephalodiscus*, for special vessels pass along the whole length of the tentacular processes, and the contained fluid is richly corpusculated.

The bases of the whorls show a thickened plate of hypoderm, which probably performs special functions in connection with the movement of the water (by ciliary action), and perhaps also with sensation.

The arrangement of the tentacles in the forms described by Wright, Allman, and Dyster seems to differ considerably from that in the present species. In the former the inner row bends over the mouth very symmetrically, while the outer forms an equally beautiful cup. In life the tentacles can be moved individually. Dyster found that the anterior region (his "head") could be reproduced in forty-eight hours—not, it is true, completely, but with a mouth and short tentacles which sufficed to cause food-currents.

Body-Cavity.

The body-cavity is separated by the basement-tissue into two regions, viz. (1) the body-cavity of the anterior region and tentacles, and (2) the body-cavity of the trunk (Pl. III. fig. 1). This was first clearly pointed out by Mr. Caldwell. The former chamber is complex and sinuous from the number of processes and septa for spaces or organs connected with it, and it is difficult of demonstration. Into the great vascular area the ciliated funnels of the sense-organs debouch.

In the posterior division, viz. that including the rest of the body, the mesenteries divide the body-cavity into three chambers (Pl. I. fig. 4). Thus a median mesentery attaches the œsophagus and stomach to the body-wall ventrally, while a mesentery passing on each side from the other arch of the alimentary canal separates the intestine in a special segment. Moreover, the latter chamber is subdivided by a mesentery which proceeds from the posterior wall of the intestine to the body-wall. The right arch of the intestine is further closely connected with the right mesentery, or perhaps it is more strictly in accordance with fact to say that the right mesentery is divided by the intestine. It thus happens that the intestine is fixed centrally by one and distally by two mesenteries. The latter are for the most part formed of basement-tissue which thus evenly splits—for instance, when encircling the intestine in the right mesentery.

Before leaving the mesenteries, notice may be made here of a peculiar organ occurring chiefly in the left intestinal mesentery anteriorly (Pl. I. figs. 3 and 4, *cos*). As soon as the basement-tissue forms the septum on each side for the enclosure of the rectum, and before the nephridia debouch into the space lying exterior to this region, a special thickening is observed on each side close to the pharyngeal division of the alimentary canal, the inner surface (abutting on the intestinal space) being coated with closely arranged, and apparently sensory, cylindrical epithelium, an aperture (Pl. I. fig. 3), moreover, occurring in the centre of the enlargement. After a short course, the organ on the right mesentery (which is chiefly occupied by the intestine) becomes pediculate in transverse section, that is to say, the long fold becomes narrowed along the edge of attachment to the mesentery, and afterwards disappears. The left organ, on the other hand, takes the form of an elevated cushion of sensory epithelium upon a somewhat fusiform thickening of the basement-tissue forming the mesentery (Pl. II. fig. 6). This condition is best seen in adults; indeed, in the young example specially examined it could not be satisfactorily made out.

This would seem to be a further development of smaller patches of the same kind in the anterior spaces, which form just behind the nerve-centre. These have various epithelial patches or cushions on their inner surfaces, and finally unite and become continuous with the intestinal area in which the apparatus above noted occurs. In longitudinal sections these spaces often show a peculiarly wrinkled appearance anteriorly—from the arrangement of the epithelial bands. Such may represent a kind of sensory apparatus.

No distinct lining-membrane was visible in the spaces of the body-cavity posteriorly, but an endothelium (peritoneum, Caldwell) may be found in fresh examples. All that could be said was that the numerous fibres entangled many free cells and granules in certain regions. The blood-spaces of the anterior region, again, show in many parts a finely arranged epithelium (tessellated), the cells of which, moreover, stand prominently outward like minute villi in lateral views.

The posterior body-cavity is also traversed by the radial muscular fibres, which anteriorly pass towards the centre in definite bands (Pl. I. fig. 4). In young specimens the anterior region of this division is almost wholly occupied by the large gullet, the intestine and the radiate and longitudinal muscular fibres, the body-cavity being limited to the chinks between these.

Metschnikoff mentions that he found many colourless cells in the body-cavity of the young *Phoronis*, the elongated forms especially interesting him from their resemblance to sperms. Dyster, again, states that no perivisceral corpuscles occurred in his specimens.

Digestive System.

The mouth opens at the bottom of the anterior or ventral (and outer) whorl of the branchial apparatus, the basal web of which is continuous from side to side (Pl. III. figs. 1 and 3). The arrangement of the parts forms a spacious funnel, terminating in the mouth. The bases of the outer series of tentacles are continued for some distance into this oral funnel as elevated and ciliated ridges, and thus at a given level this surface differs from the opposite one, where the flap-like extension of the mucous layer occurs. The latter covers the base of the second branchial whorl, and consists of a greatly increased hypodermic layer continuous with that coating the oral chamber. It terminates in a somewhat free margin anteriorly (*i.e.* distally), and the tissue forming the tip has a foliate arrangement in section (Pl. III. fig. 1, *a*). A layer of basement-tissue is continued from the reticulated coat of the gullet (sub-mucous), but this ends at the commencement of the free margin. The mucous lining of the mouth thus passes up the funnel all round to meet the hypodermic investment covering the bases of the tentacles.

The first or pharyngeal part of the alimentary canal has its walls transversely folded in zig-zags, the next and longest region (œsophagus) is mostly devoid of them, but they again become very well marked in front of the dilatation (stomach proper) generally found at the posterior end of the body. The intestinal canal then bends forward along the neural aspect to terminate in the anus—on the elevation between the two branchial fans. The œsophageal and stomachal regions are fixed by a median ventral mesentery and the various radiate muscles formerly described, and by the two intestinal mesenteries on its posterior face; one of these mesenteries (the right) and a median dorsal, moreover, fixing the intestine in a special manner.

The mucous surface of the canal is composed of a cylindrical cellular layer somewhat resembling the hypoderm. It forms a thick and richly folded granular and streaked tissue in the region at the base of the branchial fans. In the narrow pharyngeal division the layer attains considerable thickness, the folds forming numerous areolæ when viewed from the surface. This condition is less marked in the œsophageal region. In what may be termed the first stomachal region immediately behind the former, the streaked glandular tissue has a finely cellular and granular aspect on the surface. In the dilated stomachal region proper, the folds of this tissue again increase in thickness. The mucous coat of the intestine is similar in structure, but much thinner.

Towards its termination the rectal portion of the gut generally retains a somewhat triangular outline in the preparations. On approaching the level of the constricted canals of the nephridia, the basement-layer of the rectum shows externally and posteriorly crenate processes; then a kind of reticulation occurs in the same tissue with muscular fibres (Pl. II. fig. 1), and the canal terminates in a small circular aperture, which still has a ring of basement-tissue beneath the mucous lining. The terminal part is thus very muscular as well as elastic, and well fitted to send a jet of fæces a considerable distance. Dyster, indeed, observed the latter in the living form voided by jerks, the fusiform pellets being connected by slender filaments. These fusiform pellets are common in *Appendicularia*, which feeds on similar food.

Food seldom occurs in the first regions of the alimentary canal, but in the stomachal and intestinal portions the granular contents abound in Foraminifera, Radiolarians, Diatoms, spicules of Echinoderms and sponges, with other organic debris. Very little mud and few or no sand-grains occur in the intestine, the organisms just noted forming elongated and coherent masses by aid of a translucent and finely granular stroma, probably the result of secretion, though in some the great abundance of minute greenish granules suggested the possible presence of such low gelatinous organisms as occasionally occur in our own seas.

In the larval form (Actinotrocha) R. Wagener found Bacillaria, Peridiniæ, and spores of Algæ, and Schneider mentions similar forms with Diatoms in the same stage; moreover, in the Sipunculoid form into which the larva is metamorphosed, he describes œsophagus, stomach, and intestine. Similar food occurred in the canal of the Australian *Phoronis*, though there was a greater abundance of muddy debris.

Dr. Strethill Wright considered that the alimentary system of *Phoronis* resembled that in *Plumatella*, the mouth being placed within the tentacular ring and closed by a semicircular lip or valve. In the new form the oral aperture is closed by simple approximation of the surfaces, as the very short free margin can hardly be taken into account functionally. Wright describes the long gullet as terminating in a gizzard the interior of which was provided with bodies apparently cartilaginous and of a prismatic shape. The gizzard communicated with a thick-walled stomach. He probably refers to the massive folds of the mucous surface, as no hard parts occur in the canal. He did not follow the intestine minutely, but he noticed a membranous tube containing fusiform fæces passing to the anus, whence they were often ejected.

Kowalewsky describes the alimentary canal in *Phoronis* as built up on the same plan as in *Ascidia*,[1] the first opening in the embryo being the anus, and the mouth appearing subsequently. The same author mentions that the alimentary canal is suspended by a mesentery. Caldwell, again, derives the anus as well as the mouth from the blastopore, the remnant of the primitive streak—the posterior solid cord of cells—opening up and forming a canal leading from the archenteron to the exterior.

Circulatory Organs.

The chief point observable in regard to the circulatory organs in the preparations is the presence of the great dorsal trunk, which extends almost, but not quite, from the posterior to the anterior end of the body along the posterior (or dorsal) arch of the alimentary canal in the groove between the intestinal mesenteries. In the anterior or contracted region of the body rupture of this vessel frequently occurs, the contents passing laterally, so as to simulate a second vessel. On the right of this region, and not on the anterior or ventral surface, the other great trunk proceeds. The dorsal trunk terminates in the great sinus in the anterior body-cavity (Pl. II. fig. 1), and thence the vessels to the branchiæ go forward. Many large branches occur in the spaces between the alimentary canal and the body-wall, and are very conspicuous in the interstices of the radiate fibres in the anterior region, and at the tip of the tail after the great dorsal and lateral trunks disappear. They are especially abundant in connection with the reproductive organs, as Kowalewsky and others noticed. Many small vessels are apparent beneath the primary divisions of the alimentary canal, but no large trunk occurs in that position. None of the vessels are so small as to merit the name of capillaries, and all are loaded with large circular nucleated cells.

In the living form Dr. Strethill Wright observed an artery passing forward in the axis of the body close to the gullet till it reached the concave side of the tentacular

[1] Entwicklungeschichte d. einfachen Ascidien, note, p. 5, *Mem. Acad. impér. St. Petersb.*, t. x.

crown, where it divided into two branches, which passed within and around the tentacular cup, and sent a twig to each of the tentacles. Along these the corpusculated blood streamed, returning by a vein in each, while four large trunks passed from the base of the ring (one from the inside, and another from the outside of each of the horns of the ring). Each pair and afterwards the two trunks united, and then the two latter coalesced to form a single large vein, which traversed the axis of the body on the opposite side of the gullet to the artery. The whole of the trunks are contractile, the artery pulsating about fifteen times per minute. Professor Allman, again, found that the blood returned by the same channel in the tentacles—the current being thus alternately forward and backward; and in the examples from the Challenger only one distinct trunk is visible. Dyster describes the blood as ascending some tentacles and descending others. The pulsations occur only in the artery, whereas in the vein the current is continuous, and the main trunks are connected by numerous branches. Schneider regards, after Krohn and Claparède, the vessels just alluded to as dorsal and ventral; and he makes the statement (which has not been confirmed) that the red blood-corpuscles in the young form float freely in the body-cavity, and then enter the vessels at the base of the tentacles. In a note on the British species, Kölliker gives the size of the nucleated and intensely red blood-corpuscles as 0·004–0·005, and mentions also colourless amœboid cells and yellowish corpuscles. Dyster gives the diameter of the corpuscles in his species as 1-3200th to 1-1700th in., and about 1-8000th of an inch in thickness; while Kowalewsky estimated them as about four times the size of those in man.

Nervous System.

In the preliminary account no observations of note were made on the nervous system, but the subsequent appearance of Mr. Caldwell's paper in the Proceedings of the Royal Society again directed attention to the subject, though, from the imperfect preservation of the specimens collected both by the Challenger and Dr. Haswell, considerable difficulties were met with.[1]

Mr. Caldwell observes[2] that "nervous processes of the ectoderm cells retain their connection with the ectoderm, and concentrations, both of fibres and ganglion-cells, occur in the skin outside the homogeneous basement-membrane. The central nervous system remains therefore in the epidermis, *representing* the primitive condition.

"Concentrations of the nervous system take place round the mouth to form a *postoral nerve-ring*. The anus lies outside this. The ring follows the line along the base of the tentacles, and has therefore, like them, the form of a horse-shoe. In front of

[1] Dyster could detect no distinct nervous system, "though it is possible two obscure organs at the posterior part of the floor of the lophophore may be œsophageal ganglia." The animals showed no sensibility to light.

[2] *Proc. Roy. Soc.*, vol. xxxiv. p. 372.

this ring are situated a pair of sense-organs, which I shall speak of as 'ciliated pits.' They lie in the concavity of the lophophore, on either side of the anus. They have the characteristic structure of sensory epithelium, consisting of sense-cell, ganglion, and nerve-fibres. Sars has figured in *Rhabdopleura* a pair of ciliated protuberances in what I hope to show is a homologous position.

"A further concentration takes place in the form of a cord, which runs from the median dorsal part of the nerve-ring two-thirds of the length of the foot along its left side. It is therefore asymmetrical, and lies in the epidermis outside the basement-membrane. Inside this nerve-cord lies an apparently hollow tube. This tube recalls the so-called large fibres of the Chætopoda."

Moreover, during development, Caldwell found the ectoderm became thickened in two regions, viz. in the præoral lobe, and in the form of a postoral ring round the mouth. "The former becomes the future nerve-ganglion; the latter indicates the position of the line of future tentacles and the circumœsophageal nerve-ring of the older animal." From the former, in some species, Caldwell states that a number of nerve-fibres pass forwards to a sense-organ. In one species four eye-spots are present. Further, "along a line at the base of the rudiments of the adult tentacles, the nervous prolongations of the ectoderm have formed a definite ring." A series of remarkable events, however, occurs during the metamorphosis from a free to a fixed life, "the whole præoral lobe with ganglion and sense-organs passes into the stomach," and is there digested. Thus no anterior dorsal sensory part of the central nervous system persists in the adult, the postoral circumœsophageal ring alone remaining, and being in connection with the sense-organs. Similar features were observed by Kleinenberg[1] in *Lopadorhynchus,* the circular nerve disappearing completely with the vibratile organ.

The previous information on this subject has been given somewhat fully because the condition of the specimens procured by the Challenger offers various features both interesting and novel. The central region of the system lies over, *i.e.* on the anal side of, the mouth in connection with the firm basement-tissue, forming the support of the branchial apparatus, and thus it occupies a similar situation to that in *Cephalodiscus.*

On making sections of the region just indicated, and at the level of the hypoderm of the nephridial eminences, but before reaching the lumen of the canal, it is found that the branchial whorls have considerably diminished, though three volutions are more or less present on each side. The oral funnel is still wide, and the second or inner line of the series has on the anal (or neural) aspect the two free flaps formerly mentioned. Each inner edge of the latter shows a well-defined though narrow border of hypoderm with blackish pigment—beneath which is a firm and somewhat thick layer

[1] *Atti d. R. Accad. d. Lincei,* t. vi p. 15, 1881; and *Ann. and Mag. Nat. Hist.,* ser. 5, vol. ix. p. 67.

of basement-tissue. On the aboral (dorsal) edge, the hypoderm becomes massive, and terminates in a rounded elevation or ridge, which is separated by a sinus from the narrow hypoderm of the branchial whorls. Beneath the basement-tissue, along the inner curve of the whorl, is a granular layer covering the basal branchial chambers. The first noteworthy change in the latter region is the somewhat foliate arrangement of the hypoderm on the aboral ridge, followed by the disappearance of most of the thick basement-tissue in the middle of the inner lateral (neural) region of each whorl, its place being taken by a finely granular tissue (Pl. III. fig. 2, *nc*), with a faint trace of delicate fibres. This tissue then increases considerably in bulk, and stretches from the edge of the second whorl behind the mouth to the elevated hypodermic ridge posteriorly, round the edge of which it turns. Below it is a line of basement-tissue (*bt*) which stains deeply.

The furrow between the elevated aboral ridge and an inner (*i.e.* nearer the middle line) one now formed by the nephridial duct of the side deepens, so that the nervous tissue in the former is more evidently distinguished as a somewhat clavate expansion in transverse section (Pl. III. fig. 2). From the middle of the latter fine fibres pass orally to the ciliated chamber, and the portion of the nerve-mass in front (*i.e.* on the oral side) lies in connection with its thick and richly-folded hypoderm. The supporting basement-tissue externally is thicker and stronger, and gives attachment to the radial muscles of the branchial fan in front.

This nerve-centre rests on a broad plate of basement-tissue which extends from the nephridia forward to the centre of the whorl on each side (Pl. III. fig. 1, *bt*)—thus forming a support for both organs. The portion of the nervous system in the hypodermic tissue on the outer side of the nephridial groove (which at a higher level constitutes an elevated ridge) now forms a separate longitudinal band with much pigment externally. By and by the anterior and central part of the nervous apparatus becomes lost in the tissue near the ciliated space, though broad fibrous bands and cells are visible for some distance backward (Pl. II. fig. 1, *n*). The separate band (Pl. II. fig. 2, *nt*), again, follows the nephridial channels—lying on the inner border of the hypoderm for a short distance, spreads out on the lateral region of the body, as a thin layer over the basement-tissue, and then gradually disappears. These bands are therefore narrow in front and expanded posteriorly.

On the outer side of the diminished borders of the second branchial whorls, as they commence right and left of the median line, is a prominent process or flap (Pl. III. figs. 1 and 3, *cb*). Viewed from the neural (or anal) side, the hypoderm at the base of the whorl is greatly increased, and approaching the median fissure it becomes free, and forms a thick button-like flap with a large aperture, and with much pigment on the free edge. It is finely hypodermic in structure, and is continuous with that tissue covering the base of the whorl. It contains a considerable chamber, which communicates externally by the aperture just described. This aperture in section is thick and slightly mammillate. The inner half of the outer wall of the organ is more closely grained and streaked than the outer, the fine hypodermic tissue being probably ciliated during life. The other wall of the organ, *i.e.* that adjoining the second whorl, is uniformly finished with a fine margin—also probably covered with cilia. A little mucus, which stains deeply, occurs in the centre of the chamber.

In young examples the above-mentioned free flaps are simple, and the central chamber is rudimentary. In function this structure is probably connected with sensation.

In sections immediately behind the nerve-centre, the massive basement-tissue forming the axis of the fan on each side is perforated by the anterior end of the posterior body-cavities, which form narrow spaces—at first directed obliquely outwards and backwards, and finally expanding into the great chambers exterior to the intestinal area.

Nephridia.

The external apertures of the nephridia, which perform the function also of generative ducts, occur on each side of the anus, on a lateral elevation a little internal to the skeletogenous elements of the branchial apparatus. These apertures are not readily observed, since they are situated quite at the anterior end of each ridge. They are somewhat spout-like, and carry the ova near the papilla of the hypodermic flap, placed at the base of the second whorl. The exact connections of this aperture with neighbouring parts could not be clearly ascertained, and it is possible a functional connection with the hypodermic process may exist. At any rate the ova would issue conveniently for finding their way to the internal whorls. Each aperture leads into a spacious chamber lined by a coat of closely-arranged epithelium, resembling a modification of the hypoderm, and it may be ciliated during life, though Dyster, who examined a British species in life, says that it is not ciliated. A thin basement-layer occurs outside this layer. It is wide at the posterior and outer edge in section in this region, but slit-like anteriorly (*i.e.* towards the oral region). The channel at this level is more or less free. Just behind the nerve-centre—where the basement-tissue forms a floor or support—the channel forms a firm rounded tube (Pl. II. fig. 1, and Pl. III. fig. 2, *np*), its basement-tissue being continuous with that supporting the central nervous system. Externally (posteriorly) is a thick layer of hypoderm with dark pigment towards the free edge. The channel suddenly widens into a transversely elongated chamber, then contracts so as to form a rounded aperture in section in the dense basement-tissue of the region, and, approaching the inner edge of this tissue, debouches into the lateral chambers of the body-cavity outside the division for the intestine, but within the marginal cavity on each side continuous with the vascular lacunæ at the base of the branchial system. A considerable amount of basement-tissue still supports its margin all round, and especially posteriorly toward its termination. The secerning tissue is thus largely developed at its outer and inner regions.

The foregoing canals were noticed by Kowalewsky, and their function correctly interpreted. Nothing, however, has been seen resembling the long moniliform canal described by Kölliker,[1] which ends blindly at the anterior region. Dyster states that the ova were discharged alternately by the two ducts.

Caldwell[2] describes the posterior pair of mesodermic diverticula opening in the larva in the middle line and communicating with the exterior in each case by a small pore, which he thinks probably persists as the nephridial opening of its side. The excretory cells lie in the blood-space of the splanchnopleure, and not in the body-cavity. He also states that the external openings of the nephridia are parts of the blastopore. The nephridia attach themselves entirely to the posterior mesoderm (for the latter is divided into an anterior and a posterior part). "The division of the blastopore caused the division of the mesoderm, and results, amongst other things, in metameric segmentation."

Reproductive Organs and Development.

The ova are developed in the posterior region of the body in racemose masses attached to the vessels round the main division of the alimentary canal. While one side of the body is thus occupied, the other has a bulky lobulated (in section somewhat areolated) granular tissue, which represents the male elements (Pl. II. fig. 2, *ovr* and *t*). Kowalewsky mentions that the latter occur in a different region from the former, but such was not indicated in the present specimens. Dyster correctly observed both ova and spermatozoa "beneath" the stomach. The ova are thus shed into the body-cavity, fertilized therein, undergoing, according to Kowalewsky, the earlier stages of their development there, and then pass outward by the nephridia to lodge in the branchial whorls.

The ova lie freely amongst the tentacles; and there was no indication in the preparations that they adhere together. Certain specimens would indicate that the older larvæ occupy the outer whorls of the tentacles, the earlier forms mainly occurring in the centre (Pl. III. fig. 1). This condition, however, may simply indicate that the action of the cilia in the free larvæ had caused a change of position.

The history of the development of the young *Phoronis* is most interesting. The larval form was first found in the sea off Heligoland by Johannes Müller,[3] in one of his memorable excursions; and he gave it the name of *Actinotrocha*, from its ciliated arms; but he was unaware of its relationships—indeed, he thought it might be a larval Mollusk. A more detailed account of its structure was published the following year by

[1] *Op. cit.*, p. 12. [2] *Quart. Journ. Micr. Sci.*, vol. xxv. p. 19, 1885.
[3] *Müller's Archiv f. Anat. u. Physiol.*, p. 101, Taf. v. figs. 1, 2, 1846.

Rudolph Wagener;[1] the general features of the body, the alimentary canal with what he calls a hepatic dilatation anteriorly, and other doubtful organs being mentioned. He noticed the rudiments of the permanent tentacles at the base of the larval tentacles; but he thought them mere appendages. C. Gegenbaur[2] next found some examples of Müller's *Actinotrocha branchiata* towards the end of December at Messina, about 0·35 in. long, with fourteen tentacles; while others appeared in February, 0·5 in. in length, with twenty-four tentacles. He mentions most of the anatomical features formerly indicated, but added nothing to its relationships, for he was inclined to consider it the larva of an Echinoderm. It was not until Krohn and Schneider found this larval form undergo metamorphosis into a Sipunculoid worm—which Kowalewsky somewhat later showed was *Phoronis*—that, as mentioned in the introductory remarks, the true life-history was ascertained.

In the examples procured by the Challenger the free eggs in almost all cases seem to have advanced beyond the earlier stages, and indeed to show various phases of embryonic existence. The rounded forms had a diameter which ranged on each side of 1-240th of an inch, and thus the eggs of this large form are even less than those of the smaller British species described by Dyster, who gave the diameter at 1-200th of an inch. An egg-capsule is sometimes difficult of detection in the preparations of the extruded ova; and all that can be said is that the exterior of the early forms presents a definite pale margin, best seen in those, for instance, divided into a few spheres, and with a central cavity in section, though in others a capsule is present. The former condition was also noticeable in those at the gastrula-stage. Their development would seem to be rapid; indeed, Dyster states that in a few hours the surface of the newly extruded products becomes ciliated all over, and the embryos are capable of quitting the parent entirely at the end of the second day. The body-cavity of the præoral lobe is very early formed, the two cavities, archenteron and body-cavity of the hood, apparently being seen in the section shown in Pl. III. fig. 6. In outline many of the embryos show at first an hour-glass constriction, and then a comma-shape, apparently from the development of the præoral lobe. In the stage shown in Pl. III. fig. 5, the præoral lobe is on the right, and its body-cavity clearly outlined. The lobe bends downwards over the mouth (*m*). The archenteron is indicated in the body on the left, and also indications of the posterior body-cavity close to the upper hypodermic border in the figure. Moreover, some show two or three papillæ projecting from the body of the larva, these representing rudiments of the tentacles, and they appear to be proportionally large.

In the embryos the hypoderm is very early differentiated, and a thin pale line beneath probably indicates the formation of the basement-tissue. The central cavity is, moreover, lined with a distinct epithelium.

[1] *Op. cit.* 1847, pp. 202–206, Taf. ix.

[2] *Zeitschr. f. wiss. Zool.*, Bd. v. p. 317, 1854.

An older larva abounded amidst the tentacles of the Australian form, and its resemblance to the free-swimming Actinotrocha was at once apparent.

In his description of the larva of the British form, Dyster appears to refer to the præoral lobe by his term abdominal division; for he states that the "cephalic" segment divides into three lobes, of which the lateral are longest. This probably refers to the early condition of the ciliated arms of Actinotrocha. He has the merit of being one of the few to see the early larval stages of this peculiar form.

Very soon after the stage mentioned in the preceding paragraphs the larval *Phoronis* swims freely in the water, and presents a large præoral lobe or hood—the mouth lying in the fold between it and the body, a stomach, and an anus. The rudimentary arms soon appear; indeed, in many, as above mentioned, they have the form of blunt papillæ arranged in a somewhat linear manner on the aboral face, before the larval animal leaves the tentacles of its parent. The body and arms elongate, a peculiar sac or pouch is formed in the ventral wall of the body just behind the arms, and this rapidly enlarges so as nearly to fill the perivisceral cavity, and its inner wall is rugose. The larval *Phoronis* now becomes quiescent, and suddenly the long pouch is thrust outward through its opening in the body-wall, like the finger of a glove or the proboscis of a Nemertean. Moreover, the loop of the alimentary canal slips into the extruded pouch; the larval body contracts so as to approximate mouth and anus. The præoral lobe slips into the œsophagus, leaving only a process—the "epistome." The arms of the Actinotrocha-stage atrophy, and from a basal remnant the tentacles of the adult spring.

Homologies.

Some of the earlier authors linked *Phoronis* with the Polyzoa, chiefly on account of its lophophore; though Professor Allman at once pointed out that, notwithstanding the singular resemblance in certain parts of its structure between it and the hippocrepian Polyzoa, it had no real affinity, "and must be viewed as a remarkable example of representative form—of *homomorphism* as distinguished both from homology and analogy." He thought, indeed, its relationships lay rather with the Annelids, a conclusion which Krohn and Schneider had arrived at with regard to the "Gephyrean worm," resulting from the metamorphosis of Actinotrocha. Kowalewsky considered it neither a Gephyrean nor a Polyzoon, but an enigmatical form approaching the worms, and diverging from the Mollusks. Claparède,[1] again, considered that the position of *Phoronis* was between the Gephyrea and Bryozoa. The juxtaposition of mouth and anus is a condition, he says, foreign to the Annelids, and much can be said in favour of this view.

External Form.—In external form *Phoronis* has little or no connection with any

[1] Annél. Chétop. Naples, p. 409, note.

known Aspidophorous or other Polyzoon, except as regards the lophophore, the structure of which approaches in certain respects that of *Cephalodiscus* and *Rhabdopleura*. The only trace of the buccal shield is the epistome, which in this species appears to be represented by the two peculiar hypodermic organs with the external apertures, which probably subserve a sensory function.

Branchial and Circulatory Systems.—In the structure of the branchial tentacles, as just mentioned, a common plan pervades *Cephalodiscus* with its allies and this form, since the basement-tissue and the hypodermic investment are similar, though it must be borne in mind that other types present a close resemblance. These branchial tentacles appear to arise from a region corresponding to the collar-region of *Cephalodiscus.* Moreover, the blood-vessel contained in each filament, and the great trunks in the vascular space at the base in *Phoronis*, are diagnostic. Further, the blood-vessels have distinct and highly contractile walls in every case, and the contained red nucleated corpuscles are remarkable. This system therefore differs from the lacunar arrangement at the base of the plumes in *Cephalodiscus*.

Digestive System.—This closely corresponds in arrangement with that in the Aspidophorous group of the Polyzoa, as well as with the latter in general. The various parts of the apparatus, its minute structure, the approximation of mouth and anus, are all features common to the group. Moreover, it is not easy to see on what grounds Mr. E. B. Wilson[1] has assumed that the flexure of the gut in *Phoronis* renders it probable that a primitively straight form by the force of a tubicolous habit has become bent, and the anus by and by conveniently fixed near the mouth. The illustration he takes, viz. *Sabellaria*, does not seem to have much weight, for there are many other tubicolar annelids in which a very different condition exists, yet the curvature of the tail, according to Mr. Wilson's hypothesis, would be equally necessary. This author further states that the resemblance of *Phoronis* to the Polyzoa is an entirely secondary one, and "a result of strictly tubicolous life." The habit, therefore, seems to account for various features. The nature of the food and the mode by which it is obtained agree with the condition in the Aspidophora. No gill-slits, however, have yet been recognised in *Phoronis*.

Nervous System.—This occurs as a hypodermic development bounded internally by the basement-tissue, very much as in *Cephalodiscus*, though it is double in *Phoronis*, apparently in connection with the two great branchial whorls, and the intrusion of the nephridia and median anus. In minute structure it is similar to that in *Cephalodiscus;* but in addition to the central masses, there are two posterior cords which proceed for a short distance along the body-wall, and then, spreading out under the lateral hypoderm, disappear. The absence of a large anterior region (as in *Cephalodiscus*), and the fusion of the parts at the tentacular base, are probably in connection

[1] *Quart. Journ. Micr. Sci.*, vol. xxi. p. 210, 1881.

with the modification of the nervous system. Moreover, the ganglion in the hood or præoral lobe of Actinotrocha has been lost in the metamorphosis.

The peculiar organs situated above the mouth, and in connection with the second branchial series, may possess a sensory function, though it is probable also that the thickened hypoderm at the bases of the various branchial whorls may perform similar service. The remarkable mesenteric (hypodermic-like) folds, and their extensions in the spaces just behind the central nervous system, appear likewise to have allied functions. It is probable that the functions of the former may be made more manifest by further study. It seems to be much less developed in the young than in the adult. Should internal apertures at any stage ever be found, their homologies with the collar-pores of *Cephalodiscus* and *Balanoglossus* would be interesting.

Body-Wall.—The structure of the body-wall externally approaches that of *Cephalodiscus,* both in regard to its thick glandular hypoderm, its basement-tissue, and the abundance of its secretion for the formation of a tube. In some respects it also resembles that of *Balanoglossus.* On the other hand, its muscular system shows a great advance on that of *Cephalodiscus,* the stalk of the latter alone presenting similar powerful bands. The somewhat pennate arrangement of the longitudinal muscular bands in *Phoronis* quite differs from that of its allies.

The *Body-Cavity* appears to show only two divisions, an anterior and a posterior, the latter having a corpusculated fluid in its interior. *Phoronis* would therefore seem to have undergone considerable modifications. The posterior body-cavity is divided by various mesenteries, and largely occupied by radiate muscular fibres and connective-tissue. The connection of the vascular spaces in front with the tentacles may be held as indicative of some affinity with the collar-spaces of *Cephalodiscus,* which (spaces) can likewise be traced into the tentacles. There is room for further researches in this region of the body at various stages of development, and especially the post-larval.

In regard to the *Reproductive Organs, Phoronis* is better known than either *Rhabdopleura* or *Cephalodiscus,* and the development and life-history have been more or less completely outlined. *Phoronis* is conspicuously hermaphrodite. The interesting resemblance of its larval form (Actinotrocha) to the larval form of *Balanoglossus,* discovered by Mr. Weldon, have been alluded to by Mr. Sidney Harmer, and indicate how complex the relationships of such forms are. The latter author thinks it probable that since the oviducts of *Cephalodiscus* do not open into the body-cavity, the collar-pores rather than these may be the homologies of the nephridia of *Phoronis.* If, however, an aperture were found on each side into the body-cavity between the mouth and the nephridia—even in the young animal—this view would require modification.

On the whole, then, on comparing *Phoronis* with *Cephalodiscus* and its allies, we miss the proboscis; while the collar and trunk are more or less fused. There are no gill-slits. The nervous system seems to be placed in a region probably homologous with the collar of *Cephalodiscus*. Its muscular and circulatory systems are more highly developed than in any of those indicated. It differs also in the absence of reproduction by budding.

While it is difficult in the case of such peculiar types as *Phoronis* to draw parallel features with any group with which they may be associated, yet in the present state of our knowledge there does not appear to be any other division with which *Phoronis* more closely agrees than with the forms above mentioned, and especially with the Aspidophorous group of the Polyzoa. *Phoronis*, indeed, is one of those forms which cannot all at once be placed in close relationship with known groups, and the true position of which, perhaps, cannot yet be accurately fixed. At present, however, I am inclined to coincide in the view of Professor Lankester, that it may conveniently be classified as an aberrant Polyzoon.

CONTENTS.

PLATE I.

PLATE I.

Explanation of the letters used in the Plates.

al Alimentary canal.
an Anus.
bc[1] Body-cavity of præoral lobe.
bc[2] Body-cavity of second region.
bc[3] Body-cavity of trunk.
bp Branchial plumes.
bt Basement-tissue.
ch Ciliated hypodermic organ.
cm Circular muscular coat.
cos Peculiar ciliated folds (sensory ?).
gbs Glandular organ at posterior end.
hp Hypoderm.
int Intestine.
lm Longitudinal muscular fibres.
lpm Longitudinal muscular coat (somewhat pennate).
m Mouth.
msv Ventral mesentery.
msd Dorsal mesentery.
np Nephridia.
ns Nerve-centre.
nt Nerve-cords.
œ Œsophagus.
ov Ova.
r Rectum.
rm Radiate muscles.
vb Blood-vessels.
vc Vascular spaces in region behind tentacles.
vt Stomach.

Fig. 1. Outline of *Phoronis buskii* from the posterior aspect, that is, with the split between the branchial fans and the anal region facing the observer. Enlarged about four times.

Fig. 2. Opposite aspect of the anterior end of the same form, which in this case shows two longitudinal grooves. Similarly enlarged.

Fig. 3. Transverse section of the anterior region of the body—in the region of the rectum, and with the lateral vascular spaces, *vc*, which may represent the collar-cavities, still present. The ciliated thickenings on the mesenterial wall are seen at *cos*, and the nephridial channel just before it ceases at *np*. × 40 diam.

Fig. 4. Transverse section of the anterior region of the body behind the former, and after the parts have assumed the typical condition, with the somewhat pennate longitudinal muscular bands. The intestine at this part is empty, and has assumed its usual triradiate aspect, the mesentery, *msd*, fixing it dorsally and ventrally and also on the right. The peculiar ciliated fold of the other (left) mesentery is seen at *cos*. The large median and lateral (right) blood-vessels are cut at *vb*; and one of the anastomatic branches at vb^1; *msv*, the ventral mesentery. × 40 diam.

Fig. 5. More highly magnified view of a portion of the body-wall in the same region. The hypoderm, *hp*, has a pale cuticular margin, and abuts on the basement-tissue, *bt*; *cm*, circular muscular coat; *lpm*, foliate or penniform arrangement of the longitudinal muscular fasciculi, with basal processes, and intermediate connective-tissue and radiate muscular strands, *rm*. × 350.

Fig. 6. Transverse section of the body-wall near the posterior end. The peculiar arrangement of the longitudinal fibres just inside the basement-tissue is shown at *lm*, spaces, moreover, occurring within these, apparently from contraction of the circular fibres and basement-tissue. Within the circular coat (*cm*) is a granular endothelium or a modification of this coat.

Fig. 7. Section of a branchial tentacle with the hypoderm less developed than in the following.

Fig. 8. Section of a branchial tentacle in which the hypoderm completely surrounds the basement-tissue, and has long cilia on its broad edge.

E.L., E.P., & J.W. del.

PHORONIS BUSKII, M'I.

PLATE II.

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Explanation of the letters used in the Plates.

al Alimentary canal.
an Anus.
bc^1 Body-cavity of præoral lobe.
bc^2 Body-cavity of second region.
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lm Longitudinal muscular fibres.
lpm Longitudinal muscular coat (somewhat pennate).
m Mouth.
msv Ventral mesentery.
msd Dorsal mesentery.
np Nephridia.
ns Nerve-centre.
nt Nerve-cords.
œ Œsophagus.
ov Ova.
r Rectum.
rm Radiate muscles.
vb Blood-vessels.
vc Vascular spaces in region behind tentacles.
vt Stomach.

Fig. 1. Transverse section of the anterior region about the level of the anus. The branchial meshes occur externally, the great vascular spaces, *vs*, just within these; while the anus and the nephridial channels have also come in the line of section. The pharyngeal region of the alimentary canal is seen at *al*. The nerve-tissue is indicated at *w*; and the anterior ends of the posterior body-cavities at bc^3. x 40 diam.

Fig. 2. Transverse section of the posterior region of the body of the Australian *Phoronis*, showing the reproductive organs—*ovr*, ovary; *t*, *testis*. Between these organs various blood-vessels are observed—*vt*, stomach; *int*, intestine. x 40 diam.

Fig. 3. Transverse section of the tip posteriorly—with the peculiar glandular organ (*gbs*). The muscular layers (*ml*) of the body-wall have largely mingled, so that they cannot be individually separated. The centre of the glandular organ is filled with glandular tissue, and it has externally basement- and muscular tissue with endothelium. x 80 diam.

Fig. 4. A further stage in the structure just described—in a section behind the former. The organ has now become connected by its basement-tissue with that in the body-wall, and a lumen appears in the centre. x 80 diam.

Fig. 5. Transverse section of the tip behind the foregoing, showing the transference of the lumen of the canal of the glandular structure quite outside the basement-tissue, and, indeed, to the thick hypoderm of the region. The muscular coat (*ml*) consists of intermingled fibres, which thus cross to complete the body-wall posteriorly. x 120 diam.

Fig. 6. Longitudinal section of the folded hypodermic tissue attached to the left mesentery in the posterior division of the body-cavity. It rests on a considerable layer of basement-tissue. x 350 diam.

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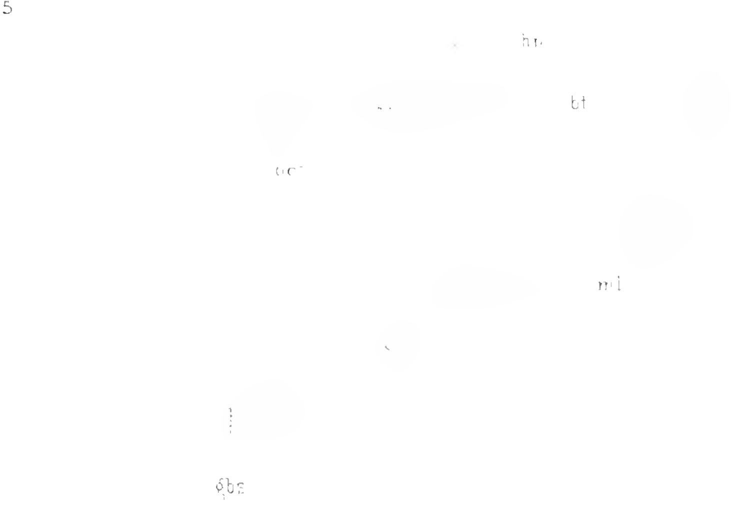

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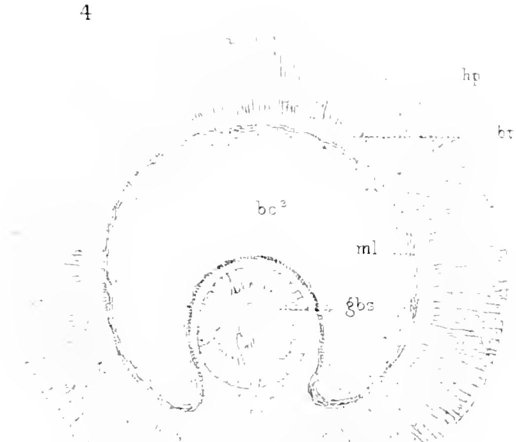

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W.C.M., E.P., & J.W. del.

J. Huth, Lith^r Edin^r

PHORONIS BUSKII, M^c I.

PLATE III.

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Explanation of the letters used in the Plates.

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œ Œsophagus.
ov Ova.
r Rectum.
rm Radiate muscles.
vb Blood-vessels.
vc Vascular spaces in region behind tentacles.
vt Stomach.

Fig. 1. Longitudinal section through the base of the branchial tentacles and the anterior region of the body. The funnel leading to the mouth is indicated at *m*; *a*, the specially developed hypodermic layer with the somewhat free edge; *vb*, the vessels at the bases of the various branchial whorls, which are arranged in series one above another; *ms*, the special fan-like muscles which act on the several whorls. The large amount of skeletogenous or basement-tissue in this section is characteristic of the region. The section is slightly oblique, and thus the nephridial channel, *np*, is very distinct. The space in which the folded mesenterial organ arises is marked *cos*, and the continuation in the body-cavity, *cos^1*; *cb*, the ciliated hypodermic organ; *œ*, œsophagus; *hp*, hypoderm peculiarly folded. The bases of the whorls show thickened hypodermic patches with black pigment. x 40 diam.

Fig. 2. Transverse section of the central nervous system in a young example; *nc*, finely granular tissue, with a trace of fibres. x 210 diam.

Fig. 3. Transverse section of the bases of the branchial fans, the great central muscles of which are indicated by *mc*. The knife has passed through the ciliated hypodermic organs, *cb*, on each side; *hp^1*, the median ventral or anterior hypoderm which at each side gradually merges into the skeletal arches in connection with the branchial apparatus; *bpc*, the free margins of the two inner (second) branchial series of the region. x 40 diam.

Fig. 4. Transverse section of the body-wall towards the posterior end of the body, showing the somewhat symmetrical disposition of the hypodermic tissue, the long gland-cells presenting a slightly radiate arrangement towards the surface; *dm*, decussation of the muscular layers of the region. x 350 diam.

Fig. 5. Vertical and nearly antero-posterior longitudinal section of a larval *Phoronis* from the tentacles of its parent; *am*, central chamber (archenteron); *bc^1*, body-cavity of the præoral lobe which forms an arch over the mouth; *bc^3*, a long slit, which may represent the body-cavity of the trunk. The hypoderm is clearly outlined all over. x 350 diam.

Fig. 6. Oblique section of an embryo, showing the apparently large size of the body-cavity of the præoral lobe, *bc^1*. The archenteron is indicated at *am*, but no special differentiation yet exists, since it is bounded only by the basement-tissue beneath the hypoderm. x 350 diam.

PHORONIS BUSKII, M'I.

THE

VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY.

REPORT upon the TUNICATA collected during the Voyage of H.M.S. Challenger during the Years 1873-76. By WILLIAM A. HERDMAN, D.Sc., F.L.S., F.R.S.E., Professor of Natural History in University College, Liverpool.

PART III.

PREFACE.

THE first part of this Report, published in 1882, treated of the ASCIDIÆ SIMPLICES of the Challenger collection; while the second part, published in 1886, was occupied mainly by the description of the ASCIDIÆ COMPOSITÆ, and contained also a supplementary report upon some Simple Ascidians which had reached my hands after the completion of Part I. The present, third, part completes the Report, and contains,—

I. The description of the remainder of the collection, viz. :—

THE ASCIDIÆ SALPIFORMES.
THE THALIACEA.
THE LARVACEA.

II. General conclusions in regard to the Affinities and Classification of the Tunicata, with an account of their probable Phylogeny.

III. Two Appendices on Ascidiæ Simplices.

In regard to the first of the above sections, the descriptive part of the Report, the Ascidiæ Salpiformes includes the single family Pyrosomatidæ, and forms the third suborder of the order Ascidiacea,—the first and second being the Ascidiæ Simplices and the Ascidiæ Compositæ,—and so completes that group. The Thaliacea is a second order, and includes the important genera *Salpa* and *Doliolum*, along with some less well-known allied forms. The third order, Larvacea, contains the Appendiculariidæ, and so completes the Tunicata. Consequently, although the forms discussed in this part of the Report are all pelagic free-swimming Tunicates, still they are not closely related, but fall into three distinct groups, which are less allied to one another than the Ascidiæ Salpiformes are to the Ascidiæ Simplices or to the Ascidiæ Compositæ.

By far the greater number of the pelagic Tunicata collected by the Challenger Expedition belong to the genus *Salpa*, and to a few of the more common and widely-distributed species of that genus, so that a great part of the work has consisted in the laborious examination of large numbers of specimens of a species from various localities in order to determine whether they were all the same. The specimens were all in rectified spirit, and were most of them well enough preserved for systematic and anatomical purposes; while some few were in an excellent state of preservation, and afforded material for the elucidation of some histological details.

Altogether the collection of pelagic Tunicata contains at least twenty-six species, of which nine are new to science. It has not been found necessary to establish any new genera; but a new family, the Octacnemidæ, has been formed for the reception of the remarkable deep-sea genus *Octacnemus*, Moseley. The plates illustrate the new species and new structural details in regard to some of those already known.

In the second section of this Report I have incorporated, with the sanction of Dr. John Murray, those theoretical conclusions at which I have arrived in regard to the relationships of the Tunicata and the course of their evolution, after nearly ten years' continuous study of the group, in the course of which I have examined for myself nearly every generic type, and by far the greater number of the known species.

A small number of pelagic Tunicates, collected during the cruises of H.M.SS. "Porcupine," "Knight Errant," and "Triton," which had been sent to me for examination by Dr. Murray, are also described in this Report.

The Appendices include—

A. A description of a few Simple Ascidians sent to me since the publication of the last part of this Report.

B. An account of a remarkable Dorsal Tubercle found in a fragment of a large species of *Ascidia* from Kerguelen Island.

CONTENTS.

INTRODUCTION.

I SHALL follow here the same plan which I adopted in the preceding part of this Report, and give, along with a supplementary bibliography, a short account of the history of the groups to be described farther on.

HISTORY.

The group Tunicata when first established as a class by Lamarck[1] in 1816, contained only two pelagic forms, *Salpa* and *Pyrosoma*. Of these the genus *Salpa* had been established by Forskåhl in 1775, but some of the forms which are now referred to it or to *Cyclosalpa* had been previously described more or less fully under the names *Holothuria* (Linnæus), *Holothurium* (Pallas), *Thalia* (Browne), and *Dagysa* (Banks). Forskåhl had been fortunate in finding a large proportion of the existing species of *Salpa*, and much of the confusion in the group has been caused by other authors since re-describing his species under new names, generic and specific.

Pyrosoma had been first made known by Péron in 1804, and was shortly afterwards treated more fully by Lesueur and Savigny. These researches, along with those of Cuvier on the anatomy of *Salpa*, showed the relationship of those pelagic forms to the Simple and Compound Ascidians then being investigated by Savigny, and enabled Lamarck to unite them all in the class Tunicata.

A few years afterwards, in 1819, Chamisso published the observations made during his celebrated voyage round the world, and announced the important discovery that *Salpa* in its life-history passes through the series of changes which were afterwards more fully described by Steenstrup in 1842 as alternation of generations. He observed first that each species of *Salpa* had two forms which were produced alternately, so that, as Chamisso put it, "a *Salpa* mother is not like its daughter or its own mother, but resembles its sister, its grand-daughter, and its grand-mother."

The next discovery of importance was likewise made on *Salpa*. In 1822, Kuhl and van Hasselt observed the alternation in the direction in which the wave of contraction passes along the heart, and in which the blood circulates through the body. It has since been found by many investigators that this remarkable observation, first discovered in the case of *Salpa*, holds good for all groups of the Tunicata.

[1] For references to the literature, see Part I., Bibliography; and also farther on in the present part, under the various families and genera.

The great French circumnavigating expeditions of the third decade of the century, although they made known the external appearances of some new forms amongst pelagic Tunicates, contributed little to the anatomy, or any other real knowledge of the group, and added not a little to the confusion in which the synonymy was even then beginning to be involved.

In 1831, *Oikopleura*, the best known genus of the Larvacea (Appendiculariidæ), was described by H. von Mertens. This observer had found this most important pelagic form near Bering Strait in 1828, where a form, possibly the same, had been seen and imperfectly characterised (under the name *Appendicularia*) by Chamisso some years before. Mertens was fortunate enough to see it in the act of forming and getting rid of its periodically produced temporary test, which has since borne the German name "Haus," applied to it by Mertens.

Anchinia, another important pelagic Tunicate, and its close ally *Doliolum*, were made known in 1833 and 1835, the former being established by Eschscholtz, and the latter by Quoy and Gaimard as one of the results of the voyage of the "Astrolabe."

Costa's observations on the Mediterranean *Salpæ*, those of Milne-Edwards on *Pyrosoma* and on *Salpa*, and of Eschricht on two little-known forms of *Salpa* (*Salpa cordiformis-zonaria*), made in 1839–41, added considerably to the knowledge of the anatomy and physiology of these genera. M. Sars and Krohn, during the decade that followed, contributed important observations on the Salpidæ—the latter author treating more especially of the reproduction, the development, and the life-history. Krohn likewise did good service at this period by attempting to clear up the synonymy of *Salpa*, and to range the two kinds of generations (the solitary and the chain forms) under their proper species.

By far the most important contributions, however, of the middle of the century were Huxley's well-known memoirs on the pelagic Tunicata *Salpa*, *Doliolum*, *Pyrosoma*, and *Appendicularia*. Huxley's observations upon these forms were made during the voyage of H.M.S. "Rattlesnake," and, so far as *Salpa* is concerned, covered partly the same ground as the independent observations of Krohn, published previously. The memoir on *Salpa* treats mainly of the structure of two different forms of the genus (evidently the "solitary" and "chain" generations of *Salpa democratica-mucronata*), of their methods of reproduction, and of their relation to one another. He discovered the testis in the chain *Salpa*, thoroughly established the truth of Chamisso's description of the "alternation of generations," and pointed out the essential difference between the two methods of reproduction occurring in the life-history. In his observations upon *Pyrosoma*, which were made upon the living animal, Huxley corrected and added to the descriptions of his predecessors, especially in regard to the reproductive organs. He also in an important section of his memoir discussed the relationships between the various groups of Tunicata, and pointed out the similarity in structure and in life-history between *Pyrosoma* and *Salpa* on the one hand, and between *Pyrosoma* and the Compound Ascidians on the other.

In the Remarks upon *Appendicularia* and *Doliolum*, Huxley proved conclusively that the first of these forms belonged to the Tunicata. It had previously been described by Chamisso as a Cœlenterate, and by v. Mertens as a Pteropod. He also was the first to give a good anatomical description of *Appendicularia*, and to point out the interest attaching to the persistent tail. For *Doliolum* he performed a similar service, giving for the first time a thorough description of the structure of this little-known form, and indicating its true position amongst the other Tunicata.

Interest was now thoroughly awakened in regard to these important forms and their complicated life-histories; and during the ten years that followed a number of the leading European naturalists produced papers on the pelagic Tunicata. Gegenbaur wrote on *Doliolum* and on *Appendicularia*, Krohn on *Doliolum*, H. Müller on *Salpa*, C. Vogt on *Salpa*, Leuckart on *Salpa* and *Doliolum*, Allman on *Appendicularia*, Keferstein and Ehlers on *Doliolum*, and Huxley on all four genera.

The great embryological impulse which was given by Kowalevsky's celebrated memoir on the development of a Simple Ascidian in 1866 did not affect the literature of the pelagic Tunicata so immediately as it did that of the Ascidiacea, and for some years after all the more important papers were on the Simple or the Compound Ascidians. In 1872 appeared Fol's important treatise on the Appendicularians. This is by far the most comprehensive work on the Larvacea that has yet been written, and was the first to give an adequate account of the group as a whole. In 1875, Kowalevsky in one of his admirable embryological memoirs gave a detailed account of the development of *Pyrosoma*, confirming and supplementing the previous description by Huxley, who had first discovered the remarkable "cyathozooid," and its relations to the first Ascidiozooids of the colony. Attention was now directed to the Salpidæ, and from that time up to the present there has been a more or less continuous series of, in many respects, conflicting accounts of the development, gemmation, and life-history of *Salpa*. The more important of these papers have been written by Brooks (1875 and 1886), Todaro (1875, 1880, 1882, and 1887), Barrois (1881–82), Seeliger (1885), and especially Salensky (1877, 1878, and 1882–83). A very useful paper by Traustedt, published in 1885, deals with all the known species of the Salpidæ, discussing their characters, distinguishing them, and reducing their synonymy to order.

The Cyclomyaria have also been largely investigated during the last five or six years. The complicated life-history of *Doliolum* has been gradually worked out by the successive papers of Grobben and Uljanin, while the allied form *Anchinia* has been investigated by Korotneff, Kowalevsky, Barrois, and Wagner, thus bringing our knowledge of the pelagic Tunicata up to its present condition.

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ANATOMY.

As the three groups of pelagic Tunicata treated in this part of the Report differ from one another considerably in structure, and as, moreover, the section Anatomy in the introduction to Part I. gave a general account of the anatomy of all the Tunicata, it will be better to consider the further structural details under the head of each group separately, than to attempt any general description common to all. Reference may be made for the anatomy of the Pyrosomatidæ to pp. 17 *et seq.*, for the Doliolidæ to p. 41, for the Salpidæ to p. 55, and for the Appendiculariidæ to p. 100.

DESCRIPTIONS OF THE GENERA AND SPECIES.

In the generic and specific descriptions, I have as far as possible followed the same system as that employed in the case of the Simple and Compound Ascidians in the previous parts of the Report. The branchial aperture in all cases is regarded as indicating the anterior end of the body, while the nervous system is dorsal, and the endostyle ventral.

I still make use of the classification given at the beginning of Part I., with those few additions which are rendered necessary by discoveries made since 1882.

The class Tunicata is divided into three orders, the Ascidiacea, the Thaliacea, and the Larvacea.

Order I. ASCIDIACEA.[1]

This group includes fixed or free-swimming Simple or Compound Ascidians, which in the adult are never provided with a tail, and have no trace of a notochord. The free-swimming forms are colonies, and the Simple Ascidians are fixed.

The test is permanent and well developed; as a rule, it increases with the age of the individual.

The musculature of the mantle is in the form of an irregular network, there being no regular circular bands.

The branchial sac is large and well developed. Its walls are perforated by numerous slits (the stigmata) opening into a single peribranchial cavity, which communicates with the exterior by the atrial aperture.

The anus opens into the peribranchial cavity.

Many of the forms reproduce by gemmation, and in most of them the sexually produced embryo developes into a tailed larva.

The order Ascidiacea is divided into three sections,—the Ascidiæ Simplices, the Ascidiæ Compositæ, and the Ascidiæ Salpiformes.

[1] For the characters of order II. see page 36, and of order III. see page 96.

Suborder I. ASCIDIÆ SIMPLICES.[1]

This group contains fixed Ascidians which are solitary, and very rarely reproduce by gemmation; if colonies are formed, the members of the colony are not buried in a common investing mass, but each has a distinct test of its own.

The Ascidiæ Simplices include four families. The Challenger Simple Ascidians were described in Part I. of this Report, and in Part II. Appendix A.[2]

Suborder II. ASCIDIÆ COMPOSITÆ.[3]

This group contains fixed Ascidians which reproduce by gemmation so as to form colonies in which the Ascidiozooids are buried in a common investing mass, and have no separate tests.

The Ascidiæ Compositæ include seven families. The Challenger Compound Ascidians were described in Part II. of this Report.

Suborder III. ASCIDIÆ SALPIFORMES.

This group contains free-swimming pelagic Ascidians which reproduce by gemmation so as to produce colonies having the form of a hollow cylinder closed at one end. The Ascidiozooids forming the colony are embedded in the common test in such a manner that the branchial apertures all open on the outer surface and the atrial apertures on the inner surface next to the central cavity of the colony. The first four Ascidiozooids are produced by gemmation from a rudimentary larva (the cyathozooid) developed sexually.

The Ascidiæ Salpiformes include a single family, the PYROSOMATIDÆ, containing one well-marked genus *Pyrosoma*.

Family PYROSOMATIDÆ.

Colony free-swimming, and having the form of a hollow cylinder closed at one end.

Systems—only one present, the terminal aperture being the common cloacal opening.

Ascidiozooids elongated antero-posteriorly, and placed in a single layer with their branchial apertures opening on the surface of the colony and their atrial apertures into the axial common cloaca. Body not divided externally into regions. Apertures not lobed.

[1] See also Part I. of this Report (Zool. Chall. Exp., part xvi., 1882), page 57.
[2] See also Appendix A. of the present Part.
[3] See also Part II. of this Report (Zool. Chall. Exp., part xxviii., 1886), page 28.

Test gelatinous and transparent, containing no spicules, but many small cells.

Branchial Sac well developed, not folded. Consisting of numerous transverse vessels separated by narrow slits (the stigmata), and numerous internal longitudinal bars.

Tentacles present; simple.

Dorsal Lamina in the form of languets.

Alimentary Canal placed posteriorly to the branchial sac.

Reproductive Organs placed in the wall of the peribranchial cavity, posterior to the branchial sac. The embryo becomes a rudimentary larva (the cyathozooid), which gives rise to the first Ascidiozooids of the colony.

Gemmation takes place from a ventral and posterior stolon.

This family, the only one yet known in the Ascidiæ Salpiformes, corresponds exactly to Savigny's family LUCIÆ,[1]— a group which, although called a family by Savigny, that author really regarded as being of much higher rank than we now understand by a family, since he considered it equivalent in his system of classification to the whole of the Simple and Compound Ascidians together. His family I. is "TETHYÆ," and he divides that into two groups—(1) "Téthyes Simples," the Simple Ascidians; and (2) "Téthyes Composées," the Compound Ascidians; while his family II. is "LUCIÆ," the Pyrosomatidæ, which thus ranks with what we now call an order. The term Pyrosomatidæ was first used, I believe, as a family designation by Prof. T. R. Jones[2] in 1848. Its characters are naturally those of the suborder Ascidiæ Salpiformes, and these will be discussed further under the heading of the single genus.

Pyrosoma, Péron.

Pyrosoma, Péron, Ann. d. Mus., tom. iv. p. 437, 1804.

Colony free-swimming, and having the form of a cylinder with a large central cavity closed at one end and open at the other.

Systems—only one present, the terminal aperture being the common cloacal opening, and the central cavity the common cloaca.

Ascidiozooids elongated antero-posteriorly, and placed in a single layer with their anterior ends external and their posterior ends internal. Branchial apertures anterior, opening on the surface of the colony. Atrial apertures posterior, opening into the centrally placed common cloaca. Body not divided externally into thorax and abdomen. Apertures not lobed.

Test gelatinous and transparent, containing numerous stellate branched cells.

Branchial Sac well developed, not folded, and not extending to the posterior end of the body. Vessels of two kinds: transverse vessels, which are

[1] Mémoires, p. 139.

[2] In the article Tunicata in Todd's Cyclopædia of Anatomy and Physiology.

numerous and closely placed, leaving elongated slits between, which are transversely directed; and longitudinal vessels, which are not quite so numerous, and cross the transverse vessels so as to form small quadrangular meshes.

Tentacles simple, one ventrally placed, larger than the rest.

Dorsal Lamina represented by a series of eight or more tapering languets.

Dorsal Tubercle, with a simple aperture.

Alimentary Canal short and simple, placed posteriorly to the branchial sac.

Reproductive Organs hermaphrodite, placed posteriorly to the branchial sac, in diverticula of the peribranchial cavity.

Gemmation from a ventrally-placed stolon formed at the posterior end of the endostyle.

This genus was founded by Péron in 1804.[1] His specimens were obtained in the equatorial Atlantic between Mauritius and Europe during a voyage round the world along with Lesueur, and were very imperfectly described and figured in his memoir, and also in the account of the voyage. The genus is characterized very briefly as follows:—"Pyrosoma. *Corpus liberum, subconicum, extremitate ampliore apertum, vacuum, aperturæ margine intus tuberculis cincto.*" The further description is worthless.

The specific description:—"Pyrosoma atlanticum. *Æquatorio-atlanticum, gregarie-pelagivagum viridissime phosphorescens, coloribus eximiis tunc effulgens in aquis viginti duobus reaumurianis calidioribus occurens,* 10–12–14–16 *centimetros æquans,*" contains no character which is of any use in determining the species; and the animal was evidently regarded by its first investigator as a zoophyte, consisting of a single polype of which the terminal aperture was the mouth, while the Ascidiozooids were interpreted as simple elongated glands having a phosphorescent function. The plate, drawn by Lesueur, is very little better than the description. It represents the external appearance and a longitudinal section of the colony.

Lamarck[2] shortly afterwards placed *Pyrosoma* in the Radiata beside *Beroë*, but added nothing to the knowledge of its nature.

Péron and Lesueur again met with *Pyrosoma* in a voyage to Nice, and a new species then obtained was described by Lesueur[3] in 1813 under the name of *Pyrosoma elegans.* This differed from *Pyrosoma atlanticum* in having the tubercles on the surface arranged regularly in verticils. A third species which was found at Nice was discussed by Lesueur[4] in a more important paper, Mémoire sur l'organisation des

[1] Mémoire sur le nouveau genre Pyrosoma, *Ann. Mus. Hist. Nat.*, tom. iv. p. 437; also, Péron and Lesueur, Voyage aux Terres austr., tom. i. p. 488, pl. 30, fig. 1.

[2] Philosophie Zoologique, tom. i. p. 294, 1809.

[3] *Nouv. Bull. Soc. Philomath.*, tom. iii. p. 283.

[4] *Journal de Physique*, tom. lxxx. p. 413.

Pyrosomes, published in 1815. In this work the true nature of *Pyrosoma* is recognised, some of the former errors in the description corrected, and the genus is removed from the Radiata and placed in the Mollusca alongside *Salpa*. A detailed description, with figures, of the new species *Pyrosoma giganteum* is given, and some of the features in which it differs from the other known species *Pyrosoma atlanticum* and *Pyrosoma elegans* are pointed out. The figures illustrating this paper are good,[1] and are of great assistance in determining the species.

Savigny, to whom we naturally turn for accurate information upon every genus of the Tunicata known in his day, gives a detailed account of the structure of *Pyrosoma giganteum* in his second memoir.[2] His investigations are quite independent of those of Lesueur, and were made upon specimens from Nice sent by Risso to Cuvier, and placed by the latter in the hands of Savigny. The genus was then for the first time properly characterised, his description forming, in fact, with a few slight alterations and additions, the definition now employed.

Savigny divided the species into two groups:—

I. Pyrosomata verticillata—containing the single species *Pyrosoma elegans*, Lesueur; and

II. Pyrosomata paniculata—containing the two species *Pyrosoma atlanticum*, Péron, and *Pyrosoma giganteum*, Lesueur.

Of these two sections of the genus, the first is characterised by having the Ascidiozooids arranged in verticils or regular rings, some of which at regular intervals project beyond the others. The second section has the colony formed of Ascidiozooids, not verticillate, but arranged in very irregular circles in which the more prominent ones are irregularly scattered. If this character, the arrangement of the Ascidiozooids in the colony, is to be depended upon, then none of the Challenger specimens belong with certainty to the first section of the genus, and a specimen in the Zoological Museum of University College, Liverpool, obtained, named as *Pyrosoma elegans*, from the Zoological Station, Naples, does not belong to that species, since its Ascidiozooids are irregularly scattered. There are also other points in which it does not agree with the descriptions of Lesueur and Savigny.

Of the two species belonging to the second section, Savigny distinguishes *Pyrosoma atlanticum* from *Pyrosoma giganteum*, as having a more conical shape, and as differing in the form of the external projecting ends of the Ascidiozooids—those of *Pyrosoma atlanticum* being subulate, while in *Pyrosoma giganteum* they are hemispherical or conical, the larger ones having their extremities lanceolate and finely denticulate. Savigny divided the specimens of *Pyrosoma giganteum* which he examined into three kinds or varieties, which will be discussed farther on under the species.

[1] For a detailed criticism of Lesueur's paper, see Huxley, *Trans. Linn. Soc. Lond.*, vol. xxiii. p. 194, 1862.

[2] Mémoires, pp. 52 *et seq.*

Savigny's[1] account of the anatomy, with the exception of the reproductive organs and a few points of secondary importance, is very accurate and detailed.

Lamarck,[2] in 1816, formed the class Tunicata and ranged the genus *Pyrosoma*, now removed from the Mollusca, in the same order with the Compound Ascidians, and next after *Botryllus*. He briefly characterises the genus and the three known species, and appends a few remarks, but adds nothing to the anatomical discoveries of Lesueur and Savigny.

Milne-Edwards,[3] in 1840, investigated the circulation in *Pyrosoma*. He showed that the nature of the heart and the general course of the blood was much the same as in the ordinary Ascidians.

The next memoir of importance is Huxley's excellent Observations upon the Anatomy and Physiology of *Salpa* and *Pyrosoma*,[4] published in 1851. His investigations were made upon a specimen of *Pyrosoma atlanticum* captured in the middle of the South Pacific Ocean during the voyage of the "Rattlesnake." Huxley gives a very complete account of the structure of this species, correcting some of the errors of his predecessors, especially in regard to the reproductive organs. He showed for the first time the true nature and position of the testis and ovary. In a very interesting section of his paper on the Homology of Organs in the Tunicata, he shows the relationship of *Pyrosoma* to *Salpa* on the one hand, and to the Botryllidæ and the Compound Ascidians on the other. Savigny[5] had long before noticed the close resemblance between *Pyrosoma* and *Botryllus* in some respects, and as I have already pointed out,[6] and shall discuss again more in detail farther on, I believe that the Ascidiæ Salpiformes are much more closely related to the Ascidiæ Compositæ than to any of the Thaliacea.

In a further paper On the Anatomy and Development of *Pyrosoma*, read in December 1859, and published in 1862,[7] Huxley gave an elaborate account of the structure, of the budding, and of the embryonic development of *Pyrosoma giganteum*, from a specimen obtained in the North Atlantic, and preserved in spirit, and containing many embryos in various stages of development. He was able to show that cross-fertilisation must take place, since when the ova are mature in an Ascidiozooid, the testis is still in a rudimentary condition. He traced the embryonic development, and the formation of the remarkable Cyathozooid and of the series of four Ascidiozooids[8] attached to it, and their gradual conversion into the young colony. This was the first accurate and consecutive account of the life-history of *Pyrosoma*; and it is an

[1] Système des Ascidies, p. 205.
[2] Histoire Naturelle des Animaux sans Vertèbres, tom. iii. p. 109. Paris 1816.
[3] *Comptes rendus*, tom. x. p. 284; also *Ann. Sci. Nat.* (Zool.), sér. 2, tom. xii. p. 375.
[4] *Phil. Trans.* 1851, part ii. p. 567.
[5] Mémoires.
[6] In Part II. of this Report, published in vol. xiv., 1886.
[7] *Trans. Linn. Soc. Lond.*, vol. xxiii. p. 193; also *Ann. and Mag. Nat. Hist.*, 1860, ser. 3, vol. v. pp. 29–35.
[8] This useful term was first introduced by Huxley in his memoir in the *Trans. Linn. Soc. Lond.* (*loc. cit. supra*). In the preliminary paper in the *Ann. and Mag. Nat. Hist.* (1860), he uses the term "Ascidiite."

admirable piece of work,—especially when we remember that the only available material was a single colony preserved in spirit, from which sections were cut and mounted in glycerine.

In 1861 Keferstein and Ehlers[1] gave an account of the anatomy of specimens of *Pyrosoma giganteum* and *Pyrosoma elegans* obtained at Naples and Messina. Their work was carried on about the same time as that of Huxley, and forms an independent corroboration of his results. The work of the German authors deals mainly, however, with the anatomy and histology; they only touch briefly upon the embryology and the gemmation.

The only remaining work that need be noticed is Kowalevsky's[2] memoir on the development of *Pyrosoma*, which appeared in 1875. This celebrated embryologist gave an elaborate account of the life-history of *Pyrosoma*, confirming Huxley's discoveries, but tracing the stages more minutely, and going into further histological detail. No papers of importance have been published since then, and no new species of *Pyrosoma* have been described.

The genus, then, contains so far only the three species known to Lesueur in 1815, viz. :—

Pyrosoma atlanticum, Péron.
Pyrosoma elegans, Lesueur.
Pyrosoma giganteum, Lesueur.

To these the Challenger investigations have added a new species of gigantic size obtained twice in the Atlantic. It will be found described below under the name of *Pyrosoma spinosum*, n. sp.

The characters of this group of Ascidians, the Ascidiæ Salpiformes, are very well marked. The shape of the colony and its free-swimming condition distinguish it clearly from all other Tunicata. The only form which approaches it in shape of colony is *Cœlocormus huxleyi*,[3] and it is doubtful whether that species is free-swimming, or merely lies unattached at the sea-bottom.

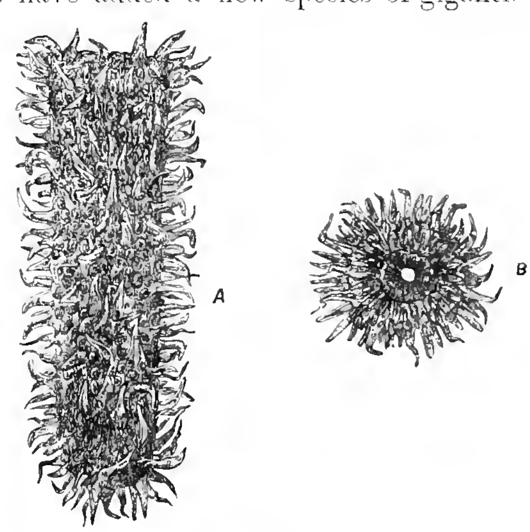


Fig. 1.—Colony of *Pyrosoma*, natural size (from the Encyclopædia Britannica, 9th ed.).
A. Side view. B. End view.

[1] Zoologische Beiträge, iv., Bemerkungen über die Anatomie von Pyrosoma, p. 72, Leipzig, 1861.
[2] Ueber die Entwickelungsgeschichte der Pyrosoma, *Archiv f. Mikr. Anat.*, Bd. xi. p. 597.
[3] See this Report, Part II. 1886, p. 318.

The general shape of a *Pyrosoma* colony is seen in fig. 1. Small colonies are as a rule more regular, and taper more towards the closed end than large ones. The narrower closed end is rounded, the other is truncated, and has a larger or smaller opening in its centre (Pl. I. figs. 1, 4). The size of this aperture, or rather of the lip or diaphragm which reduces it, has been used as a character distinguishing species; but F. D. Bennet[1] showed, in 1837, that in the living *Pyrosoma* the diaphragm can be moved so as to allow the aperture to enlarge and contract (see below, p. 28). Fig. 1, B, shows the open end of a *Pyrosoma* colony in which the diaphragm is extended so as to leave only a small central apèrture.

The processes projecting from the surface of the colony vary considerably in arrangement, size, and shape in different species and colonies. Each one indicates the anterior end of an Ascidiozooid, and the branchial apertures can be seen (Fig. 1) either at the ends, or at the bases, or half way up the processes. The usual arrangement is for each large Ascidiozooid to form a dome-like projection or papilla on the surface of the colony at the extremity of which the branchial aperture is placed, while a longer or shorter process of the test extends outwards beyond that (see Figs. 2 and 4).

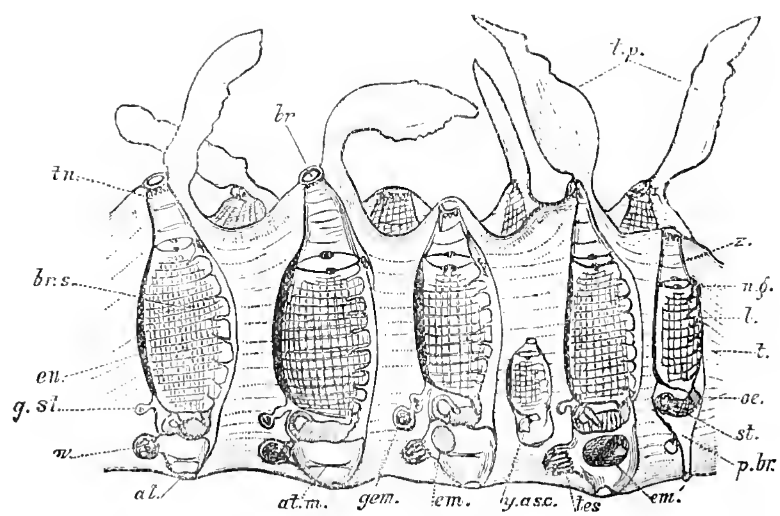


FIG. 2.—Part of a section through a *Pyrosoma* colony.

at. atrial aperture, *at.m.* atrial muscle, *br.* branchial aperture, *br.s.* branchial sac, *em.* young embryo, *em'.* older embryo, showing cyathozooid and ascidiozooids, *en.* endostyle, *gem.* bud on stolon, *g.st.* gemmiparous stolon, *l.* dorsal lanquet, *n.g.* nerve ganglion, *œ.* œsophagus, *ov.* ovum, *p.br.* peribranchial cavity, *st.* stomach, *t.* test, *tes.* testis, *t.p.* process of test, *tn.* tentacles, *y.asc.* young ascidiozooid, *z.* zona prebranchialis.

The Ascidiozooids are placed in a single layer, each having, when fully developed, its branchial aperture opening on the outer surface of the colony, and its atrial aperture opening into the central cavity of the colony or common cloaca. Consequently the antero-posterior axis of the Ascidiozooid coincides with the thickness of the wall of the

[1] *Proc. Zool. Soc. Lond.*, part v. p. 51.

Pyrosoma colony (Fig. 2). The Ascidiozooids all have their dorsal surfaces turned the same way, but the direction is different in different species. Huxley in his first memoir[1] described the Ascidiozooids of *Pyrosoma atlanticum* as having their dorsal surfaces[2] directed towards the open end of the colony; and in his second memoir[3] he describes the same condition in the case of *Pyrosoma giganteum*. In *Pyrosoma elegans*, however, Keferstein and Ehlers[4] found that the dorsal surfaces of the Ascidiozooids were turned towards the closed end of the colony. The Ascidiozooids are not arranged in systems or groups, and as their atrial apertures all open into a single common cloaca which has only one opening to the exterior, the whole colony may be regarded, as Savigny pointed out, as forming a single large system. The Ascidiozooids placed near the open end of the colony are provided with tubular prolongations of their dorsal body-wall, containing muscle fibres, and probably acting as dilatators of the opening.

The test is remarkably clear and transparent. In its histological characters it agrees with the test of many of the Ascidians. It contains test cells which are mostly stellate, and have branched processes (Pl. I. fig. 6). There are no bladder cells, no pigment cells, and no spicules.

Each Ascidiozooid is elongated antero-posteriorly (Figs. 2 and 4) and consists of two parts, the large thorax and the small abdomen, but these regions are not separated by any external constrictions. The branchial and atrial apertures are merely rounded openings with no lobes. The atrial is not prominent, and there is no atrial siphon (Pl. I. fig. 3).

The branchial aperture is raised on a projection as described above, and leads into a short branchial siphon, which is continued backwards by a large tubular or infundibular cavity, widening slowly or rapidly, according to its length, until it joins the branchial sac. Round the walls of this large cavity, which evidently corresponds to the zona præbranchialis of Simple Ascidians, are found two circular muscle bands, and other very delicate muscle fibres may be found encircling the body farther back. In *Pyrosoma spinosum*, n. sp., the muscle bands around the large branchial region of the body are numerous. There is always a strong atrial muscle in the wall of the peribranchial cavity, and an atrial sphincter. These are the only muscle fibres in the mantle, which is otherwise a clear membrane forming the body wall, and clothed externally by the ectoderm, a layer of squamous epithelium, and on the inner surface by another layer of squamous epithelium, the parietal layer of the atrial membrane (or third tunic).

At the anterior end of the præbranchial zone, and just inside the branchial aperture, is placed the circle of simple unbranched tentacles. They are about twelve in number,

[1] *Phil. Trans.* 1851, part ii. p. 581.

[2] It must be remembered that Huxley called the neural surface ventral and the endostyle dorsal, the reverse of the nomenclature of regions now generally accepted.

[3] *Trans. Linn. Soc. Lond.* 1862, p. 201.

[4] Zool. Beiträge, p. 72.

and one of them, placed in the mid-ventral line, is always considerably larger than the rest (Pl. I. fig. 2).

The branchial sac occupies about the middle two-fourths of the length of the Ascidiozooid. It is the widest part of the body. The stigmata are very conspicuous; they are transversely directed slits extending along the whole breadth of each side of the sac, and separated by the transverse vessels. These stigmata, therefore, correspond not to the stigmata of the ordinary Simple and Compound Ascidians, such as the species of *Ascidia* or of *Botryllus*, where the slits are elongated antero-posteriorly, and are separated not by the transverse but by the fine longitudinal vessels (Fig. 3, A), but to the rows of stigmata which lie between the transverse vessels, and are divided

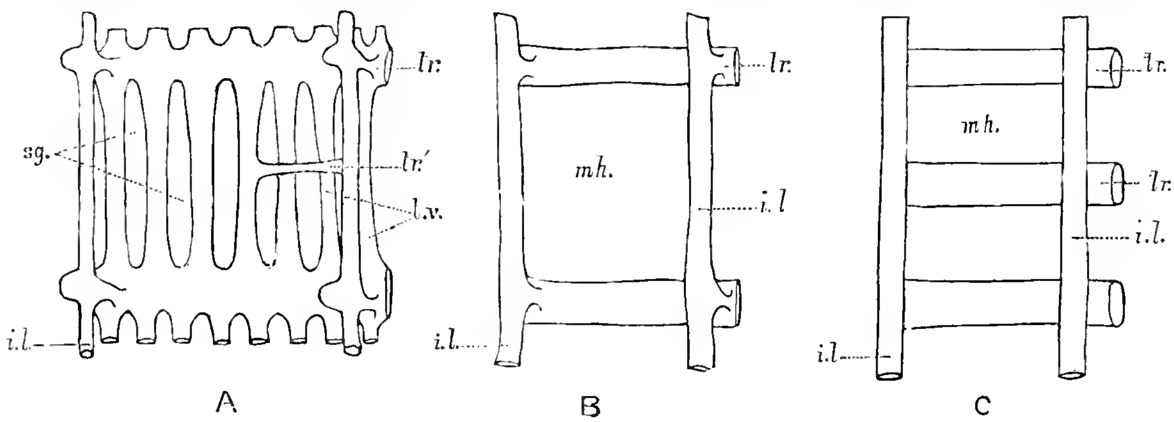


Fig. 3.—Diagrams showing the structure of the branchial sac in :—
A. *Ascidia*, B. *Culeolus*, and C. *Pyrosoma*.
i.l. internal longitudinal bar, *l.v.* fine longitudinal or interstigmatic vessels (in *Ascidia* only), *mh.* mesh, *sg.* stigmata, *tr. tr'.* transverse vessels.

into meshes by the internal longitudinal bars,—one complete mesh, divided into six stigmata, is shown in Fig. 3, A.

In the genera *Culeolus* and *Fungulus* and *Bathyoncus*, however, amongst Simple Ascidians,[1] and in *Pharyngodictyon* amongst Compound Ascidians,[2]—all of them deep-sea genera, made known through the Challenger investigations,—we find a condition of the branchial sac similar to that of *Pyrosoma*. In these forms there are no fine longitudinal vessels, and consequently the meshes formed by the intersection of the transverse vessels and internal longitudinal bars are not cut up into stigmata, but remain as large quadrangular spaces (Fig. 4, B). If, now, the transverse vessels become more numerous and more closely placed, so as to reduce the quadrangular meshes to transversely elongated slits, we arrive at the condition found in *Pyrosoma* (Fig. 4, C). In *Culeolus* and its allies, in *Pharyngodictyon*, and in *Pyrosoma*, there are therefore no true stigmata, and no interstigmatic vessels, such as those of *Ascidia*, but merely meshes bounded by the transverse vessels and the internal longitudinal bars.

[1] See Part I. of this Report. [2] See Part II. of this Report.

In *Pyrosoma* there are from twenty to fifty transverse vessels, and about the same number of slits, which are usually about equal in breadth to the thickness of a vessel. The internal longitudinal bars are from fifteen to thirty in number on each side. They are ciliated on their edges. The meshes formed by the intersection of the transverse vessels and the internal longitudinal bars are generally elongated transversely, and are about three times as long as they are broad (see Pl. I. figs. 17, 19).

At the anterior end of the branchial sac is found the peripharyngeal groove, bounded by the two peripharyngeal bands (Pl. I. figs. 18, 19, *pp.*).

The endostyle runs along the ventral edge of the branchial sac in the usual manner. It is very regular in its course (Fig. 4, *en.*).

The dorsal lamina on the opposite edge of the branchial sac is in the condition of a series of finger-like languets, having blunt points and ciliated on their anterior edges. It is a curious fact that the dorsal languets are fewer in number than the transverse vessels of the branchial sac, and appear to bear no definite relation to them.

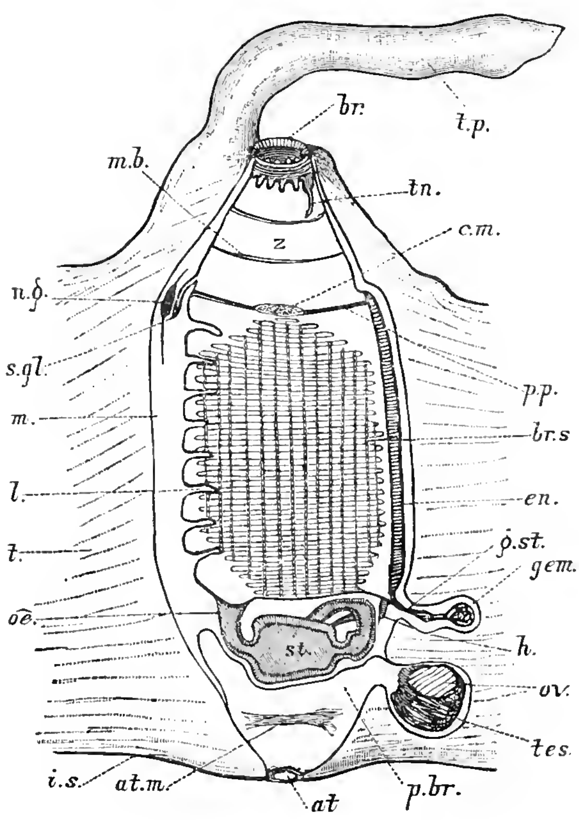


FIG. 4.—A single Ascidiozooid of *Pyrosoma*, lying in the test, seen from the right side.

at. atrial aperture, *at.m.* atrial muscle, *br.* branchial aperture, *br.s.* branchial sac, *c.m.* mass of phosphorescent cells, *en.* endostyle, *gem.* young bud on *g.st.* gemmiparous stolon, *h.* heart, *i.s.* inner surface of colony, *l.* languet, *m.* mantle, *m.b.* muscle band, *n.g.* nerve ganglion, *œ.* œsophagus, *ov.* ovum, *p.br.* peribranchial cavity, *p.p.* peripharyngeal bands, *st.* stomach, *s.gl.* subneural gland, *t.* test, *tes.* testis, *t.p.* process of test, *tn.* large ventral tentacle, *z.* zona prebranchialis.

The nerve ganglion is placed at the anterior end of the branchial sac on the dorsal edge (Fig. 4, *n.g.*). It has a small pigmented sense-organ placed upon it. The subneural gland bears the usual relation to the ganglion, being on its ventral surface. The gland has a duct leading forwards and ventrally to open into the posterior dorsal part of the prebranchial zone on the dorsal tubercle. The aperture of the duct is simple, but prominent (Pl. II. fig. 13).

On each side of the anterior end of the branchial sac, close to the peripharyngeal band, is seen a mass of rounded glandular cells (Pl. I. figs. 18, 19, and 20), which have given rise to a good deal of speculation. They were supposed by Savigny to be laterally placed ovaries. This mistake was corrected by Huxley, who found the true position of the ova. Huxley himself suggested that the cell masses were kidneys, and Keferstein and Ehlers regarded them as being probably organs for aiding in the production of buds. Panceri[1] first showed that they are really organs for the production of the phosphorescence, for which *Pyrosoma* is so famous.

The alimentary canal is placed posteriorly to the branchial sac (Fig. 4). The œsophageal opening is wide. It lies at the dorsal edge of the posterior end of the branchial sac, and the œsophagus curves posteriorly and ventrally to open into the dorsal end of the large quadrangular stomach. The stomach lies with its longer axis directed dorso-ventrally. It is usually narrower at the intestinal than at the œsophageal end. The intestine is a narrow curved tube which runs at first ventrally, and then curves anteriorly, then dorsally, and, finally, a little posteriorly, so as to describe nearly a complete circle. The anus opens into the peribranchial cavity, which is a large space consisting of three regions—(1) a median part occupying the posterior part of the body, and opening into the common cloaca by means of the atrial aperture; and (2 and 3) two lateral parts extending anteriorly from the median part, one at each side of the branchial sac. Into these lateral regions of the peribranchial cavity the slits in the wall of the branchial sac open, while the anus opens into the median posteriorly placed region.

Ramifying over the wall of the intestine is found a system of delicate tubules which branch and anastomose, and finally end in small ampullæ. This, like the corresponding systems in other Tunicata, is probably a digestive gland. It pours its secretion by a common duct into the pyloric or ventral end of the stomach on its anterior border.

The heart is situated near the posterior end of the endostyle; and close to it, and therefore placed posteriorly and ventrally, there is a diverticulum of the body wall containing a process from the endoderm. This structure is the gemmiparous stolon upon which the buds destined to become the future Ascidiozooids of the same colony are produced. This stolon is evidently identical both in constitution and in position with the various processes for the production of buds found in the Compound

[1] *Atti Accad. Sci. Fis. e Mat. Napoli*, vol. v., no. 13.

Ascidians.[1] Huxley[2] and Kowalevsky[3] have both described in an admirable manner the process by which buds are developed upon the stolon of *Pyrosoma*.

The reproductive organs are formed in diverticula of the posterior median part of the peribranchial cavity, the testis on the left side, the ova on the right. The testis is a lobed organ, which was regarded as the liver until Huxley showed its true nature in 1851. It remains in a rudimentary condition until after the ova have matured. Thus the Ascidiozooids of *Pyrosoma*, like so many of the Compound Ascidians, are protogynous, and self-fertilisation is prevented.

The ova are produced one at a time. After fertilisation the development takes place in a diverticulum of the peribranchial cavity, called the ovisac by Huxley, and comparable with the incubatory pouch found in the genus *Colella* amongst Compound Ascidians.[4]

The segmentation is meroblastic, and an elongated blastoderm is formed on the surface of a mass of yolk. This becomes converted into an embryo, with a tubular alimentary canal, a dorsally placed neural tube, and a pair of laterally placed atrial cavities. This embryo then divides into an anterior and a posterior part. The anterior segments into four pieces, which afterwards develop into the first Ascidiozooids of the colony, while the posterior part remains in a rudimentary condition, and was called by Huxley the "Cyathozooid;" it eventually atrophies. As the four Ascidiozooids increase in size, they grow round the Cyathozooid and soon encircle it. The Cyathozooid absorbs the nourishing yolk upon which it lies, and distributes it to the Ascidiozooids by means of a heart and a system of vessels which have formed. When, finally, the Cyathozooid atrophies and is absorbed, its original atrial aperture remains and deepens, to become the central cavity of the young colony which now consists of four Ascidiozooids placed in a ring around where the Cyathozooid was, and all enveloped in a common test.

The colony gradually increases by the formation of buds from these four original Ascidiozooids.[5] Although in most of the species the Ascidiozooids are placed with their ventral surfaces towards the closed end of the colony, and gemmation takes place only from the ventral surface of the Ascidiozooids, still the younger members of the colony are not found, as would be expected, mainly at the closed end of the colony. In most specimens besides those scattered irregularly through the colony, a number of young Ascidiozooids are found round the edge of the common cloacal aperture, while the closed end of the colony, on the other hand, is occupied wholly by adult and, in fact, old-looking Ascidiozooids, not very closely placed. Possibly, as Huxley has suggested, this state of affairs may be brought about by a migration of the young

[1] See further on p. 24.
[2] *Trans. Linn. Soc. Lond.* 1862, p. 211.
[3] *Archiv f. Mikr. Anat.*, Bd. xi.
[4] This Report, Part II. p. 72.
[5] For further details as to the embryology of *Pyrosoma*, see Huxley, *Trans. Linn. Soc.* 1862, and Kowalevsky, Ueber die Entwickelungsgeschichte der Pyrosoma, *Archiv f. Mikr. Anat.*, Bd. xi. 1875, p. 597.

buds from the position where they are formed to the dorsal sides of the parent Ascidiozooids (see below, p. 33).

Pyrosoma, although pelagic in its habits, is not at all closely related to the other pelagic Tunicates—the Larvacea and the Thaliacea. Huxley at one time (1851) pointed out the similarity in some details of structure between *Pyrosoma* and *Salpa*; but that seems to have been more with the object of showing that the Tunicata could not be divided into two great groups, the Monochitonida and the Dichitonida, than for the purpose of demonstrating any close relationship between the two genera, since he at the same time recognised the similarity in structure between *Pyrosoma* and *Botryllus*. Savigny also had long before pointed out the resemblance of *Pyrosoma* to the Compound Ascidians. In the second part of this Report[1] I insisted strongly on this as being the true relationship of the Ascidiæ Salpiformes, and I showed how the new family Cœlocormidæ, then created for the remarkable *Cœlocormus huxleyi*, formed a link connecting the aberrant *Pyrosoma* with such normal Compound Ascidians as the Distomidæ.

Uljanin,[2] in discussing the relationship of *Pyrosoma*, has connected it with the Compound Ascidians by means of *Distaplia*, his reason for so doing being apparently that gemmation is effected in *Distaplia* by means of a ventral stolon, as is the case in *Pyrosoma*. It is possible, however, that too much has been made of the peculiarities of *Distaplia*. It seems to me to be an ordinary typical Compound Ascidian, belonging to the family Distomidæ, and having no closer relationship to *Pyrosoma*, or to the Thaliacea, than is found in many other Ascidiæ Compositæ. As to the ventral stolon, many Compound Ascidians produce buds upon a stolon or outgrowth which is ventral in origin. The vascular stolon of the Clavelinidæ, and the post-abdomen of the Polyclinidæ, from both of which buds are formed, are in part prolongations from, or contain, the heart, which is admitted to be a ventral vessel. Even the remarkable process of gemmation seen in the Didemnidæ and Diplosomidæ, where the body of the new Ascidiozooid appears at first to be formed by the union of two distinct outgrowths from the body of the parent, is merely a modification of the same process, since the two bud rudiments are simply the divisions of a single ventral outgrowth or stolon. Consequently in most, if not in all, Compound Ascidians, gemmation is effected by means of a more or less modified ventral stolon, and the probability is, that the process is the same in *Cœlocormus*. In other respects I regard *Cœlocormus* as being more nearly related in structure to *Pyrosoma* than is any other Compound Ascidian. The remarkable life-history of *Pyrosoma*, the formation of the Cyathozooid, from which the first four Ascidiozooids of the colony are formed, at first seems to be quite peculiar to this genus, and unlike anything seen in the Compound Ascidians; but after all it may be regarded as a form of embryonic blastogenesis,—a process which is already known to occur in the

[1] Zool. Chall. Exp., part xxxviii. 1886.
[2] Fauna u. Flora d. Golfes v. Neapel, Monogr. x. p. 123.

Diplosomidæ amongst the Compound Ascidians, and may possibly occur also in others. Since, then, the two remarkable processes in the life-history of *Pyrosoma*, the asexual production of Ascidiozooids from a ventral stolon, and the embryonic blastogenesis in the sexual reproduction, are both found amongst normal Compound Ascidians; and since the remarkable shape of the colony, and of the adult Ascidiozooids, is seen in the abnormal Compound Ascidian *Cœlocormus huxleyi*, there can, I think, be little doubt that *Pyrosoma* is related to the Ascidiæ Compositæ, and that *Cœlocormus* occupies a position between the two groups.

The following is a scheme of the species in this genus. *Pyrosoma atlanticum* and *Pyrosoma giganteum* are, however, such closely related forms that a number of characters have to be taken into account in distinguishing between them. I know of no one good character by which these species can be separated :—

Pyrosoma.

- Ascidiozooids arranged in regular verticils.
  - *Pyrosoma elegans.*
- Ascidiozooids arranged irregularly.
  - Surface of the colony provided with large processes of the test.
    - Colony conical, processes of test subulate or conical.
      - *Pyrosoma atlanticum.*
    - Colony cylindrical, processes of test flattened and lanceolate at their free ends.
      - *Pyrosoma giganteum.*
  - Surface of the colony provided with short sharp spines only.
    - *Pyrosoma spinosum.*

Pyrosoma atlanticum, Péron (Pl. I. figs. 1–3).

This is the original species described first by Péron in 1804. It is also probably the species investigated by Huxley in 1851. For the characters by which it may be distinguished from the other two older species, we are indebted to Lesueur and to Savigny.

One specimen of *Pyrosoma atlanticum* was obtained by the Challenger Expedition in the surface-net off Cape Verde in August 1873. It is of regular conical form, tapering towards the closed end of the colony. It is of a transparent slightly bluish grey colour. The measurements are as follows :—

Total length,	9·5 cm.
Breadth close to open end,	3·0 cm.
Do. at closed end,	0·8 cm.
Diameter of common cloacal aperture,	1·3 cm.
Thickness of colony from outer to inner surface,	0·3 cm.

The closed end of the colony is formed by one central Ascidiozooid with six others arranged around it. After that the Ascidiozooids are arranged quite irregularly, but are all placed with their ventral surfaces towards the closed end of the colony, so that the common cloacal aperture is situated dorsally to the Ascidiozooids.

A small colony obtained off the coast of Africa on August 16, 1873, is probably also referable to this species; but it is young, and the characters are not well marked (see p. 33).

Pyrosoma giganteum, Lesueur (Pl. I. figs. 4–21).

Pyrosoma giganteum, Lesueur, Journ. de Physique, 1815, p. 413.

This is the species of *Pyrosoma* which has been the most thoroughly investigated. It was described and well figured by Lesueur in 1815. It was independently investigated at the same time by Savigny, who gave an account of its anatomy in 1816. It underwent further investigation at the hands of Keferstein and Ehlers in 1861; and, finally, it was the subject of Huxley's careful and detailed researches made in the following year. Each of these distinguished naturalists added somewhat to the knowledge gained by his predecessors.

One specimen of this species was obtained by the Challenger Expedition in the surface-net off Cape Verde in August 1873. It is of cylindrical form, and has the terminal opening very small.

The measurements are as follows:—

Total length, ...	10·5 cm.	Diameter of cloacal cavity, close to opening,	1·4 cm.
Breadth near open end, ...	1·5 cm.	,, ,, ,, near middle, .	1·0 cm.
,, at thickest part (near middle),	2·5 cm.	,, of common cloacal aperture, .	0·4 cm.
,, at closed end, ...	1·5 cm.	Thickness of colony, . .	about 0·3 to 0·4 cm.

The Ascidiozooids are placed just as in the case of *Pyrosoma atlanticum*, with their ventral surfaces towards the closed end of the colony, and the long processes of the test on the outer surface are placed on the dorsal edges of the branchial apertures, and are therefore turned towards the open end of the colony (Fig. 5).

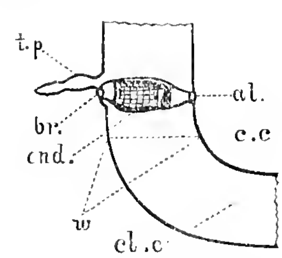


FIG. 5.—Diagram showing the relation of the Ascidiozooid, and of the process of the test to the closed end of the colony in *Pyrosoma giganteum*.

at., atrial aperture; *br.* branchial aperture; *c.c.* common cloaca of the colony; *cl.c.* closed end of the colony; *cnd.* endostyle indicating the ventral edge of the Ascidiozooid; *t.p.* process of the test; *w.* thickness of the colony.

Savigny[1] distinguishes three varieties in this species :—

(*a*) Body having, both externally and internally, a strong brown tint, which appears to be due to a brown matter which fills the branchial cavity. The terminal papillæ are large, and for the most part obtuse. The diaphragm is very narrow, and leaves a large aperture. Total length, 13 to 14 inches.

(*b*) Body bluish or slightly violet, perfectly diaphanous. The papillæ are rather narrow. There is no ring-like diaphragm at the aperture, which is surrounded only by very young Ascidiozooids. Total length, 6 inches.

(*c*) Body bluish, perfectly diaphanous. The papillæ are longer and more pointed than in the preceding varieties. The ring-like diaphragm leaves only a very narrow opening, which is surrounded by Ascidiozooids nearly all of which are adult. Total length, 3, 6, 7 inches.

Of these varieties the Challenger specimen from off Cape Verde most nearly resembles the last (var. *c*).

The test in this specimen is very richly provided with test cells. In the surface layers they are especially numerous, and are nearly all greatly elongated and arranged so as to be nearly parallel to one another. Here and there a stellate or a large round granular cell is to be found (Pl. I. fig. 5). In the deeper parts of the test between the Ascidiozooids, the cells are not so numerous and are nearly all stellate, with very long branched processes (Pl. I. fig. 6). Here also some of the large round granular cells are present. At the branchial aperture, as in other Tunicata, the test is turned in to line the branchial siphon. In this inflected part of the test (Pl. I. fig. 7) the cells are few and small, but in the test outside the branchial aperture, and just above the sphincter muscle, a very large number of small rounded cells are present.

The Challenger Expedition also obtained six specimens (probably from near the surface) in the Antarctic Ocean, to the south of Australia, which I refer to the present species. They are from Station 159, March 10, 1874, lat. 47° 25′ 0″ S., long. 130° 22′ 0″ E., surface temperature 51°·5, bottom temperature 34°·5, and were captured in the trawl, which had been down to a depth of 2150 fathoms. They are all of large size, but some are incomplete. The dimensions of the largest are as follows :—[2]

Total length,	36 cm.
Breadth at open end,	3 cm.
Breadth at widest point,	4·5 cm.
„ closed end,	1·5 cm.
Diameter of common cloacal aperture,	1·0 cm.
Thickness of colony (from outside to inside),	0·4 cm.

[1] Système des Ascidies, p. 207.

[2] One of the fragments, however, must have belonged to a much larger specimen, as it is 7 cm. in breadth, and has the common cloacal aperture 4·5 cm. in diameter.

All these specimens from the Antarctic belong to Savigny's first variety (var. *a*), being of a yellowish brown colour and of large size, and having the processes short. The condition of the diaphragm varies greatly (see Pl. II. fig. 4, and compare with fig. 1). In the specimen measured the diaphragm is of considerable breadth, leaving only a small aperture 1 cm. across. In the large fragment, on the other hand, there is practically no diaphragm, the lumen of the common cloaca being very little reduced at its opening. In one or two specimens the diaphragm is turned outwards, so that its free edge points away from the opening in place of across it. There can be no doubt as to the contractility of the diaphragm, although several of the older observers evidently considered it as an inert cartilaginous immoveable prolongation of the test. Bennet in 1837 described it as being moveable in the living *Pyrosoma*; and the very various conditions in which it is found in different specimens would certainly lead one to believe that it can be readily contracted and dilated.

The diaphragm is a prolongation of the common test, and is, like the rest of the test in the colony, composed of a gelatinous or cartilaginous matrix, in which numerous rounded, fusiform, and stellate test cells are embedded. It is, however, penetrated by a large number of closely placed tubes, containing muscle fibres in their walls. These tubes were recognised by Huxley, who showed them to be prolongations from the dorsal edges of the bodies of the Ascidiozooids; but he refers to them as stolons, and makes no statement in regard to their probable function. From their appearance, structure, and arrangement, however, they evidently correspond to the tubular retractor muscles of the Ascidiozooids found in the test of many colonies of the Compound Ascidians.[1]

These muscular tubes in the diaphragm of *Pyrosoma* are closely placed (Pl. I. fig. 9), and run from the end of the colony inwards to the free edge of the diaphragm. Each tube when highly magnified (300 diam.) is seen to have its wall formed of two layers, an external epithelial, which is evidently a prolongation of the ectoderm of an Ascidiozooid, and an internal muscular, which is formed of a layer of unstriated muscle fibres running longitudinally along the tube (Pl. I. fig. 10, *m.b.*). The contraction of these muscle fibres would draw the free edge of the diaphragm outwards, and so enlarge the common cloacal aperture, while probably the elasticity of the test-matrix suffices to extend the diaphragm when the muscles relax.

The colour of the specimens from the Antarctic varies somewhat, some of them being distinctly browner than others. The brown tint is caused by numerous masses of reddish-brown pigment cells which are scattered over the surface of the viscera. It is not due to food, or to any brown substance lying in the branchial sac, as described by Savigny. On cutting a section of the brownest colony in the collection the colour is distinctly seen to be confined to the deeper layer of the colony where the alimentary and reproductive viscera of the Ascidiozooids are placed, and on dissecting out an

[1] See this Report, Part II.

Ascidiozooid the pigment masses scattered over the surface of the organs are very conspicuous.

In all these specimens from the Antarctic, the processes on the outside of the colony are few in number and are very irregularly distributed. In the most crowded spot there are only about three processes in a square centimetre, and on an average there is probably not so much as one process in a square centimetre, while in several of the colonies there are tracts of from 5 to 10 cm. in extent on which no processes are present. The processes are mostly about 4 or 5 mm. in length. They are conical in their basal part, with the branchial aperture at the apex of the cone, and having the terminal part of the process extending outwards on the dorsal edge of the branchial aperture. This terminal part of the process is flattened and expanded so as in some cases to approach the lanceolate form described by Savigny and Lesueur. It is also grooved along the side next to the branchial aperture (Pl. I. fig. 8).

A small colony obtained at Station 204, off the Philippine Islands, is also probably referable to this species, but it is young, and the colony has not the usual shape (see p. 34).

Two small colonies, collected on September 10, 1873, off the coast of Brazil (see p. 34), and the large decayed specimen from Station 160 (see p. 34), may also possibly belong to this species.

Pyrosoma spinosum, n. sp. (Pl. II. figs. 9–15).

External Appearance.—Shape, unknown. Size, over 4 feet in length. Colour, yellowish grey, semi-transparent.

Ascidiozooids large, conspicuous. No large projections from the outer surface of the colony.

Test gelatinous, transparent. Covered on the outer surface with small sharp-pointed spines. Inner surface smooth and glistening.

Mantle with a well-developed muscular system over the thoracic region of the body.

Branchial Sac large, vessels very numerous.

Dorsal Languets more than eight.

Localities.—(1.) June 25, 1873; Station 69; lat. 38° 23′ 0″ N., long. 37° 21′ 0″ W.; depth, 2200 fathoms; surf. temp. 71°, bottom temp. 36°·2.

(2.) October 11, 1873; Station 133; lat. 35° 41′ 0″ S., long. 20° 55′ 0″ W.; depth, 1900 fathoms; surf. temp. 58°, bottom temp. 35°·4.

This is the largest kind of *Pyrosoma* known, and although I have only had some fragments of colonies to examine, I have no hesitation in forming a new species for it.

At Station 133 in the South Atlantic, 400 miles west of Inaccessible Island, a fragment of a large *Pyrosoma* came up in the trawl, which had been down to a depth of 1900 fathoms. The specimen may have been captured at any point during the ascent of the trawl.

At Station 69 in the North Atlantic, a large *Pyrosoma*, which is recorded in Mr. Murray's note-book as having measured, when living, 4 feet 2 inches in length and 9 inches in breadth, was captured by means of the trawl let down to 2200 fathoms. This magnificent specimen was not preserved entire. A few small pieces were put in absolute alcohol and in picric acid, and that is the material I have examined.

Professor Moseley[1] writes of this specimen as follows: "A giant *Pyrosoma* was caught by us in the deep-sea trawl. It was like a great sac, with its walls of jelly about an inch in thickness. It was 4 feet in length and 10 inches in diameter. When a *Pyrosoma* is stimulated by having its surface touched, the phosphorescent light breaks out at first at the spot stimulated, and then spreads over the surface of the colony as the stimulus is transmitted to the surrounding animals. I wrote my name with my finger on the surface of the giant *Pyrosoma* as it lay on deck in a tub at night, and my name came out in a few seconds in letters of fire."

These various fragments (from Stations 69 and 133) appear to belong to the same species.

The exact shape of the colony and the condition of the common cloacal aperture are unknown, but the appearance of the outside of the colony is very characteristic. There are, at least in the fragments preserved, no large processes from the outer surface of the test, such as are known in the other species of *Pyrosoma*; on the other hand, a large number of closely-placed, small, sharp-pointed spines are found all over the outer surface of the colony (Pl. II. fig. 9). These have their points all directed one way, towards the dorsal edge of the Ascidiozooids, and so they give the surface of the test a scaly appearance, quite unlike that of the other species of *Pyrosoma*. As none of the fragments contain either the closed end of the colony or the common cloacal aperture, it is impossible to say which way the Ascidiozooids are arranged in the colony; but if they are placed with their ventral surfaces towards the closed end of the colony, then, as in moving through the water the closed end goes first, the spines placed on the ventral edges of the Ascidiozooids with their points directed dorsally will no doubt be of service as a protection to the branchial apertures which they overhang (Pl. II. fig. 10). Besides these spines, which are distinctly related to the Ascidiozooids, there are also smaller ones scattered over the surface of the test between the Ascidiozooids.

The test is very soft and gelatinous, although thick; it is perfectly transparent, and the yellowish tint of the colony as a whole is due to the Ascidiozooids, which are more opaque than the test. The Ascidiozooids in surface view occupy rounded areas

[1] Notes by a Naturalist on the Challenger. Macmillan & Co., London, 1879, p. 574.

about 3 mm. in diameter; they are arranged with considerable regularity in rows, the Ascidiozooids in adjacent rows alternating with one another (Pl. II. fig. 11). The inner surface of the test next to the common cloaca is perfectly smooth and glistening. The atrial apertures of the Ascidiozooids are conspicuous rounded openings up to 1 mm. in diameter (Pl. II. fig. 12). The thickness of the colony, from the outer to the inner surface of the test, is from 1 cm. to 1·2 cm., and that is, of course, also the antero-posterior length of the fully developed Ascidiozooids.

The fragment preserved in picric acid has both the branchial and atrial apertures larger and more conspicuous than in the spirit specimens, probably because the picric acid has not contracted the tissues so much. The atrial apertures are especially large, and are rounded openings with no lobes (Pl. II. fig. 12). They vary from about 1·5 mm. to 3 mm. in diameter, and are arranged with considerable regularity in alternating rows. This picric acid specimen is not, however, in good condition for histological examination. The small fragments preserved in alcohol are much better in this respect.

The branchial sac is very large. There are at least thirty internal longitudinal bars on each side of the endostyle, and over fifty transverse vessels on each side. The ciliated cells of the transverse vessels are large and distinct, and there are about twelve cilia on each cell (Pl. II. fig. 14). The meshes formed by the intersection of the transverse vessels and internal longitudinal bars are elongated transversely, and are about two to three times as long as they are wide.

There are at least ten long narrow languets along the dorsal edge of the branchial sac. In other respects this species agrees in structure with *Pyrosoma giganteum*.

The dorsal tubercle has a circular aperture which leads, by means of a bent tube running along the under surface of the ganglion, to a triangular subneural gland (Pl. II. fig. 13).

The testis is composed of a large number of cæca, certainly over twenty (Pl. II. fig. 15); while in the other species there are only about a dozen cæca.

Undetermined Specimens of Pyrosoma.

The following specimens of *Pyrosoma*, either on account of their bad state of preservation, or because of their being very young colonies, cannot be determined as to their species with certainty.

(1.) A very young *Pyrosoma* colony was obtained by means of the tow-net on April 12, 1876, Station 351; North Atlantic; lat. 9° 9′ 0″ N., long. 16° 41′ 0″ W.; surf. temp. 81°·8. It is a small octagonal plate 2 mm. in diameter and slightly over 1 mm. in thickness. At the angles the test is produced into short, pointed spines, and there are four pale yellow Ascidiozooids embedded in the clear test (Pl. II. figs. 1–4). When examined under a 1-inch objective the colony presents the appearance shown in

Pl. II. fig. 4. The Ascidiozooids are closely packed together, and all lie in the same plane. Each is rudely triangular in shape, with the base external and the apex towards the centre of the colony. Between the four blunt apices a space is left in which lie the young buds. The branchial aperture of each Ascidiozooid opens upon a flat area of test, and between each pair of Ascidiozooids there is a similar flat area of test; thus the eight flattened sides of the colony are formed (Pl. II. fig. 4). At each of the angles of the octagon the test is prolonged outwards to form a pair of closely placed triangular pointed spines. There is a low ridge of test surrounding each of the four flattened areas upon which the branchial apertures of the Ascidiozooids open, and from these ridges shorter triangular spines project upwards at intervals. These are not shown in Pl. II. fig. 4, which represents an optical section.

In surface views of the closed and open ends of the colony they are seen to differ in shape and arrangement of spines both from one another and from the middle of the colony as seen in optical section. The closed end (Pl. II. fig. 2) is rudely quadrangular in shape, and is divided into four nearly equal parts by ridges springing from the middle of the sides and meeting in the centre. Each of the four parts bears two pointed projections on its outer end. These are unequal and irregular in shape, and in one case only one spine is present.

The open end of the colony (Pl. II. fig. 3) is stellate in outline. It has eight points, four of which are rather larger than the intermediate ones. These four are the outer ends of the triangular areas (A_1 to A_4) in which the Ascidiozooids lie, while the four smaller points are the outer ends of the regions of test lying between the Ascidiozooids. Eight ridges of test run inwards from the reëntrant angles between these points, and so divide this end of the colony into eight radially disposed bands. In the centre is placed the common cloacal opening, which is still small. Its edge is crenated, each of the eight ridges forming a projection.

The Ascidiozooids have their ventral sides turned to the closed end of the colony. The branchial sac is large. Its anterior end is very wide, and it tapers to the narrow posterior end (Pl. II. fig. 4). The transverse vessels and internal longitudinal bars of the branchial sac, the sphincter muscle of the branchial aperture, the endostyle, the nerve-ganglion, and the alimentary canal, are all well formed; but no reproductive organs are visible. It is interesting to find that the large ventral tentacle is the only one of the circlet that has made its appearance.

At the posterior end of each Ascidiozooid is seen a small bud attached to a short stolon springing from the body wall close to the posterior end of the endostyle (Pl. II. fig. 4). This colony is evidently very young, and contains only the first four Ascidiozooids formed in the embryo. From the arrangement of the spines and ridges on the test it probably belongs to the same species as the young colony to be described next (No. 2).

The first buds formed by the original Ascidiozooids of the colony are seen from this specimen to lie neither on the ventral nor on the dorsal side of the parents, but at their posterior ends. These first buds, as may be seen from the older colony described below (see Pl. II. fig. 7), along with four others, evidently pass as they grow larger to the dorsal side of the parent Ascidiozooids, and so form the circle of young Ascidiozooids surrounding the open end of the colony; while the buds formed later, the third and succeeding series, take up their position on the ventral side of the parent, and become the Ascidiozooids at the closed end of the colony.

(2.) A very young colony (Pl. II. fig. 5), labelled "Surface, South Atlantic," like the last cannot be referred to its species because of its immature condition. It measures 6 mm. in length and about 5 mm. in breadth. It is nearly solid, the central common cloaca being very small, and its terminal opening also minute. There are sixteen Ascidiozooids arranged with perfect regularity (Pl. II. fig. 7). Four large ones occupy the middle of the colony, eight smaller are placed round the common cloacal aperture, while four still smaller occupy the closed end of the colony. The large central ones are probably the four original Ascidiozooids formed from the embryo, and they have evidently produced each two Ascidiozooids on their dorsal sides, thus accounting for the eight round the cloacal aperture, and then each one Ascidiozooid on their ventral sides, these being the four small ones at the closed end of the colony. The large Ascidiozooids are short bodied, wide dorso-ventrally, and narrow from side to side. The three rows of Ascidiozooids alternate with one another most regularly. If the colony be so placed that the four large Ascidiozooids point north, south, east, and west, then the four smallest will be north-east, south-east, south-west, and north-west, while the eight others will be, a pair between north and east, a pair between east and south, a pair between south and west, and the last pair between west and north (see Pl. II. fig. 6, which represents a diagrammatic view from the closed end of the colony with all the Ascidiozooids shown).

The surface of the colony is very irregular. The test is raised up to form a number of conical sharp-pointed processes (Pl. II. figs. 5 and 7). There are a series of these around the common cloacal aperture, and others at regular intervals over the surface of the colony. They do not correspond in number or position to the Ascidiozooids, but are placed here and there upon ridges of the test which mark out the surface of the colony into areas, each of which is occupied by an Ascidiozooid. The branchial apertures are therefore placed upon smooth regions of the test (Pl. II. fig. 7, *br.*).

The large Ascidiozooids are in a condition of active gemmation, each having two or three young buds attached to its stolon. These buds look as if they would take up their position between their parents and the closed end of the colony.

(3.) A small colony obtained off the coast of Africa on August 16, 1873; Station 100; lat. 7° 1′ 0″ N., long. 15° 55′ 0″ W.; surf. temp. 79°, is probably *Pyrosoma atlanticum*, Péron, but the characters are not yet well marked. It measures 2·2 cm. in length and

1·5 cm. in greatest breadth. The short colony is nearly cylindrical, with the closed end rounded. The common cloacal aperture is very small. The processes on the outside of the colony are still very short, and are simply conical or hemispherical. The Ascidiozooids are small, a large number of them appearing to be still immature.

(4.) A small colony obtained at Station 204, off the Philippine Islands, November 2, 1874, lat. 12° 43′ 0″ N., long. 122° 10′ 0″ E.; depth, 100–115 fathoms; surf. temp. 84°, is very probably referable to *Pyrosoma giganteum*, but has not the cylindrical shape usual in that species. It is a little over 3 cm. in length and 1·5 cm. in breadth at the broadest point, which is near the middle; from this point it tapers towards both ends. The common cloacal aperture is large. The processes on the outside of the test are prominent, some of them being especially large. These have the flattened lanceolate extremities characteristic of the species.

(5.) One specimen and half a dozen fragments of *Pyrosoma* colonies were found at Station 160, March 13, 1874, lat. 42° 42′ 0″ S., long. 134° 10′ 0″ E.; surf. temp. 55°, bottom temp. 33°·9, in the trawl, which had come up from a depth of 2600 fathoms. The complete colony is 27 cm. in length and 2 cm. in breadth. It scarcely tapers, and has a well-marked sphincter. It may possibly belong to *Pyrosoma giganteum;* but it is in such a decayed condition, the whole surface of the colony being ragged, and the Ascidiozooids indistinguishable, that the species cannot be determined with certainty. The fragments found at the same locality are in an equally bad state, and none of them even indicate the size and shape of the colonies they belonged to. Probably all of these were dead and decayed specimens when they were captured.

(6.) Two small colonies obtained on September 10, 1873; Station 122; off the coast of Brazil; lat. 9° 10′ 0″ S., long. 34° 49′ 0″ W.; surf. temp. 77°·5, may possibly belong to *Pyrosoma giganteum*, Lesueur, but the characters are not well marked. They measure respectively 2·5 and 1·8 cm. in length, and are both 1 cm. in breadth. The Ascidiozooids in both are rather large, and the processes on the outside of the colony are rather prominent in the larger specimen.

(7.) Four small colonies collected on the surface of the West Pacific Ocean, north of the Admiralty Islands, on March 16, 1875; Station 222; lat. 2° 15′ 0″ N., long. 146° 16′ 0″ E.; surf. temp. 82°·8, may possibly be *Pyrosoma elegans*, Lesueur, but are not fully enough developed to be referred with certainty to their species; they present some points of interest. Their dimensions are as follows:—

	A.	B.	C.	D.
Length, ...	1·3 cm.	1·5 cm.	1·7 cm.	1·8 cm.
Greatest breadth, . . .	1·0 cm.	1·0 cm.	0·7 cm.	0·9 cm.

In all of them the Ascidiozooids are large and conspicuous, and in one (specimen B) they project from the surface of the colony in the form of short truncated cones, from 1 to nearly 2 mm. in length (Pl. II. fig. 8). There are no projections from the surface of the test beyond those formed by the Ascidiozooids. At the closed end of this colony the four terminal Ascidiozooids are very distinct, and form a row by themselves (Pl. II. fig. 8, 1, 2, 3, 4). This was given by Lesueur as one of the characters of his species *Pyrosoma elegans*, but Savigny declares that with care it may be made out in specimens of *Pyrosoma giganteum* also. I have never seen it so distinct as in the present specimen.

In the other three colonies the Ascidiozooids are not so prominent as in the case of the specimen just described, but here and there one is found on a conical eminence, or forming a projection on the surface; so they probably all belong to one species, and specimen B is more inflated than the other three. In all these colonies, but especially in C and D, the Ascidiozooids are arranged with regularity in transverse rows. There are from seven to nine rows in each colony, and the rows are most closely placed at the open end of the colony, where also all the young Ascidiozooids are situated. This arrangement of the Ascidiozooids of the colony in regular series or verticils is the chief character distinguishing *Pyrosoma elegans*, Lesueur, from the other species, and possibly these colonies may be young specimens of that species. On the other hand, the regularity of arrangement may merely be due to the fact that they are still fairly young colonies in which there has not yet been time for the Ascidiozooids to become irregularly scattered.

(8.) A small colony, from Station 170, July 14, 1874; lat. 29° 55′ 0″ S., long. 178 14′ 0″ W.; 520 fathoms; surf. temp. 65°, bottom temp. 43°, is in such a bad state of preservation that nothing can be made out from it except that it is a *Pyrosoma*. It is 1 cm. in length and about 6 mm. in greatest breadth.

(9.) A small colony collected on the surface of the Pacific Ocean on April 5, 1875; Station 230; lat. 26° 29′ 0″ N., long. 137° 57′ 0″ E.; surf. temp. 68°·5, resembles specimen B, described above under (7), and may also possibly be referable to *Pyrosoma elegans*, Lesueur. It, however, consists of the test of the colony only; the Ascidiozooids have entirely disappeared, although the projections they formed on the surface of the colony are still visible. Probably the specimen was a dead and decayed one when collected. It measures 1·3 cm. in length and 1·0 cm. in greatest breadth. The common cloacal aperture is exceedingly small, being only 1 mm. across.

(10.) Two young colonies were collected on the surface of the Pacific in March 1875. They were mounted as microscopic objects during the expedition, and have become so transparent that almost nothing can be made out in them. The one is 1 mm. and the other 2 mm. in diameter. The smaller has four Ascidiozooids only. The larger appears to have more, but I cannot make them out with any certainty.

(11.) A young colony was collected on the surface of the Atlantic on April 13, 1876; Station 352; lat. 10° 55′ 0″ N., long. 17° 46′ 0″ W.; surf. temp. 77°·7. It had been mounted like the last specimens, but fortunately was stained in carmine first. This colony is apparently slightly older than the one obtained on April 12, 1876, and described above (No. 1). It is nearly 2 mm. in thickness, and has four Ascidiozooids; the tentacles are, however, all developed.

Order II. THALIACEA.

The Thaliacea are free-swimming pelagic forms, which may be either simple or compound, and, in the adult, are never provided with a tail or a notochord.

The test is permanent, and may be either well developed or very slight.

The musculature of the mantle is in the form of more or less complete circular bands, by the contraction of which locomotion is effected.

The branchial sac has either two large or many small apertures (stigmata), leading to a single peribranchial cavity which communicates with the exterior by the atrial aperture.

The anus opens into the peribranchial cavity.

Alternation of generations occurs in the life-history, and may be complicated by polymorphism.

This order includes all the pelagic Tunicata, with the exception of *Pyrosoma* and the Appendiculariidæ. It seems a natural, well-defined group, characterised amongst the free-swimming forms by the absence of a tail and a notochord in the adult, and by the occurrence of alternation of generations in the life-history. Temporary colonies may be formed at one stage in the life-history, but they never increase in size by gemmation from the Ascidiozooids, which eventually separate from one another. This, along with the alternation of generations, distinguishes the Thaliacea from the Ascidiæ Salpiformes, and the absence of a tail and notochord separates them from the Larvacea.

The Thaliacea may be divided into two groups, the CYCLOMYARIA and the HEMIMYARIA.

Suborder I. CYCLOMYARIA.

Free-swimming pelagic forms which exhibit alternation of generations in their life-history, but never form permanent colonies.

The body is cask-shaped, with the branchial and atrial apertures at the opposite ends.

The test is more or less well developed.

The mantle has its musculature in the form of circular bands surrounding the body.

The branchial sac is fairly large, occupying the anterior half or more of the body. Stigmata are usually present in its posterior part only. The peribranchial cavity is mainly posterior to the branchial sac.

The alimentary canal is placed close to the posterior end of the branchial sac.

Hermaphrodite reproductive organs are placed ventrally near the intestine.

This suborder was formed by Uljanin[1] in 1884 for the reception of the single family

[1] Fauna und Flora des Golfes von Neapel, Monogr. x., Doliolum. Leipzig, 1884.

Doliolidæ. It is clearly distinguished from the second suborder, the Hemimyaria, by the condition of the muscle bands and of the branchial sac, and by the life-history. The muscle bands are complete rings, while in the Hemimyaria they are always more or less incomplete. The branchial sac in the Cyclomyaria has always a distinct cavity, and communicates with the peribranchial cavity only by small slits or stigmata. The life-history is also very characteristic, as the sexual generation in the Cyclomyaria is always polymorphous, while in the Hemimyaria it consists of one form only.

Family Doliolidæ.

Body free, more or less barrel-shaped; branchial and atrial apertures terminal, lobed.

Test rather slightly developed.

Mantle containing transverse muscle bands, which form hoops surrounding the body.

Branchial Sac well developed. Stigmata not numerous, generally placed far back.

Dorsal Lamina and *Tentacles* absent.

Alimentary Canal at the posterior end of the branchial sac.

Reproductive Organs hermaphrodite..

Gemmation takes place.

Life-History complicated by alternation of generations and polymorphism.

This family contains two genera: *Doliolum*, Quoy and Gaimard, and *Anchinia*, Eschscholtz (and later, C. Vogt). It was first formed as a family by Keferstein[1] in 1862, and since then it has always been placed in its present position along with the Salpidæ in the group Thaliacea.

The genus *Doliolum* is well represented in the Challenger collection, but no specimens referable to the genus *Anchinia* were obtained.

Genus *Doliolum*, Quoy and Gaimard.

Body always more or less barrel-shaped, not attached, and never forming a colony. Branchial aperture at the anterior end, atrial at the posterior, both surrounded by lobes.

Test very thin, containing no test cells.

Mantle containing well-developed, transversely-arranged muscle bands, which in the fully-developed sexual animal are always eight in number. They surround the body like hoops.

[1] Bronn's Klass. u. Ord. d. Thierreichs, Bd. iii. p. 216.

Branchial Sac usually of moderate size, occupying the anterior half or three-quarters of the body. Its wall contains transverse and fine longitudinal vessels, separated by stigmata, but no internal longitudinal bars, and it is never folded. The stigmata are placed transversely, and vary in number from five to fifty or more on each side of the sac.

Dorsal Lamina and *Tentacles* absent.

Nerve Ganglion placed in the median dorsal line, a little anterior to the middle of the body, and between the third and fourth muscle bands.

Dorsal Tubercle placed some distance in front of the nerve ganglion, and surrounded by the spirally-coiled dorsal ends of the peripharyngeal bands.

Alimentary Canal placed ventrally, behind the branchial sac.

Reproductive Organs ventral, opening into peribranchial cavity near to anus. A tailed larva is formed.

This genus was formed in 1835 by Quoy and Gaimard[1] for the reception of two species of pelagic Tunicates which were found near the islands Amboina and Vanikoro, in the Banda Sea, during the voyage of the "Astrolabe" round the world, under Dumont d'Urville. The name *Doliolum* had, however, been applied twelve years before by Otto[2] to the gelatinous "Haus" of the crustacean *Phronima sedentaria*. But as that object is merely a part of the test of a dead Tunicate, the specific names employed by Otto and Delle Chiaje, and the generic name *Doliolum* as applied to the *Phronima* covering, must lapse, and therefore there need be no difficulty in retaining that name in the sense in which it was used by Quoy and Gaimard.

Quoy and Gaimard described and figured little more than the external appearance of their two forms of *Doliolum*. They placed the genus correctly enough near *Salpa* amongst the pelagic Tunicata, and they characterised it by its barrel-like form, its terminal apertures, its encircling muscle bands (which, however, they mistook for vessels), and its internal branchia (the anatomy of which they seem to have quite misunderstood). The two species they describe are *Doliolum denticulatum* and *Doliolum caudatum*, the latter being undoubtedly a "nurse" form or blastozooid. They add nothing further in regard to the internal structure of the animals, and the short descriptions and the figures are scarcely sufficient to determine the species, beyond showing that their *Doliolum denticulatum* is one of the species with a long branchial sac and numerous stigmata.

The first detailed account of the structure of the genus *Doliolum* was given by Huxley[3] in 1851, when he described under the name of *Doliolum denticulatum*, Quoy

[1] Voyage de l'Astrolabe, Zool. tom. iii. p. 599.
[2] Beschr. ein. neu. Moll. u. Zooph., *Acad. Cæs. Leop., Nova Acta*, Bd. xi. pt. 2, p. 313.
[3] Remarks upon Appendicularia and Doliolum, *Phil. Trans.* 1851, part ii. p. 599.

and Gaimard, a species taken by himself in the South Pacific, between Sydney and New Zealand, during the voyage of the "Rattlesnake." Whether this species was actually the same as that found by the "Astrolabe" it is impossible to decide now on account of the deficiencies in Quoy and Gaimard's description; but as Huxley was satisfied as to their identity, and has given us a full description, with figures, of his specimens, it seems best to adopt that description as applying to the species *Doliolum denticulatum*, Quoy and Gaimard. Uljanin,[1] however, while considering that Quoy and Gaimard's species cannot now be determined, refers Huxley's *Doliolum denticulatum* to a new species *Doliolum gegenbauri*, which he describes afresh (1884). This is surely unnecessary. Even if it be admitted that Quoy and Gaimard's species can never be determined positively, and must therefore lapse, yet *Doliolum denticulatum*, Huxley (1851), must take precedence over *Doliolum gegenbauri*, Uljanin (1884), and therefore the only change necessary is to substitute Huxley's name for Quoy and Gaimard's as the authority for the species.

In 1852, Krohn's[2] paper dealing with the Mediterranean species of the genus gave for the first time an account of some observations on the complicated process of reproduction and life-history. Although Krohn's account was in some respects erroneous, still he was the pioneer in regard to this difficult subject. He found the tailed larva, and he first pointed out that there was an alternation of generations, and recognised some of the leading stages in the life-history. Gegenbaur's[3] observations about the same time still further elucidated the matter, and both authors added considerably to the knowledge of the different forms of *Doliolum* present in the Mediterranean. Leuckart's[4] paper on Salpæ and allied forms, and Keferstein and Ehlers'[5] memoir on *Doliolum*, added considerably to the knowledge both of the structure and of the embryology of the genus.

The condition of the knowledge of species at that time (1861) was as follows:—

Krohn had described four new species, *Doliolum ehrenbergii* (which he identified with *Doliolum denticulatum*, Quoy and Gaimard. He changed the specific name, because he found that the denticulation was common to various species. This is *not* the same species as Huxley's *Doliolum denticulatum*), *Doliolum mülleri*, *Doliolum nordmanni*, and *Doliolum troschelii*. The last two are, however, "nurse" or immature forms (blastozooids belonging to *Doliolum mülleri*), with nine muscle bands and a dorsal outgrowth; so that only two good species were added, *Doliolum ehrenbergii*, Krohn, and *Doliolum mülleri*, Krohn. Gegenbaur investigated, in addition to Krohn's

[1] Fauna und Flora des Golfes von Neapel, Monogr. x. Doliolum, p. 134, Leipzig, 1884.
[2] Ueber die Gattung Doliolum, &c., *Arch. f. Naturgesch.*, Jahrg. 18, Bd. i. p. 53.
[3] Ueber die Entwicklung von Doliolum, *Zeitschr. f. wiss. Zool.*, Bd. v. p. 13, 1854; and also Bd. vii. p. 283. 1856.
[4] Zoologische Untersuchungen, Heft ii., Giessen, 1854.
[5] Zoologische Beiträge, Heft iii. p. 53, Leipzig, 1861.

species, a third, which, however, he did not name. It has since been described by Grobben[1] as *Doliolum rarum*. Keferstein and Ehlers added no new species to the list, but erroneously regarded the *Doliolum ehrenbergii* of the Mediterranean, which they investigated, as being *Doliolum denticulatum*.

For a long period subsequent to Keferstein and Ehlers' work no further investigations were made upon *Doliolum*. More recently, Fol, Grobben, Uljanin, and others have by their important observations done much to complete our knowledge of the structure and development of the various species, and to work out the details of the complicated life-history which is now known, thanks mainly to the investigations of Grobben[2] and of Uljanin,[3] to be as follows:—

The embryo becomes a tailed larva which develops into an asexual form known as the "Nurse" ("Amme"), which I propose should be named Blastozooid. This asexual form is characterised by having nine muscle bands round the body, the stigmata few in number and confined to the posterior end of the branchial sac, an auditory organ on the left side of the body, a ventrally-placed gemmiparous stolon close to the heart, and by the possession of a dorsal outgrowth from the body which is directed backwards (Pl. III. fig. 9). The young buds formed on the ventral stolon migrate across the body, and become attached to the dorsal outgrowth in three rows, a median and two lateral, and then proceed to develop into the members of the second generation, the blastozooid which produced them being the first.

The second or sexual generation is polymorphous, and includes three distinct forms, which are known as nutritive forms, foster forms, and reproductive forms. For these I propose the names Gastrozooid, Phorozooid, and Gonozooid respectively. The nutritive forms (gastrozooids) are produced from the lateral buds. They remain attached to the dorsal outgrowth of the body of the nurse, and serve to supply it with nutriment. They differ considerably in appearance from the other forms of *Doliolum*, and their reproductive organs remain undeveloped. The foster forms (phorozooids) have the ordinary barrel-shaped body, surrounded by eight muscle bands. They are set free from the nurse, but always retain as a ventral outgrowth the remains of the stalk by means of which they were formerly attached. On this ventral outgrowth develop the buds which produce the third form of the same generation, viz. the reproductive animals. These buds of the reproductive form do not originate on the ventral outgrowth of the foster forms, but are derived from the proliferation of the original buds formed on the stolon of the blastozooid, and therefore belong to the same generation as the foster forms on whose bodies they afterwards develop. The reproductive forms (gonozooids) are very like the foster forms in appearance, but have no ventral process. Finally,

[1] *Arbeit. d. zoolog. Instit. z. Wien*, Bd. iv. Hft. 2, 1882.
[2] Doliolum und sein Generationswechsel, &c., *Arbeit. d. zoolog. Instit. z. Wien*, Bd. iv. Hft. 1.
[3] Fauna u. Flora d. Golfes v. Neapel, Monogr. x., Doliolum.

in these forms the reproductive organs become fully developed, thus completing the life-history, which may be represented diagrammatically thus:—

Egg.
Tailed larva.
Nurse
(Blastozooid). } 1st generation.

Buds.
Nutritive forms (Gastrozooid.)
Reproductive forms (Gonozooid).
Foster forms (Phorozooid). } 2nd generation.

The structure of the reproductive form (Gonozooid) of the sexual generation is shown in the accompanying woodcut.

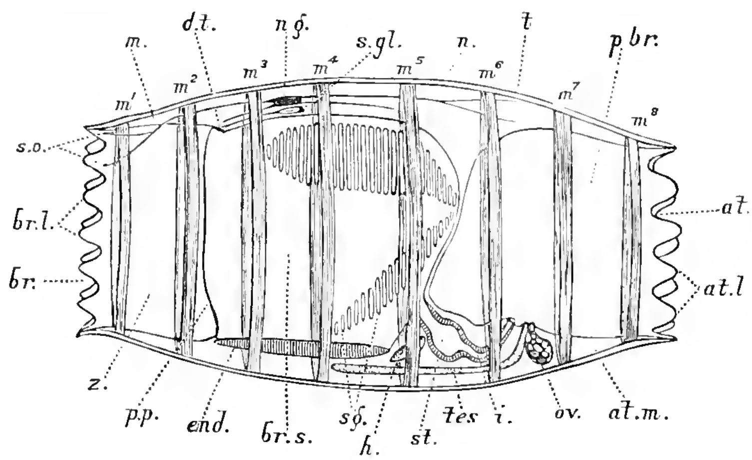


Fig. 6.—Diagram of the Gonozooid of *Doliolum*, from the left side.

at. atrial aperture; *at.l.* atrial lobes; *at.m.* membrane lining peribranchial cavity; *br.* branchial aperture; *br.l.* branchial lobes; *br.s.* branchial sac; *d.t.* dorsal tubercle; *end.* endostyle; *h.* heart; *i.* intestine; *m.* mantle; m^1—m^8, muscle bands; *n.* nerve; *n.g.* nerve ganglion; *ov.* ovary; *p.br.* peribranchial cavity; *p.p.* peripharyngeal band; *s.o.* sense organs; *t.* test; *s.gl.* subneural gland; *st.* stomach; *sg.* stigmata; *tes.* testis; *z.* zona præbranchialis.

The body is of a regular barrel-shape, and has wide-open branchial and atrial apertures at its extremities. These are surrounded by lobes. The test is a very delicate cuticular layer covering the surface of the squamous ectoderm. The mantle has a well-developed musculature in the form of eight muscle bands (Fig. 6, m^1 to m^8) surrounding the body. The first and eighth of these act as branchial and atrial sphincters, while all the hoop-like muscles combine in causing a current of water to flow through the branchial and peribranchial cavities in such a way as to propel the body through the water.

The branchial sac is wide anteriorly, where it is separated from the combined branchial siphon and prebranchial zone (there are no tentacles to form the usual boundary between those two regions) by the peripharyngeal bands, and tapers slightly to the rounded posterior end, which is placed between the fifth and sixth muscle bands. The stigmata are arranged in two series on each side of the sac. The dorsal series commences at the third muscle band and extends posteriorly to the end of the sac; while the ventral series runs from the fourth band anteriorly to beyond the fifth posteriorly, where it joins the corresponding series of the other side.

The endostyle is straight. It extends from between the second and third to between the fourth and fifth muscle bands (Fig. 6, *end.*). There are no dorsal languets.

The nervous system consists of a single ganglion placed in the mantle in the mid-dorsal line between the third and fourth muscle bands. It gives off distributory nerves anteriorly and posteriorly. The sense organs consist of some groups of modified epithelial cells in which nerves end, placed upon the branchial and atrial lobes. In the Blastozooid, however, there is in addition an otocyst placed on the left side of the body between the third and fourth muscle bands, and the ganglion lies between the fourth and fifth muscle bands.

On the ventral surface of the ganglion is found the usual subneural gland, with a delicate duct which runs forward to open into the prebranchial zone in the mid-dorsal line by means of a funnel-shaped cavity richly ciliated internally (Fig. 6, *d.t.*). The rounded opening of this ciliated funnel is surrounded by the spirally-coiled dorsal ends of the peripharyngeal bands.

The peribranchial cavity is a large space lying posteriorly to the branchial sac, and opening externally by the terminal atrial aperture. It has an anterior lateral extension on each side of the branchial sac into which the stigmata open.

The alimentary canal is curved so as to form a V-shaped loop, concave dorsally, placed at the posterior end of the branchial sac, and occupying the ventral part of the peribranchial cavity. The œsophagus is a short wide tube running backwards to open into the rounded stomach. The intestine springs from the posterior end of the stomach, and runs at first posteriorly and then dorsally to open into the peribranchial cavity near its middle. A system of digestive tubules ramifies over the greater part of the wall of the intestine, and opens by a duct into the stomach.

The heart is placed ventrally, close to the œsophageal aperture. The hermaphrodite reproductive organs lie ventrally, and open into the peribranchial cavity close to the anus. The ovary is a small rounded sac, but the testis is a greatly elongated tube (see Fig. 6, *tes.*), which varies in its extent and shape in different individuals of the same species.[1] When fully developed it may extend anteriorly as far as the first muscle band. It lies at the left side of the body.

In Uljanin's recent monograph on the genus *Doliolum* only four species are recognised :—

[1] See *Trans. Roy. Soc. Edin.*, vol. xxxii. part i. pl. xx. figs. 6–11, 1883.

(1.) *Doliolum mülleri*, Krohn.
(2.) *Doliolum rarum*, Grobben.
(3.) *Doliolum ehrenbergi*, Krohn.
(4.) *Doliolum gegenbauri*, Uljanin.

The last-named species is (according to Uljanin) the *Doliolum denticulatum* of Huxley, while *Doliolum denticulatum* and *Doliolum caudatum* of Quoy and Gaimard are regarded as doubtful species which cannot be identified. As I have already explained above (p. 39), if Quoy and Gaimard's species are to be given up as unrecognisable and pass out of the literature of science, then Huxley's name, *Doliolum denticulatum*, has priority over Uljanin's; but I prefer to regard Huxley's species and Quoy and Gaimard's as identical. In either of these cases *Doliolum gegenbauri* would lapse as being an unnecessary synonym. A careful comparison, however, of the description and figures of Huxley with those of Uljanin does not support the identity of the two species insisted on by the latter author, and the branchial sacs certainly have very different relations in the two forms. Consequently it may be right to retain the specific name *gegenbauri* for the new Mediterranean species described by Uljanin, and having the arrangement of stigmata shown in Pl. III. fig. 2.

During the cruise of H.M.S. "Triton" in the summer of 1882 in the North Atlantic, Dr. John Murray captured in the tow-net vast numbers (thousands were preserved) of a *Doliolum* in the reproductive stage, which I described fully,[1] and identified doubtfully with *Doliolum denticulatum*, Quoy and Gaimard, after pointing out the differences existing between the "Triton" specimens and the species described as *Doliolum denticulatum* by Huxley and by Keferstein and Ehlers. I have now no doubt that Keferstein and Ehlers' species was distinct from Huxley's, and I am inclined to regard the "Triton" specimens as belonging to a third species, distinct from both the others, which may be appropriately named *Doliolum tritonis*.

The Challenger collection contains specimens of three species which appear to be different from any previously described. Of these, two are closely related, and are evidently not far distant from *Doliolum ehrenbergi*; while the third is very different, and belongs to the group of species with comparatively few stigmata containing *Doliolum rarum* and *Doliolum mülleri*.

Altogether, then, nine species of the genus may now be distinguished:—

Doliolum denticulatum, Q. and G. (and Huxley).
Doliolum ehrenbergi, Krohn.
Doliolum gegenbauri, Uljanin.
Doliolum tritonis, Herdman.
Doliolum affine, n. sp.
Doliolum challengeri, n. sp.
Doliolum mülleri, Krohn.

[1] Report on the "Triton" Tunicata, *Trans. Roy. Soc. Edin.*, vol. xxxii. part i. p. 93, 1883.

Doliolum rarum, Grobben.
Doliolum krohni, n. sp.

These may be divided into two sections :—(1) With numerous stigmata extending along the greater part of the length of the branchial sac, including the first six species; and (2) with only a few stigmata at the posterior end of the branchial sac, including the remaining three species.

Doliolum denticulatum, Quoy and Gaimard.

Doliolum denticulatum, Quoy and Gaimard, Voyage de l'Astrolabe, Zoologie, tom. iii. part 2, p. 599, 1835.
Doliolum denticulatum, Q. and G., Huxley, Phil. Trans. 1851, part ii. p. 595.
Not *Doliolum denticulatum*, Q. and G., Krohn, Arch. f. Naturgesch., 1852, p. 57.
Not *Doliolum denticulatum*, Q. and G., Keferstein and Ehlers, Zoologische Beiträge, p. 65, 1861.
Not *Doliolum denticulatum*, Q. and G., Grobben, Arb. zool. Inst. Wien, Bd. iv. p. 55, 1882.
Not *Doliolum denticulatum*, Q. and G., Herdman, Trans. Roy. Soc. Edin., vol. xxxii. part i. p. 93, 1883.

This species, the oldest member of the genus, was found in 1827 on the surface of the Pacific Ocean, near the islands of Vanikoro and Amboina, by the French naturalists Quoy and Gaimard, during the voyage of the "Astrolabe." They described and figured it in the official account of the expedition published in 1835. The diagnosis given is as follows :—

"Doliolum, corpore minimo, hyalino, cylindrico-ovato subtruncato, in utroque apice perforato, antice crenulato; circulis octonis salientibus."

The short description which follows the diagnosis adds nothing of importance, but merely shows that the observers mistook the branchial sac for a pair of plume-like internal gills, the muscle bands for vessels, and the endostyle for an aorta. The figures[1] show two views of the entire animal, a representation of the (supposed) plume-like gills, and an end view of the anterior extremity. There appear from the figures to have been ten branchial lobes, if Quoy and Gaimard are correct in designating the end which they figure with denticulations as the anterior. The position of the endostyle in relation to the muscle bands would rather lead to the opposite conclusion, but probably it is represented too far back in the body. The second species of *Doliolum* described by Quoy and Gaimard, *Doliolum caudatum*, is an asexual form with nine muscle bands and a well-marked dorsal outgrowth. Possibly it is the Blastozooid belonging to the present species.

During the voyage of H.M.S. "Rattlesnake" in 1849, Huxley found specimens of *Doliolum* in the South Pacific, a little to the northward of Sydney, N.S.W., between Sydney and New Zealand, and in considerable numbers just at the entrance of the Bay of Islands. These he identified with the species *Doliolum denticulatum* described by Quoy and Gaimard, and he published a detailed anatomical account with figures in the

[1] Atlas, Mollusques, pl. 89, figs. 25–28.

Philosophical Transactions for 1851, and it is to that account we must go for information as to the characters of the present species.

Huxley represents the branchial aperture as surrounded by about nine rounded denticulations, while the atrial has a larger number of narrower and more pointed processes. The endostyle commences anteriorly a little behind the second muscle band, and extends back nearly to the fourth.[1] The stigmata of the branchial sac commence dorsally a little in front of the second muscle band, and extend back to about the sixth; they then reach forwards ventrally as far as the third muscle band, thus overlapping the posterior half of the endostyle. The alimentary canal forms a V-shaped loop between the fifth and seventh muscle bands. The intestine appears to curve dorsally, anteriorly, and to the right.[2] The testis is long and narrow; it lies on the left side ventrally, and extends anteriorly nearly as far as the first muscle band. The dorsal tubercle and the spirals of the peripharyngeal bands are placed between the first and second muscle bands. These are the more important characters of this species which can be made out from the description and figures given by Huxley.

Although several authors since 1851 have described specimens under the name of *Doliolum denticulatum*, yet a careful examination of their figures and descriptions shows that they all refer to species other than the true *Doliolum denticulatum*. Krohn's *Doliolum denticulatum*, for which he also proposed the name *ehrenbergii*, is not the same as Huxley's, and therefore becomes the type of the new species *Doliolum ehrenbergi*. The *Doliolum denticulatum* of Keferstein and Ehlers was probably, as Uljanin points out, Krohn's *Doliolum ehrenbergii*; and Grobben's *Doliolum denticulatum* was probably also the same species. The species found by the "Triton" Expedition in the North Atlantic in 1882, and which I referred at the time with some hesitation to *Doliolum denticulatum*, is, I now consider, not that species. Consequently the true *Doliolum denticulatum* has apparently not been recorded since Huxley's paper was published in 1851.

During the Challenger Expedition the following specimens were collected which I refer to this species:—

(1.) August 11–12, 1874; off Kandavu, Fiji; surface; surf. temp. 77°·5; one specimen, 4 mm. long, 3 mm. broad.

(2.) April 2, 1874; Station 162, off East Moncœur Island, Bass Strait; lat. 39° 10′ 30″ S., long. 146° 37′ 0″ E.; surface; surf. temp. 63°·2; two rather narrow specimens (?), 5 mm. long, 2 mm. broad.

(3.) April 11, 1876; Station 350, tropical Atlantic, lat. 7° 33′ 0″ N., long. 15° 16′ 0″ W.; surface; surf. temp. 84°; six small rather narrow specimens (?).

(4.) April 29, 1876; tropical Atlantic, lat. 18° 8′ 0″ N., long. 30° 5′ 0″ W.; surface; surf. temp. 74°; one small specimen.

[1] I number the muscle bands one to eight consecutively, beginning at the branchial aperture. Huxley does not count the first and eighth, and numbers the others one to six, consequently his third is my fourth.

[2] In reading Huxley's description it is necessary to remember that he called the dorsal surface ventral and the ventral dorsal. The right and left sides must also be reversed.

The specimens from localities (2) and (3) are a little doubtful, as they are not in good condition. The following specimen, which is in still worse condition, and cannot be identified, may possibly belong to the present species:—

(5.) June 3, 1874; Station 163B, off Port Jackson, Australia; lat. 33° 51′ 15″ S., long. 151° 22′ 15″ E.; surface; surf. temp. 69°; one small specimen (? ?), 3 mm. long (in bad condition).

Doliolum ehrenbergi, Krohn.

Doliolum ehrenbergii (also *Doliolum denticulatum*), Krohn, Arch. f. Naturgesch., Jahrg. 18, Bd. i. p. 57, 1852.
Doliolum denticulatum, Q. and G., Keferstein and Ehlers, Zoologische Beiträge, 1861.
Doliolum ehrenbergii, K., Ussow, Proc. Imper. Soc. of Nat. Hist., &c., vol. xviii. fasc. 2, Moscow, 1876.
Doliolum denticulatum, Q. and G., Grobben, Arb. zool. Inst. Wien, Bd. iv. 1882.
Doliolum ehrenbergii, K., Uljanin, Fauna u. Flora d. Golfes v. Neapel, 1884.

This common species was first found and described in 1852 by Krohn, who, however, was under the impression that he was dealing with Quoy and Gaimard's *Doliolum denticulatum*. About ten years later it was more fully described by Keferstein and Ehlers. Since then the species has been discussed by Ussow, Grobben, and Uljanin.

This species differs from the last (comparing Uljanin's account of *Doliolum ehrenbergi* with Huxley's of *Doliolum denticulatum*) in the branchial sac, which in the present species has a larger number of stigmata (up to forty-five on each side), and extends forward ventrally to the first muscle band (Pl. III. fig. 5).[1] The endostyle is short. It commences one-third of the way from the second to the third muscle band, and only extends to the fourth, so that it does not cover two intermuscular spaces (see Pl. III. fig. 5).

I place in this species, with a certain amount of doubt, the following specimens collected during the Challenger Expedition:—

(1.) June 17, 1874; Station 165, South Pacific, between Australia and New Zealand; lat. 34° 50′ 0″ S., long. 155° 28′ 0″ E.; surf. temp. 64°·5; one small specimen.

(2.) February 11, 1876; Station 318, South Atlantic; lat. 42° 32′ 0″ S., long. 56° 29′ 0″ W.; tow-net at trawl down to a depth of 2040 fathoms; bottom temp. 33°·7, surf. temp. 57°·5; eight specimens, in rather bad condition.

(3.) Same place; tow-net at surface; two specimens.

(4.) April 29, 1876; North Atlantic, off the West Coast of Africa, lat. 18° 8′ 0″ N., long. 30° 5′ 0″ W., at night; surf. temp., at midnight, 73°·7; a dozen specimens. These last have the stigmata extending forwards to between the first and second muscle bands.

(5.) May 12, 1876; North Atlantic, lat. 42° 54′ 0″ N., long. 28° 54′ 0″ W.; surf. temp. 58°·2; one specimen.

[1] It must be pointed out, however, that Keferstein and Ehlers represent their so-called *Doliolum denticulatum*, which Uljanin identifies with the present species, as having the stigmata extending ventrally only as far forwards as the third muscle band.

The alimentary canal of the specimen collected on May 12, 1876, is shown in Pl. III. fig. 7.

Doliolum affine, n. sp. (Pl. III. fig. 6).

Body of the usual cask-like form.

Mantle having the usual eight muscle bands.

Branchial Sac large. Stigmata commencing dorsally midway between the first and second muscle bands, and extending back to midway between the fifth and sixth; ventrally they extend forwards nearly to the third muscle band.

Endostyle extending from the second to the fourth muscle band.

In this new species I place the following specimens collected during the Challenger Expedition :—

(1.) April 3, 1875; Pacific; surface; lat. 24° 49′ 0″ N., long. 138° 34′ 0″ E.; surf. temp. 71°·5; half a dozen specimens.

(2.) April 4, 1875; Pacific; surface; lat. 25° 33′ 0″ N., long. 137° 57′ 0″ E.; surf. temp. 69°; two dozen specimens.

(3.) June 17, 1875; Station 237, North Pacific; surface; lat. 34° 37′ 0″ N., long. 140° 32′ 0″ E.; surf. temp. 73°; one hundred specimens.

(4.) October 19, 1875; Station 287, South Pacific; surface; lat. 36° 32′ 0″ S., long. 132° 52′ 0″ W.; surf. temp. 57°·8; fifteen specimens.

Plate III. fig. 8, shows the dorsal surface of a specimen of this species from the South Pacific, October 19, 1875.

This species is closely related to *Doliolum ehrenbergi* (Pl. III. fig. 5).

Doliolum tritonis, Herdman (Pl. III. fig. 3).

Doliolum denticulatum, Herdman, Trans. Roy. Soc. Edin., vol. xxxii. part i p. 93, 1883.

Vast numbers of this species were obtained by Dr. John Murray in the summer of 1882 in the North Atlantic, during the cruise of H.M.S. "Triton." In reporting upon the Triton collection of Tunicata in 1883,[1] I described these specimens under the name of *Doliolum denticulatum;* but I am now convinced that they do not belong to that species, but to one which has not been previously described, so I take this opportunity of changing the name to *Doliolum tritonis*. For a detailed description and figures I refer to my "Triton" Report; but it may be useful to note here that the stigmata in the branchial sac commence dorsally behind the third muscle band and extend to the sixth; while the ventral series terminates anteriorly a little behind the fourth muscle

[1] Report on the Tunicata collected during the cruise of H.M.S. "Triton" in the summer of 1882, *Trans. Roy. Soc. Edin.*, vol. xxxii. part i. p. 93.

band. The endostyle extends from between the second and third to between the fourth and fifth muscle bands, and so occupies about two intermuscular spaces (Pl. III. fig. 3).

Doliolum challengeri, n. sp. (Pl. III. fig. 4).

Body of the usual cask-like form.

Mantle having the usual eight muscle bands.

Branchial Sac well developed. Stigmata numerous. The dorsal series commences at the second muscle band, and extends back to the fifth. Ventrally the stigmata end anteriorly at the third muscle band.

Endostyle reaching from the second to the fourth muscle band.

Intestine curved, with the convexity ventral.

I place in this new species the following specimens from the Challenger collection :—

(1.) August 11–12, 1874 ; off Kandavu, Fiji ; surface ; surf. temp. 77°·5 ; several specimens.

(?) (2.) June 17, 1875 ; Station 237, North Pacific ; surface ; lat. 34° 37′ 0″ N., long. 140° 32′ 0″ E. ; surf. temp. 73° ; twelve specimens.

(3.) June 18, 1875 ; Station 238, North Pacific ; surface ; lat. 35° 18′ 0″ N., long. 144° 8′ 0″ E. ; surf. temp. 70°·5 ; two specimens.

(4.) June 19, 1875 ; Station 239, North Pacific ; surface ; lat. 35° 18′ 0″ N., long. 147° 9′ 0″ E. ; surf. temp. 70°·2 ; three specimens.

(?) (5.) June 24, 1875 ; Station 242, North Pacific ; surface ; lat. 35° 29′ 0″ N., long. 161° 52′ 0″ E ; surf. temp. 68°·5 ; three specimens.

(?) (6). April 13, 1876 ; Station 352, off the West Coast of Africa ; surface ; lat. 10° 55′ 0″ N., long. 17° 46′ 0″ W. ; surf. temp. 77°·7 ; one large and three small specimens.

This species is closely allied to *Doliolum denticulatum*. The specimens from the North Pacific, collected on June 17, 18, and 19, 1875, are all mounted as microscopic objects. The nerve ganglion is placed in front of the fourth muscle band, but close to it.

In the specimens from near Fiji, August 11–12, 1874, the testis is long, and extends forward to the third muscle band. The alimentary canal is placed between the fifth and the seventh muscles.

The specimens collected on June 17 and 24, 1875, and on April 13, 1876, differ slightly from the others. In those of June 24, the stigmata of the dorsal series commence at the third muscle band, as in *Doliolum tritonis*, in place of at the second.

The specimens from the Atlantic, collected on April 13, 1876, are on two slides mounted as microscopic objects. The stigmata extend forwards dorsally to the second muscle band, but very little structure beyond that can be made out from the specimens.

I am doubtful how far the number and position of the stigmata can be taken as a diagnostic character in these species of *Doliolum*. Possibly there may be a certain amount of individual variation. It is evident that *Doliolum denticulatum*, Q. and G., *Doliolum ehrenbergi*, Krohn, *Doliolum gegenbauri*, Uljanin, *Doliolum tritonis*, Herdman, and the two new species *Doliolum affine* and *Doliolum challengeri*, are all closely allied; and, on the other hand, *Doliolum mülleri*, Krohn, *Doliolum rarum*, Grobben, and the new species *Doliolum krohni*, described below, are also closely related to one another; but whether these nine species are all distinct, or whether they might not be better arranged as so many varieties of two species, *Doliolum denticulatum* and *Doliolum mülleri*, is a question which will have to be discussed when we know more about their characters in the various stages of their life-histories, and when we know the range of their individual variations.

Doliolum krohni, n. sp. (Pl. III. fig. 1).

Body of the usual cask-like form.

Mantle having the usual eight muscle bands.

Branchial Sac with comparatively few stigmata, which are restricted to the posterior end of the sac. There are about twenty-five pairs, which run in an oblique band posteriorly and dorsally from a little in front of the fifth muscle band to a little behind the sixth.

Endostyle extending from the second muscle band nearly to the fifth.

I refer to this new species the following specimens:—

(1.) December 14 and 15, 1875; South Pacific, off Valparaiso; lat. 33° 31′ 0″—33° 12′ 0″ S., long. 74° 43′ 0″—76° 29′ 0″ W.; surf. temp. 62°—62°·5; about thirty specimens.

(2.) Two microscopic slides mounted during the expedition. From same locality as (1).

This species is related to *Doliolum mülleri*, Krohn, and *Doliolum rarum*, Grobben, as all three species are characterised by having the stigmata in the branchial sac restricted to the posterior end of the organ. In *Doliolum rarum* there are only five pairs of stigmata. In *Doliolum mülleri* there are ten to twelve pairs, and they form a band which runs dorso-ventrally midway between the fifth and sixth muscle bands, and nearly parallel to them. In the present species (see Pl. III. fig. 1) there are twenty-five pairs of stigmata, forming an inclined band crossing both fifth and sixth muscle bands as it runs posteriorly and dorsally. The posterior extremity of the endostyle reaches back almost to where the stigmata commence.

Specimens of the Asexual Generation.

Specimens of Blastozooids, or the "nurse-form" of *Doliolum*, were obtained at the following localities :—

(1.) April 2, 1874 ; Station 162, off East Moncœur Island, Bass Strait ; surface ; surf. temp. 63°·2 ; twenty specimens, varying in size from 5 mm. to 1·5 cm. in length and from 1 mm. to 4 mm. in breadth. The average breadth is 2 mm.

(2.) October 21, 1875 ; Station 288, South Pacific ; lat. 40° 3′ 0″ S., long. 132° 58′ 0″ W. ; surface ; surf. temp. 54°·5 ; two specimens.

(3.) February 11, 1876 ; Station 318, South Atlantic ; lat. 42° 32′ 0″ S., long. 56° 29′ 0″ W. ; tow-net at trawl down to a depth of 2040 fathoms ; bottom temp. 33°·7 ; thirty specimens.

(4.) Same place and date ; tow-net at surface ; surf. temp. 57°·5 ; five specimens.

(5.) April 11, 1876 ; Station 350, North Atlantic ; surface ; lat. 7° 33′ 0″ N., long. 15° 16′ 0″ W. ; surf. temp. 84° ; one specimen.

(6.) April 13, 1876 ; Station 352, North Atlantic ; surface ; lat. 10° 55′ 0″ N., long. 17° 46′ 0″ W. ; surf. temp. 77°·7 ; one large and one small specimen (mounted as microscopic objects).

(7.) May 3, 1876 ; Station 353, North Atlantic ; lat. 26° 21′ 0″ N., long. 33° 37′ 0″ W. ; surf. temp. 70°·7 ; one specimen.

(8.) May 7, 1876 ; North Atlantic ; lat. 34° 22′ 0″ N., long. 34° 23′ 0″ W. ; surface, at night ; surf. temp. 67°·5 ; six large specimens (in bad condition).

These Blastozooids are large, and have long narrow bodies provided with nine wide muscle bands (see Pl. III. fig. 9) and a dorsal outgrowth, which in some specimens is very large.

The nerve ganglion is placed between the fourth and the fifth muscle bands. The first and ninth bands are much narrower than the rest, and are evidently the sphincter muscles of the branchial and atrial apertures. The seventh and eighth muscle bands are interrupted in the mid-dorsal line, and their free ends are diverted posteriorly to enter the dorsal outgrowth which springs at that point from the body wall (Pl. III. fig. 9, *s.*). The muscle bands of these specimens are very much wider than those of the Blastozooid of *Doliolum mülleri* as figured by Keferstein and Ehlers,[1] and I am unable to refer them to any known species. Possibly they belong to one of the new species of which the sexual forms have been described above ; or they may not all belong to the same sexual form. It is impossible to refer them to their species until the life-histories have been worked out on living material.

[1] Zoologische Beiträge, Pl. 10, fig. 1.

Suborder II. HEMIMYARIA.

Free-swimming pelagic forms which exhibit alternation of generations in their life-history and in the sexual condition form temporary colonies.

The body is more or less fusiform, with the longer axis antero-posterior, and the branchial and atrial apertures nearly terminal.

The test is well developed.

The musculature of the mantle is in the form of a series of transversely running bands, which do not form complete and independent rings as in the Cyclomyaria.

The branchial and peribranchial cavities form a continuous space in the interior of the body opening externally by the branchial and atrial apertures, and traversed obliquely from the dorsal and anterior end to the ventral and posterior by a long narrow vascular band, which represents the dorsal lamina, the dorsal blood-vessel, and the neighbouring part of the dorsal edge of the branchial sac of an ordinary Ascidian.

The alimentary canal is placed ventrally. It may be either stretched out, so as to extend for some distance anteriorly, or, as is more usual, be concentrated to form along with the reproductive organs a rounded opaque mass near the posterior end of the body, known as the visceral mass or "nucleus."

The embryonic development is direct, no tailed larva being formed.

I have formed this suborder to correspond with Uljanin's group Cyclomyaria. The name Hemimyaria refers to the incomplete condition of the muscular rings. The suborder includes two very distinct families, the SALPIDÆ, which contains the typical members of the group, and the OCTACNEMIDÆ, including a single very remarkable form (*Octacnemus bythius*, Moseley), which in some respects does not conform with the characters given above.[1]

Family I. SALPIDÆ.

Body not attached, elongated; branchial and atrial apertures at the opposite ends.

Test well developed, gelatinous or cartilaginous.

Mantle with well-marked muscle bands, which, however, do not form complete rings, but are wanting ventrally.

Branchial and Peribranchial Cavities forming a large central space opening to the exterior at both ends; side walls of branchial sac not developed.

Dorsal Lamina in the form of a vascular band traversing the central cavity.

Alimentary Canal usually forming a small coiled mass placed posteriorly and ventrally.

[1] See below, p. 88.

Reproductive Organs hermaphrodite, but the ova and spermatozoa are not mature at the same time.

Gemmation takes place; and alternation of generations occurs in the life-history.

This important family contains the well-known genus *Salpa* and its immediate allies. As it is the typical group of the Hemimyaria, its characters are mainly those of that suborder; and as they will be discussed under the heading of the genus *Salpa*, it is not necessary to notice them further here.

The family Salpidæ was formed by Professor Edward Forbes in 1853. It contains two genera—*Salpa*, Forskåhl, and *Cyclosalpa*, Blainville. They may be distinguished as follows:—

SALPIDÆ.

Alimentary canal extended.	Alimentary canal coiled up.
Cyclosalpa.	*Salpa.*

Salpa, Forskåhl.

Holothuria, Linn., Syst. Nat., ed. x., tom. i., p. 657, 1758.
Dagysa, Banks and Solander, Hawkesworth's Voyages, vol. ii. p. 2, 1773.
Holothurium, Pallas, Spicilegia Zoologica, p. 26, 1774.
Salpa, Forskåhl, Descrip. anim. &c., p. 112 (in part), 1775.
Dagysa, Gmelin, Linn., Syst. Nat., ed. xiii., 1788–91.
Biphora, Bruguière, Encycl. méth., tom. i., Paris, 1789.
Thetys, Tilesius, Abbild. und Beschr. &c., p. 150, 1802.
Thalia, Blumenbach, Abbild. naturhist. Gegenst., No. 30, 1810.
Iasis, Savigny, Mémoires, p. 235, 1816.
Pegea, Savigny, Mémoires, p. 235, 1816.
Biphora, Costa, Fauna del Regno di Napoli, p. 3.
Biphora, Sars, Bidrag til Sødyrenes Naturhistorie, p. 51, 1829.
Pterotyra, Lesson, Voy. de la Coquille, p. 378, 1830.
Dubreuillia, Lesson, Voy. de la Coquille, p. 278, 1830.
Pegea, Macdonald, Trans. Linn. Soc. Lond., vol. xxiii. p. 371, 1862.
Salpa, Cuvier, Lamarck, Chamisso, Krohn, Huxley, Vogt, Todaro, Traustedt, and others (in part).

Body not attached, elongated, with the apertures at the opposite ends.
Test gelatinous or cartilaginous; transparent.
Mantle with muscle bands which are more or less incomplete ventrally.
Branchial Sac opening freely into the peribranchial cavity; no lateral walls.
Dorsal Lamina in the form of a vascular band marking the junction of branchial and atrial sacs.

Alimentary Canal coiled up to form a small opaque mass placed posteriorly and ventrally.

Chain of Embryos in the form of an elongated band.

This important genus has had many synonyms, but few of them have attained to any currency, and there is no doubt that *Salpa*, Forskåhl, is the correct name for the genus. The earlier names under which some of the forms were described were *Dagysa* (Banks and Solander, 1773) and *Holothurium* (Pallas, 1774). *Holothuria* was also made use of by Linnæus (1758).

Forskåhl was the first to give a proper definition of the genus to which he applied the name *Salpa*.[1] He recognised two groups—those forms with a nucleus and those with none, and described the following species from the Mediterranean:—*Salpa maxima*, *Salpa pinnata*, *Salpa democratica*, *Salpa mucronata*, *Salpa punctata*, *Salpa confœderata*, *Salpa fasciata*, *Salpa sipho*, *Salpa africana*, *Salpa solitaria*, and *Salpa polycratica*. Most of these are good species, so that the founder of the genus had before him a fair number of the species now known to belong to it.

Browne[2] had previously, and he also subsequently, described some *Salpæ* from the West Indies under the name of *Thalia*, which I place as a synonym of *Cyclosalpa* (see below, p. 86).

Tilesius in 1802 described, under the name *Thetys vagina*, the large species which is now known as *Salpa costata-tilesii*.

Cuvier's important memoir on the genus (1804), besides making known many points in the anatomy, and demonstrating the relationship of *Thalia* (*Cyclosalpa*) and *Salpa* to the Ascidians, contained descriptions of the species—*Salpa cristata* (= *Cyclosalpa pinnata*, Forsk.), *Salpa tilesii*, *Salpa scutigera*, *Salpa octofora*, *Salpa cylindrica*, and *Salpa fusiformis*, the last four being new species. He placed the genus *Salpa* amongst the "Mollusques acéphales nus."

Savigny in his third memoir (1816) gives an account of the structure of *Salpa*, and of its relations to the other Tunicata. He also illustrates by a plate the anatomy of two of Cuvier's species, *Salpa octofora* and *Salpa cylindrica*, for which he forms two unnecessary new genera, *Pegea* and *Iasis*.

In the description of some surface forms obtained during the voyage of the Corvette "L'Uranie," under Freycinet, Quoy and Gaimard in 1825[3] describe the species—*Salpa maxima*, *Salpa costata*, *Salpa bigibbosa*, *Salpa hexagona*, *Salpa gibbosa*, *Salpa longicauda*, *Salpa tricuspidata*, *Salpa infundibuliformis*, *Salpa suborbicularis*, *Salpa informis*, *Salpa rhomboides*, *Salpa triangularis*, *Salpa emarginata*, and *Salpa*

[1] Descriptiones animalium, p. 112, 1775.
[2] Nat. Hist. of Jamaica, London, 1756, and also 1785 (2nd ed.).
[3] *Ann. d. Sci. Nat.*, tom. vi. p. 28, 1825.

polymorpha. Two of these, *Salpa rhomboides* and *Salpa polymorpha*, are probably not Tunicata at all. *Salpa tricuspidata* is probably the solitary form of *Salpa democratica-mucronata*, and *Salpa gibbosa* the solitary form of *Salpa costata-tilesii*. In the official account of the voyage[1] they figure various varieties of *Salpa costata-tilesii* and two other species, *Salpa longicaudata* (probably the solitary form of *Salpa democratica-mucronata*) and *Salpa birostrata* (probably the aggregated form of *Salpa runcinata-fusiformis*). A few years afterwards the same authors[2] added to the list the species *Salpa bicaudata*, *Salpa cordiformis*, and *Salpa microstoma*.

Chamisso[3] had first discovered in 1819 the remarkable alternation of generations which takes place in the life-history of *Salpa*, each species occurring in two forms,—the solitary asexual and the aggregated sexual,—which are usually very unlike one another, and are produced alternately. Kuhl and van Hasselt[4] afterwards discovered the well-known periodic reversal of the heart-beat; and the circulation was more fully investigated later by Eschscholtz[5] and by Milne-Edwards.[6] Meyen[7] (1832) described the nervous system and some other parts in the anatomy of *Salpa*.

Eschricht[8] in 1841 gave a very full account of the species *Salpa cordiformis-zonaria*, with a description of the method of formation of the "chain," and excellent figures. M. Sars[9] also gave an account of the process of gemmation in another northern form.

The first good account of the reproductive organs is due to Krohn,[10] who, in 1846, wrote on the life-history and classification of the genus. This was followed in 1851 by Huxley's memoir[11] on *Salpa* and *Pyrosoma*, which gave an account of his observations made during the voyage of the "Rattlesnake," and independently of those of Krohn. These two important works added considerably to the knowledge of both the structure and the life-history of *Salpa*, and Krohn also did good service in clearing up the synonymy of the species to a considerable extent, and in placing the aggregated and solitary forms of the same species together.

C. Vogt in 1854[12] carried on the work begun by Krohn, and gave a very full account of the embryology and life-history of *Cyclosalpa pinnata*, with a shorter description of other species. H. Müller[13] and Leuckart[14] also about the same time contributed to the knowledge of the structure and relations of *Salpa*, giving a good account of the nervous system and sense organs, and of some parts of the development.

Costa, Macdonald, M'Intosh, and other zoologists have added more or less important

[1] Freycinet, Voyage autour du Monde, Zool., Paris, 1824.
[2] *Ann. d. Sci. Nat.*, tom. x. p. 225, 1827.
[3] De animalibus quibusdam, etc., fasc. i., de Salpa.
[4] *Ann. d. Sci. Nat.*, tom. iii., 1824.
[5] *Oken, Isis*, 1824.
[6] *Ann. d. Sci. Nat.* (Zool.), sér. 2, tom. xiii., 1840.
[7] *Acad. Cæs. Leop.*, *Nova Acta*, tom. xvi., 1832.
[8] Anat. physiol. Undersøgelser over Salperne, *K. Dan. Vidensk. Selsk.*, Afh. viii. p. 297, 1841.
[9] Fauna littoralis Norvegiæ, 1846.
[10] *Ann. d. Sci. Nat.* (Zool.), sér. 3, tom. vi. p. 110, 1846.
[11] *Phil. Trans.*, 1851, part ii. p. 567.
[12] *Mém. de l'Inst. Genev.*, tom. ii., 1854.
[13] *Verh. phys.-med. Gesellsch. Würzburg*, Bd. iii. p. 57, 1852; and *Zeitschr. f. wiss. Zool.*, Bd. iv. p. 329, 1853.
[14] Zoologische Untersuchungen, ii., Salpa und Verwandte, Giessen, 1854.

observations on various species of *Salpa*, and most writers on the Tunicata have discussed the position and affinities of this aberrant genus; but the most important memoirs since 1860 have been confined to the embryology, the gemmation, and the life-history. Amongst them may be mentioned especially the works of Salensky, Todaro, Brooks, and Seeliger. Of these the most important are the researches of Salensky,[1] to which we owe the greater part of our detailed present knowledge of the embryology of *Salpa*. The accounts given by Todaro[2] conflict in many points with the descriptions by other authors; and Brooks[3] has put forth the remarkable view that *Salpa* is not after all an example of alternation of generations, but that the ovary really belongs to the solitary form, which is therefore a female producing a series of males (the aggregated forms) by asexual gemmation and depositing in each of them an ovum which will afterwards, when fertilised, develop in the body of the male into a solitary or female *Salpa*. Thus, according to Brooks, the female produces two forms of young—males asexually, and females sexually; and these two forms differ not only in mode of origin and sex, but also in structure. There are, however, no sufficient grounds for supposing that the ovum does not belong to the *Salpa* in which it develops, and therefore the sexual or chain form is usually regarded as a protogynous hermaphrodite, producing first an ovum, which is fertilised by the spermatozoa of an older *Salpa* of the same kind, and then, after it has got rid of the embryo, developing a testis. The embryo, on the other hand, becomes a solitary *Salpa* which is asexual, and produces the aggregated forms by gemmation.

The structure of the adult (sexual) *Salpa* is shown in Fig. 7.

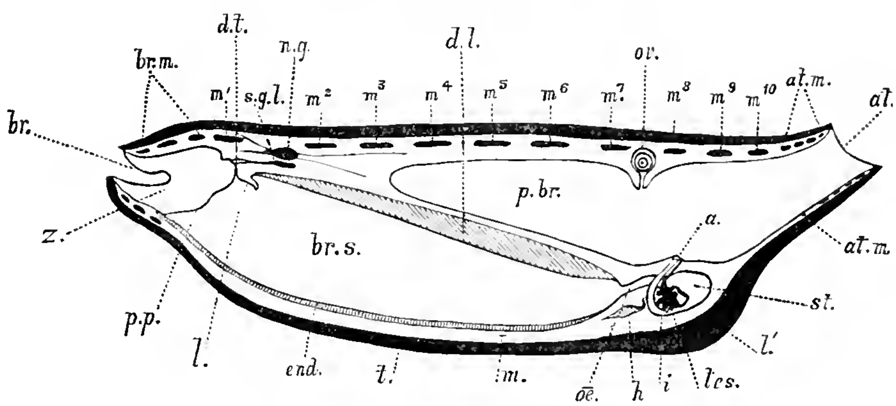


FIG. 7.—Semi-diagrammatic representation of *Salpa* from the left side.

a. anus; *at.* atrial aperture; *at.m.* muscles of atrial aperture; *br.* branchial aperture; *br.m.* muscles of branchial aperture; *br.s.* branchial sac; *d.l.* dorsal lamina (= "gill"); *d.t.* dorsal tubercle; *end.* endostyle; *h.* heart; *i.* intestine; *l.* languet; *m.* mantle; *m'*—*m*¹⁰. muscle bands; *n.g.* nerve ganglion; *oe.* œsophagus; *ov.* embryo in ovisac; *p.br.* peribranchial cavity; *p.p.* peripharyngeal band; *st.* stomach; *s.gl.* subneural gland; *t.* test; *t'.* thickened test over viscera; *tes.* testis; *z.* zona præbranchialis.

[1] *Zeitschr. f. wiss. Zool.*, Bd. xxvii. xxviii. xxx. &c.
[2] *Atti della R. Accad. dei Lincei*, 1875, 1883, 1887, &c.
[3] *Bull. Mus. Comp. Zoöl.*, vol. iii. No. 14, p. 291, 1876.

The body is elongated and more or less fusiform, with the branchial and atrial apertures at the opposite ends of the body. These openings are not surrounded by a number of lobes as in many other Tunicata, but are usually tubular or bilabiate. Each leads into a large space, the branchial sac and the peribranchial cavity, and these are in free communication at the sides of the median dorsal lamina or "gill" (Fig. 7, *d.l.*), which is a narrow vascular band running obliquely from the dorsal and anterior to the ventral and posterior end of the cavity. The water therefore has a free passage through the body of the animal—in at the branchial aperture through the branchial sac, past the sides of the dorsal lamina into the peribranchial cavity, and out by the atrial aperture.

The test is well developed, and in most species is thick but soft and transparent. It may become thicker and firmer in some parts, and usually there is a protecting shield of this nature over the visceral mass near the posterior end of the ventral surface (Fig. 7, *t'*).

The mantle adheres closely to the inner surface of the test. It has its musculature in the form of a variable number (generally from six to eight) of muscle bands which run transversely across the dorsal surface of the body and die away on the sides, so that the ventral part of the mantle has no musculature. Thus the muscle bands do not form complete rings as they do in the genus *Doliolum*, but are merely curved bands partly encircling the body. In many cases certain of the bands join or closely approach one another (see Pl. VI. fig. 5), generally in the median dorsal line; and all such arrangements of the muscle bands as well as their number are constant in the species and in the aggregated and solitary forms, and constitute one of the most important characters in the identification of specimens.

The branchial sac is a large cavity, but its lateral walls are entirely absent. The endostyle (Fig. 7, *end.*) indicates its ventral edge, and the dorsal lamina (*d.l.*) or "gill," its dorsal, so that in a lateral view, such as Fig. 7 represents, its boundaries are perfectly definite; but there are no side walls joining the endostyle to the dorsal lamina and separating the branchial sac from the lateral parts of the peribranchial cavity. There are therefore in connection with this branchial sac no transverse or longitudinal vessels, and no stigmata. It is exactly as if in an ordinary Ascidian all the stigmata on each side of the sac had coalesced to form a single large aperture. The so-called "gill" of *Salpa*, then, evidently corresponds to the dorsal lamina of the Ascidian with the large dorsal blood-sinus which lies behind it.

The anterior end of the "gill" or dorsal lamina is prolonged ventrally to form a prominent tentacular organ, the languet, which projects freely into the anterior end of the branchial sac. It is probably a sense organ (Fig. 7, *l*). The nerve ganglion is placed near the front of the body in the median dorsal line. It is short and rounded, and gives off nerves from the sides as well as from its anterior and posterior ends (see Pl. VIII. fig. 15); an otocyst (?) and a pigment spot are found in connection with the ganglion. These, with the possible addition of the languet and the ciliated groove in the dorsal tubercle, or opening of the subneural gland, are the only sense organs known.

There is no circle of tentacles in the branchial siphon. The peripharyngeal bands are in their usual position in the Tunicata, running round the front of the branchial sac from the anterior extremity of the endostyle to the front of the dorsal lamina. There is a subneural gland underlying the ganglion. Its duct leads forwards, and opens into the front of the branchial sac just anterior to the peripharyngeal bands. The opening widens out to form a richly ciliated groove, which may be either straight and elongated antero-posteriorly (Pl. VI. fig. 11) or curved upon itself to form a more or less elaborate "dorsal tubercle."

The endostyle is long and straight. It runs to the posterior end of the branchial sac, where it and the dorsal lamina meet on the opposite sides of the œsophageal aperture. The heart is placed near the posterior end of the endostyle, ventrally to the œsophagus.

The alimentary canal is relatively small, and is coiled up along with the testis to form a small compact opaque mass, the "nucleus" or visceral mass (Pl. IX. fig. 7, *visc.*). This arrangement of the viscera is characteristic of *Salpa*, and distinguishes it from the next genus *Cyclosalpa*, in which the alimentary canal is stretched out, and consequently no "nucleus" is formed. The anus opens into the peribranchial cavity on the dorsal surface of the nucleus (Fig. 7, *a*).

The figure (Fig. 7, p. 55) represents an aggregated or sexual *Salpa* which in an earlier period of its existence was a member of a chain, and consequently it shows a testis and a developing embryo. The ova (always few in number, usually only one) appear at a very early period in the developing chain *Salpa*, while it is still a part of the gemmiparous stolon in the body of the solitary *Salpa*; while the testis, on the other hand, does not develop until much later. This protogyny prevents self-fertilisation. The ovum is situated in the median dorsal line, not far from the posterior end of the body, and lies at first in a blood-sinus of the mantle, enclosed in an ovisac, the wall of which is prolonged to form a narrow tube, the oviduct, which opens into the peribranchial cavity on its right side. Spermatozoa from another and older sexual *Salpa*, belonging to a different chain, gain access by means of this oviduct and fertilise the ovum.

The embryonic development is carried on in a "brood-pouch" formed by an enlargement and modification of the oviduct into a sac which projects into the peribranchial cavity, and eventually ruptures so as to set the embryo free. At an early period in its development, part of the wall of the ovisac, probably along with part of the embryo itself, becomes converted into the "placenta," an organ in which the fœtal and maternal blood-streams circulate in close proximity, or actually coalesce during one period. At a somewhat later stage, a number of cells placed near the posterior end of the body alongside the future nucleus, and probably belonging to the hypoblast, become filled up with oil globules to form a mass of nutrient material,—the "elæoblast,"—which is used up later on in the development. Many suggestions have been made by the various writers as to the homology of this elæoblast. The most probable is that it is the disappearing rudiment of the tail found in the larval condition of most Ascidians. The free-swimming tailed larval stage is not found in the life-history of *Salpa*—the development being direct.

The testis, which arrives at maturity in the aggregated *Salpa* only after the embryo has been got rid of, is a system of tubules ramifying on the outer surface of the visceral mass and opening into the peribranchial cavity.

The embryo produced sexually by the aggregated *Salpa* becomes a solitary *Salpa*, and this while still young develops a stolon as a projection on the right side of the body ventrally and close to the heart. This stolon is an outgrowth of the body-wall, containing prolongations of all the more important systems of the body—branchial sac,

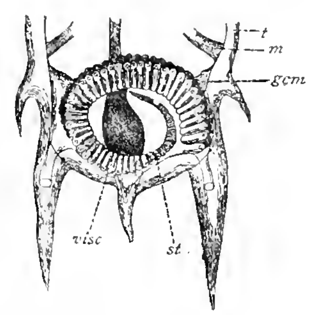


FIG. 8.—Posterior part of solitary form of *Salpa democratica-mucronata*, showing a well-developed chain.—(From the Encyclopædia Britannica, 9th ed.)

gem. young aggregated *Salpæ* forming the chain; *m.* muscle band of mantle; *st.* stolon; *t.* test; *visc.* visceral mass.

pericardium, blood-sinuses of mantle, elæoblast (hypoblast cells ?), and probably nervous system. As the stolon elongates it becomes segmented into pieces, each of which develops eventually into the body of an aggregated *Salpa* (see Fig. 8). After the solitary *Salpa* has become fully developed, the chain produced by the stolon is set free in sections, each section being composed of a number of aggregated *Salpæ* at about the same stage of development. In most cases the *Salpæ* in a chain are placed in a double row, and alternate so that each one touches the bodies of four of its fellows. It is joined to each of these neighbours by processes of its body-wall composed of the mantle covered by a layer of ectoderm. When the chain is still young the test is thin, and these processes, which join the bodies of adjacent *Salpæ*, are relatively long, and keep the members of the chain far apart; but as they grow older, and their tests thicken, the *Salpæ* become pushed farther apart, and the joining processes are finally completely embedded in the tests, and the chains are then ready to break up on the slightest touch, and the *Salpæ* lead the rest of their existence in a separate condition.

Out of the enormous number of aggregated *Salpæ* collected during the Challenger Expedition, none were adhering together when they reached my hands. In all cases the chains, being fully developed, had become broken up into their constituent *Salpæ*.

Each species of *Salpa* thus occurs in two very distinct forms (Fig. 9, A and B),—the solitary asexual (*proles solitaria*) and the aggregated sexual (*proles gregata*, or "chain"),—and the latter may either be found united together in a chain or singly (see fig. 9, B).

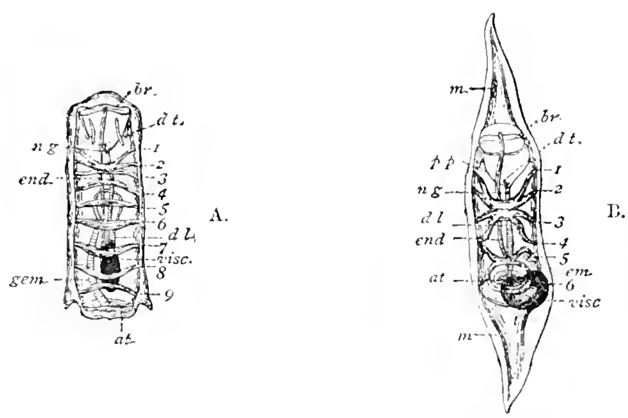


FIG. 9.—*Salpa runcinata-fusiformis*. A. Solitary form. B. Aggregated form.—(From the Encyclopædia Britannica, 9th ed.) 1–9. muscle bands; *at.* atrial aperture; *br.* branchial aperture; *d.l.* dorsal lamina; *d.t.* dorsal tubercle; *em.* embryo; *end.* endostyle; *gem.* gemmiparous stolon; *m.* mantle; *n.g.* nerve ganglion; *pp.* peripharyngeal band; *visc.* visceral mass (nucleus).

This circumstance, and the fact that both forms of most species had been found and described before their relationship to one another was discovered, has led to the application of two specific names to each species—not as synonyms, but the one applicable to the solitary form and the other to the aggregated. Thus in the case of the species represented in fig. 9, the solitary form is generally known as *Salpa runcinata*, Chamisso, and the aggregated form as *Salpa fusiformis*, Cuvier; and it has become customary when writing of the species as a whole to use both names and both authorities; thus—*Salpa runcinata-fusiformis*, Chamisso-Cuvier. This plan was first employed by Krohn in 1846;[1] it was adopted by Traustedt in his admirable revision of the species of *Salpa* published in 1885, and I have followed it here.

If, on the other hand, one of the names were to be chosen to indicate each species of *Salpa*, then two alternatives would be open: (1) To follow priority only, without reference to the sexual condition of the form first named; and (2) to choose in all cases the earliest name of the sexually mature or chain form of the species. This second course, which seems in some respects the preferable one, would result in a form being chosen to give its name to the species which is not larger, nor more highly organised, nor longer lived than the other form, but merely because it reproduces sexually. And,

[1] *Ann. d. Sci. Nat.* (Zool.), sér. 3, tom. vi. p. 110.

finally, if either of the two alternative plans for choosing a single specific name were adopted, it would be liable to result in considerable confusion between the species as a whole and either of its constituent forms; for example, *Salpa fusiformis* is now generally used to indicate the aggregated form of its species, but it would, if the second of the above plans were adopted, come to be the name for both the solitary and the aggregated forms,—and it might in some cases be difficult to tell in what sense the name was being used.

In the case of a few species, where the solitary and aggregated forms were found together, and their relationship was known when they were first described, only one specific name was given, and in these cases, of course, there is no need for any change; but in the majority of the species, where the two generations have become well known under distinct names, I believe it will lead to least confusion and trouble with synonymy in the future if the double or compound names, as used in Traustedt's paper and in the following pages, be systematically adopted.[1]

The species in this genus are closely related, and are not readily separated into natural groups. A discussion of their mutual relations, and a tabular synopsis of the genus, will be found in Traustedt's recent paper.[2]

The Challenger collection of *Salpæ* is very large, numbering between three and four thousand specimens, but they are all referable to fourteen species, six of which are new to science.

Salpa costata-tilesii, Quoy and Gaimard—Cuvier (Pl. IV. figs. 1–8).

Salpa tilesii, Cuvier, Ann. du Mus., tom. iv. p. 375, 1804.
Salpa costata, Quoy and Gaimard, Freycinet, Voyage, p. 504, 1824.
Salpa costata-tilesii, Krohn, Ann. d. Sci. Nat. (Zool., sér. 3), tom. vi. p. 114, 1846.
Salpa costata-tilesii, Traustedt, *loc. cit.*, p. 379, which see for further synonymy.

All the specimens of this species in the Challenger collection are more or less injured or imperfect. They all belong to the solitary form *Salpa costata*, Quoy and Gaimard. The localities are as follows:—

(1.) June 23, 1874; Station 166, South Pacific, between Australia and New Zealand; lat. 38° 50′ 0″ S., long. 169° 20′ 0″ E.; surf. temp. 58°·5; one specimen (A).

(2.) July 8, 1874; Station 168, off the east coast of New Zealand; lat. 40° 28′ 0″ S., long. 177° 43′ 0″ E.; depth, 1100 fathoms; bottom temp. 37°·2, surf. temp. 57°·2; one specimen (B).

(3.) April 5, 1875; Station 230, North-West Pacific, to the south of Japan; lat. 26° 29′ 0″ N., long. 137° 57′ 0″ E.; surf. temp. 68°·5; one specimen (C).

(4.) October 18, 1875; South Pacific; surface; lat. 36° 0′ 0″ S., long. 132° 22′ 0″ W.; surf. temp. 58°·5; one specimen (D).

[1] This question of nomenclature is discussed more fully in a paper published in *Proc. Biol. Soc. Liverpool*, vol. ii. p. 133, 1888.

[2] Bidrag til Kundskab om Salperne, *Vidensk. Selsk. Skr.*, 6 Række, naturvid. og. math. Afd. ii. 8, p. 345. Kjøbenhavn, 1885.

Specimen A (Pl. IV. fig. 1) measures 17 cm. in length, exclusive of the horn-like projections on the posterior end of the body. The horns measure 4·5 cm. in length and 8 mm. in breadth. They are more flattened and more constricted at the base (Pl. IV. fig. 2) than those figured by Traustedt.

The test is transparent, soft, and gelatinous, except on the ventral posterior part of the body, where it becomes stiffer and considerably thickened to form a protecting pad over the nucleus. The test forming the horns is also stiffer than elsewhere. Towards the ventral edge of the body the test is raised up to form a number of conical pointed projections, about 1·5 mm. to 2 mm. in height and in diameter at the base, springing from slight hollows (see Pl. IV. fig. 5).

This specimen has a chain of embryos, about 5 mm. in thickness, placed at the ventral edge of the posterior part of the body. The larger embryos when separated measure each 4 mm. in length and 2 mm. in greatest breadth.

This is the largest specimen of the species *Salpa costata-tilesii* which I have seen. A specimen in the British Museum collection, from Western Australia, measures 14 cm. in length. Traustedt, however, describes his largest specimen as being 19 cm. in length. The British Museum specimen has the test tuberculated, like that of specimen A above described.

Specimen B is a fragment of the test of a very large *Salpa*, probably belonging to this species. It is about 12 cm. in length, and the body when entire must have been considerably larger. It includes the thickened region covering the nucleus, and a part of the tuberculated ventral surface of the test. The tubercles are of considerable size.

Specimen C measures 6 cm. in length. The greatest breadth, just behind the branchial aperture, is 3·5 cm., while the breadth at the atrial aperture is 2 cm. The test is very clear and transparent, the endostyle showing through it distinctly as a conspicuous white line. The thickening over the region of the nucleus is placed more posteriorly than is shown in Traustedt's figure,[1] or than I have seen it in other specimens. It is nearly 2 cm. in antero-posterior length, and extends close up to the atrial aperture posteriorly (Pl. IV. figs. 3 and 4). There are pointed papillæ scattered over the ventral surface of the test, especially around the nuclear swelling and in front of it, and a few papillæ are also found along the ventral lip of the branchial aperture.

The dorsal tubercle of this specimen does not agree exactly with that figured by Traustedt (see Pl. IV. fig. 8). It differs slightly in the shape of all its parts, and the languet does not project so much as is shown in the case of Traustedt's specimen.

Specimen D measures about 14 cm. in length, but is not complete anteriorly. The test is exceedingly soft and gelatinous, and very thin considering the large size of the animal. Over the region of the nucleus, as usual, it becomes rather thicker and stiffer. There are no projections from any part of the surface of this test.

[1] Bidrag til Kundskab om Salperne, Tab. ii. fig. 39.

In the mantle of this specimen the muscle bands are more distinct than in the case of specimen A from Station 166. The "gill" or dorsal lamina (see Pl. IV. fig. 6) has very closely placed transverse ridges running transversely in irregularly convoluted courses. The ridges are formed of columnar epithelium.

There is evidently a considerable amount of variability in this large species. There are some forms which have the test smooth (*e.g.* Challenger specimen D and Traustedt's specimen[1]) and there are some which have it tuberculated (*e.g.* Challenger specimens A and C, and British Museum specimen). It might be worth while to separate off the latter as a variety *echinata*. Then the position of the nucleus is liable to variation (compare Pl. IV. figs. 3 and 4, with fig. 1, and with Traustedt's figures). Lastly, the dorsal tubercle may differ in shape and size in different specimens, as is shown above.

The anterior extremity of the endostyle extends forwards in front of the peripharyngeal bands (see Pl. IV. fig. 7), and the right and left peripharyngeal grooves are completely cut off ventrally from one another and from the groove of the endostyle.

Traustedt has given figures of this species seen from the dorsal and ventral surfaces. Plate IV. fig. 1, shows the Challenger specimen A seen from the left side, half the natural size.

Salpa, sp., (?) n. sp. (Pl. IV. fig. 9).

External Appearance.—The shape is oblong, with the ends nearly equally wide, and the dorsal and ventral edges almost straight. The branchial and atrial apertures are terminal, large and bilabiate. The nucleus is placed on the ventral edge of the posterior end. On each side of the body there are several large tubular projections with open ends. Length of the body about 16 cm.

The Test is moderately thick and firm. At the posterior end, over the region of the nucleus, it becomes stiffer and thicker than elsewhere. Along the posterior part of the dorsal surface, and around the branchial and atrial apertures, there are a number of large pointed tubercles. The tubular projections on the sides of the body are formed by a prolongation of the test with a slightly thickened margin to the terminal aperture. Otherwise the surface of the test is smooth.

The specimen from which the above description is drawn up is a fragment of a large *Salpa* which was found in the same bottle with a fragment of *Salpa costata-tilesii* (specimen B) from Station 168, off the east coast of New Zealand, July 8, 1874; lat. 40° 28′ 0″ S., long. 177° 43′ 0″ E.; surf. temp. 57°·2.

If it belongs to a new species, it is probably closely allied to *Salpa costata-tilesii*. Unfortunately, only a portion of the test, including the branchial and atrial apertures,

[1] See his figures 38 and 39.

the nuclear thickening, and the greater part of one side of the body remains; of the mantle and the nucleus and other internal organs no traces are left.

The figure (Pl. IV. fig. 9) shows the specimen, about one half the natural size, with the test restored as much as possible to its natural condition. The branchial aperture is very large. Its dorsal and ventral lips are semicircular, and the opening measures 6 cm. from side to side. It is surrounded by a slightly thickened border (Pl. IV. fig. 9). The nuclear thickening of the test is placed very far back, close to the atrial aperture. It is over 6 cm. in length antero-posteriorly. It is distinct, from its thickness and smoothness, but is not so prominent as in the case of *Salpa costata-tilesii* (Pl. IV. fig. 1, *visc.*). The atrial aperture is diamond-shaped when seen from the posterior end. It measures upwards of 2 cm. across. Its edges are thin, and are imperfect in the specimen.

The pointed tubercles scattered along the dorsal part of the test are exactly like those which are found on the ventral surface in *Salpa costata-tilesii* (see Pl. IV. figs. 1 and 4). The ventral surface in the present specimen is perfectly smooth. The remarkable tubular processes of the test which are found on the sides of the body are nearer to the ventral than the dorsal edge. Two are placed near the middle of the body, and two near the posterior end (Pl. IV. fig. 9), close to the nuclear swelling. The processes are from 5 mm. to 1 cm. in extreme length, and their terminal openings are about 5 mm. in diameter.

This species differs from the solitary form of *Salpa costata-tilesii* in its external appearance, in the absence of any horn-like processes at the posterior end of the body, in the position of the nuclear thickening of the test, in the position of the pointed tubercles, and especially in the presence of the curious tubular projections on the sides of the body. It, however, resembles the aggregated form of that species in which there are no horns in some respects, but differs in possessing the tubular appendages. If these remarkable structures could be explained as being the modified remains of the processes of the test which join the young aggregated forms together in the chain, then I should be inclined to refer this specimen to *Salpa costata-tilesii*, aggregated form; but no traces of any such projections are to be seen in Traustedt's figures. It is evident that the examination of further specimens is necessary, before this form can be referred to its position with certainty.

Salpa hexagona, Quoy and Gaimard.

Salpa hexagona, Quoy and Gaimard, Freycinet, Voyage, p. 505, 1824.
Salpa hexagona, Traustedt, *loc. cit.*, p. 379, which see for further synonymy.

Two specimens of the aggregated form of this species were collected in the North Pacific on August 24, 1875, lat. 13° 1′ 0″ N., 151° 50′ 0″ W., from the surface, at night, surf. temp. 78°·2. They measure 2·2 cm., and 1·8 cm. in length. They agree in all respects with Traustedt's description and figures. A third specimen of the same form, measuring 1·8 cm., is amongst the specimens mounted as microscopic slides during the expedition. It is from the same locality.

Salpa musculosa, n. sp. (Pl. VI. figs. 1–4).

External Appearance.—The shape is elongated, with the anterior and posterior ends somewhat abruptly narrowed. The middle part of the body tapers slightly towards the posterior part, and is ridged longitudinally. The apertures are both terminal. The branchial is large, and has semicircular lips. The atrial is smaller and more circular in outline. It has no prominent lips. The surface is smooth. The colour is a yellowish grey.

Length, 4 cm.; greatest breadth, 1·2 cm.

The Test is thin, and only moderately firm. It is fairly transparent.

The Mantle has a well-developed musculature. There are ten very wide muscle bands, which nearly touch one another, so as to form almost a complete muscular investment.

The Endostyle is conspicuous.

The Dorsal Lamina has the ribbed portion rather narrow.

The Dorsal Tubercle is large but simple. It is elongated antero-posteriorly.

The *Visceral Mass* is of moderate size. It is placed near the posterior end of the body.

Localities.—(1.) April 12, 1876; Station 351, Atlantic, off the West Coast of Africa; surface; lat. 9° 9′ 0″ N., long. 16° 41′ 0″ W.; surf. temp. 81°·8; two specimens.

(2.) April 13, 1876; Station 352, lat. 10° 55′ 0″ N., long. 17° 46′ 0″ W.; surf. temp. 77°·7; two specimens.

This species resembles the solitary form of *Salpa hexagona* somewhat in shape, in the position of the apertures, and especially in the musculature, but differs from that species in several points of structure, and particularly in the total absence of the large posteriorly-placed spines found in *Salpa hexagona*.

The body is somewhat prismatic in shape (Pl. VI. fig. 1). The dorsal and ventral surfaces are flat, and are bounded by prominent ridges, while the sides of the body are (in the spirit specimens) rather depressed. There are thus four longitudinal ridges, a dorsal and a ventral on each side of the body. In the specimens examined, a transverse section of the middle of the body would have a quadrangular shape with projecting angles (Pl. VI. fig. 2). In the solitary form of *Salpa hexagona* there are six longitudinal ridges.

The anterior end of the body is wider than the posterior (Pl. VI. fig. 1), and passes more gradually into the larger middle part. The body is rounded anteriorly, while posteriorly it is truncated. This difference is due to the shapes of the apertures. The branchial is bilabiate, and the anterior parts of the lips are rounded,—the dorsal projecting slightly farther forward than the ventral. The atrial aperture, on the other hand, has no distinct lips, but is merely the circular termination of the atrial siphon (Pl. VI. figs. 1 and 3).

The dimensions given above are those of one of the specimens obtained on April 12, 1876. The other is 3·2 cm. in length and nearly 1 cm. in breadth. The two specimens collected on April 13, 1876, measure 3·2 cm. and 2·8 cm. in length, while their greatest breadth is about 1·3 cm. All the specimens are from the Atlantic; they are in rather bad condition.

All the specimens of this species are of an opaque yellowish-grey colour; but this is due more, I believe, to the strongly-developed musculature of the mantle than to the test. In the narrow intervals between the muscle bands, the test appears clear and transparent. The longitudinal ridges on the test are very slightly thicker than the rest of the surface. They are, however, due more to folding than to thickening. They are not echinated.

The musculature is very remarkable (Pl. VI. figs. 1, 3, and 4). It is in a condition paralleled only by the solitary form of *Salpa hexagona*. The muscle bands are so wide that they almost touch their neighbours, and here and there they do touch and fuse with one another. There are nine or ten bands on each side, of which the first is single in the dorsal middle line (Pl. VI. figs. 3 and 4), but breaks up as it runs outwards to the sides into three branches, one of which continues its course transversely, while the other two turn forwards towards the branchial aperture (Pl. VI. fig. 4). If these two anterior branches be regarded as distinct muscle bands, then the total number would be twelve, of which the first, second, and third fuse dorsally. At the posterior end of the body it becomes difficult to distinguish the exact number of bands as they lie close together and partially fuse at intervals. In *Salpa hexagona*, solitary form, there are eleven bands, of which the posterior is partially divided, while the arrangement at the anterior end of the body is quite different from that seen in the present species.

The endostyle is large (Pl. VI. fig. 3, *en.*), and extends farther forwards than the anterior end of the dorsal lamina. The peripharyngeal bands run dorsally and posteriorly. The dorsal lamina is attached to the mantle as far back as the third muscle band (Pl. VI. fig. 4, *d.l.*). Its ribbed portion is narrower than usual, and the transverse ridges are slight and irregular (Pl. VI. fig. 4). The dorsal tubercle scarcely projects from the surface of the triangular perituberculár area (Pl. VI. figs. 3 and 4), and the languet is apparently absent. The ganglion is placed on the first, or at the junction of the first and second muscle bands. It is farther back than in most species of *Salpa*, but not nearly so far back as in *Salpa hexagona*, where, according to Traustedt, it lies on the fifth muscle band.

The visceral mass is globular, and of an opaque, yellowish-white colour. It lies at the base of the atrial siphon, rather to the right side of the posterior end of the endostyle (Pl. VI. figs. 1 and 3, *visc.*).

Salpa echinata, n. sp. (Pl. V. figs. 1–10).

External Appearance.—The body is elongated, sub-cylindrical, and rather swollen towards the posterior part. The anterior end is narrow, but rounded. The posterior end is wider, but more irregular in shape. The dorsal surface is flat; the ventral is gently convex. The branchial aperture is on the dorsal surface near the anterior end. It is rather small, and is semicircular in outline. The atrial aperture is placed at the posterior end of the body, and is surrounded by irregular spinose processes of the test. The surface is smooth, with the exception of a series of dorsal, lateral, and ventral echinated ridges, which run more or less longitudinally from end to end. These ridges become more numerous anteriorly, but more prominent towards the posterior end of the body.

Length, 4 cm.; breadth, near anterior end, 7 mm., near posterior end, 1 cm.

The Test is clear and transparent. It is soft and rather thin, except where thickened to form the echinated ridges, and on the posterior part of the ventral surface, over the visceral mass. The posterior swollen part where the ridges are largest is considerably stiffer than the anterior part.

The Mantle has the musculature moderately developed. There are nine transverse muscle bands visible on the sides of the body. Of these, the first, second, and third approach one another dorsally, and fuse in the middle line, while the remaining six keep distinct, and are nearly equidistant from one another. All the muscle bands die away ventrally.

The Endostyle is very distinct. It extends forwards in front of the branchial aperture.

The Dorsal Tubercle is simple, but of fairly large size. It is elongated antero-posteriorly, and has gently rounded ends.

The Visceral Mass is placed near the posterior end of the ventral surface. It is not large.

Localities.—(1.) October 21, 1875; Station 288, South Pacific; surface; lat. 40° 3′ 0″ S., long. 132° 58′ 0″ W.; surf. temp. 54°·5; two specimens.

(2.) November 5, 1875; Station 295, South Pacific; surface, taken at night; lat. 38° 7′ 0″ S., long. 94° 4′ 0″ W.; surf. temp. 58°·5; one specimen.

(3.) January 21, 1876; Station 314, near the Straits of Magellan; lat. 51° 35′ 0″ S., long. 65° 39′ 0″ W.; depth, 70 fms.; bottom temp. 46°, surf. temp. 48°; two specimens.

(4.) April 12, 1876; Station 351, Atlantic, off the West Coast of Africa; surface; lat. 9° 9′ 0″ N., long. 16° 41′ 0″ W.; surf. temp. 81°·8; one specimen.

The presence in this species of echinated ridges, terminating posteriorly in spines, shows some resemblance to *Salpa hexagona*, but the two species differ in many points —notably in the musculature. The distribution of the present species is wide. It was taken twice in the Pacific and twice in the Atlantic. It appears to be identical with the species found on the east coast of North America, which is sent out under the name of "*Salpa* (large species)" by the United States Fish Commission.

A noteworthy point in regard to the shape is the bulb-like swelling of the posterior part of the body (Pl. V. figs. 1–3). It is seen in all the specimens. The narrow anterior half of the body is almost cylindrical, and it terminates in a smooth, rounded, anterior end. The posterior extremity, on the other hand, is irregularly pointed, and bears the atrial aperture. The dorsal surface is flattened, and even slightly depressed, while the sides of the body are rounded (Pl. V. fig. 3). The ventral surface attains its greatest convexity about two-thirds of the way back (Pl. V. fig. 2). The longitudinal serrated ridges are arranged as follows :—

There are two main dorsal ridges which spring from the pointed posterior end, and rapidly diverge until they are about 8 mm. apart on the wide bulbous part of the body (Pl. V. fig. 1) ; they then approach slightly, and again diverge so as to attain a lateral position, which they preserve until they gradually die away on the anterior end of the body. Between these main dorsal ridges there are other shorter and less conspicuous ridges on the dorsal surface,—one on each side of the middle line on the posterior wider part of the body, and two on each side of the middle line on the anterior narrower part of the body (Pl. V. fig. 1). There are also a few scattered minute pointed tubercles between these ridges. Along each side of the body, rather nearer the ventral than the dorsal surface, runs a well-marked longitudinal serrated ridge. Its course is fairly straight (Pl. V. fig. 2). It is most strongly marked at the posterior end, and dies away anteriorly. Finally, in the median ventral line, on the wider posterior end of the body, there is a strongly-marked longitudinal serrated ridge (Pl. V. fig. 3). About 1·2 cm. from the posterior end this ventral ridge bifurcates, and the two branches, which diverge slightly, run forwards till they die away on the anterior extremity of the body. All these ridges are more conspicuous on the posterior part of the body, and end posteriorly in prominent spines. There are thus five main ridges (two dorsal, two lateral, and a ventral), and two slighter ones, on the posterior half of the body ; and six main ridges (two dorsal, two lateral, and two ventral), and four slighter ones, on the anterior half (see the transverse sections of the anterior, fig. 6, and of the posterior, fig. 5, parts of the body showing the shape and the arrangement of the ridges).

The test of the anterior half of the body is very weak, posteriorly it is much firmer, and over the region of the nucleus it becomes considerably thickened. The edges of the small semicircular branchial aperture (Pl. V. fig. 1) are also thickened so as to form a distinct margin. The atrial aperture has no bounding margin except the spinose processes which terminate the longitudinal ridges posteriorly.

The measurements given above are taken from the specimen obtained on November 5, 1875. The two specimens collected on October 21, 1875, are larger, and measure 5·5 cm. and 4·2 cm. in length. The two specimens from Station 314, January 21, 1876, measure 3·7 cm. and 5 cm. in length. The remaining specimen, collected on April 12, 1876, is 3 cm. in length.

The muscle bands in the mantle are rather narrow, and are all of much the same size. There is no musculature on the ventral surface, as all the bands end on the sides of the body (Pl. V. fig. 2). The musculature of the dorsal surface (Pl. V. fig. 1) is somewhat like that of the solitary forms of *Salpa runcinata-fusiformis* and of *Salpa cylindrica*, but differs from both. In *Salpa runcinata* the eighth and ninth bands approach and meet dorsally, and in *Salpa cylindrica* the fourth band joins with the first, second, and third dorsally; while in the present species the fourth, eighth, and ninth bands are quite distinct and independent of their neighbours. Figure 7 shows the junction of the first, second, and third bands dorsally.

The conspicuous endostyle (Pl. V. figs. 3 and 9, *en.*) is of a slightly yellow colour. In the specimen collected on November 5, 1875, it is 3 cm. in length, and extends from close to the anterior end of the body (1 mm. in front of the peripharyngeal band) to the anterior part of the visceral mass. The peripharyngeal bands bend posteriorly on the sides of the body and on the dorsal surface (Pl. V. fig. 9, *p.p.*), so that the dorsal tubercle comes to be placed posterior to the anterior extremity of the endostyle.

The nerve ganglion is small and of rounded form. The dorsal lamina is fairly large. The transverse ridges on it are rather wide, closely placed, and arranged with great regularity (Pl. V. fig. 8). Their course is almost straight. The dorsal tubercle has a curved free margin (Pl. V. fig. 9, *d.t.*), with rounded anterior and posterior ends. The languet is not well marked.

The visceral mass is formed of two parts, of which one is globular in shape, and is composed of the alimentary and reproductive viscera; while the other is of curved or irregularly crescentic shape, and is probably the remains of the elæoblast (Pl. V. figs. 3, 4, and 10). Figure 4 also shows, placed more anteriorly in the median ventral line, a spherical dark-coloured mass, which may be what is left of the "placenta" of the embryo. In that case the specimen figured is of course a solitary form, although it shows no trace of a developing chain.

Salpa mollis, n. sp. (Pl. V. figs. 11–15).

External Appearance.—The shape is elongated, and sub-cylindrical. The anterior and posterior ends are moderately wide, and the sides are nearly parallel. The branchial aperture is placed on the dorsal edge, nearly 2 cm. from the anterior end of the body. The atrial aperture is at the posterior end. The surface is covered with small pointed tubercles placed mainly in longitudinal rows, of which there are six to eight on each side. Towards the extremities of the body these rows become more distinct, and at the posterior end they are raised up to form prominent toothed ridges.

Length nearly 12 cm., breadth 3 to 3·5 cm.

The Test is very transparent, and is thin and soft all over the body. Its thickness between the toothed ridges is about 1 mm.

The Mantle has its musculature moderately developed. There are ten transverse muscle bands on the dorsal surface. Of these the second and third approach and join one another dorsally, while the rest remain independent. All the muscle bands die away on the ventral surface.

The Endostyle is conspicuous on the ventral surface. It runs from the first to the ninth muscle band.

The Dorsal Lamina is large, but clear and transparent. The transverse ridges are very slightly marked.

The Dorsal Tubercle is large, but simple. It is elongated antero-posteriorly.

The Visceral Mass is not large. It is placed near the posterior end of the body, between the ventral ends of the eighth and ninth muscle bands.

Locality.—November 6, 1875; South Pacific; at night; lat. 37° 50′ 0″ S., long. 93 54′ 0″ W.; surf. temp. 59°·7.

The above description is taken from a single large specimen, somewhat injured, which was collected near Station 295, in the South Pacific. The test is singularly soft and flexible, so that it is impossible to say exactly what the shape of the body was when living. A notable feature in the external appearance is the presence of the numerous small papillæ scattered all over the body. The toothed ridges which they form at the posterior end of the body (Pl. V. fig. 13) are about 2 mm. in height. Plate V. fig. 14 represents a section across part of the test and two of the ridges, natural size. Between the ridges there are numerous irregularly scattered smaller papillæ (Pl. V. fig. 13). The branchial aperture is a transverse curved slit, with slightly thickened lips (Pl. V. fig. 15). The atrial aperture is torn in the present specimen.

The musculature of the dorsal surface (Pl. V. fig. 11) resembles somewhat that of the solitary form of *Salpa africana-maxima*, where, however, there are only nine bands altogether, and the second and third do not join as they do in this species. The muscle bands run round the sides of the body, and end on the edges of the ventral surface, so as to leave a space free from muscles on each side of the endostyle (Pl. V. fig. 12). There are scattered muscle fibres on the tube-like posterior part of the mantle which forms the atrial siphon.

The endostyle does not extend so far forwards as in the case of *Salpa echinata*, but its anterior end projects a little in front of the peripharyngeal band (Pl. V. fig. 15, *p.p.*), and is distinctly in front of the dorsal tubercle. It does not reach so far forwards as the branchial aperture. The peripharyngeal bands have an undulating course (Pl. V. fig. 15). Commencing from the anterior extremity of the endostyle, they run outwards and then forwards to the side of the body, and then backwards and inwards along the dorsal surface to the anterior end of the dorsal lamina. The languet or posterior part of the dorsal tubercle is moderately developed (Pl. V. fig. 15, *d.t.*), and points backwards.

The transverse ribs on the dorsal lamina are so slight as to be scarcely visible (Pl. V. fig. 15, *d.l.*) They are narrow, and very irregular in their course. The whole dorsal lamina, like the rest of the body in this species, is very transparent and gelatinous.

The visceral mass is compact and small relatively to the size of the body (Pl. V. fig. 12). It is of an opaque white colour.

Salpa cordiformis-zonaria, Quoy and Gaimard—Pallas (Pl. VII. figs. 1–9).

Holothurium zonarium, Pallas, Spicil. Zool., fasc. x. p. 26, 1774.
Salpa cordiformis, Quoy and Gaimard, Ann. d. Sci. Nat., tom. x. p. 226, 1827.
Salpa cordiformis-zonaria, Krohn, Ann. d. Sci. Nat. (Zool.), sér. 3, tom. vi. p. 112, 1846.
Salpa cordiformis-zonaria, Traustedt, *loc. cit.*, p. 382, which see for further synonymy.

The specimens of this species in the collection represent both the solitary and the aggregated forms. They are from the following localities :—

(1.) June 23, 1874 ; Station 166, Pacific, west of New Zealand ; lat. 38° 50′ 0″ S., long. 169° 20′ 0″ E. ; depth, 275 fathoms ; bottom temp. 50°·8, surf. temp. 58°·5 ; two specimens of the solitary form (3·5 cm. and 2·8 cm. in length).

(2.) August 25, 1874 ; Station 181, South-West Pacific ; lat. 13° 50′ 0″ S., long. 151° 49′ 0″ E. ; surf. temp. 80° ; two specimens of the aggregated form (1 cm. and 1·5 cm. in length).

(3.) March 16, 1875 ; Station 222, West Pacific, north of the Admiralty Islands ; surface ; lat. 2° 15′ 0″ N., long. 146° 16′ 0″ E. ; surf. temp. 82°·8 ; one specimen of the aggregated form (small), two specimens of the solitary form (2·5 cm. and 3 cm. in length).

(4.) April 3, 1875; North Pacific ; surface ; lat. 24° 49′ 0″ N., long. 138° 34′ 0″ E. ; surf. temp. 71°·5 ; one specimen of the aggregated form (2·2 cm. in length).

(5.) June 5, 1875 ; Station 236, off Japan ; lat. 34° 58′ 0″ N., long. 139° 29′ 0″ E. ; surf. temp. 66°·5 ; one specimen of the aggregated form (3·2 cm. in length).

(6.) January, 1876 ; Straits of Magellan ; th reespecimens of the aggregated form (one nearly 6 cm. in length, one test only).

(7.) January 1, 1876 ; Station 305, off the West Coast of South America ; lat. 47° 47′ 0″ S., long. 74° 47′ 0″ W. ; surf. temp. 55°·5 ; one specimen of the aggregated form (3·3 cm. in length).

(8.) January 11, 1876; Station 311, Straits of Magellan; lat. 52° 45′ 30″ S., long. 73° 46′ 0″ W.; surf. temp. 50°; two specimens of the aggregated form (4 cm. in length).

(9.) February 14, 1876; Station 320, South Atlantic, off Buenos Ayres; lat. 37° 17′ 0″ S., long. 53° 52′ 0″ W.; surf. temp. 67°·5; one specimen of the aggregated form, and one specimen of the solitary form (6 cm. in length).

(10.) March 9, 1876; Station 331, South Atlantic; lat. 37° 47° 0″ S., long. 30° 20′ 0″ W.; surf. temp. 64°·5; three specimens of the aggregated form.

(11.) April 28, 1876; North Atlantic; lat. 17° 47′ 0″ N., long. 28° 28′ 0″ W.; surf. temp. 73°·5; three specimens of the aggregated form (from 2 cm. to 2·5 cm. in length, two of them imperfect).

(12.) Collected during the cruise of H.M.S. "Knight-Errant;" North Atlantic, to the north-west of Scotland; several specimens of the aggregated form.

Both the solitary and the aggregated forms in this collection differ somewhat from the figures of the species given by Traustedt.

The two specimens of the solitary form from Station 166 (see Pl. VII. fig. 4) have the two laterally placed spines near the atrial aperture and the broad truncated anterior end, and the muscle bands are wider than in the aggregated form, although not so wide as in the specimens figured by Traustedt. The pointed posterior end is relatively longer, and tapers to a finer point than is the case in Traustedt's figure. In all other respects the specimens are typical. The two specimens collected in the Pacific, on March 16, 1875, have the posterior processes all well marked and sharp pointed, and in other respects agree with the typical form.

The large specimen of the solitary form from Station 320 measures 6 cm. in length and 2 cm. in breadth. It has very wide muscle bands, more like those figured by Traustedt than any of the other Challenger forms. They are about 8 mm. in width. In the shape of the body, however, this specimen is not in the typical condition. It has a very short process at the posterior end of the body, which is not quite median in position, and the lateral spines are very slightly developed and are unsymmetrical. In these respects this specimen shows an approach to the characters of the aggregated form.

The aggregated form of this species was met with by the Challenger much more frequently than the solitary; and the specimens collected by the "Knight-Errant" Expedition in the North Atlantic during the summer of 1880 belong entirely to the aggregated form. These specimens differ in shape amongst themselves to a considerable degree (Pl. VII. figs. 1, 2, and 3). The anterior end may be rounded and blunt, or conical and pointed, or quite irregular in shape; while the posterior end may also be irregularly rounded, or may be produced to form a process tapering more or less to a point. This pointed posterior end is never median, but turns somewhat towards the right side of the body in all the specimens (Pl. VII. figs. 2 and 3). The sides of the body in my specimens do not bulge outwards, as is shown in Traustedt's figure,[1] but are straight and parallel, and in this respect are more like Traustedt's figures[2] of the solitary form.

The Challenger specimen of the aggregated form from Station 320, in the South Atlantic, is precisely like those collected by the "Knight-Errant" in the North Atlantic, and has the pointed posterior end turned very much to the right side.

One of the specimens from the Straits of Magellan is the largest in the collection. It is nearly 6 cm. in length, and has the posterior projection over 1 cm. in length. In the specimen obtained in the Pacific, on April 3, 1875, the posterior projection is relatively very long, and the muscle bands in the mantle are narrow. In one of the specimens obtained in the North Atlantic, on April 28, 1876, the posterior projection is also very long; while, on the other hand, the specimens from Station 311, in the Straits of Magellan, have their posterior ends very blunt, there being almost no process. The specimen from Station 236, off the coast of Japan, is rather more slender than usual, and has the posterior projection long and pointed. It measures 7 mm. in length, the length of the whole body being 3·2 cm.

The three specimens collected in the South Atlantic, on March 9, 1876, have embryos, occupying the exact position figured by Traustedt. A part of one of these specimens is shown on Plate VII. fig. 5, with three embryos lying between the 5th and 6th muscle bands. Figures 6–9 on Plate VII. illustrate some points in the histology of the aggregated forms collected on March 9, 1876. Figure 6 shows the nervous system, dorsal tubercle, and neighbouring parts. The muscle fibres in these specimens are very distinctly nucleated and cross-striated. Figure 7 shows a part of the edge of the dorsal tubercle, and figure 8 some of the ciliated cells more highly magnified. The large nucleated cells forming the lateral appendages of the nerve ganglion are shown in fig. 9.

The three processes of the mantle, shown running into the test at the anterior end of the body in Traustedt's figure, are not always present in the Challenger specimens. In some there are two processes, in some only one, and in some none of them are present.

Salpa cylindrica, Cuvier (Pl. VII. fig. 10).

Salpa cylindrica, Cuvier, Ann. du Mus., tom. iv. p. 381, 1804.
Iasis cylindrica, Savigny, Mém., p. 124, 1816.
Salpa cylindrica, Traustedt, *loc. cit.*, p. 277, which see for further synonymy.

Both solitary and aggregated forms of this species are represented in the Challenger collection. The following is a list of the localities at which the specimens were obtained:—

(1.) December 27, 1873; Station 145A; lat. 46° 41′ 0″ S., long. 38° 10′ 0″ E.; off

[1] *Loc. cit.*, tab. i. fig. 21.
[2] *Loc. cit.*, tab. i. figs. 18 and 19.

Prince Edward Island, in the Southern Ocean; taken at night; surf. temp. 41°·5; one specimen, probably of the solitary form of this species (only a fragment, in bad condition).

(2.) February 2, 1874; Station 150, in the Southern Ocean; lat. 52° 4′ 0″ S., long. 71° 22′ 0″ E.; surf. temp. 37°·5; one specimen of the solitary form (1·5 cm. in length).

(3.) February 3, 1874; in the Southern Ocean, near Heard Island; lat. 52° 20′ 0″ S., long. 72° 14′ 0″ E.; surf. temp. 38°; one specimen, probably of the solitary form of this species (in bad condition).

(4.) August 25, 1874; Station 181, in the West Pacific; lat. 13° 50′ 0″ S., long. 151° 49′ 0″ E.; surf. temp. 80°; six specimens, probably of the solitary form of this species (in very bad condition; average length about 2 cm.).

(5.) March 16, 1875; Station 222, in the West Pacific, north of the Admiralty Islands; surface; lat. 2° 15′ 0″ N., long. 146° 16′ 0″ E.; surf. temp. 82°·8; one specimen of the solitary form (rather large and opaque).

(6.) April 5, 1875; Station 230, Pacific; lat. 26° 29′ 0″ N., long. 137° 57′ 0″ E.; surf. temp. 68°·5; one specimen, possibly of this species, in bad condition (in a tube along with a young *Pyrosoma*).

(7.) November 5, 1875; Station 295, South Pacific; surface, at night; lat. 38° 7′ 0″ S., long. 94° 4′ 0″ W.; surf. temp. 58°·5; five specimens of the solitary form (small), and five specimens of the aggregated form (small, and in bad condition).

(8.) April 26, 1876; North Atlantic, off the West Coast of Africa; lat. 16° 49′ 0″ N., long. 25° 14′ 0″ W.; surf. temp. 73°·2; four specimens of the solitary form (largest 4 cm. in length and 1 cm. in breadth), and many specimens of the aggregated form (small, average length 5 mm.). In the same bottle is part of the test of a large *Salpa*, species indeterminable.

(9.) April 27, 1876; North Atlantic; lat. 17° 18′ 0″ N., long. 26° 32′ 0″ W.; surf. temp. 73°·5; about fifty specimens of the solitary form (mostly in bad condition), the largest is 4·5 cm. in length; and one specimen of the aggregated form (6 mm. in length).

(10.) April 28, 1876; North Atlantic; lat. 17° 47′ 0″ N., long. 28° 28′ 0″ W., surf. temp. 73°·5; one specimen of the solitary form (3·5 cm. in length), and two specimens of the aggregated form (small, 5 mm. in length).

(11.) April 29, 1876; North Atlantic; lat 18° 8′ 0″ N., long. 30° 5′ 0″ W.; surface, at night; surf. temp. 73°·7; one specimen of the solitary form (2·2 cm. in length), and twenty-four specimens of the aggregated form (average 6 mm. in length).

The largest specimen of the solitary form of this species in the collection. is one of those obtained in the North Atlantic on April 27, 1876. It measures 4·5 cm. in length and 1 cm. in breadth. The average size of the other specimens obtained at the same locality is 1·5 cm. in length and 4 mm. in breadth. The width and the distance apart of the muscle bands of the mantle differ considerably in these specimens. Smaller muscle bands are visible in some of the specimens (*i.e.* those collected in the North

Atlantic, on April 26, 1876), both anteriorly and posteriorly to the nine chief bands. These are indicated in Traustedt's figures.

Where it is present, the chain of embryos is longer and narrower than is represented in Traustedt's figures[1] of this species. This last remark applies to all the solitary forms in the collection. They have the embryonic chain exactly in the position shown by Traustedt, but it is always long and narrow.

The aggregated forms vary considerably both in shape and size. Most of the specimens in the collection are 5 mm. or 6 mm. in length, but some extend up to 1 cm. The processes of the test at the anterior and posterior ends of the body are longer and sharper in the specimen obtained on April 27, 1876, than is represented in Traustedt's figures.

The arrangement of the nervous system, dorsal tubercle, and neighbouring parts, in a specimen of the aggregated form collected on April 26, 1876, is shown in Pl. VII. fig. 10. The ganglion is of rounded form, and has a large pigmented sense-organ (ocular) placed on its anterior end. The dorsal tubercle is elongated antero-posteriorly, and is slightly curved. The peritubercular area is continued posteriorly into a well-marked epipharyngeal groove (Pl. VII. fig. 9, *j.*). The point where the dorsal lamina becomes free from the mantle is shown at *k.* The dorsal lamina is marked by transverse bands of ciliated epithelium (Pl. VII. fig. 10, *d.l.*).

Salpa runcinata-fusiformis, Chamisso—Cuvier (Pl. VI. figs. 5–12).

Salpa fusiformis, Cuvier, Ann. du Mus., tom. iv. p. 382, 1804.
Salpa runcinata, Chamisso, De Animalibus, &c., p. 16, 1819.
Salpa runcinata-fusiformis, Krohn, Ann. d. Sci. Nat. (Zool.), ser. 3, tom. vi. p. 112, 1846.
Salpa runcinata-fusiformis, Traustedt, *loc. cit.*, p. 370, which see for further synonymy.

This well-known species is the second commonest in the Challenger collection; both solitary and aggregated forms, and especially the latter, having been taken at a large number of localities. As a rule, the aggregated forms occurred in far greater numbers than the solitary.

The following is a list of the localities, and the number of specimens from each :—

(1.) December 27, 1873; Station 145A, off Prince Edward Island, in the Southern Ocean; lat. 46° 41′ 0″ S., long. 38° 10′ 0″ E.; surf. temp. 41°·5; many specimens of the aggregated form (in bad condition).

(2.) February 3, 1874; near Heard Island, in the Southern Ocean; lat. 52° 20′ 0″ S., long. 72° 14′ 0″ E.; surf. temp. 38°; one specimen of the solitary form (?), in bad condition, along with a *Salpa*, which is probably a bad specimen of the solitary form of *Salpa cylindrica*.

(3.) February 11, 1874; Station 152, Antarctic Ocean; lat. 60° 52′ 0″ S., long. 80° 20′ 0″ E.; surf. temp. 34°·5; about one hundred and sixty specimens of the aggregated form (many of them large), and one large and several small specimens of the solitary form.

[1] *Loc. cit.*, tab. ii. figs. 35 and 36.

(4.) August 25, 1874; Station 181, in the South-west Pacific; lat. 13° 50′ 0″ S., long. 151° 49′ 0″ E.; surf. temp. 80°; one specimen of the aggregated form.

(5.) November 13, 1874; Station 205, off the Philippine Islands; lat. 16° 42′ 0″ N., long. 119° 22′ 0″ E.; surf. temp. 82°; four specimens, probably belonging to the aggregated form of this species (in bad condition).

(6.) January 9, 1875; off the Philippine Islands; lat. 16° 35′ 0″ N., long. 117° 47′ 0″ E.; surf. temp. 76°·5; eight specimens of the aggregated form.

(7.) February 1875; north of New Guinea, West Pacific; surface; two specimens of the solitary form (1·2 cm. and 1·8 cm. in length respectively).

(8.) March 16, 1875; Station 222, north of the Admiralty Islands, West Pacific; lat. 2° 15′ 0″ N., long. 146° 16′ 0″ E.; surf. temp. 82°·8; six specimens of the aggregated form (fairly large), and five specimens of the solitary form (1·5 cm. in length).

(9.) May 12, 1875; Station 232, off Japan; lat. 35° 11′ 0″ N., long. 139° 28′ 0″ E.; surf. temp. 64°·2; one specimen of the aggregated form (nearly 4 cm. in length; in bad condition).

(10.) July 21, 1875; Station 256, North Pacific; taken at night; lat. 30° 22′ 0″ N., long. 154° 56′ 0″ W.; surf. temp. 74°; three specimens of the solitary form (8 mm. to 1·4 cm. in length).

(11.) October 20, 1875; South Pacific; lat. 38° 54′ 0″ S., long. 133° 21′ 0″ W.; surf. temp. 55°·5; three specimens of the aggregated form (the largest is 6 cm. in length and 2 cm. in breadth).

(12.) November 5, 1875; Station 295, South Pacific, at night; lat. 38° 7′ 0″ S., long. 94° 4′ 0″ W.; surf. temp. 58°·5; five specimens of the solitary form (poor specimens), and four specimens of the aggregated form (poor specimens).

(13.) November 6, 1875; South Pacific; lat. 37° 50′ 0″ S., long. 93° 54′ 0″ W.; surf. temp. 59°·5; one specimen of the aggregated form (6 cm. in length, and 2 cm. in breadth).

(14.) November 8, 1875; South Pacific; surface; lat. 37° 56′ 0″ S., long. 90° 39′ 0″ W.; surf. temp. 58°·7; one specimen of the aggregated form (2 cm. in length). This specimen is one of those mounted as a microscopic object during the expedition. There is a second smaller specimen of probably the same form on a microscope slide, the locality of which has been lost.

(15.) February 12, 1876; Station 319, South Atlantic, off the east coast of South America; near the surface; lat. 41° 54′ 0″ S., long. 54° 48′ 0″ W.; surf. temp. 59°·5; ten small specimens of the aggregated form, and six small specimens of the solitary form (stained in carmine and preserved in glycerine).

(16.) March 9, 1876; Station 331, South Atlantic; lat. 37° 47′ 0″ S., long. 30° 20′ 0″ W.; surf. temp. 64°·5; one hundred specimens of the aggregated form (mostly about 2 cm. in length), and one specimen of the solitary form (1·6 cm. in length and 6 mm. broad).

(17.) March 10, 1876; Station 332, South Atlantic; lat. 37° 29′ 0″ S., long. 27° 31′ 0″ W.; surf. temp. 64°; three hundred specimens of the aggregated form (many of them small and not in a good state of preservation), and fifteen specimens of the solitary form (the largest is 3·3 cm. in length and 2·3 cm. in breadth).

(18.) April 13, 1876; Station 352, North Atlantic; lat. 10° 55′ 0″ N., long. 17° 46′ 0″ W.; surf. temp. 77°·7; forty-three specimens of the aggregated form (several small, the rest of medium size, 2·3 cm. in length), and one specimen of the solitary form (fragment).

(19.) April 26, 1876; North Atlantic; lat. 16° 49′ 0″ N., long. 25° 14′ 0″ W.; surf. temp. 73°·2; ten specimens of the aggregated form (fairly large).

(20.) April 29, 1876; North Atlantic; lat. 18° 8′ 0″ N., long. 30° 5′ 0″ W.; surf. temp. 74°; ten specimens of the solitary form (1·4 cm. to 2·2 cm. in length).

(21.) May 7, 1876; North Atlantic; at night; lat. 34° 22′ 0″ N., long. 34° 23′ 0″ W.; surf. temp. 67°·5; eight specimens of the aggregated form.

(22.) Collected during the cruise of H.M.S. "Triton" in August 1882; in the North Atlantic, to the north-west of Scotland; one specimen of the solitary and one of the aggregated form.

The specimens collected by the Challenger vary considerably in size in both forms of the species. Taking the aggregated form first, we find that the hundred specimens collected in the South Atlantic, on March 9, 1876, vary in length from 5 mm. to 4 cm. The greater number of them are about 2 cm. in length. The largest specimens are those obtained in the South Pacific, on October 20 and November 6, 1875. They measure 6 cm. in length by 2 cm. in greatest breadth.

The other dimensions of the specimens from the South Pacific, on November 6, 1875, are as follows:—

From the anterior end of the body to the middle of the dorsal junction of the muscle bands,	2·5 cm.
From the middle of the dorsal junction of the muscle bands to the posterior end of the visceral mass,	2·0 cm.
From the posterior end of the visceral mass to the posterior end of the body,	1·5 cm.

Several of the specimens from Station 152, in the Antarctic, measure over 5 cm. in length by nearly 2 cm. in greatest breadth. In some of these the anterior and posterior tapering processes of the body are relatively very much shorter than in the specimen figured by Traustedt,[1] and the posterior one has the test thickened, and provided with a sharp ridge running along each side of the dorsal surface. In some of the specimens these ridges are toothed or finely serrated (Pl. VI. fig. 5). In a few of the specimens there are also a ventral and two more or less complete lateral ridges, giving the body an angular or somewhat prismatic appearance. In fact, the shape of the body, and especially the proportion of the anterior and posterior pointed ends, seems liable to a great deal of variation.

The specimens obtained in the North Atlantic, on April 26, 1876, have their ends bifurcated in place of being pointed (see Pl. VI. fig. 6), and some have the

[1] Bidrag til Kundskab om Salperne, Tab. ii. fig. 31.

angular appearance produced by the longitudinal ridges as described above. The appearance of these specimens is very different from that of the typical form, and they might be regarded as a distinct variety. In one of the specimens collected on April 26, 1876, however, the one end of the body was bifurcated while the other was pointed. One of the specimens also collected at Station 222, in the Pacific, on March 16, 1875, has the posterior end of the body bifurcated; and of those collected in the North Atlantic, on May 7, 1876, at night, a few have bifurcated ends, while the rest are pointed. They are all rather prismatic in form.

The very large specimen obtained in the South Pacific, on November 6, 1875, has the posterior process of the body prismatic, and provided with slightly serrated ridges, while the anterior process is plain. The equally large specimen obtained in the South Pacific, on October 20, 1875, has the serrated ridges continued all along the body, but they become more marked towards the posterior end.

In other cases, again, the posterior process may be much reduced. In some of the specimens collected in the South Atlantic, on March 10, 1876, the posterior process may be said to be absent, and the body is rounded off close behind the nucleus; while in others from the same locality the posterior end of the body is well developed.

The muscular system of the mantle is also liable to a certain amount of variation, not in regard to the number and arrangement of the muscle bands, which seem to be very constant, but in regard to the width of the bands and their distinctness. In some cases, however, the musculature differs from that of the specimen figured by Traustedt. Fig. 7 on Pl. VI. shows a specimen obtained on November 6, 1875, in which the muscle bands are relatively wide and distinct, and in which the first muscle band (1) does not reach so far forwards as usual, while the branchial muscle band (*br.m.*) extends farther back.

In fig. 12 on the same plate a more important variation is shown. It represents part of the musculature of a specimen obtained in the South Atlantic, on February 12, 1876, in which the fourth and fifth muscle bands not only touch at the sides of the body, but actually join and anastomose, some of the fibres being traceable from the fourth into the fifth, and others from the fifth into the fourth, so as to form a decussation. In the same figure (Pl. VI. fig. 12) *emb.* shows the position of the embryo.

The dorsal lamina ("gill") and dorsal tubercle of this species are shown about twice the natural size in Pl. VI. fig. 7, and more highly magnified in fig. 11. The dorsal lamina increases gradually in width, and is simply marked with oblique bands. The dorsal tubercle is of an elongated elliptical shape, with a narrow slit running along the centre of its length. There is scarcely any projection, only the anterior end being raised to form a slight hood (Pl. VI. fig. 11).

The nerve ganglion is small and rounded. It is placed immediately behind the posterior end of the dorsal tubercle (Pl. VI. fig. 11, *n.g.*)

The solitary form does not show so wide a variation as the aggregated form in this species, judging from the Challenger specimens. The largest complete specimen of the solitary form in the collection is one obtained at Station 152, in the Antarctic, measuring 6·5 cm. in length and 2 cm. in breadth, and having a long chain of embryos about 3 mm. in diameter. A fragment of a large specimen was collected in the North Atlantic, on April 13, 1876, in which no muscle bands are visible, and the nucleus is covered with a layer of dark pigment. Also on March 10, 1876, a fragment of a very large specimen was obtained at Station 332, in the South Atlantic, which showed the nucleus covered with dark pigment. These fragments probably belong to this species, but it is impossible to determine them with certainty.

A good deal of variation is found in regard to the length, the shape, and the position of the embryonic chain. In some of the smaller specimens, such as the three collected in the North Pacific, on July 21, 1875, and varying from 8 mm. to 1·4 cm. in length, no embryos are present, while in the specimen obtained in the South Atlantic, on March 9, 1876, and measuring 1·6 cm. in length, there is a well-developed chain of embryos.

In most of the smaller specimens the visceral mass forms relatively a very large projection on the ventral surface with the test over it somewhat thickened. This is seen well in the specimens collected on February 11, 1874 (Antarctic), and on March 16, 1875 (Pacific). Another point in which the specimens differ is the condition of the lateral spines or projections of the test at the posterior end of the body. The two specimens obtained to the north of New Guinea in February 1875, have the two lateral spines well marked, but they also have a median posterior spine placed behind the nucleus and not represented in Traustedt's figure, so that the posterior end of the body becomes triangular in shape, with a spine at each of the angles.

In the specimens collected on March 10, 1876 (South Atlantic), the lateral posterior spines are distinct, and like those figured by Traustedt; but in the specimen obtained the previous day (March 9, 1876) these spines are scarcely present. In this specimen the viscera are very distinct, the nucleus and the embryonic chain being very conspicuous through the test. A clear vesicle is placed at the anterior end of the nucleus: possibly it is the remains of the elæoblast. The dorsal tubercle is more curved than is shown in Traustedt's figure, and its outline forms an irregular sigmoid.

One of the specimens collected on March 10, 1876, contains a large shrimp which completely fills up and even distends its cavity, the mantle and test being tightly stretched over it, and the viscera somewhat displaced.

The dorsal lamina in the solitary form has a more complicated structure than it has in the aggregated form (compare figs. 8 and 11, *d.l.*, on Pl. VI.). In the solitary form the rather narrow transverse ribs become enlarged near the dorsal edge of the lamina to form a series of curious urn-shaped structures (Pl. VI. fig. 8, *c.t.*). Each transverse rib is formed by a pair of closely placed ridges of ciliated epithelium (Pl. VI. fig. 9, and fig. 8, *c.gr.*) separated by a groove. The cells are large and of short columnar form, and bear each a large clump of cilia (Pl. VI. fig. 10). Pigment cells are scattered here and there over the surface of the dorsal lamina between the transverse ciliated ridges.

Salpa democratica-mucronata, Forskål (Pl. VIII. figs. 1–10).

Salpa democratica, Forsk., Descript. anim., &c., p. 113, 1775.

Salpa mucronata, Forsk., Descript. anim., &c., p. 114, 1775.

Salpa democratica-mucronata, Krohn, Ann. d. Sci. Nat. (Zool.), ser. 3, tom. vi. p. 112, 1846.

Salpa democratica-mucronata, Traustedt, *loc. cit.*, p. 365, which see for further synonymy.

This well-known species is the commonest in the Challenger collection. It was obtained at the following localities:—

(1.) December 14, 1873; in Simon's Bay, Cape of Good Hope; surf. temp. 58°·5; about twenty specimens, large and small, of both solitary and aggregated forms (bad condition).

(2.) December 18, 1873; Station 142, off the Cape of Good Hope; lat. 35° 4′ 0″ S., long. 18° 37′ 0″ E.; surf. temp. 65°·5; thirty specimens of the solitary form (in bad condition).

(3.) December 19, 1873; Station 143, south of the Cape of Good Hope; lat. 36° 48′ 0″ S., long. 19° 24′ 0″ E.; surf. temp. 73°; surface to 100 fathoms; one specimen of the solitary form (small), and three specimens of the aggregated form.

(4.) April 2, 1874; Station 162, off East Moncœur Island, Bass Strait; lat. 39° 10′ 30″ S., long. 146° 37′ 0″ E.; surf. temp. 63°·2; one hundred and forty specimens of the solitary form (about 1 cm. in length), and five hundred or more specimens of the aggregated form, averaging 6 mm. in length; also two specimens of the solitary form (1·2 cm. in length) mounted on microscope slides and labelled "Off Australia."

(5.) June 3, 1874; Station 163B, off Port Jackson; surface; lat. 33° 51′ 15″ S., long. 151° 22′ 15″ E.; surf. temp. 69°; one specimen of the solitary form in spirit, and one mounted on a microscope slide.

(6.) June 15, 1874; off Port Jackson; surface; lat. 34° 6′ 0″ S., long. 155° 12′ 0″ E.; surf. temp. 62°·7; two specimens of the solitary form (small).

(7.) June 17, 1874; Station 165, between Sydney and Wellington, New Zealand; lat. 34° 50′ 0″ S., long. 155° 28′ 0″ E.; surf. temp. 64°·5; two specimens of the solitary form, and three specimens of the aggregated form (small).

(8.) October 22, 1874; Station 199, off Mindanao, Philippine Islands; lat. 5° 44′ 0″ N., long. 123° 34′ 0″ E.; surf. temp. 83°; two specimens of the solitary form (small).

(9.) March 16, 1875; Station 222, north of the Admiralty Islands, West Pacific; surface; lat. 2° 15′ 0″ N., long. 146° 16′ 0″ E.; surf. temp. 82°·8; one specimen possibly belonging to this species (in bad condition).

(10.) November 5, 1875; Station 295, South Pacific; lat. 38° 7′ 0″ S., long. 94° 4′ 0″ W.; surf. temp. 58°·5; one specimen of the solitary form (1·3 cm. in length), and one specimen of the aggregated form (5 mm. in length).

(11.) November 6, 1875; South Pacific; surface, at night; lat. 37° 50′ 0″ S., long. 93° 54′ 0″ W.; surf. temp. 59°·7; two specimens of the solitary form (large).

(12.) November 18, 1875; South Pacific; surface; lat. 34° 9′ 0″ S., long. 72° 32′ 0″ W.; surf. temp. 57°·8; one specimen of the solitary form, and eight specimens of the aggregated form (various sizes).

(13.) December 15, 1875; Pacific, off Valparaiso; surface; lat. 33° 12′ 0″ S., long. 76° 29′ 0″ W.; surf. temp. 62°·5; several specimens of the solitary form (mounted on microscope slides).

(14.) February 12, 1876; Station 319, South Atlantic; near the surface; lat. 41° 54′ 0″ S., long. 54° 48′ 0″ W.; surf. temp. 59°·5; seventy specimens of the solitary form (large and small), also about twenty very young solitary forms about 4 mm. in length; one thousand to two thousand specimens of the aggregated form (average size 6 mm.), also several mounted on microscope slides, and some of both forms stained in carmine and preserved in glycerine.

(15.) February 28, 1876; Station 323, South Atlantic; lat. 35° 39′ 0″ S., long. 50° 47′ 0″ W.; surf. temp. 73°·5; several specimens of the aggregated form.

(16.) February 29, 1876; Station 324, South Atlantic; near the surface; lat. 36° 9′ 0″ S., long. 48° 22′ 0″ W.; surf. temp. 71°·5; eight specimens of the solitary form (of fair size), and nearly fifty specimens of the aggregated form (some small).

(17.) March 1, 1876; South Atlantic; near the surface; lat. 36° 1′ 0″ S., long. 47° 35′ 0″ W.; surf. temp. 72°; one specimen of the solitary form, and ten specimens of the aggregated form (various sizes).

(18.) March 3-5, 1876; South Atlantic; lat. 37° 0′ 0″—37° 32′ 0″ S., long. 44° 23′ 0″—42° 0′ 0″W.; surf. temp. 68°·2—70°·5; one hundred and fifty specimens of the solitary form (about 1 cm. in length), and about one hundred specimens of the aggregated form (about 6 mm. in length).

(19.) March 14, 1876; Station, 334, South Atlantic; lat. 35° 45′ 0″ S., long. 18° 31′ 0″ W.; surf. temp. 68°·5; three specimens of the aggregated form (stained and preserved in glycerine).

(20.) April 6, 1876; Station 346, Tropical Atlantic; surface; lat. 2° 42′ 0″ S., long. 14° 41′ 0″ W.; surf. temp. 82°·7; seven specimens of the solitary form.

(21.) April 11, 1876; Station 350, North Atlantic; lat. 7° 33′ 0″ N., long. 15° 16′ 0″ W.; surf. temp. 84°; four small specimens of the solitary form.

(22.) April 13, 1876; Station 352, North Atlantic, off the West coast of Africa; lat. 10° 55′ 0″ N., long. 17° 46′ 0″ W.; surf. temp. 77°·7; one specimen of the solitary form.

(23.) May 3, 1876; Station 353, North Atlantic; tow-net down to 80 fathoms; lat. 26° 21′ 0″ N., long. 33° 37′ 0″ W.; surf. temp. 70°·7; two specimens of the solitary form (one very small), and three specimens of the aggregated form (poor specimens).

(24.) Collected during the second cruise of H.M.S. "Porcupine" in the summer of 1869; Station No. 33, off the South Coast of Ireland, surface; several specimens of both the solitary and the aggregated forms.

The Challenger collection of this species shows a considerable amount of variation both in size and shape. Taking the solitary form first, we find specimens ranging from 5 mm. to nearly 15 mm. in length of body, exclusive of the posterior prolongations or spines, collected on the same occasion (April 2, 1874, off the Australian coast). The general length of the one hundred and forty specimens in that gathering, and of the one hundred and fifty specimens collected in the South Atlantic, on March 3–5, 1876, is 1 cm., exclusive of the posterior processes. These processes measure about 5 or 6 mm. in length, relatively as long as in Traustedt's variety *flagellifera*. In many of the specimens obtained March 3–5, 1876, the distal portions of the posterior processes are of an opaque white colour. When examined under the microscope they are seen to have a yellowish tint, and to be nodulated on the surface (Pl. VIII. fig. 1).

Some of the smaller specimens (*e.g.* those obtained in the South Atlantic on February 12, 1876) have no chains of embryos, although in all other respects they resemble the larger specimens; while other still smaller specimens (about 4 mm. in length) have the posterior processes of the body exceedingly short (Pl. VIII. fig. 2). Some of these specimens have serrated ridges at the anterior end of the body.

In these young specimens the proliferation of the ectoderm to form the young test cells is particularly well seen (Pl. VIII. fig. 6). The test cells are most abundant at the growing points of the test processes. The ectoderm cells are mostly stellate (Pl. VIII. fig. 7). In those specimens where the test is slightly echinated in places, a test cell in process of becoming a small bladder cell is seen at the base of each of the small spines (Pl. VIII. fig. 5, *bl.*).

Turning now to the aggregated form, we find that the average length is about 6 mm.; while in the large gathering obtained in the South Atlantic on February 12, 1876, the specimens vary from 3 mm. to 10 mm.

The shape of the aggregated form also varies. The specimens obtained on February 28, 1876, are more angular in shape than usual. The three specimens collected in the Southern Ocean, on December 19, 1873, have bifid ends, recalling the condition found in some specimens of the aggregated form of *Salpa runcinata-fusiformis* (see p. 76 and Pl. VI. fig. 6).

In some other specimens, again, especially in some of those collected off the coast of Australia, on April 2, 1874, the posterior end of the mantle runs out into a tapering process (Pl. VIII. fig. 4), in place of being simply rounded off behind the nucleus, as is shown in Traustedt's figures. In other specimens from the same locality, however, the posterior end of the mantle is in the normal condition.

This is the species described by Professor M'Intosh,[1] under the name *Salpa spinosa*, Otto, as being present along with *Salpa runcinata-fusiformis* in great abundance in some parts of the Hebrides.

Salpa nitida, n. sp. (Pl. VIII. figs. 11–15).

External Appearance.—The body is of an elongated ovate shape, and has no processes. Length 9 mm., breadth 5 mm.

[1] *Journ. Linn. Soc. Lond.* (Zool.), vol. ix. p. 11, 1868.

The Test is clear and transparent, and is thin all over the body.

The Mantle has the musculature very distinct. The first and second bands join on the sides of the body, but are incomplete dorsally. The third, fourth, fifth, sixth, and seventh bands are distinct from one another, and are only interrupted in the median ventral line. The third band approaches the fourth on the mid-dorsal line, but does not fuse with it. There are short curved bands at the ends of the transversely elongated branchial and atrial apertures, and there are also a few very slight short muscle bands in the median dorsal line immediately in front of the atrial aperture.

The Endostylē is conspicuous and straight. It extends forwards in front of the branchial aperture.

The Dorsal Lamina is rather narrow. It is attached as far back as the fifth muscle band.

The Dorsal Tubercle is very simple, and of elliptical outline. The nerve ganglion is placed immediately behind it.

The Visceral Mass is unusually small.

Locality.—March 16, 1875; Station 222, north of the Admiralty Islands, Pacific; lat. 2° 15′ 0″ N., long. 146° 16′ 0″ E.; surf. temp. 82°·8; one specimen.

This little specimen from the surface of the tropical Pacific is in external appearance somewhat like the aggregated form of *Salpa democratica-mucronata*, but differs from it in several points of internal structure. At first I was inclined to place it as a variety of that species, but have now decided to treat it as distinct.

The musculature is peculiar, and differs from that of the last species; it is shown in fig. 13 on Plate VIII. The first and second bands are short, and the second extends much farther ventrally than dorsally. The remaining bands (Pl. VIII. fig. 13, 3–7) are very long, extending almost to the median ventral line, and not fusing with their neighbours dorsally. The curved muscle bands around the ends of the branchial and atrial apertures (Pl. VIII. fig. 13, *br. m.*, *at. m.*) are stout and of a yellowish colour, and are forked at their ends. Finally, the slender bands in front of the atrial aperture are composed each of a single muscle fibre, and are interrupted in the median dorsal line.

The minute structure of the muscles in this specimen is easily made out. The fibres are very distinct, and are cross striated (Pl. VIII. fig. 11). They have each a number of large distinct nuclei placed in single file. When more highly magnified (Pl. VIII. fig. 12), the cross striation is seen to be due to the presence of a series of quadrangular bodies placed in a single row along each of the fibrils of which the muscle fibres are composed. The nucleus of a fibre covers the breadth of four or five fibrils. By examining very young specimens of *Salpa democratica-mucronata* it is possible to trace the formation of a muscle band out of a few rows of ordinary fusiform mesoblast cells (Pl. VIII. fig. 8) through the stages shown in figs. 9 and 10, in which there are many nuclei in the fibre, but the cross striation is not yet present, and it has not broken up into fibrils, up to the completely differentiated tissue shown in figs. 11 and 12.

The nervous system and the dorsal tubercle are particularly well preserved, and are clearly visible in the specimen which is now mounted as a microscopic object (see Pl. VIII. figs. 14 and 15). There is a triangular peritubercular area in which the closely placed nerve ganglion and dorsal tubercle (Pl. VIII. fig. 14) are situated. This is a point in which the present species differs from *Salpa democratica-mucronata*, where the dorsal tubercle is considerably in front of the nerve ganglion.

The ganglion is of rounded form, with a large club-shaped sense organ (ocular) near its anterior end, and with a pair of laterally placed wing-like appendages (Pl. VIII. fig. 15, *ap.*). There are at least sixteen or eighteen distributory nerves given off from the ganglion, and they arise from its sides as well as from the ends. Four of the nerves, running two anteriorly and two posteriorly, are large, the rest are nearly all very small. On one of the smaller nerves springing from one side of the ganglion a small rounded granular mass is placed; this is possibly another sense organ (Pl. VIII. fig. 15, *s.o.*).

The large club-shaped sense organ attached near the anterior end of the ganglion (Pl. VIII. fig. 15, *op.*) is probably an organ of sight. It has a clear, transparent, concavo-convex disc on its free end, and behind that is a layer of somewhat ovate columnar cells, darkly pigmented of a reddish colour, which probably forms the retina. The short stalk is mainly cellular, and where it joins the ganglion there is another band of dark reddish pigmented cells (Pl. VIII. fig. 15).

The dorsal tubercle is very large, but has a simple structure. Its posterior end is embedded in the front of the ganglion. The edges of the elongated elliptical slit are formed of regularly placed columnar cells richly ciliated. The rest of the surface of the tubercle is also ciliated, which gives it a finely striated appearance (Pl. VIII. fig. 15).

There are three very young embryos (or ova) situated on the left side of the body, behind the endostyle, and between the sixth and seventh muscle bands. This specimen is therefore an aggregated or sexual form.

Salpa africana-maxima, Forskål.

Salpa maxima, Forsk., Descrip. anim., p. 112, 1775.
Salpa africana, Forsk., Descrip. anim., p. 116, 1775.
Salpa africana-maxima, Krohn, Ann. d. Sci. Nat., (Zool.), ser. 3, tom. vi. p. 112, 1846.
Salpa africana-maxima, Traustedt, *loc. cit.*, p. 374, which see for further synonymy.

A single large *Salpa* obtained in the Southern Ocean is probably referable to the solitary form of this species. The locality is March 10, 1874, Station 159; lat. 47° 25′ 0″ S., long. 130° 22′ 0″ E.; surf. temp. 51°·5.

The specimen is nearly 7 cm. in length, but it has only eight muscle bands, while Traustedt figures nine, and in his description says 9(-10) are present. The first, second, and third muscles approximate in the mid-dorsal line. Part of a chain of embryos is seen near the posterior end of the body, behind the visceral mass.

Salpa scutigera-confœderata, Cuvier—Forskål (Pl. IX. fig. 9).

Salpa confœderata, Forsk., Descrip. anim., p. 115, 1775.
Salpa scutigera, Cuvier, Ann. du Mus., tom. iv. p. 377, 1804.
Salpa scutigera-confœderata, Vogt, Mém. de l'Instit. Genev., tom. ii. p. 6, 1854.
Salpa scutigera-confœderata, Traustedt, *loc. cit.*, p. 362, which see for further synonymy.

This species was obtained at the following localities:—

(1.) October 27, 1874; Station 202, off the Philippine Islands; lat. 8° 32′ 0″ N., long. 121° 55′ 0″ E.; surf. temp. 83°; five specimens of the aggregated form.

(2.) November 6, 1875; South Pacific; lat. 37° 50′ 0″ S., long. 93° 54′ 0″ W.; surf. temp. 59°·5; one large specimen (in bad condition).

The specimen obtained in the South Pacific, on November 6, 1875, is very large, being about 8 cm. in length, but it is in such bad condition that it is impossible to determine whether it is a solitary or an aggregated form. In fact, the specimen only retains the torn and decayed test, and sufficient of the mantle to show the characteristic X-shaped muscle bands, and thus indicate the species.

The aggregated forms from Station 202, at the Philippines, are all small, and vary in length from 1·5 cm. to 1·7 cm. The breadth of the body at the posterior end is 8 mm. In all of these specimens there are curved horn-like processes at the posterior end of the body, which are not shown in Traustedt's figures. Possibly they are only present in the young, and disappear afterwards. These processes are fully 5 mm. in length, and contain prolongations of the mantle into their interior (Pl. IX. fig. 9).

All these specimens had been preserved in picric acid, and are not in good condition, their tissues being very brittle. For *Salpa* strong spirit is undoubtedly much better than picric acid.

Salpa quadrata, n. sp. (Pl. IX. figs. 1–8).

External appearance.—The body is short and of rudely quadrate form; it is compressed from side to side, and of considerable extent dorso-ventrally. Both ends are truncated, and the anterior is broader than the posterior. The apertures are terminal and are both slightly depressed, with no very prominent lips. Both dorsal and ventral edges are nearly flat. The surface is quite smooth.

The length is about 1 cm., and the greatest breadth about 8 mm.

The Test is clear and transparent. It is moderately thick and firm.

The Mantle has a very slight musculature. There are only four short muscle bands, and they are arranged so as to form two small X-shaped figures on the dorsal surface, one near the anterior and the other near the posterior end.

The Endostyle is rather short and curved. It extends from the branchial aperture about half-way to the posterior end of the body.

The Dorsal Lamina consists of a short and club-shaped anterior part, which is not attached at its posterior end, but hangs freely in the branchial cavity, and a smaller posterior part close to the œsophageal aperture. It is strongly ribbed transversely throughout its length.

The Dorsal Tubercle has an antero-posteriorly elongated double groove with the opening at the posterior end. There is also a languet-like projection at the anterior end.

The Visceral Mass is of large size, and is placed posteriorly and ventrally.

Locality.—April 13, 1876; Station 352, North Atlantic; lat. 10° 55′ 0″ N., long. 17° 46′ 0″ W.; surf. temp. 77°·7.

A single specimen of this curious form was obtained in the North Atlantic, off the West Coast of Africa, in the surface tow-net. In general appearance (Pl. IX. fig. 1) it is rather unlike a *Salpa*, being short, and wide dorso-ventrally, but narrow from side to side. On discovering the remarkable condition of the dorsal lamina, I was at first inclined to separate this form from *Salpa* as the type of a new genus, but I have decided not to take this step on the strength of the single specimen, in case of the short, free, club-shaped dorsal lamina (Pl. IX. figs. 4, 6) being merely an individual abnormality. Of the known species of *Salpa* this form approaches most nearly to the solitary generation of *Salpa scutigera-confœderata*, but differs from it in shape and many minor details in addition to the dorsal lamina.

The test is not thickened over the visceral mass. The musculature of the mantle is even slighter than that of *Salpa scutigera-confœderata*, but is arranged in the same manner so as to form two X-shaped marks in the median dorsal line (Pl. IX., compare figs. 1 and 9). The anterior X is placed close behind the nerve ganglion (Pl. IX. figs. 2, 3, 4, *m.b.*), while the posterior one (Pl. IX. fig. 5) is near the atrial aperture. The branchial aperture is crescentic with slight lips (Pl. IX. figs. 1, 2, 3), while the atrial is a transverse slit with a slightly lobed margin (Pl. IX. fig. 5).

The course of the endostyle is shown in fig. 1. It curves first ventrally and then posteriorly, and is continued back from where it stops, about the middle of the body, to the visceral mass by a fold of the ventral wall of the branchial sac. There is a distinct break or gap between the extremity of the endostyle and this fold (Pl. IX. fig. 7).

At its anterior end the endostyle is continued forwards in front of the peripharyngeal bands (Pl. IX. fig. 4, *en.*).

At one point on the ventral edge of the body, near the middle of the endostyle, there is a small cubical outgrowth from the mantle into the test (see Pl. IX. figs. 1 and 8).

The dorsal lamina is in a most remarkable condition in the single specimen (Pl. IX. fig. 4, &c., *d.l.*). Its anterior part forms a short, curved, club-like projection from the dorsal edge of the branchial sac close behind the peripharyngeal bands. It is strongly marked with transverse ridges and grooves. There is also a similar smaller projection from the dorsal edge of the œsophageal aperture (Pl. IX. fig. 6), which is probably the posterior end of the dorsal lamina.

The nerve ganglion is small and rounded. It lies immediately in front of the anterior muscle bands (Pl. IX. fig. 4, *n.g.*). It has two laterally-placed curved appendages which lie on its sides and anterior end. The dorsal tubercle is immediately in front of the ganglion, and in its appearance recalls that of some of the Simple Ascidians.

Cyclosalpa, Blainville.

Thalia, Browne, Hist. of Jamaica, London, 1756.
Holothuria, Linn., Syst. Nat., ed. x. 1758 (in part).
Salpa, Forskåhl, Descr. anim., 1775 (in part).
Cyclosalpa, Blainville, Dict. des Sci. Nat., tom. xlvii. p. 94, "Salpa," 1827.
Orthocœla, Macdonald, Trans. Roy. Soc. Edin., vol. xxiii. p. 181, 1864.
Pyrosomopsis (?), Macdonald, *l.c.*, p. 180.
Salpa, Cuvier, Lamarck, Chamisso, Vogt, Costa, Leuckart, Todaro, Traustedt, &c. (in part).

Body not attached, elongated, with the apertures at the opposite ends.
Test gelatinous and transparent.
Mantle with muscle bands, which form incomplete rings.
Branchial Sac forming with the peribranchial cavity a large central space.
Dorsal Lamina a vascular band which traverses the combined branchial and peribranchial cavities from the dorsal and anterior to the ventral and posterior ends.
Alimentary Canal stretched out along the ventral surface of the body; no "nucleus" or visceral mass.
Embryonic Chain in the form of a circle or ring of from seven to twelve Ascidiozooids attached together.

I consider it best to raise the little group of species allied to *Cyclosalpa pinnata* once more to the dignity of a genus under the name introduced by Blainville in

1827. Of the synonyms given above, *Thalia* is pre-Linnean, and *Holothuria* is preoccupied, while *Salpa* has been appropriated by the more important section of the family. *Orthocœla*, Macdonald, is a better designation, but must yield priority to *Cyclosalpa*.

By the majority of authors since the time of Blainville, *Cyclosalpa pinnata* has been placed as a species of *Salpa*, but Macdonald[1] in 1864 founded for it the new genus *Orthocœla*, on account of the straight condition of the alimentary canal, which forms a marked contrast to the coiled-up visceral mass found in the species of *Salpa*. Traustedt, though not recognising this as a separate genus, makes it a distinct section of *Salpa*.

The characters of the genus agree with those of *Salpa*, with the exceptions of (1) the extended condition of the alimentary canal, and (2) the curious form produced by the animals of the aggregated generation which are united to form, not a ribbon-like chain as in the species of *Salpa*, but a ring or circlet of generally about nine members.

This genus contains three species, viz.:—

Cyclosalpa pinnata, Forskåhl; *Cyclosalpa affinis*, Chamisso; and *Cyclosalpa dolicosoma-virgula*, Todaro—Vogt.

Cyclosalpa pinnata (Forskåhl).

Salpa pinnata, Forskåhl, Descr. Anim., p. 113, 1775.
Orthocœla pinnata, Macdonald, Trans. Roy. Soc. Edin., vol. xxiii. p. 171, 1864.
Salpa pinnata, Traustedt, *loc. cit.*, p. 353, which see for further synonymy.

This is the only species of the genus in the Challenger collection, and it is only represented by a single specimen of the solitary generation, obtained on the surface of the Pacific between Papua and Japan. It measures about 1·5 cm. in length, and is not in a very good state of preservation.

Family II. OCTACNEMIDÆ.

Body flattened antero-posteriorly (?), probably attached.
Test gelatinous, thin, transparent.
Branchial Sac with no stigmata or openings into the peribranchial cavity.
Alimentary Canal placed dorsally and posteriorly. Coiled up along with the reproductive organs to form a visceral mass.
Life-History unknown.

This family is formed for the reception of the remarkable *Octacnemus bythius*, which was discovered by the Challenger Expedition, and was first described by Professor

[1] The genus *Pyrosomopsis* established at the same time by Macdonald is apparently the aggregated condition of a *Cyclosalpa*.

Moseley[1] in 1876. It is apparently a deep-sea representative of the pelagic Salpidæ, and may possibly be fixed to the bottom. Our knowledge of its structure is still very limited, and the embryology and life-history are totally unknown.

Although in some respects this form does not agree with the definition of the sub-order Hemimyaria given above, still on account of its probable relationship to the Salpidæ—and considering the imperfection of our knowledge of *Octacnemus*—I have thought it best to place it in this sub-order, at least until we know more about it, rather than to form an additional group for its reception.

Octacnemus, Moseley.

Octacnemus, Moseley, Trans. Linn. Soc. Lond., ser. 2 (Zool.), vol. i. p. 287, 1876.

Body flattened antero-posteriorly (?), probably attached by the posterior end. Margins prolonged to form eight conical processes.

Test gelatinous, thin, transparent.

Mantle slight. Musculature in the form of narrow muscle bands, which are mainly confined to the conical processes.

Branchial Sac with its length directed dorso-ventrally, and having merely imperforate pits in its walls, and no direct connection with the peribranchial cavity.

Dorsal Lamina unrepresented.

Alimentary Canal coiled up along with the reproductive organs to form a visceral mass, placed at the dorsal edge of the posterior end of the body.

Reproductive Organs hermaphrodite.

Further characteristics and remarks upon the structure and affinities of the genus will be found under the species described below.

Whether the two specimens in the collection represent distinct species or not, I cannot determine. They differ in some respects, but are so imperfect, that I do not feel justified in founding a second species.

Octacnemus bythius, Moseley (Pl. X. figs. 1–18).

Octacnemus bythius, Moseley, Trans. Linn. Soc. Lond., ser. 2 (Zool.), vol. i. p. 287, 1876.

This species was formed by Professor Moseley in 1876 for the reception of a specimen obtained on March 1, 1875; Station 218; South Pacific; lat. 2° 33′ 0″ S.,

[1] On two new Forms of Deep-sea Ascidians, obtained during the Voyage of H.M.S. "Challenger," *Trans. Linn. Soc. Lond.*, ser. 2 (Zool.), vol. i. p. 287, 1876.

long. 144° 4′ 0″ E; depth, 1070 fathoms; surf. temp. 84°, bottom temp. 36°·4. The single specimen was considerably injured when obtained, but was dissected while fresh by Professor Moseley. The remains were then preserved in spirit.

A second specimen of probably the same species was also obtained during the Challenger Expedition, on December 14, 1875, at Station 299, off the west coast of South America; lat. 33° 31′ 0″ S., long. 74° 43′ 0″ W.; from a depth of 2160 fathoms; surf. temp. 62°, bottom temp. 35°·2. This specimen is likewise much injured, having evidently had its delicate tissues torn by the trawl. The material which came into my hands was therefore in such a fragmentary condition that I have been able to do little more than confirm the results obtained by Moseley in his examination of the first specimen, and add a few histological details. Under these circumstances I shall commence by quoting Moseley's description,[1] and shall then add my own observations and remarks:—

"*Octacnemus bythius*, gen. et spec. nov.

"This stellate Ascidian was trawled March 1, 1875, in 1070 fathoms; lat. 2° 33′ S., long. 144° 04′ E., about forty miles north of Rossy Island, Schouten Islands. From its peculiar appearance, due to the presence of the eight long radiating conical processes of the test, the animal was at first supposed to be a Medusa. The single specimen was considerably injured, the muscular networks maintaining their attachments in only three of the conical processes, but the test was entire.

"The test of the animal is gelatinous and hyaline. On the under surface the body presents a flat area of a nearly oval form (Pl. X. fig. 1). The border of this base is thickened into a slightly prominent, rounded ridge, running round the periphery of the entire basal area; and, further, is indented slightly opposite the interspaces between the long conical processes, so as to have an undulating outline. Towards one end of the base (which end of the animal will be termed anterior, since it is that in which the nerve ganglion lies), and in the middle line, is a prominence, also oval in outline (Pl. X. fig. 1, *ad.*). This prominence is formed of a process of the basal part of the test. It terminates outwardly in a tangled mass of rootlets, massed amongst which was found much sand and shell-particles from the bottom. The Ascidian was evidently attached by this process or pedicle.

"Above the margin of the base the body of the animal is somewhat contracted, but its walls then again spread outwards, and extend into eight wide conical processes. The processes terminate in abruptly narrowed tentacular-like tips (Pl. X. fig. 1), which are imperforate, and in which no sense organ or any special structure could be discovered.

"On the upper aspect of the body the eight conical processes are directly continuous with the upper surface, which is somewhat hollowed or saucer-shaped.

[1] I am indebted to Professor Moseley for having kindly given me the use of his original drawings to illustrate this description of his species (see Pl. X. figs. 1–5). I have made the necessary changes in the references to the figures which occur in the text.

"Toward its anterior part in the middle line the upper surface is perforated by a transverse slit, the inhalent aperture (Pl. X. fig. 2, *br*). The exhalent aperture is situated in front of this, and at a lower level, proceeding from the wall of the body just above the base as a short cylindrical tubular process (Pl. X. figs. 1 and 2, *at*). The inhalent aperture is enclosed by a pair of simple rounded lips, and is without tentacles.

"The test forms a wide cavity, which extends freely into the capacious hollow conical processes. The two apertures, inhalent and exhalent, form the only communication between this cavity and the exterior.

"A flat horizontal membrane is stretched across the test cavity in such a manner as to separate off an upper chamber communicating with the inhalent aperture from a lower communicating with the exhalent. This membrane, in the central region of the body, is thick and of an opaque white colour (Fig. 10, *g*, on p. 93). This thickened central portion runs out peripherally into eight processes directed to the intervals between the long conical processes of the test. Opposite these intervals the processes become attached, or give origin to bands of muscular fibres, which bands after a short radial course, in which their fibres remain parallel, split into two halves (Pl. X. fig. 1, *m.b′.*). The halves of the bands diverge at an angle from one another, and proceed to the tips of the long conical processes, where each is joined by the tip of a corresponding half-band from the next adjoining process. The half-bands, as they run towards the tips of the conical processes, give off a series of transverse muscular threads, which, passing from band to band, form a series of loops one beyond the other, continued almost to the tip of the conical processes. These radial muscles are apparently the homologues of the longitudinal muscles of ordinary Ascidians. They would become longitudinal were the upper part of the discoid body of the animal drawn upwards, so as to make the respiratory cavity tubular instead of saucer-shaped. A second series of muscular threads lies beneath the radiating bands just described, about their points of bifurcation, and extending thence almost to their points of origin. This second set of muscles takes a circular direction (Pl. X. fig. 1, *m.b.*), and is continued round the entire circuit of the animal, the several strands, of which there are about twelve, appearing to be continuous throughout their length. These circular muscles lie beneath the radial ones; and, were the respiratory cavity elongated into a cylinder, the radial or longitudinal muscles would thus be internal in position, the circular external. In order to prevent confusion, and because of the difficulty in drawing them clearly, not nearly the entire number of transverse and circular strands is inserted in the figures in the accompanying Plate (figs. 1 and 2). Their arrangement is shown in detail in fig. 5.

"Over the muscular meshwork thus formed, and extending from it to be continuous in all directions with its thickened central portion, the horizontal membrane is continued as a thin and transparent lamina. Opposite the indentations in the margin of the thickened central portion of the membrane, *i.e.* between the processes or thickened folds attached to the muscular bands, this thin lamina is loose and hangs in bags or depressions.

"In the bottom of each of these depressions is a slight three-cornered elevation (Pl. X. fig. 2), at the tip of which a perforation or aperture may possibly be present; but in the specimen examined such could not be made out. At the tip of each small elevation were seen only three minute closely apposed villous folds of the membrane, between which no aperture could be detected. The central horizontal opaque white membrane is merely a thickened part of the general membrane, which is spread over the muscular meshwork, and reaches to the tips of the large conical processes. It is probably respiratory in function, and represents a gill.

"The membrane was observed to be attached to the inner surface of the test-wall at the intervals between the conical processes; but the specimen was too much injured to allow of the investigation of the extent and manner of its attachment within the conical processes. It appeared to be attached laterally on either side to the inner walls of these processes, and is probably reflected so as to line their cavities. No normal perforated gill could be discovered in any part of this membrane; but probably the central thickened portion has a respiratory function, and possibly the eight small elevations may prove to be openings. No reflection of the membrane over the inner surfaces of the upper and lower walls of the test was observed.

"The membrane was composed of an irregular mesh of fibrous tissue with numerous rounded gland-like cells, and numerous nerves proceeding to the radial muscular bands.

"The mouth lies in the anterior part of the thickened portion of the membrane above described, and at a short distance behind the inhalent aperture. Behind it is the endostyle. The mouth is a simple oval aperture, encircled by a few sphincter muscular threads. It leads directly into the digestive tract, which is embedded in a compact nucleiform mass, which is seen conspicuously through the transparent test on viewing the animal from beneath. The nucleus lies entirely beneath the horizontal membrane, which is attached round the margin of the mouth. The exact arrangement of the viscera inside the nucleus was not determined. A short tubular rectum projects from the anterior and inferior extremity of the nucleus.

"Posteriorly to this, on the inferior surface, is a well-developed ovary, and behind this, again, the testis. The ovary is a racemose gland, whilst the testis is composed of short cæcal tubes. In minute structure these organs agree closely with the testis and ovaries of other Ascidians.

"Between the mouth and rectum, in the middle line, lies the heart-shaped nerve ganglion, immediately beneath which is a spherical body, which had the appearance of a thin-walled sac full of a milky fluid. The wall of this sac is composed of a layer of cells of rectangular outline, from the inner surface of which fine hair-like processes depend. The hairs are not straight, but wavy, and appeared stiffer than ordinary cilia. This sense organ was not in sufficiently good preservation to allow of more accurate histological investigation. A large nerve from the ganglion passed directly over it in the middle line.

"A pair of strong muscular masses is developed at the posterior part of the nucleus, one mass lying on either side. These muscles appear to take origin from the under side of the thickened horizontal membrane above, and to terminate on the sides of the posterior part of the nucleus. The terminations of the muscular slips composing the muscles are bifurcate (Pl. X. fig. 3, *m.b.*). Other narrow transverse muscular bands are present between the mouth and rectum, embracing the fore part of the nucleus (Pl. X. fig. 3, *m.b.*). The use or homologies of these muscles are not apparent.

"The endostyle lies in the middle line, at the back of the nucleus, between the pair of posterior muscles of the nucleus (Pl. X. fig. 3, *en.*). It is very short. It showed the characteristic structure of the Ascidian endostyle—long, fine, granulated, spindle cells, packed close side by side, with their long axes at right angles to the length of the organ.

"The relation of the endostyle to the horizontal membrane was not observed, since the organ was only discovered after the nucleus had become detached from the membrane. The endostyle was then found tucked in between the paired posterior muscles of the nucleus. It is placed in the position given to it in the figures, because this seems to be the necessarily correct one. The organ, at all events, is on the ventral side of the animal, or on the side of the mouth opposite to that on which the nerve ganglion lies, which is its normal seat.

"The length of the base of the Ascidian was 5·5 cm., breadth 4·75 cm.; extreme length between tips of the protuberances 7·5 cm.

"On the whole this very perplexing animal appears to be an Ascidian, in which the respiratory sac is flattened out so as to become nearly horizontal, and in which no gill network is present. In *Cystingia* (Bronn, Kl. und Ord. ii. p. 131) a gill network cannot be distinguished.

"The radial muscles belong to the longitudinal set of other Ascidians and are internal; the circular are external in relative position. I can find no homologues of the muscles of the nucleus. In having the viscera contracted into so small a nucleus, the animal resembles *Salpa*. The nerve ganglion is abnormal in position, in being situate on the nucleus. It nevertheless is normal, in lying between mouth and anus, whilst the endostyle is on the opposite side of the mouth, as in other Ascidians.

"The name *Octacnemus bythius* is proposed for this curious eight-rayed deep-sea form."

Professor Moseley expresses his views as to the structure of this animal in diagrammatic form in the following figure (Fig. 10), which shows the most essential points made out by his investigations.

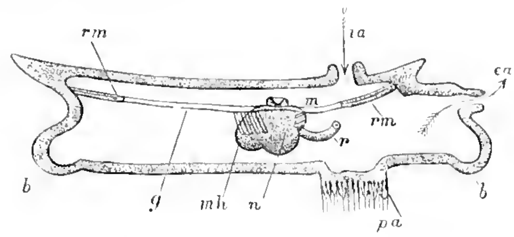


FIG. 10.—Diagrammatic section of *Octacnemus bythius* (after Moseley).
b. margin of basal disc; *i.a.* branchial aperture; *e.a.* atrial aperture; *p.a.* pedicle of attachment; *n.* nucleus; *g.* horizontal membrane; *r.m.* radiating muscles; *r.* rectum; *m.* mouth; *m.h.* muscles of nucleus.

Description of the Second Specimen, and General Remarks.

After the curious external form, the most remarkable point in regard to *Octacnemus* is certainly the condition of the branchial sac, in which there are evidently no apertures for allowing water to pass into the peribranchial cavity. In comparing this condition with that seen in the genus *Cystingia*, Moseley is probably incorrect, since there is nothing in the original description of that form to lead us to suppose that there are no openings in the branchial sac. As to the nature of the "horizontal membrane" of the above description, I agree with Moseley that it represents part at least of the branchial sac, and I would suggest that it is merely the posterior part of the ventral wall of that organ, the anterior part of which has fused with the mantle. The accompanying diagram (Fig. 11) represents my view as to the morphology of the animal, and shows its relations to the structure of other Tunicata.

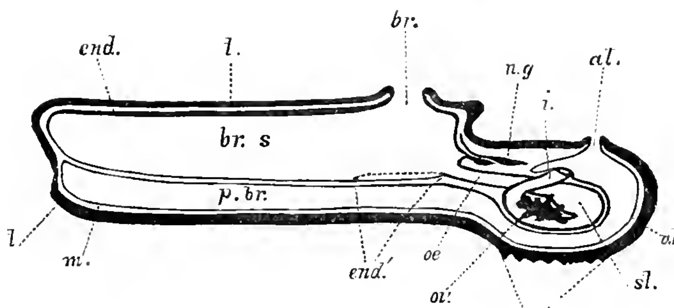


FIG. 11.—Diagram showing the probable structure of *Octacnemus*. (From left side.)
ad. probable place of attachment; *at.* atrial aperture; *at. m.* membrane lining peribranchial cavity; *br.* branchial aperture; *br.s.* branchial sac; *end. end.′* portions of endostyle; *i.* intestine; *m.* mantle; *n.g.* nerve ganglion; *oe.* œsophagus; *ov.* ovary; *p.br.* peribranchial cavity; *st.* stomach; *t.* test.

The body is apparently flattened antero-posteriorly, so that the anterior or upper surface upon which the apertures are both placed is not far from the posterior or lower attached side. If the œsophageal aperture be regarded as indicating the posterior end of the branchial sac, and the atrial aperture, as usual, as the dorsal side of the body, then the ventral edge of the branchial sac is more extensive than the dorsal, and has its anterior half fused with the mantle to form the anterior part of the body-wall, while its posterior half forms the greater part of the horizontal membrane (Fig. 11, p. 93), the remainder being the posterior part of the dorsal edge of the branchial sac. According to this interpretation of the structure, the short endostyle described by Moseley (Pl. X. fig. 3, *en.*) would be confined to the posterior end of the ventral edge of the sac: its position is shown diagrammatically by *end'.* in the above woodcut (Fig. 11).

The large space below the horizontal membrane in which the visceral mass is placed, and which opens to the exterior by the atrial aperture, I regard, then, as a peribranchial cavity which lies wholly at the posterior end of the branchial sac, and which has no communication with the cavity of the branchial sac except indirectly by means of the alimentary canal.

The specimen from Station 299, off Valparaiso, in the South Pacific, which I have examined, resembles Moseley's figures (Pl. X. figs. 1–5) of *Octacnemus bythius* in general shape, but differs (see Pl. X. figs. 6 and 7) in having a well-marked prominence upon the dorsal edge of the body in which the visceral mass is lodged,[1] and upon the anterior surface of which the atrial aperture opens. The breadth of the specimen across the outstretched processes is now 8 cm., but was probably about 12 cm. when living, judging by the amount Moseley's specimen has contracted since he measured it.

The branchial aperture is large and is transversely elongated, while the atrial is smaller and more circular. They are placed 2 cm. apart, and the atrial aperture is 1 cm. from the dorsal edge of the body. The rounded dorsal projection which contains the viscera (Pl. X. fig. 7, *ad.*) is roughened on its lower surface, and if the body were attached to some foreign object it must have been by this part.

The test is thin, and easily torn, over the greater part of the body; but it is thickened round the margins of the posterior end so as to form slight pads at the bases of the conical processes (see Pl. X. fig. 8, *t'.*). Test cells are numerous and of various shapes (Pl. X. fig. 12), but are mostly of small size. No large bladder cells are present, but a few rounded cells larger than their neighbours have considerable vacuoles (Pl. X. fig. 12), and so show an approach to the formation of bladder cells.

The mantle is thin, but has a good deal of musculature. It adheres closely to the inner surface of the test. The muscle bands have the general arrangement described and figured by Moseley (Pl. X. figs. 1, 2, and 5). Figure 14 shows more exactly the arrangement of the chief muscle bands on the conical processes. In a longitudinal section of one of the processes the chief transverse muscle bands are seen cut in section on the inner surface of the thickened pad of test. Besides these chief muscle bands, there are numerous very fine bands formed of one, two, or three muscle fibres each,

[1] Possibly the visceral mass was displaced in Moseley's specimen.

which form a delicate network, and in some places the strands of this net are curiously curled (Pl. X. fig. 13).

I have found in the horizontal membrane (a part of the wall of the branchial sac) a number of small scattered pits, sometimes placed singly, and sometimes united in twos and threes (Pl. X. fig. 15). These are just visible to the eye (Pl. X. fig. 9, *br.s.*), and look like small openings, but they are really small imperforate sacs, the walls of which are thinner than the rest of the membrane; and they may possibly be the representatives of the perforations or stigmata in the ordinary Ascidian branchial sac. Over the general surface of the membrane is a layer of squamous epithelium (Pl. X. fig. 16), the cells of which are rounded or polygonal in form; while on the margins of the little pits the cells become nearly rectangular in surface view (Pl. X. fig. 17), and fusiform in profile (Pl. X. fig. 18). Possibly this altered epithelium bordering the depression may represent the line of ciliated cells round the edges of the stigmata in the normal branchial sac.

The nervous system, the subneural gland, the dorsal tubercle, and the neighbouring muscle bands are shown in fig. 11. The ganglion, which is placed upon the anterior dorsal part of the visceral mass (Pl. X. fig. 10, *n.g.*), is triangular in shape (Pl. X. fig. 11, *n.g.*), and has nerves prolonged from each angle. The subneural gland is a large elliptical mass which extends from the front of the ganglion to half-way up the dorsal tubercle (Pl. X. fig. 11, *s.gl.*). It is apparently the spherical thin-walled body taken for a sense-organ by Moseley. The dorsal tubercle has a spoon-shaped opening leading into a narrow duct which is lost on the lower surface of the subneural gland. The neighbouring muscle bands are arranged in a symmetrical manner round the ganglion, as shown in fig. 11.

A somewhat irregular opaque line is visible on the anterior surface of the body showing through the clear test (Pl. X. fig. 6, *en.*). It runs from near the branchial aperture in an oblique course ventrally, and to the left side. This is produced by an elevation on the inner surface of the anterior half of the branchial sac, which I believe represents the endostyle of other Tunicata. If this be the case, it does not correspond to the short endostyle described by Moseley as placed upon the nucleus, and in my specimen I failed to find any trace of an endostyle in that position. This may be one of the points of difference if these two specimens belong to distinct species of *Octacnemus*. In Moseley's form only the posterior part of the endostyle may have been retained, while in my form only the anterior half is found (see Fig. 11, p. 93, *end* and *end'*).

The visceral mass lies loosely in the interior of the dorsally placed projection of the body (Pl. X. fig. 9), and can be easily withdrawn from it. It has occurred to me that possibly Moseley's specimen had been distorted while coming up in the trawl, and that the visceral mass had become displaced. If that be not the case, then the two specimens differ somewhat in the position of the viscera (Pl. X., compare figs. 1 and 9). The visceral mass forms a compact rounded clump, part of which is coloured dark brown, while the remainder is pale yellow (Pl. X. fig. 9). The brown portion is the alimentary canal, and the yellow is formed of the reproductive organs, part of it being the ovary and the rest the cæca of the testis. Fig. 10 shows the anterior surface of the visceral mass on which the nervous system (*n.g.*) is placed. The large dark-coloured mass is the wall of the stomach (*st.*), and the reproductive organs appear at both sides of it.

On the whole, I regard this form as being allied to *Salpa*. The condition of the visceral mass is very like the "nucleus" in *Salpa*, and occupies much the same position in the body (compare Fig. 7. p. 55, and Fig. 11, p. 93). The musculature might readily be derived from a series of transversely-running bands by an antero-posterior shortening which would approximate the bands closely, and then by a portion of the muscles being drawn out radially into the eight conical processes. The endostyle and the nervous system are in their proper places, but there seems to be no trace of a dorsal lamina; and the branchial sac is certainly in a remarkable condition. If the obliteration of the side walls of the sac in *Salpa* has been brought about by the locomotory habits of that form, of course no such change would be necessary in the case of an ally such as *Octacnemus*, which was attached, or at least not locomotor; but it is difficult to see why the stigmata in the walls of the sac should become closed up, unless perhaps nutrition and aeration were performed sufficiently by the water gaining access to the large cavities of the body through the branchial and atrial apertures, without there being any definite current.

Order III. LARVACEA.

The Larvacea are free-swimming pelagic forms, provided with a large locomotor appendage (the tail), in which there is a skeletal axis (the urochord).

A relatively large test (the "Haus") is formed with great rapidity as a secretion from the ectoderm; it is merely a temporary structure which may be cast off and replaced by another.

The branchial sac is simply an enlarged pharynx with two ventral ciliated openings (stigmata) leading to the exterior. These open independently on the ventral surface. There is no separate peribranchial cavity.

The nervous system consists of a large anterior and dorsally-placed ganglion, and a long nerve-cord, with smaller ganglia, stretching backwards from it over the alimentary canal to reach the tail, along which it runs on the left side of the urochord.

The alimentary canal lies behind the branchial sac, and the anus opens ventrally on the surface of the body in front of the stigmata.

The reproductive organs are placed at the posterior end of the body.

Gemmation does not take place, and alternation of generations and metamorphosis do not occur in the life-history.

This order corresponds to Balfour's[1] group Perennichordata. It includes a single family, the Appendiculariidæ.

This is one of the most interesting groups of the Tunicata, as it shows more completely than any of the rest the characters of the original ancestral forms. Its members have undergone comparatively little degeneration, and consequently they correspond more nearly to the tailed-larval condition than to the adult forms of the other groups of Tunicata.

Family Appendiculariidæ.

Body more or less ovate with the longer axis antero-posterior, and having a large appendage (the tail) attached to the ventral surface. The branchial aperture is anterior.

The Test is periodically developed into a very large, investing capsule which is after a time cast off from the body.

The Branchial Sac is simple, and has only two openings, which are placed one on each side of the ventral edge, and lead to separate atrial apertures.

The Nervous System consists of a large ganglionic mass placed dorsally near the anterior part of the body, and a nerve cord with ganglionic thickenings which is continued posteriorly into the appendage.

The Alimentary Canal lies posterior to the branchial sac. The anus opens on the exterior of the body.

The Reproductive Organs, like the anus, are independent of the atrial apertures.

All the members of this family are minute and free-swimming. They occur on the surface of the sea in most parts of the world.

The first form belonging to this family was made known by Chamisso[2] in 1821 under the name of *Appendicularia flagellum;* but the description and the figures are so vague that it is really impossible now to say with certainty which species, or even which genus, of the Appendiculariidæ Chamisso found. The specimens were obtained in Bering Strait during the circumnavigating expedition under Kotzebue in 1815–18. Some years afterwards von Mertens,[3] voyaging in the same seas, found

[1] Comparative Embryology, vol. ii. p. 8, London, 1881.

[2] De animalibus quibusdam e classe vermium, etc., fasc. 2, p. 363, *Acad. Cæs. Leop., Nova Acta*, tom. x. 1821.

[3] Beschreibung der Oikopleura, *Mém. Acad. d. Sci. St. Petersb.*, sér. 6, tom. i., p. 205, 1831.

and described an Appendicularian under the name of *Oikopleura chamissonis.* Whether this species is the same one as that found by Chamisso it is impossible to determine; and as Mertens was undoubtedly the first to characterise a genus of the Appendiculariidæ in a recognisable manner, I have no hesitation in following Fol[1] in considering Mertens to have the priority with his generic name, and in applying the name *Appendicularia* to another genus of the group defined much later by Fol in 1874. As for Chamisso's specific name *flagellum*, it must, I think, lapse altogether, as no one can say with certainty what his species was.

Quoy and Gaimard[2] in their description of the animals collected during the voyage of the "Astrolabe," under Dumont d'Urville, formed the genus *Fritillaria* for one of the Appendiculariidæ; but this genus, like the *Appendicularia* of Chamisso, is so imperfectly characterised, that it is impossible to say exactly what form was meant, and therefore it seems best now to use the name, as proposed by Fol, for a well-defined modern genus of the family.

In 1846, J. Müller[3] described, under the name of *Vexillaria flabellum*, some specimens of an Appendicularian found in the North Sea. They probably belong to the genus *Oikopleura*, but the species is not recognisable.

In 1851, W. Busch found at Gibraltar a species of *Fritillaria* which he described[4] under the name of *Eurycercus pellucidus.* Fol considers this species the same as *Appendicularia furcata* of Vogt, and describes it under the name *Fritillaria furcata;* but if this synonymy be correct, the specific name *pellucidus* has the priority.

In the same year (1851) the first of Huxley's important anatomical papers[5] on the Appendiculariidæ was published. It dealt with the structure of a form found on the coast of New Guinea and in the Southern Pacific, which Huxley regarded as being the same as the subject of Chamisso's original description, and named *Appendicularia flagellum.* Leuckart,[6] C. Vogt,[7] and Gegenbaur,[8] during the next few years, all contributed to our knowledge of the group, and described various new species.

Professor Allman[9] in 1858 redescribed the "Haus" as observed by him in an Appendicularian obtained on the coast of Scotland. Many of the previous investigators of the group had not been fortunate enough to find this covering, and Allman's observation of it in April 1858 was the only record of its having been seen since Mertens

[1] Études sur les Appendiculaires du détroit de Messine, p. 16, 1872.
[2] Voyage de l'Astrolabe, Zool., tom. iv. p. 304, 1833.
[3] *Müller's Archiv f. Anat. u. Phys.*, Jahrg. 1846, p. 106.
[4] Beobach. u. Anat., &c., Wirbellos. Thiere, p. 118.
[5] *Phil. Trans.* 1851, part ii.; see also *Quart. Journ. Micr. Sci.*, vol. iv., 1856.
[6] Zoologische Untersuchungen, Heft ii. p. 77, 1854.
[7] *Mém. de l'Instit. Genev.*, tom. ii. p. 74, 1854.
[8] *Zeitschr. f. wiss. Zool.*, Bd. v. p. 344, 1854; and Bd. vi. p. 406, 1855.
[9] *Proc. Roy. Soc. Edin.*, vol. iv. p. 123; and also *Quart. Journ. Micr. Sci.*, vol. vii. p. 86, 1859, where there is a figure given of the *Appendicularia* in the "Haus."

first described it in 1831. Two years later (1860) Claparède[1] likewise observed this remarkable condition of the test in specimens obtained on the west coast of Scotland.[2]

In 1871 two short papers appeared, Notes on Appendicularia, by Saville Kent,[3] and On the anatomy of the genus Appendicularia, by E. Moss,[4] the latter containing the description of a new species with a remarkable branchial sac resembling that of the genus *Doliolum*.

We now come to the most important paper which has been written on the Larvacea—the only one which shows any approach to being a monograph of the group. It is Fol's Études sur les Appendiculaires du détroit de Messine,[5] published at Geneva in 1872. This work contains a detailed account of the anatomy and histology of the family, followed by a full description of the genera and species, illustrated by eleven admirable plates and some woodcuts. Fol divides the family Appendiculariidæ as follows :—

APPENDICULARIIDÆ.

- Having a heart, an endostyle with ciliated bands, and a shorter or longer intestine between the stomach and the rectum.
  - Body compact, endostyle straight, tail three to four and a half times the length of the body. No hood. *Oikopleura.*
  - Body elongated, endostyle curved, tail one and a half times the length of the body. A fold of the integument forms a hood. *Fritillaria.*
- Having no heart nor endostyle. The pharynx is provided with four rows of ciliated processes. No intestine except the rectum. . . . . *Kowalevskia.*

He describes altogether eleven species; five belonging to *Oikopleura*, five to *Fritillaria*, and one to *Kowalevskia*. In a further paper in 1874,[6] Fol adds a new genus to the group under the old name *Appendicularia*.

In the same year Ray Lankester[7] gave an account of the interesting structure of the heart in a species which he investigated at Naples. The walls of this organ are formed of two cells only which occupy its ends, and are connected by very delicate contractile fibrils of protoplasm.

A couple of short papers by A. Sanders[8] appeared also in 1874, dealing with some points in the structure of some Appendiculariidæ which appeared in great abundance

[1] *Zeitschr. f. wiss. Zool.*, Bd. x. p. 405.

[2] It is curious that all the records of the occurrence of Appendicularians with the "Haus" attached come from northern seas. Mertens' original specimens were from Bering Strait, Allman's and Claparède's from the Scottish coasts, and Prof. M'Intosh has recently informed me that specimens with the "Haus" occurred in abundance in St. Andrews Bay during 1887 (see also *Ann. and Mag. Nat. Hist.*, ser. 5, vol. xx., p. 102).

[3] *Quart. Journ. Micr. Sci.*, N.S., vol. xi. p. 267.

[4] *Trans. Linn. Soc. Lond.*, vol. xxvii. p. 299.

[5] *Mém. Soc. de Phys. et d'Hist. Nat. de Genève*, tom. xxi.

[6] *Archives de Zool. expér.*, tom. iii. p. xlix.

[7] *Quart. Journ. Micr. Sci.*, N.S., vol. xiv. p. 274

[8] *Monthly Micr. Journ.*, vol. xi. p. 141 ; and vol. xii. p. 209.

that summer in Torquay harbour. They were evidently species of the two genera *Oikopleura* and *Fritillaria*.

The only papers of any importance which have appeared since that date are one by Eisen[1] on a new species, described under the name of *Vexillaria speciosa*; one by J. Barrois[2] on a new species from the English Channel; two by Langerhans,[3] including a list of the Appendicularians of Madeira, with a description of two new species of *Oikopleura*; and a short paper by Ray Lankester[4] on the vertebration of the tail, which he had observed in some species of the group.

The characters of this well-defined group are very important and interesting. The body-form, with the well-developed tail, is the most distinctive feature (see Figs. 12 and 13). The tail is attached, not at the posterior end of the body, but on the ventral surface near the middle, and in a state of rest it generally inclines forwards.

The tail agrees in essential structure with that of the larval Ascidian. It is traversed by a notochord, or urochord, placed between plates of muscular tissue divided into sections or myotomes.[5] On the left side of the urochord lies a nerve cord, corresponding to the neural canal of the larval Ascidian, and having slight ganglionic enlargements at intervals. From this cord motor nerves are given off to the groups of muscle fibres; the tail thus shows distinct traces of metameric segmentation. The outside of the tail, like the rest of the body, is formed of the ectoderm, which produces on occasions the thickened and curiously-shaped "Haus," the homologue of the test of other Tunicata (see Fig. 12).

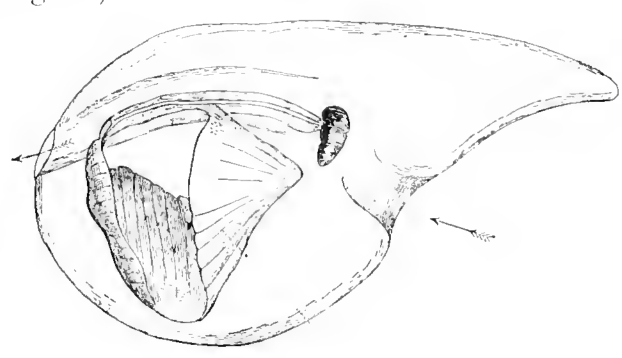


FIG. 12.—*Oikopleura* in "Haus," from the Encyclopædia Britannica, 9th ed. (after Fol).

This structure may be many times the size of the body proper, and has quite a different shape. It is only loosely attached to the ectoderm, and there are passages in

[1] *K. Svensk. Vetensk. Akad. Handl.*, Bd. xii., 1874.
[2] *Bull. Sci. du depart. du Nord*, tom. viii. p. 113, 1876.
[3] *Monatsber. d. k. Akad. Wiss. Berlin*, p. 561, 1877; and *Zeitschr. f. wiss. Zool.*, Bd. xxxiv. p. 144, 1880.
[4] *Quart. Journ. Micr. Sci.*, N.S., vol. xxii. p. 387, 1882.
[5] According to Langerhans there are ten of these segments in species of *Oikopleura* and *Fritillaria* he examined at Madeira (*Zeitschr. f. wiss. Zool.*, Bd. xxxiv. p. 144).

it by which water enters to the body of the Appendicularian and passes from it (see arrows Fig. 12).

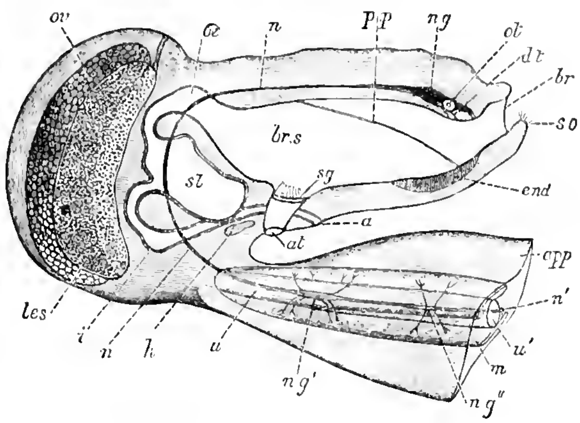


FIG. 13.—Diagram of *Appendicularia* from the right side. (From the Encyclopædia Britannica, 9th ed.)
a. anus; *app.* tail; *at.* one of the atrial apertures; *br.* branchial aperture; *br.s.* branchial sac; *d.t.* dorsal tubercle; *end.* endostyle; *h.* heart; *i.* intestine; *m.* muscle band of tail; *n.* nerve cord in body; *n.'* nerve cord in tail; *n.g.* large anterior (cerebral) ganglion; *n.g.'* caudal ganglion; *n.g.''* enlargement of nerve cord in tail; *œ.* œsophagus; *ot.* otocyst; *ov.* ovary; *p.p.* peripharyngeal band; *sg.* one of the stigmata; *s.o.* oral sense-organs; *st.* stomach; *tes.* testis; *u.* urochord; *u.'* its cut end.

The branchial aperture or mouth is at the anterior end of the body, and leads into a branchial sac or pharynx which presents for notice only an endostyle, peripharyngeal bands, and two ciliated openings into tubes leading to the exterior. There are no tentacles, no dorsal lamina or languets, and no systems of vessels. The endostyle is very short, only reaching one-third or halfway along the ventral edge of the sac. The peripharyngeal bands run from the anterior ventral part of the sac obliquely backwards and dorsally, so as to reach the dorsal middle line near the posterior end of the sac (see Fig. 13, *p.p.*).

The two ciliated openings (often called stigmata) are placed far back in the branchial sac, one at each side of the mid-ventral line. These openings correspond not to the stigmata of ordinary Ascidians, such as the species of *Ascidia*, but to the primary stigmata which first appear in the larva, and, according to Van Beneden and Julin, to the internal openings of the gill-clefts in *Amphioxus* and the Vertebrata. The tubes from the ciliated openings run ventrally, and open independently to the exterior in front of the tail and behind the anus (see Fig. 13, *at*). These tubes correspond to the right and left atrial involutions of the epiblast, which in ordinary Ascidians fuse dorsally to form the peribranchial cavity. The Larvacea therefore in this respect also possess a character which is only a temporary stage in the development in other groups of the Tunicata.

At its posterior end the branchial sac narrows to become continuous with the œsophagus, which curves posteriorly and ventrally to enter the large and sometimes bilobed stomach. The intestine (except in the case of Fol's remarkable *Kowalevskia* *tenuis*) leaves the stomach on its posterior end, and curves ventrally and then anteriorly to open to the exterior (Fig. 13, *a*) in the middle ventral line in front of the pair of atrial apertures. This independent opening of the intestine upon the surface of the body is just what might be expected from the incomplete and embryonic condition of the peribranchial cavity. The heart is placed in the middle line of the body ventrally to the stomach and near the posterior end of the branchial cavity. According to Lankester, it is formed of two cells which are placed at the opposite ends, and are connected by delicate contractile protoplasmic fibrils.

The nervous system consists of a large (cerebral) ganglion, which is placed near the anterior end of the body on the dorsal edge of the branchial sac (see Fig. 13, *n.g.*). This corresponds to the single ganglion of ordinary Ascidians. From this cerebral ganglion a nerve cord runs backwards along the dorsal edge of the branchial sac, and then curves ventrally and passes the alimentary viscera to reach the tail, along which it runs on the left side of the urochord. Near the base of the tail there is a distinct elongated caudal ganglion (Fig. 13, *n.g.'*) on the nerve cord, and farther on there are the slight enlargements already referred to. All these are connected with distributory nerves, and Langerhans[1] has described both motor and sensory nerves in the tail.

There are various sense organs in the body. The cerebral ganglion has connected with it an otocyst, a pigment spot, and a tubular process opening into the branchial sac, and representing the dorsal tubercle and associated parts of an ordinary Ascidian. On the ventral edge of the branchial aperture are placed some groups of modified ectodermal cells, which are possibly tactile organs (Fig. 13, *s.o.*), and there may be others of the same nature on other parts of the body.

The reproductive organs are placed at the posterior end of the body. They consist of either single or paired large sac-like ovaries and testes, the latter communicating with the dorsal surface of the body by means of a delicate duct, while the ova are only set free by rupture of the body-wall. The testis arrives at maturity before the ovary, so that although hermaphrodite, the Appendiculariidæ are not self-fertilizing. This is a case of protandry, while in most other Tunicata which I have examined protogyny appears to be the rule.

Very little is known as yet in regard to the development. There is no reproduction by gemmation, and therefore no alternation of generations in the life-histories of this group.

The family contains about two dozen species, which may be grouped in the following four genera:—

[1] *Zeitschr. f. wiss. Zool.*, Bd. xxxiv. p. 144.

I. *Appendicularia*, Chamisso (1821), emend. Fol (1874).

Body contracted, depressed anteriorly, swollen posteriorly. No hood present.
Tail measuring twice to thrice the length of the body.
Endostyle slightly curved.
Rectum enormous, larger than stomach and intestine together.
Of this genus in the restricted form only two or three species have been described.

II. *Oikopleura*, Mertens (1831).

Body ovoid, concentrated. No hood present.
Tail measuring thrice to four and a half times the length of the body. It is about four to six times as long as it is broad.
Endostyle straight.
This genus contains about a dozen species.

III. *Fritillaria*, Quoy and Gaimard (1833), emend. Fol (1872).

Body elongated, more or less narrowed in the middle where the tail is attached. Hood present.
Tail short and wide, about once and a half as long as the body.
Endostyle curved.
This genus contains about half a dozen species.

IV. *Kowalevskia*, Fol (1872).

Body ovoid, truncated anteriorly.
Tail large, lanceolate and pointed.
Endostyle and heart absent.
Pharynx with four rows of ciliated processes.
This genus contains one species, *Kowalevskia tenuis*, Fol.

The genus *Vexillaria*, J. Müller, is a synonym of *Oikopleura*; and *Eurycercus*, Busch, is a synonym of *Fritillaria*.

As Appendiculariidæ were not specially looked for or preserved during the expedition, the Challenger collection contains only a few specimens, and these were all mounted at the time as microscopic objects. Unfortunately, they are in such a condition that almost nothing beyond the body form can be made out from them, and in some it is impossible to make out even that with certainty. Consequently none of them can be referred to their species. They are all short-bodied forms, and therefore belong to either *Appendicularia* or *Oikopleura*.

List of Localities.

(1.) October 10, 1873; Station 132, South Atlantic; lat. 35° 25′ 0″ S., long. 23° 40′ 0″ W.; surf. temp. 58°; one large specimen mounted as a microscopic object; the body is 2 mm. in length, and the tail 6 mm.

(2.) February 14, 1874; Station 153, Antarctic ice barrier; lat. 65° 42′ 0″ S., long. 79° 49′ 0″ E.; surf. temp. 29°·5; one large specimen mounted; body 2 mm. in length, tail 1 cm.

(3.) September, 1874; between Api and Cape York, Australia; two large specimens mounted: the largest has the body 2 mm. long, and the tail nearly 1 cm.

(4.) September, 1875; surface, near reefs, Tahiti, Society Islands; many small specimens mounted; the body is about 0·5 mm. in length, and the tail about 2 mm.

(5.) April, 21, 1876; surface, Atlantic, off St. Vincent, Cape Verde Islands; surf. temp. 71°; several small specimens mounted on two slides; about same size as those from last locality.

GEOGRAPHICAL DISTRIBUTION.

I SHALL adopt here the same general plan as in the corresponding sections in the two preceding parts of the Report.

The track of the Challenger round the world has been divided into a series of comparatively short stages, so as to show roughly the localities between which the different observing Stations lie. These stages are arranged in the order in which they were traversed by the expedition, and consequently the Stations are in chronological order, and the lists of species occur in the order in which they were collected. The chief objects of this arrangement are to show—(1) the approximate positions of the localities at which Tunicata were obtained, and (2) the list of species from each Station. As tow-nettings were frequently taken at spots which were not numbered as Stations, the date has in the case of all localities been placed first—other particulars following in those cases in which they are known.

In the first traverse of the North Atlantic from England by the Canary Islands to the West Indies, and then north to Halifax, Nova Scotia, no surface Tunicata were collected.

In the return traverse, between Bermuda and the Canary Islands :—

June 25, 1873; Station 69; lat. 38° 23′ 0″ N., long. 37° 21′ 0″ W.; surf. temp. 71°.

Pyrosoma spinosum, n. sp., one specimen.

Between the Canary Islands and Bahia, Brazil :—

August 16, 1873; Station 100; lat. 7° 1′ 0″ N., long. 15° 55′ 0″ W.; surf. temp. 79°.

Pyrosoma atlanticum (?), one small colony.

September 1, 1873; Station 112; lat. 3° 33′ S., long. 32° 16′ W.; surf. temp. 78°.

Pyrosoma giganteum, two small colonies.

Between Bahia, Brazil, and the Cape of Good Hope :—

September 20, 1873; off Bahia.

Pyrosoma giganteum (?), two small colonies.

October 10, 1873; Station 132; lat. 35° 25′ 0″ S., long. 23° 40′ 0″ W.; surf. temp. 58°.

Appendicularia sp., one large specimen.

October 11, 1873; Station 133; lat. 35° 41′ 0″ S., long. 20° 55′ 0″ W.; depth, 1900 fathoms; surf. temp. 58°; bottom temp. 35°·4.

Pyrosoma spinosum, n. sp., one specimen.

Between the Cape of Good Hope and Kerguelen Island, the following surface Tunicata were collected:—

December 14, 1873; Simon's Bay, Cape of Good Hope; surf. temp. 58°·5.

Salpa democratica-mucronata, about twenty specimens, both solitary and aggregated forms.

December 18, 1873; Station 142; lat. 35° 4′ 0″ S., long. 18° 37′ 0″ E.; surf. temp. 65°·5.

Salpa democratica-mucronata, solitary form, thirty specimens.

December 19, 1873; Station 143; south of the Cape of Good Hope; lat. 36° 48′ 0″ S., long. 19° 24′ 0″ E.; surf. temp. 73°.

Salpa democratica-mucronata, solitary form, one specimen.

do. aggregated form, three specimens.

December 27, 1873; Station 145A; off Prince Edward Island, Southern Ocean; lat. 46° 41′ 0″ S., long. 38° 10′ 0″ E.; at night; surf. temp. 41°·5.

Salpa cylindrica, solitary form (?), one specimen.

December 27, 1873; Station 145A; lat. 46° 41′ 0″ S., long. 38° 10′ 0″ E.; surf. temp. 41°·5.

Salpa runcinata-fusiformis, aggregated form, many specimens.

Between Kerguelen Island and Melbourne, Australia, the following were obtained:—

February 2, 1874; Station 150; Antarctic; lat. 52° 4′ 0″ S., long. 71° 22′ 0″ E.; surf. temp. 37°·5.

Salpa cylindrica, solitary form, one specimen.

February 3, 1874; lat. 52° 20′ 0″ S., long. 72° 14′ 0″ E.; surf. temp. 38°.

Salpa cylindrica, solitary form (?), one specimen.

runcinata-fusiformis, solitary form (?), one specimen.

February 11, 1874; Station 152; lat. 60° 52′ 0″ S., long. 80° 20′ 0″ E.; surf. temp. 34°·5.

Salpa runcinata-fusiformis, aggregated form, about 160 specimens.

do. solitary form, several specimens.

February 14, 1874; Station 153; Antarctic ice barrier; lat. 65° 42′ 0″ S., long. 79° 49′ 0″ E.; surf. temp. 29°·5.

Appendicularia sp., one large specimen.

March 10, 1874; Station 159; lat. 47° 25′ 0″ S., long. 130° 22′ 0″ E.; surf. temp. 51°·5.

Pyrosoma giganteum, six colonies.

Salpa africana-maxima, solitary form, one specimen.

March 13, 1874; Station 160; lat. 42° 42′ 0″ S., long. 134° 10′ 0″ E.; surf. temp. 55°.

Pyrosoma sp., one specimen and fragments.

Between Melbourne and New Zealand the following were obtained:—

April 2, 1874; Station 162; off East Moncœur Island, Bass Strait; lat. 39° 10′ 30″ S., long. 146° 37′ 0″ E.; surf. temp. 63°·2.

Doliolum denticulatum, two specimens.

sp. (blastozooid), twenty specimens.

Salpa democratica-mucronata, solitary form, 140 specimens.

do. aggregated form, 500 specimens.

June 3, 1874; Station 163B; off Port Jackson; surface; lat. 33° 51′ 15″ S., long. 151° 22′ 15″ E.; surf. temp. 69°.

Doliolum denticulatum (?), one specimen.

Salpa democratica-mucronata, solitary form, two specimens.

June 15, 1874; between Sydney and Wellington; surface; lat. 34° 6′ 0″ S., long. 155° 12′ 0″ E.; surf. temp. 62°·7.

Salpa democratica-mucronata, solitary form, two specimens.

June 17, 1874; Station 165; between Sydney and Wellington; lat. 34° 50′ 0″ S., long. 155° 28′ 0″ E.; surf. temp. 64°·5.

Doliolum ehrenbergi, one specimen.

Salpa democratica-mucronata, solitary form, two specimens.

do. aggregated form, three specimens.

June 23, 1874; Station 166; lat. 38° 50′ 0″ S., long. 169° 20′ 0″ E.; surf. temp. 58°·5.

Salpa costata-tilesii, solitary form, one specimen.

cordiformis-zonaria, solitary form, two specimens.

Between New Zealand and the Fiji Islands the following were obtained:—

July 8, 1874; Station 168; lat. 40° 28′ 0″ S., long. 177° 43′ 0″ E.; surf. temp. 57°·2.

Salpa costata-tilesii, solitary form, one specimen.

sp., n. sp. (?), one specimen (test only).

July 14, 1874; Station 170; lat. 29° 55′ 0″ S., long. 178° 14′ 0″ W.; depth, 520 fathoms; surf. temp. 65°, bottom temp. 43°.

Pyrosoma sp. (?), one colony.

Between the Fiji Islands and Hong-Kong, China, the following were obtained:—

August 11–12, 1874; off Kandavu, Fiji; surface; surf. temp. 77°·5.

Doliolum denticulatum, one specimen.

challengeri, several specimens.

August 25, 1874; Station 181; lat. 13° 50′ 0″ S., long. 151° 49′ 0″ E.; surf. temp. 80°.

Salpa cylindrica, solitary form (?), six specimens.

Salpa cordiformis-zonaria, aggregated form, two small specimens.
runcinata-fusiformis, aggregated form, one specimen.

September, 1874; between Api and Cape York, Australia.
Appendicularia sp., two large specimens.

October, 1874; off Mindanao, Philippine Islands.
Salpa democratica-mucronata, solitary form, two specimens.

October 27, 1874; Station 202; lat. 8° 32′ 0″ N., long. 121° 55′ 0″ E.; surf. temp. 83°.
Salpa scutigera-confœderata, aggregated form, five specimens.

November 2, 1874; Station 204; lat. 12° 28′ 0″ N., long. 122° 15′ 0″ E.; surf. temp. 84°.
Pyrosoma giganteum (?), one small colony.

November 13, 1874; Station 205; off the Philippine Islands; lat. 16° 42′ 0″ N., long. 119° 22′ 0″ E.; surf. temp. 82°.
Salpa runcinata-fusiformis, aggregated form (?), four specimens.

Between Hong-Kong and New Guinea the following were obtained:—

January 9, 1875; lat. 16° 35′ 0″ N., long. 117° 47′ 0″ E.; surf. temp. 76°·5.
Salpa runcinata-fusiformis, aggregated form, eight specimens.

February 1875; north of New Guinea, West Pacific; surface.
Salpa runcinata-fusiformis, solitary form, two specimens.

Between New Guinea and Japan the following were obtained:—

March 1, 1875; Station 218; lat. 2° 33′ 0″ S., long. 144° 4′ 0″ E.; depth, 1070 fathoms; surf. temp. 84°, bottom temp. 36°·4; bottom, blue mud, trawled.
Octacnemus bythius, one specimen.

March 16, 1875; Station 222; north of the Admiralty Islands, West Pacific; surface; lat. 2° 15′ 0″ N., long. 146° 16′ 0″ E.; surf. temp. 82°·8.
Pyrosoma elegans (?), four small colonies.
sp. (?), two young colonies.
Salpa cordiformis-zonaria, aggregated form, one specimen.
do. solitary form, two specimens.
runcinata-fusiformis, aggregated form, six specimens.
do. solitary form, five specimens.
democratica-mucronata (?), one specimen.
cylindrica, solitary form, one specimen.
nitida, n. sp., one specimen.

April 3, 1875; Pacific; surface; lat. 24° 49′ 0″ N., long. 138° 34′ 0″ E.; surf. temp. 71°·5.
Doliolum affine, n. sp., half-a-dozen specimens.
Salpa cordiformis-zonaria, aggregated form, one specimen.

April 4, 1875; Pacific; lat. 25° 33′ 0″ N., long. 137° 57′ 0″ E.; surf. temp. 69°.
Doliolum affine, n. sp., two dozen specimens.

April 5, 1875; Station 230; Pacific; lat. 26° 29′ 0″ N., long. 137° 57′ 0″ E.; surf. temp. 68°·5.

Pyrosoma elegans (?), one small colony.

Salpa costata-tilesii, solitary form, one specimen.

cylindrica (?), one specimen.

May 12, 1875; Station 232; lat. 35° 11′ 0″ N., long. 139° 28′ 0″ E.; surf. temp. 64°·2.

Salpa runcinata-fusiformis, aggregated form, one specimen.

Date (?); between Papua and Japan.

Cyclosalpa pinnata, solitary form, one specimen.

June 5, 1875; Station 236; lat. 34° 58′ 0″ N., long. 139° 29′ 0″ E.; surf. temp. 66°·5.

Salpa cordiformis-zonaria, aggregated form, one specimen.

Between Japan and the Sandwich Islands the following were obtained:—

June 17, 1875; Station 237, North Pacific; lat. 34° 37′ 0″ N., long. 140° 32′ 0″ E.; surf. temp. 73°.

Doliolum affine, n. sp., 100 specimens.

challengeri, n. sp., many specimens.

June 18, 1875; Station 238, North Pacific; lat. 35° 18′ 0″ N., long. 144° 8′ 0″ E.; surf. temp. 70°·5.

Doliolum challengeri, n. sp., very many specimens.

June 19, 1875; Station 239, North Pacific; lat. 35° 18′ 0″ N., long. 147° 9′ 0″ E.; surf. temp. 70°·2.

Doliolum challengeri, n. sp., very many specimens.

June 24, 1875; Station 242, North Pacific; lat. 35° 29′ 0″ N., long. 161° 52′ 0″ E.; surf. temp. 68°·5.

Doliolum challengeri, n. sp., very many specimens.

July 21, 1875; Station 256; lat. 30° 22′ 0″ N., long. 154° 56′ 0″ W.; surf. temp. 74°; at night.

Salpa runcinata-fusiformis, solitary form, three specimens.

Between the Sandwich Islands and Valparaiso the following were obtained:—

August 24, 1875; surface; at night; lat. 13° 1′ 0″ N., long. 151° 50′ 0″ W.; surf. temp. 78°·2.

Salpa hexagona, aggregated form, three specimens.

September, 1875; near reefs, Tahiti; surface.

Appendicularia sp., many small specimens.

October 18, 1875; lat. 36° 0′ 0″ S., long. 132° 22′ 0″ W.; surf. temp. 58°·5.

Salpa costata-tilesii, solitary form, one specimen.

October 19, 1875; Station 287; lat. 36° 32′ 0″ S., long. 132° 52′ 0″ W.; surf. temp. 57°·8.

Doliolum affine, n. sp., fifteen specimens.

October 20, 1875; lat. 38° 54′ 0″ S., long. 133° 21′ 0″ W.; surf. temp. 55°·5.

Salpa runcinata-fusiformis, aggregated form, three specimens.

October 21, 1875; Station 288, South Pacific; surface; lat. 40° 3′ 0″ S., long. 132° 58′ 0″ W.; surf. temp. 54°·5.

Salpa echinata, n. sp., two specimens.

October 26, 1875; lat. 39° 13′ 0″ S., long. 121° 0′ 0″ W.; surf. temp. 53°·8.

Doliolum sp. (blastozooid), two specimens.

November 5, 1875; Station 295, South Pacific; surface; at night; lat. 38° 7′ 0″ S., long. 94° 4′ 0″ W.; surf. temp. 58°·5.

Salpa echinata, n. sp., one specimen.
runcinata-fusiformis, aggregated form, four specimens.
do. solitary form, five specimens.
democratica-mucronata, aggregated form, one specimen.
do. solitary form, one specimen.
cylindrica, solitary form, five specimens.
do. aggregated form, five specimens.

November 6, 1875; South Pacific; night; lat. 37° 50′ 0″ S., long. 93° 54′ 0″ W.; surf. temp. 59°·7.

Salpa mollis, n. sp., one specimen.
runcinata-fusiformis, aggregated form, one specimen.
democratica-mucronata, solitary form, two specimens.
scutigera-confœderata, one specimen.

November 8, 1875; South Pacific; surface; lat. 37° 56′ 0″ S., long. 90° 39′ 0″ W.; surf. temp. 58°·7.

Salpa runcinata-fusiformis, aggregated form, one specimen.

November 18, 1875; South Pacific; surface; lat. 34° 9′ 0″ S., long. 72° 32′ 0″ W.; surf. temp. 57°·8.

Salpa democratica-mucronata, solitary form, one specimen.
do. aggregated form, eight specimens.

Between Valparaiso and the Falkland Islands the following were obtained:—

December 14, 1875; Station 299; lat. 33° 31′ 0″ S., long. 74° 43′ 0″ W.; depth, 2170 fathoms; surf. temp. 62°, bottom temp. 35°·2.

Octacnemus bythius (?), one specimen.

December 14 and 15, 1875; off Valparaiso.

Doliolum krohni, n. sp., about thirty specimens.

December 15, 1875; Pacific; surface; lat. 33° 12′ 0″ S., long. 76° 29′ 0″ W.; surf. temp. 62°·5.

Salpa democratica-mucronata, solitary form, several specimens.

January 1, 1876; Station 305; lat. 47° 47′ 0″ S., long. 74° 47′ 0″ W.; surf. temp. 55°·5.

Salpa cordiformis-zonaria, aggregated form, one specimen.

January 11, 1876; Station 311; lat. 52° 45′ 30″ S., long. 73° 46′ 0″ W.; surf. temp. 50°.

Salpa cordiformis-zonaria, aggregated form, two specimens.

January, 1876; Strait of Magellan.

Salpa cordiformis-zonaria, aggregated form, three specimens.

January 21, 1876; Station 314; lat. 51° 35′ 0″ S., long. 65° 39′ 0″ W.; surf. temp. 48°.

Salpa echinata, two specimens.

Between the Falkland Islands and Buenos Ayres, South America, the following were obtained:—

February 11, 1876; Station 318; surface tow-net; lat. 42° 32′ 0″ S., long. 56° 29′ 0″ W.; surf. temp. 57°·5.

Doliolum ehrenbergi, two specimens.

sp. (blastozooid), five specimens.

Same locality; Station 318; tow-net at trawl down to 2040 fathoms; bottom temp. 33°·7.

Doliolum ehrenbergi, eight specimens.

sp. (blastozooid), thirty specimens.

February 12, 1876; Station 319, South Atlantic; near the surface; lat. 41° 54′ 0″ S., long. 54° 48′ 0″ W.; surf. temp. 59°·5.

Salpa runcinata-fusiformis, aggregated form, ten specimens.

do. solitary form, a few small.

democratica-mucronata, aggregated form, one to two thousand.

do. solitary form, seventy specimens, and also twenty very young.

February 14, 1876; Station 320; lat. 37° 17′ 0″ S., long. 53° 52′ 0″ W.; surf. temp. 67°·5.

Salpa cordiformis-zonaria, aggregated form, one specimen.

do. solitary form, one specimen.

Between Buenos Ayres and Ascension the following were obtained:—

February 28, 1876; Station 323, South Atlantic; lat. 35° 39′ 0″ S., long. 50° 47′ 0″ W.; surf. temp. 73°·5.

Salpa democratica-mucronata, aggregated form, several specimens.

February 29, 1876; Station 324, South Atlantic; near the surface; lat. 36° 9′ 0″ S., long. 48° 22′ 0″ W.; surf. temp. 71°·5.

Salpa democratica-mucronata, solitary form, eight specimens.

do. aggregated form, about fifty specimens.

March 1, 1876; South Atlantic; near the surface; lat. 36° 4′ 0″ S., long. 47° 35′ 0″ W.; surf. temp. 72°.

Salpa democratica-mucronata, solitary form, one specimen.

do. aggregated form, ten specimens.

March 3 to 5, 1876; South Atlantic; surface.

Salpa democratica-mucronata, solitary form, 150 specimens.

do. aggregated form, 100 specimens.

March 9, 1876; Station 331, South Atlantic; lat. 37° 47′ 0″ S., long. 30° 20′ 0″ W.; surf. temp. 64°·5.

Salpa cordiformis-zonaria, aggregated form, three specimens.

runcinata-fusiformis, aggregated form, 100 specimens.

do. solitary form one specimen.

March 10, 1876; Station 332, South Atlantic; lat. 37° 29′ 0″ S., long. 27° 31′ 0″ W.; surf. temp. 64°.

Salpa runcinata-fusiformis, aggregated form, 300 specimens.

do. solitary form, fifteen specimens.

March 14, 1876; Station 334, South Atlantic; lat. 35° 45′ 0″ S., long. 18° 31′ 0″ W.; surf. temp. 68°·5.

Salpa democratica-mucronata, aggregated form, three specimens.

Between Ascension and Cape Verde Islands the following were obtained:—

April 6, 1876; Station 346, tropical Atlantic; surface; lat. 2° 42′ 0″ S., long. 14° 41′ 0″ W.; surf. temp. 82°·7.

Salpa democratica-mucronata, solitary form, seven specimens.

April 11, 1876; Station 350, North Atlantic; lat. 7° 33′ 0″ N., long. 15° 16′ 0″ W.; surf. temp. 84°.

Doliolum denticulatum, six specimens.

sp. (blastozooid), one specimen.

Salpa democratica-mucronata, solitary form, four specimens.

April 12, 1876; Station 351, North Atlantic, off the West Coast of Africa; surface; lat. 9° 9′ 0″ N., long. 16° 41′ 0″ W.; surf. temp. 81°·8.

Pyrosoma sp., one very young colony.

Salpa musculosa, n. sp., two specimens.

echinata, n. sp., one specimen.

April 13, 1876; Station 352, North Atlantic, off the West Coast of Africa; surface; lat. 10° 55′ 0″ N., long. 17° 46′ 0″ W.; surf. temp. 77°·7.

Doliolum challengeri, four specimens.

sp. (blastozooid), two specimens.

Salpa musculosa, n. sp., two specimens.

runcinata-fusiformis, aggregated form, forty-three specimens.

do. solitary form, one specimen.

democratica-mucronata, solitary form, one specimen.

quadrata, n. sp., one specimen.

Between Cape Verde Islands and England the following were obtained :—

April 21, 1876; surface; off St. Vincent, Cape Verde Islands; surf. temp. 71°.

Appendicularia sp., several small specimens.

April 26, 1876; North Atlantic; surface; lat. 16° 49′ 0″ N., long. 25° 14′ 0″ W.; surf. temp. 73°·2.

Salpa cylindrica, solitary form, four specimens.
do. aggregated form, many specimens.
runcinata-fusiformis, aggregated form, ten specimens.
sp. (?), part of test only.

April 27, 1876; North Atlantic; surface; lat. 17° 18′ 0″ N., long. 26° 32′ 0″ W.; surf. temp. 73°·5.

Salpa cylindrica, solitary form, about fifty specimens.
do. aggregated form, one specimen.

April 28, 1876; North Atlantic; surface; lat. 17° 47′ 0″ N., long. 28° 28′ 0″ W.; surf. temp. 73°·5.

Salpa cordiformis-zonaria, aggregated form, three specimens.
cylindrica, solitary form, one specimen.
do. aggregated form, two specimens.

April 29, 1876; North Atlantic; surface; at night; lat. 18° 8′ 0″ N., long. 30° 5′ 0″ W.; surf. temp. 73°·7.

Doliolum denticulatum, one specimen.
ehrenbergi, a dozen specimens.
Salpa cylindrica, solitary form, one specimen.
do. aggregated form, twenty-four specimens.
runcinata-fusiformis, solitary form, ten specimens.

May 3, 1876; Station 353, North Atlantic; lat. 26° 21′ 0″ N., long. 33° 37′ 0″ W.; tow-net down to 80 fathoms; surf. temp. 70°·7.

Doliolum sp. (blastozooid), one specimen.
Salpa democratica-mucronata, solitary form, two specimens.
do. aggregated form, three specimens.

May 7, 1876; North Atlantic; surface; at night; lat. 34° 22′ 0″ N., long. 31° 23′ 0″ W.; surf. temp. 67°·5.

Doliolum sp. (blastozooid), six specimens.
Salpa runcinata-fusiformis, aggregated form, eight specimens.

May 12, 1876; lat. 42° 54′ 0″ N., long. 28° 54′ 0″ W.; surf. temp. 58°·2.

Doliolum ehrenbergi, one specimen.

These lists, besides giving the species obtained at each locality where surface Tunicata were collected, show that, with the exception of the first part of the voyage in the North Atlantic, these Tunicate localities were fairly evenly scattered over the whole course traversed by the ship. As might be naturally expected, at some spots, such as the localities of the dates March 16, 1875 (North Pacific), November 5, 1875 (South Pacific), February 12, 1876 (South Atlantic), and April 13, 1876 (North Atlantic), specimens and species were more abundant than at others. These regions are widely distant, and their richness may have depended upon varied causes, or may have been accidental.

It will be useful now to group the above localities at which pelagic Tunicata were obtained into geographical regions, as is done below—the object being to show the Tunicate fauna of each of these great regions as made known by the Challenger investigations.

In the North Atlantic the following four genera and eighteen species were collected:—

Pyrosoma spinosum.
atlanticum.
giganteum.
sp.
Doliolum denticulatum.
challengeri.
ehrenbergi.
tritonis.
sp. (blastozooid).
Salpa democratica-mucronata.
musculosa.
echinata.
runcinata-fusiformis.
quadrata.
cylindrica.
cordiformis-zonaria.
sp.
Appendicularia sp.

In the South Atlantic the following four genera and nine species were collected:—

Pyrosoma atlanticum.
giganteum (?).
spinosum.
sp.
Doliolum sp. (blastozooids).
Salpa democratica-mucronata.
cordiformis-zonaria.
runcinata-fusiformis.
Appendicularia sp.

In the Southern Ocean the following three genera and seven species were collected :—

Pyrosoma giganteum.
sp.
Salpa democratica-mucronata.
cylindrica.
runcinata-fusiformis.
africana-maxima.
Appendicularia sp.

In the South Pacific Ocean the following five genera and eighteen species were collected :—

Pyrosoma sp.
Doliolum denticulatum.
krohni.
challengeri.
affine.
ehrenbergi.
sp. (blastozooid).
Salpa democratica-mucronata.
costata-tilesii.
cordiformis-zonaria.
cylindrica.
runcinata-fusiformis.
echinata.
mollis.
scutigera-confœderata.
sp. (?), n. sp.
Octacnemus bythius.
Appendicularia sp.

In the seas of the Malay Archipelago the following three genera and six species were obtained :—

Pyrosoma giganteum (?).
sp.
Salpa democratica-mucronata.
scutigera-confœderata.
runcinata-fusiformis.
Appendicularia sp.

In the North Pacific the following five genera and thirteen species were obtained :—

Pyrosoma elegans (?).
sp.
Doliolum affine.
challengeri.
Salpa cordiformis-zonaria.
runcinata-fusiformis.
democratica-mucronata.
nitida.
cylindrica.
costata-tilesii.
hexagona.
Cyclosalpa pinnata.
Octacnemus bythius.

In the seas round the southern end of South America the following two genera and six species were collected :—

Doliolum ehrenbergi.
sp. (blastozooid).
Salpa democratica-mucronata.
cordiformis-zonaria.
echinata.
runcinata-fusiformis.

The North Atlantic and the two divisions of the Pacific Ocean have the longest lists, but on the whole the numbers of genera and species are fairly equally distributed. *Salpa* is the only genus which occurs in all the divisions.

The table given below shows at a glance the distribution of any species, genus, or family in the seven great areas—the North Atlantic, the South Atlantic, the Southern Ocean, the seas of the Malay Archipelago, the North Pacific, the South Pacific, and the seas round the southern end of South America. The last district, which includes portions of the South Atlantic and of the South Pacific, has been adopted because of the difficulty of separating the specimens collected around Cape Horn into an east coast and a west coast series.

Table showing the Distribution of the Families, Genera, and Species throughout the Great Ocean Basins.

Species.	1. North Atlantic.	2. South Atlantic.	3. South'rn Ocean.	4. Seas of Malay Archip.	5. North Pacific.	6. South Pacific.	7. Seas of South America
Pyrosomatidæ.							
Pyrosoma atlanticum,	×	×	×	× (?			
giganteum,	×	× (?)					
spinosum, n. sp.,	×	×					
elegans,					× (?)		
(species undetermined),	×	×	×	×	×	×	
Doliolidæ.							
Doliolum denticulatum,	×					×	
ehrenbergi,	×					×	×
affine, n. sp.,					×	×	
tritonis,	×						
challengeri, n. sp.,	×				×	×	
krohni, n. sp.,						×	
sp. (blastozooids),	×	×				×	×
Salpidæ.							
Salpa costata-tilesii,					×	×	
sp. (?), n. sp.,						×	
hexagona,					×		
musculosa, n. sp.,	×						
echinata, n. sp.,	×					×	×
mollis, n. sp.,						×	
cordiformis-zonaria,	× [1]	×			×	×	×
cylindrica,	×		×		×	×	
runcinata-fusiformis,	×	×	×	×	×	×	×
democratica-mucronata,	×	×	×	×	×	×	×
nitida, n. sp.,					×		
africana-maxima,			×				
scutigera-confœderata,				×			
quadrata, n. sp.,	×					×	
Cyclosalpa pinnata,					×		
Octacnemidæ.							
Octacnemus bythius,					×	×	
Appendiculariidæ.							
Appendicularia sp.,	×	×	×	×		×	
Total number of species which was obtained in each of the seven areas,	17	9	7	6	13	18	6

The chief conclusion to be drawn from the preceding sets of lists is that the pelagic Tunicata are very widely distributed; in fact, some species, such as *Salpa runcinata-fusiformis* and *Salpa democratica-mucronata*, have a world-wide distribution.

With the exception of the rare *Octacnemus*, which is not in its habits a pelagic form, there is apparently no genus restricted in its range to particular oceans.

In the following table, the last illustrating the Geographical Distribution, the

[1] "Knight Errant" Expedition.

occurrence of the families, genera, and species according to latitude in the northern and southern hemispheres is shown :—

North Latitude.					Species.	South Latitude.				
65°–40°	40°–30°	30°–20°	20°–10°	10°–0°		0°–10°	10°–20°	20°–30°	30°–40°	40°–65°
					PYROSOMATIDÆ.					
			×		*Pyrosoma atlanticum*,					
			×		*giganteum*,	×				×
	×				*spinosum*,				×	
		×		×	*elegans*,					
				×	sp. (?),			×		×
					DOLIOLIDÆ.					
		×		×	*Doliolum denticulatum*,		×		×	
	×	×			*ehrenbergi*,				×	×
	×	×			*affine*,				×	
×					*tritonis*,					
	×		×		*challengeri*,		×			
					krohni,				×	
	×	×	×	×	sp. (blastozooids),				×	×
					SALPIDÆ.					
		×			*Salpa costata-tilesii*,				×	×
					sp. (?), n. sp.,					×
			×		*hexagona*,					
			×	×	*musculosa*,					
				×	*echinata*,				×	×
					mollis,				×	
×	×	×	×	×	*cordiformis-zonaria*,		×		×	×
		×	×	×	*cylindrica*,		×		×	×
×	×	×	×	×	*runcinata-fusiformis*,		×		×	×
		×	×	×	*democratica-mucronata*,	×			×	×
				×	*nitida*,					
					africana-maxima,					×
				×	*scutigera-confœderata*,				×	
			×		*quadrata*, n. sp.,					
	× (?)				*Cyclosalpa pinnata*,					
					OCTACNEMIDÆ.					
					Octacnemus bythius,	×			×	
					APPENDICULARIIDÆ.					
			×		*Appendicularia* sp.,		×		×	×
3	8	10	12	12	Totals, 29 species, Totals,	3	6	1	16	13
Northern Hemisphere, 45.						Southern Hemisphere, 39.				

This table shows that the numbers of pelagic Tunicata in the two hemispheres are nearly equal. In this respect, as in their wide and fairly uniform distribution, they form a contrast to the fixed Ascidians.[1] As is seen from the line of totals in the table, the occurrences of the species curiously decrease in number in going north from the equator, and increase in going south from it. But I do not lay stress upon these numbers, as various circumstances may have affected the numbers of pelagic Tunicata collected in the different regions.

[1] See for Simple Ascidians this Report, Part I. p. 263; for Compound Ascidians this Report, Part II. p. 367.

BATHYMETRICAL DISTRIBUTION.

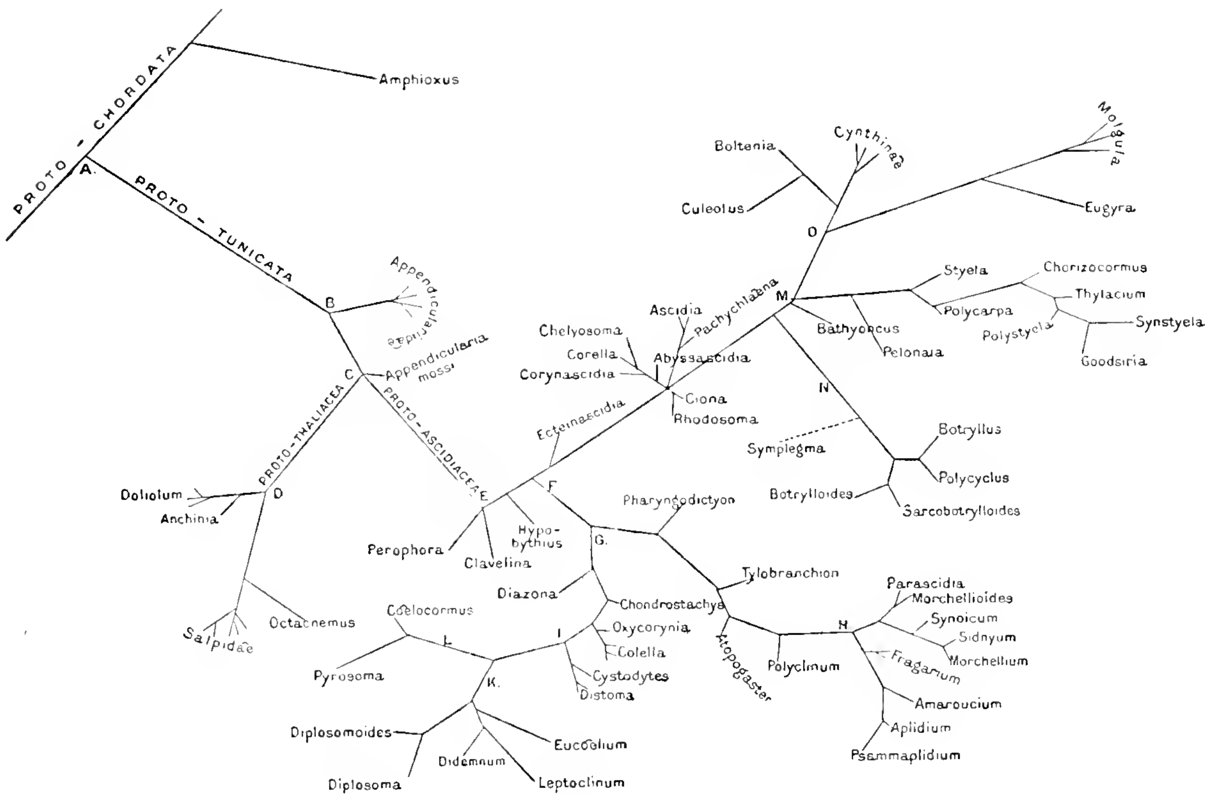
Some of the pelagic Tunicata in the Challenger collection are labelled as having been obtained in nets sent down to as much as over two thousand fathoms. But it is probably scarcely worth while recording these depths or drawing any conclusions from them, because in the absence of any means of opening and closing the mouth of the tow-net at will, so as to be able to collect from one particular stratum of water, it must be a matter of uncertainty where the specimens obtained in the net were really captured.

In the case of Station 318, where a tow-net was attached to the trawl and let down to a depth of 2040 fathoms, while another tow-net was used at the surface, the contents of the net were found to be the same in the two cases, consisting of:—

Several specimens of *Doliolum ehrenbergi*, Krohn;
and of *Doliolum* sp. (blastozooids).

So we may conclude either that the surface forms go down to a considerable depth, or that the deep tow-net captured its specimens on the way down or on the way up.

Consequently, in the present state of our knowledge, the only deep-sea group belonging to these Tunicata discussed in the present part of the Report is the family Octacnemidæ, including the genus *Octacnemus*, which is probably attached to the bottom, and has only been found at the depths of 1070 and 2160 fathoms.



GRAPHIC REPRESENTATION OF THE PHYLOGENY OF THE TUNICATA.

The annexed scheme shows diagrammatically the probable phylogeny of the Tunicata. This group of animals is represented as being derived from the Protochordata (in the top left-hand corner of the page) at the point A., a little way below the position of *Amphioxus*. It branches out into a series of lines having a tree-like form, and representing the various ancestral and existing groups of Tunicata. The names at the ends of the lines stand for genera or small groups of genera. A few of the less important genera have been omitted. The letters A. B. . . . O. represent hypothetical ancestral forms of importance which can be partially reconstructed from our knowledge of existing forms. In most cases they are placed at points where two or more lines of descent diverged from one another.

In this Phylogenetic Table all existing forms are represented as being at the *ends* of branches or twigs. In no case has the line representing the evolution of one group been allowed to pass through another group. Finally, the whole figure may be regarded as a graphic representation of the present state of our knowledge as to the affinities of the various groups of the Tunicata.

RELATIONS AND PHYLOGENY OF THE TUNICATA.

It may reasonably be expected that at the end of a Report upon such an extensive collection as the Challenger one, containing representatives of all groups of the Tunicata, I should state the conclusions at which I have arrived in regard to the relations of the Tunicata to one another, and to other groups of animals. Such conclusions are of necessity speculative in their nature, and may therefore be regarded as quite distinct from the preceding systematic and anatomical parts of the work.

I am aware that by some naturalists speculations as to the affinities and phylogeny of animals are still regarded as worthless and even dangerous; but probably such views will become rarer year by year as biology, by means of theories and reasoning, becomes more and more a true science and less of a mere accumulation of facts. I regard phylogenetic conclusions founded upon the structure and development of the animals as not only most valuable and interesting in themselves, but as exercising an important influence upon the further progress of the science. And I consider that it is the duty of a biologist, who has made a special study of a group of animals or plants, to attempt to express any views he has formed as to their relations in a phylogenetic form. Such theoretical inductions from his observations are most suggestive and helpful to other workers. If his conclusions be correct, they form an important contribution to knowledge; and if they be incorrect, they may still be useful in directing attention to points requiring further investigation, and at any rate the errors will soon be discovered and corrected by his successors.

It is only fair to those who may read my conclusions as to the relations of the Tunicata that I should state what opportunities I have had of studying the group. I have now been occupied continuously for nearly ten years in investigating Tunicata, including, besides the large and varied Challenger collection, the specimens in the British Museum, the collections sent out by the Naples Zoological Station, and by the United States Commission of Fish and Fisheries, the collections in a number of museums at home and abroad, and finally, a large number of the British and French Tunicata in a living condition. Altogether I have been enabled to dissect for myself and examine microscopically specimens of nearly every genus in the group—including all the important ones,[1] and of a large proportion of the known species. I state all these details merely to show that any speculations which follow, whether they be correct or not, are at least not unfounded, but are based upon an extensive series of observations.[2]

In regard to the relations of the Tunicata as a whole, I still incline to the view which was stated first by Balfour in 1881,[3] and to which I have adhered in several papers[4] published since, viz., that the Tunicata are to be regarded as a degenerate offshoot from the Protochordata, an early group of common ancestors of the Tunicata, *Amphioxus* and the Vertebrata. This position was adopted by E. van Beneden and Julin in their Recherches sur la Morphologie des Tuniciers,[5] and supported by a strong body of embryological evidence which goes to demonstrate (1) the fundamental agreement between the development of the larval Ascidian, which may be taken as the nearest form we know to the ancestral Tunicate, and *Amphioxus*, which is the nearest representative we have of the ancestral Chordata; and (2) the independence or considerable difference of some organs or systems in the body of the Ascidian from the corresponding parts in the Vertebrata.

This view of the origin of the Tunicata is controverted by Dohrn,[6] who regards the group as having degenerated, not from the Protochordata, but from the early Vertebrata, such as the lower fishes. This matter is still decidedly open to and is now under discussion;[7] but as the Challenger anatomical observations do not furnish any fresh evidence for either side, it is unnecessary to discuss it further here.

In the phylogenetic diagram (p. 120) the Prototunicata are shown as arising as an offshoot from the Protochordata not far from the point where the ancestors of *Amphioxus* left the main line. If, on the other hand, the vertebrate affinities of the group were adopted, the point of origin would have to be placed farther up the Chordate branch, and our conception of the early Prototunicata would be somewhat modified; but the remainder of this phylogenetic scheme from the later Prototunicata, now represented by the tailed larval Ascidian, onwards would remain unaffected by the change.

From a phylogenetic point of view the Tunicata are especially interesting—(1) on

[1] The only genera I have not had an opportunity of examining for myself are a few unimportant recently formed ones, such as *Styclopsis* and *Paramolgula*, which are closely related to older well-known genera, and present no points of fundamental importance.

[2] It would take up too much space to mention all the details of structure and development upon which the conclusions given in the following pages depend. The more important points are, however, discussed, and reference is made in the footnotes to the original works in which the structure of the various forms is described.

[3] Comparative Embryology, vol. ii. p. 271.

[4] A Phylogenetic Classification of Animals, p. 58, London; Macmillan, 1885; this Report, Part II., p. 387, 1886; On the Phylogeny of the Tunicata, *Proc. Roy. Soc. Edin.*, vol. xiii. p. 444, 1886; and Ency. Brit., 9th ed., article "Tunicata."

[5] *Archives de Biologie*, tom. vi. p. 459, 1887.

[6] Studien zur Urgeschichte d. Wirbelthierkörpers, *Mitth. d. zool. Stat. Neapel*, vol. vi. 1885.

[7] See Dohrn's Studien, etc., *Mitth. d. zool. Stat. Neapel*, vol. vii. 1887; and *Zoologischer Anzeiger*, Jahrg. x. pp. 407 and 433, 1887.

account of their connection with ancestral Chordata, (2) because of the well-marked degeneration which they exhibit, and (3) because of the curious course which the group has apparently followed in its evolution, one result of which is that one of the largest and most important sections, that of the Compound Ascidians, is, as I shall show farther on,[1] polyphyletic in origin, and is consequently an unnatural group.

Assuming the protochordate relations of the group, our conception of the ancestral form[2] from which the primitive Tunicata were derived would take the form of an elongated bilaterally-symmetrical free-swimming animal with a metamerically segmented body, terminating anteriorly in a præoral lobe. The mouth would be ventral and the anus posterior, and the anterior portion of the alimentary canal would be provided with a series of laterally-placed respiratory slits putting paired diverticula of the cavity of the fore-gut in communication with the exterior of the body. On the dorsal surface of the alimentary canal would be placed a median hypoblastic rod, the notochord, and above that again the dorsally-placed nervous system, possibly still in connection with the epiblast over it, and forming a longitudinal median tract probably produced by the union of two lateral nerve cords, and provided with an anterior enlargement in the præoral lobe, and possibly with a ganglionic thickening in each metamere. The cœlom, formed by the union of outgrowths from the archenteron, would have paired nephridia of the typical form, placing it in connection with the exterior of the body, and probably one or more such pairs were present in the præoral lobe in close relation with the ventral surface of the large nerve mass.

From such a form as this the primitive Tunicata might be evolved with a slight amount of degeneration. Nearly all the existing groups of Tunicata pass through a free-swimming larval stage, which probably represents very closely the structure of a common ancestor not far removed from the existing *Appendicularia*. Such a hypothetical form would differ mainly from its protochordate ancestors in having the notochord limited to the posterior part of the body, and not extending forwards into the region occupied by the chief parts of the nervous system and alimentary canal; and in having the anus ventral in place of posterior. It may readily be imagined that some group of the free-swimming Protochordates would find it an advantageous modification that the alimentary canal, which performed both nutritive and respiratory functions, and the main part of the nervous system, in connection with which sense organs had become developed, should be as much as possible concentrated in the anterior part of the body so as to leave the posterior part free to become modified into an efficient locomotory organ. Under such circumstances it would be natural that the notochord, the sole internal skeleton, should become restricted to the posterior.

[1] See also this Report, Part II. p. 387.

[2] See Herdman, Phylogen. Classif. of Animals, p. 57, 1885; and Van Beneden and Julin, Morph. d. Tuniciers, p. 415, 1887.

tail-like part of the body, where it would form an axis around which the muscles were placed. This would account for the change in the general shape, in the disposition of the alimentary canal, and in the relations of the notochord. The other changes which probably took place in the primitive Tunicata were the enlargement of the anterior part of the nervous system to form a vesicle in which sense organs (optic and auditory) were developed; the degeneration and abortion of the nephridia, with the possible exception of those underlying the nervous system in the præoral lobe which later on may have become modified to form the subneural gland of the Ascidian, the homologue of the hypophysis cerebri of vertebrates; and the enlargement of the anterior portion of the alimentary canal to form a respiratory tract—the primitive branchial sac.

Most of the Appendiculariidæ of the present day (see Fig. 14) represent such an ancestral form with comparatively little change. They have the branchial sac or

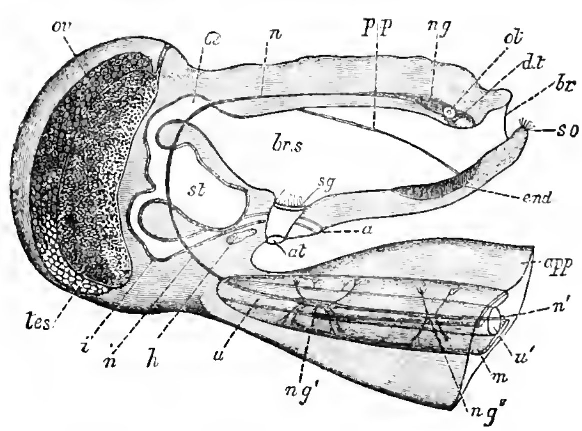


FIG. 14.—Diagram of *Appendicularia* from the right side. (From the Encyclopædia Britannica, 9th ed.)

a. anus; *app.* tail; *at.* one of the atrial apertures; *br.* branchial aperture; *br.s.* branchial sac; *d.t.* dorsal tubercle; *end.* endostyle; *h.* heart; *i.* intestine; *m.* muscle band of tail; *n.* nerve cord in body; *n.'* nerve cord in tail; *n.g.* large anterior (cerebral) ganglion; *n.g.'* caudal ganglion; *n.g."* enlargement of nerve cord in tail; *œ.* œsophagus; *ot.* otocyst; *ov.* ovary; *p.p.* peripharyngeal band; *sg.* one of the stigmata; *s.o.* oral sense organs; *st.* stomach; *tes.* testis; *u.* urochord; *u.'* its cut end.

pharynx opening to the exterior by a single pair of stigmata or gill slits which correspond to the primary or first formed stigmata of the young *Ascidia*, and may represent the ancestral condition. In some few of the Appendiculariidæ, however, considerable degeneration has taken place (*e.g. Kowalevskia*); and in one form described as new, but not named, by Dr. Moss in 1871,[1] the branchial sac has a number of stigmata, and is in a condition which recalls the arrangement found in the Doliolidæ. This species, which may be called *Appendicularia mossi*, is perhaps the nearest form known to the ancestral Tunicates from which the two great lines of degeneration diverged (see table, p. 120), the one leading to the Doliolidæ and the Salpidæ, and the other to the Simple and the Compound Ascidians.

[1] *Trans. Linn. Soc. Lond.*, vol. xxvii. p. 299.

Taking the first of these lines (in table, p. 120), it is found that the organisms which diverged towards the Thaliacea from the ancestral Appendiculariidæ allied to Moss' form remained free-swimming, but acquired the power of passing currents of water through their respiratory systems of cavities (the branchial sac, and the peribranchial cavity formed by the union posteriorly and dorsally of the two ventral tubes leading in the Appendiculariidæ from the stigmata to the exterior) in such a way as to propel themselves through the water. This would naturally result in the great enlargement of these cavities, and in the arrangement of the muscle fibres of the body-wall in a series of transversely placed bands, which would serve to drive out with force the contained water. The posterior region of the body, or tail, being now superseded as an organ of locomotion, would become gradually suppressed, and thus the ancestral Thaliacea would be evolved.

From these Protothaliacea, in which also reproduction by gemmation from a stolon and consequently alternation of generations became established, two diverging lines lead to the Salpidæ and to the Doliolidæ. The test or outer tunic, that remarkable structure so characteristic of the group, was probably first formed in the ancestral Appendiculariidæ, since it is found represented at the present day not only in the Ascidiacea, but also in the Thaliacea and in the Larvacea. Probably at first it was merely a temporary cuticular secretion of the ectoderm formed as a protection during some particular period, and comparable with the "Haus" now produced by some members of the Appendiculariidæ. It afterwards, however, became converted into a permanent layer of considerable thickness covering the outer surface of the body, and then finally became organised by the migration into it of ectoderm cells which proliferated and became modified in various ways, to form the complicated test structures found in many Tunicata.

In the line of ancestral forms leading to the Doliolidæ, however, the test must have remained in a very slightly developed condition, or may even have become more rudimentary, since in the Doliolidæ as now known the test is almost absent, being merely represented by a very delicate film covering the ectoderm. The Doliolidæ are much less modified than the Salpidæ, they still retain a "tailed" stage in their life history, and their branchial sac differs comparatively little from that of *Appendicularia mossi*, and therefore we may consider that the Doliolidæ (see Fig. 15) represent more nearly than do any of the Salpidæ the essential structure of the Protothaliacea.

In these ancestral forms the transverse muscles were probably diffuse, and scattered irregularly through the mantle; the branchial sac would be in much the same condition as in *Appendicularia mossi*, but the atrial aperture, the common excretory opening leading from the peribranchial cavity, had come to be placed at the posterior end of the body so as to be directly opposite to the branchial aperture, and so allow the water to pass straight through the body (see Figs. 15 and 16).

In the line leading from the Protothaliate to the existing Doliolidæ the muscle bands have become distinctly circumscribed so as to form a definite number of com-

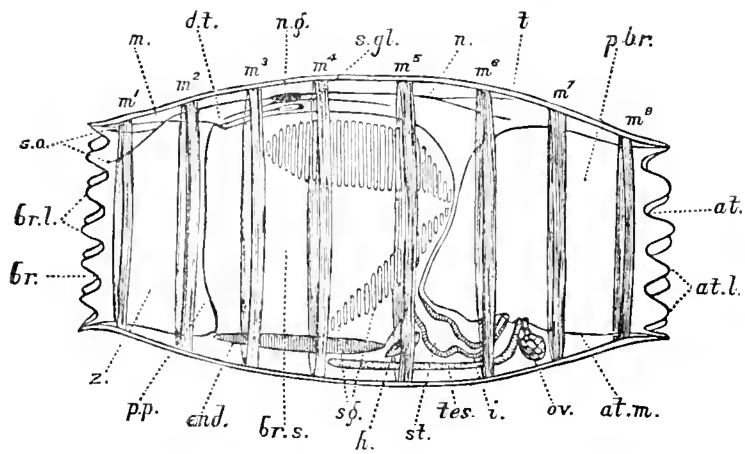


FIG. 15.—Diagram of the Gonozooid of *Doliolum*, from the left side.

at. atrial aperture; *at.l.* atrial lobes; *at.m.* membrane lining peribranchial cavity; *br.* branchial aperture; *br.l.* branchial lobes; *br.s.* branchial sac; *d.t.* dorsal tubercle; *end.* endostyle; *h.* heart; *i.* intestine; *m.* mantle; m^1—m^8, muscle bands; *n.* nerve; *n.g.* nerve ganglion; *ov.* ovary; *p.br.* peribranchial cavity; *p.p.* peripharyngeal band; *s.o.* sense organs; *s.gl.* subneural gland; *st.* stomach; *sg.* stigmata; *t.* test; *tes.* testis; *z.* zona præbranchialis.

plete circular bands surrounding the body like a series of hoops (Fig. 15). In all other essential points the structure has remained unaltered. *Anchinia*[1] I would place upon a side branch from the base of the line leading to *Doliolum* (see table, p. 120).

The line of ancestors leading to the Salpidæ is longer, and a good deal more modification has evidently taken place. The muscles in the mantle have become circumscribed to form definite bands; but these are irregularly placed, and in some cases are incomplete, while in others they branch. A well-developed but exceedingly clear and gelatinous test has been formed, and the alimentary and reproductive viscera have become concentrated (except in *Cyclosalpa*) at the posterior end of the body to form a rounded, opaque, highly-coloured mass, the so-called "nucleus" of the *Salpa*. The branchial sac has undergone great modification—probably as the result of the rapid and constant passage of streams of water through it—and at the present day its side walls, where the stigmata were probably placed in the ancestral Protothaliate and still are in some species of *Doliolum* (Fig. 15), have been converted into huge openings, leaving merely the dorsal edge of the sac in the form of a vascular band (the dorsal lamina or "gill") traversing the large open respiratory cavity (Fig. 16, *d.l.*). All these changes

[1] For the structure of *Anchinia* and its close relationship to *Doliolum*, see Kowalevsky and Barrois, *Journ. de l'Anat. et de la Physiol.* tom. xix. 1883. Also Uljanin, Fauna und Flora des Golfes von Neapel, Monogr. x, Doliolum, 1884.

are clearly in the direction of more perfect adaptation to the conditions of a free-swimming pelagic existence.

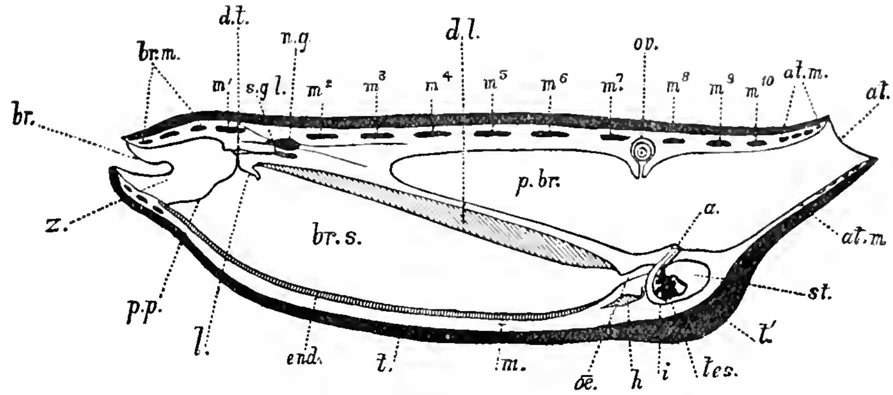


FIG. 16.—Semi-diagrammatic representation of *Salpa* from the left side.

a. anus; *at.* atrial aperture; *at.m.* muscles of atrial aperture; *br.* branchial aperture; *br.m.* muscles of branchial aperture; *br.s.* branchial sac; *d.l.* dorsal lamina (= "gill"); *d.t.* dorsal tubercle; *end.* endostyle; *h.* heart; *i.* intestine; *l.* languet; *m.* mantle; m^1—m^{10}, muscle bands; *n.g.* nerve ganglion; *œ.* œsophagus; *ov.* embryo in ovisac; *p.br.* peribranchial cavity; *p.p.* peripharyngeal band; *st.* stomach; *s.gl.* subneural gland; *t.* test; *t.'* thickened test over viscera; *tes.* testis; *z.* zona præbranchialis.

The very remarkable *Octacnemus bythius*, described first by Moseley from a Challenger specimen, is probably an abnormal and degenerate form allied to *Salpa*, which has migrated into deep water and become fixed, undergoing at the same time certain changes in body-form and in the arrangement of the musculature. The viscera, however, still form a "nucleus" as in the typical *Salpæ* (compare Figs. 16 and 17).

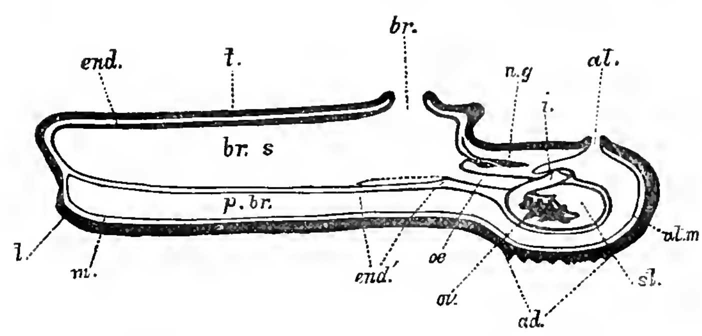


FIG. 17.—Diagram showing the probable structure of *Octacnemus*. (From left side.)

ad. probable place of attachment; *at.* atrial aperture; *at.m.* membrane lining the peribranchial cavity; *br.* branchial aperture; *br.s.* branchial sac; *end, end'* portions of endostyle; *i.* intestine; *m.* mantle; *n.g.* nerve ganglion; *œ.* œsophagus; *ov.* ovary and testis; *p.br.* peribranchial cavity; *st.* stomach; *t.* test.

The side walls of the branchial sac in *Octacnemus* have not become aborted, and the stigmata have apparently closed up.

Returning now to the ancestral Appendiculariidæ close to *Appendicularia mossi* (table, p. 120), it is found that in the second great ancestral line diverging from this point the animals changed their habits and became fixed. And just as the tailed larval Ascidian at the present day after a short free-swimming existence becomes attached, loses its locomotory organ, and undergoes other changes, so the ancestral Ascidian when it settled down on some object to lead a stationary existence, probably went through a similar but more gradual process of degeneration. The tail with its contained notochord and muscles being no longer necessary, would become rudimentary and disappear. The well-developed sense organs, which were most important to a locomotory organism, became almost useless through the change of life, and they also were suppressed, and, as a result, the nervous system which had been in most intimate connection with the sense organs underwent considerable degeneration. On the other hand, the alimentary canal, and especially its respiratory portion, or branchial sac, became greatly enlarged and somewhat more complicated. A well-marked permanent test was also produced, and the atrial aperture—formed by the union of the two primitive laterally-placed peribranchial openings—came to lie on the dorsal surface of the body not far from the anterior end. In this way an ancestral form (E. in table, p. 120) was produced somewhat resembling many of the Simple Ascidians, and probably more like a solitary *Clavelina* than any other existing form[1] (Fig. 18).

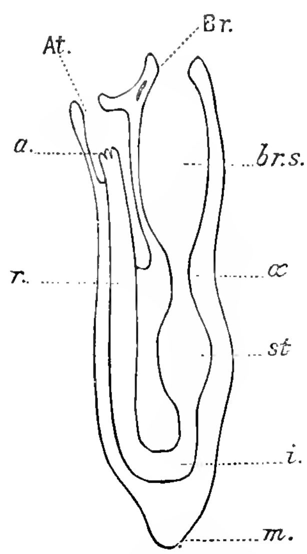


FIG. 18.—Diagram of one of the hypothetical Protoascidiacea, showing what is probably the primitive condition of the Ascidian Alimentary Canal.

a. anus; *At.* atrial aperture; *Br.* branchial aperture; *br.s.* branchial sac; *i.* intestine; *m.* posterior end of the body by which it is attached and from which outgrowths forming buds are produced; *œ.* œsophagus; *r.* rectum; *st.* stomach.

Probably this form, or one of its immediate ancestors, acquired the power of reproducing by gemmation, so as to form small, and possibly at first only temporary,

[1] In 1882 (this Report, Part I. p. 285) I placed *Clavelina* close to the ancestral form of the Ascidiæ Simplices. Recently Van Beneden and Julin have come to the same conclusion as the result of their embryological investigations, and they regard *Clavelina* as the most archaic of Ascidians (*Arch. de Biol.*, tom. vi. p. 327).

colonies. The buds would be formed as processes of the body-wall containing prolongations from a blood sinus filled with undifferentiated mesodermal cells and having a median process probably continuous with the endoderm of the branchial sac.[1] A slight modification of this process would result in the formation of a gemmiparous stolon with contained blood vessels, and an epicardial partition such as is now found in the case of *Clavelina* and *Perophora* where permanent colonies are produced, while a degeneration of the same apparatus for budding would result in the formation of rudimentary vascular projections from the body like those which exist in varied conditions in the test of *Ciona*, *Corella*, and other Ascidiidæ.[2]

This ancestral form (E. in table, p. 120, or p. 150), which may be called a Proto-ascidiate, was probably slightly elongated antero-posteriorly, and attached by the posterior end, but not pedunculated (Fig. 18). The stomach and intestine were placed posteriorly to the branchial sac, and the terminal part of the intestine, on account of the anterior position of the atrial aperture, was bent forwards so that the alimentary canal as a whole formed a narrow loop.

From this point (E.) in the table at least three ancestral lines started. The first leads with very little change to *Clavelina* (Fig. 19), where the body is

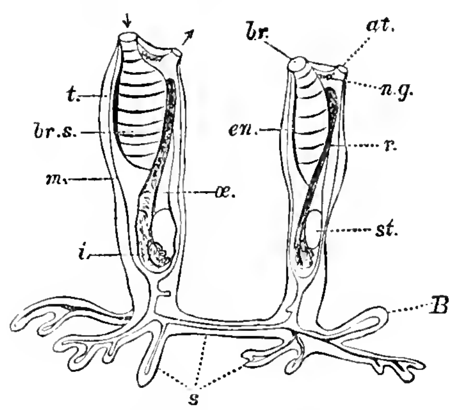


FIG. 19.—Colony of *Clavelina*.
B. bud; *at.* atrial aperture; *br.* branchial aperture; *br.s.* branchial sac; *en.* endostyle; *i.* intestine; *m.* mantle; *n.g.* nerve glanglion; *œ.* œsophagus; *r.* rectum; *s.* stolon; *st.* stomach; *t.* test.

considerably elongated and more or less pedunculated, while permanent colonies are produced—usually by means of a ramifying stolon. In *Clavelina producta*, Milne-Edwards,[3] however, a more primitive condition is found, the stolon being scarcely developed, and the buds being usually produced from the posterior part of the body of the parent Ascidian.

[1] See Van Beneden and Julin, Morph. d. Tuniciers, pp. 289 *et seq.*
[2] See Herdman, On the Evolution of the Blood-vessels of the Test in the Tunicata, *Nature*, vol. xxxi. p. 247, 1885.
[3] *Mém. Acad. Sci. Paris*, tom. xviii. p. 217, 1842.

The second line, leading to *Perophora*, shows more modification. A stolon like that of *Clavelina*, but usually longer and more regular, has been formed, and permanent colonies are produced. A change has also taken place in the shape of the body and in the relations of the alimentary canal. The branchial sac has become relatively larger, both antero-posteriorly and dorso-ventrally, the result being that it occupies nearly the whole length of the short wide body. The stomach and intestine, there being very little space posterior to the branchial sac, have come to lie upon its left side and dorsal edge, thus producing a short-bodied Ascidian with no "abdomen." This shortening of the antero-posterior extent of the body by the alimentary canal coming to lie alongside the branchial sac (Fig. 20), has apparently been produced independently in several distinct groups of the Tunicata, viz., *Perophora*, *Ascidia*, *Corella*, *Botryllus*, and the higher Simple Ascidians.

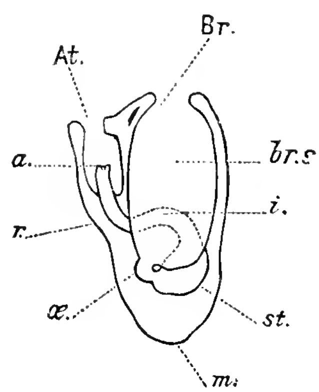


FIG. 20.—Diagram showing a modification of the ancestral Ascidian by which the body is shortened antero-posteriorly and the alimentary canal is placed alongside the branchial sac.

a. anus; *At.* atrial aperture; *Br.* branchial aperture; *br.s.* branchial sac; *i.* intestine; *m.* posterior end of the body by which it is attached and from which outgrowths forming buds are produced; *œ.* œsophagus; *r.* rectum; *st.* stomach.

The third line, leading from the Protoascidiates (E. in table, p. 120), is the very important main branch which gave origin to the various groups of Simple and Compound Ascidians. The ancestral forms occupying this line are most nearly represented at the present day by *Ecteinascidia*, an interesting genus first made known as a result of the Challenger investigations,[1] and since that studied by Sluiter;[2] but I am inclined to believe that the branch (F. in table) leading to most of the groups of Compound Ascidians was given off rather earlier than the twig leading to *Ecteinascidia*.

The small aberrant group of the Hypobythinæ[3] was probably formed as a side branch between E. and F. (see table). *Hypobythius* agrees with the ancestral Clavelinids, and

[1] Herdman, this Report, Part I. p. 239.

[2] Ueber einige einfache Ascidien v. d. Insel Billiton, *Natuurkund. Tijdschr. v. Nederl. Indië*, Dl. xlv. p. 160, 1886.

[3] Moseley, On two new forms of Deep-sea Ascidians, *Trans. Linn. Soc. Lond.*, ser. 2 (Zool.), vol. i. p. 287, 1877; and Herdman, this Report, Part I. p. 227.

differs from the Ascidiidæ in having no internal longitudinal bars in the branchial sac; while it differs from all the Clavelinidæ, and agrees with all the Ascidiidæ, in not reproducing by gemmation. It probably separated from the main branch earlier than *Ecteinascidia*, as it has not acquired internal longitudinal bars; and it lost the property of gemmation after its origin, since that property was found in the ancestral forms occupying the main branch as far along as the position of *Ecteinascidia*.

Following now the important branch given off at F. (see table, p. 120), which leads to most of the groups of Compound Ascidians, it is found that at an early period two main lines of descent were formed (G. in table), the one leading to the Polyclinidæ, and the other, I believe, through the Distomidæ to the Didemnidæ, the Diplosomidæ, *Cœlocormus*, and finally to *Pyrosoma*. In both of these lines, and in their common ancestors occupying the line from F. to G., the power of reproducing by gemmation was retained and even increased, and the members of the resulting colonies became more closely united with one another than is the case in the Clavelinidæ.

The line which leads from G. to the existing Polyclinidæ (on the right hand side of G. in the table, p. 120) must have been occupied by a series of forms in which the body became gradually more and more elongated antero-posteriorly, and finally divided more or less distinctly into three regions—(1) an anterior part, the thorax, containing the branchial sac and other organs; (2) a middle portion, the abdomen, containing the stomach and the intestinal loop; and (3) a posterior region, the post-abdomen, containing mainly the reproductive organs and the heart (see Fig. 21 on next page).

Large colonies now became formed, and the Ascidiozooids (produced by gemmation from the post-abdomen) composing the colony were so closely placed that their tests became united to form a continuous investing mass. On account of several young Ascidiozooids being usually produced from a single older Ascidiozooid in the colony, a more or less regular grouping into systems naturally took place, and then the atrial apertures of the various Ascidiozooids in a system coalesced to form a centrally placed common cloacal aperture (Fig. 21, *cl.*, and Fig. 26, p. 141). The branchial sac also went a gradual degeneration, resulting in the complete disappearance of the system of internal longitudinal bars inherited from the ancestral forms at F.

The central axis of the Polyclinidæ, extending from G. to H. in the table (p. 120), was composed of a series of ancestral forms in which these and some other less important changes were gradually being affected, but from this axis a few short side branches were given off at different periods. First, not very far from G., a line of descent diverged leading to *Pharyngodictyon*, the most remarkable of the deep-sea Compound Ascidians[1] obtained during the Challenger Expedition. The ancestors of this form must have diverged from the axis of the Polyclinidæ while internal longitudinal

[1] This Report, Part II. p. 152.

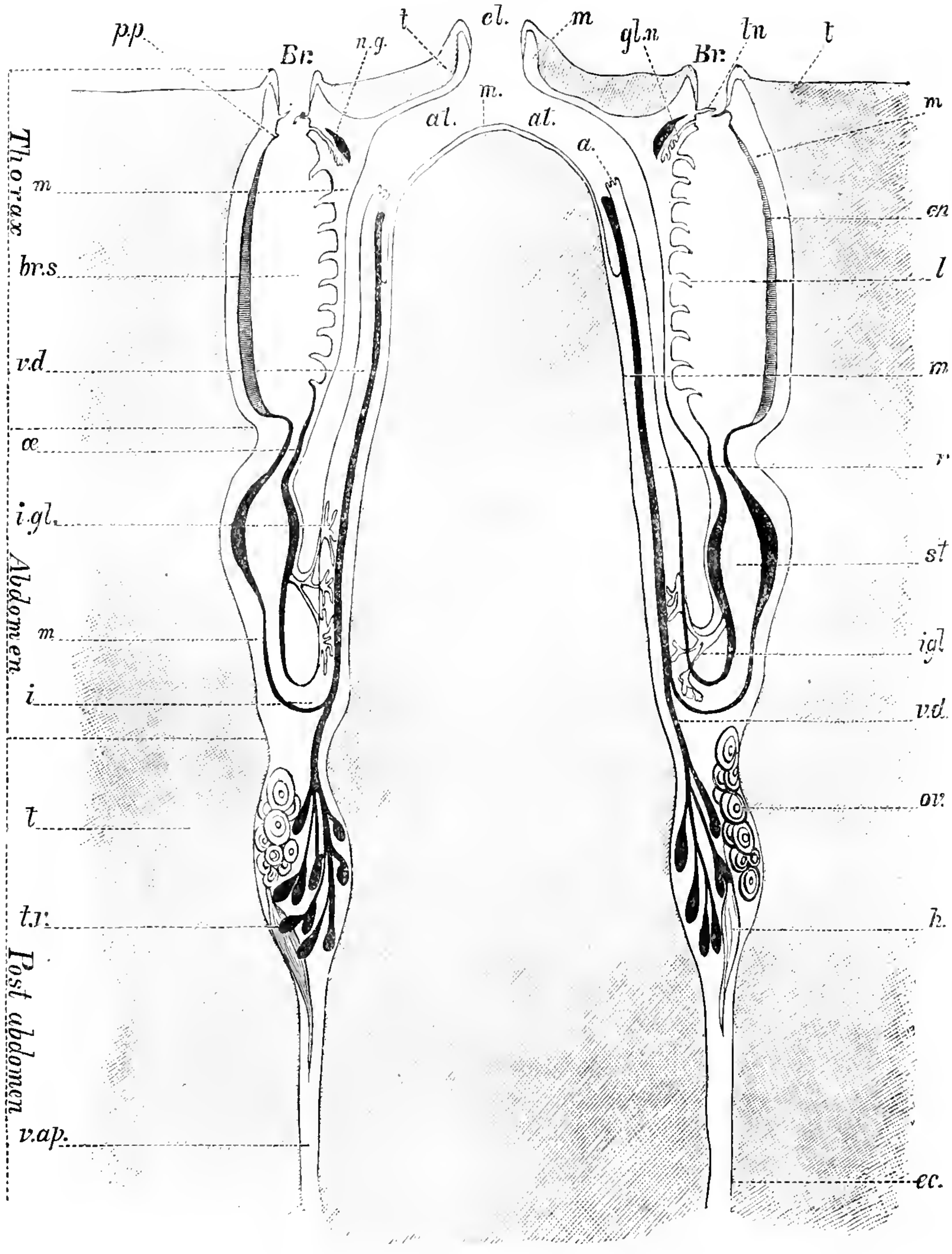


FIG. 21.—Diagram of part of a Compound Ascidian colony belonging to the Polyclinidæ, and showing two Ascidiozooids united to form a system.

a. anus; *at.* atrial aperture opening into the common cloacal cavity; *Br.* branchial aperture; *br.s.* branchial sac; *cl.* common cloacal aperture; *ec.* ectoderm; *en.* endostyle; *gl.n.* subneural gland; *h.* heart; *i.* intestine; *i.gl.* intestinal gland; *l.* languet; *m.* mantle; *n.g.* nerve ganglion; *œ.* œsophagus; *ov.* ovary; *p.p.* peripharyngeal band; *r.* rectum; *st.* stomach; *t.* test; *tn.* tentacle; *t.e.* testis; *v.ap.* vascular appendage; *v.d.* vas deferens. The limits of the thorax, abdomen, and post-abdomen are shown by the dotted lines on the left hand side.

bars were still present in the branchial sac, since these vessels are now present in *Pharyngodictyon*. In the side branch leading to *Pharyngodictyon*, however, a remarkable degeneration of the branchial sac took place, resulting in the total suppression of the system of fine interstigmatic vessels. This particular change in the structure of the branchial sac appears to be associated with the abyssal zone, since it has taken place independently in four distinct groups of deep-sea Ascidians, viz., *Culeolus*, *Fungulus*, *Bathyoncus*, and *Pharyngodictyon*, and has not been found in any shallow-water form.

The second side branch from the Polyclinidæ, that leading to the genus *Tylobranchion*, appears to have left the main axis just about the point where the internal longitudinal bars in the branchial sac were disappearing, as *Tylobranchion* now shows no internal longitudinal bars, but possesses a system of papillæ which there is reason to believe are rudimentary connecting ducts, and which sometimes give off projections resembling the rudiments of internal longitudinal bars found attached to the free ends of the connecting ducts in some Simple Ascidians.[1]

The genus *Atopogaster*, which may be placed upon a third short twig given off from the axis of the Polyclinidæ, differs very slightly from typical members of the family. The only modification of importance which is found, is in the structure of the stomach. The wall of this organ is thrown into a series of more or less distinct transverse folds, a condition never found in the other genera of the family.

The last side branch from the axis previous to H. is the line leading to *Polyclinum*, a form characterised by the smooth-walled stomach, the twisted intestine, and the pedunculated, laterally-placed post-abdomen.[2]

At the point indicated by H. in the table (p. 120) the axis of the Polyclinidæ divided into two lines of descent—the one leading to a series of genera, *Parascidia*, *Morchellioides*, *Synoicum*, *Sidnyum*, and *Morchellium*, in which the stomach wall is curiously and irregularly thickened; and the other to a second series of genera, *Fragarium*, *Circinalium*, *Amaroucium*, *Aplidium*, and *Psammaplidium*, in which the stomach wall is thrown into longitudinal folds. All these genera are really very closely allied, and some species form connecting links between two or more of them.[3] A remarkable modification is found in the branchial aperture of some of the forms from both these groups. As a general rule, amongst Compound Ascidians the branchial aperture is six-lobed, but in *Parascidia* and *Morchellioides* in the one group, and in *Fragarium* and *Circinalium* in the other, the branchial aperture has become eight-lobed. *Psammaplidium* is an interesting new genus derived from the old and well-known genus *Aplidium* by a modification of the test, which has acquired the property of taking up

[1] See this Report, Part II. p. 157.

[2] See Giard, *Arch. d. Zool. expér.*, tom. i. p. 641; and von Drasche, Die Synascidien, etc., p. 23, Wien, 1883.

[3] See this Report, Part II. pp. 176 *et seq.*

and growing over sand grains and other foreign bodies so that they become a part of the investing mass. In some species of *Psammaplidium* the colony looks simply like a mass of sand grains.

Returning now to the point G. at the origin of the Polyclinidæ, we find that the second line of descent leads first of all to the main axis of the Distomidæ; and here, just as in the case of the early Polyclinidæ, a series of changes must have taken place, resulting in the formation of large colonies in which the Ascidiozooids were more or less completely embedded in a common investing mass formed by the fusion of their tests. The union of the atrial apertures to form common cloacal cavities did not take place apparently so soon or so completely as in the case of the Polyclinidæ, and in many of the Distomidæ the atrial apertures of the Ascidiozooids are found opening independently on the exterior of the colony.

The line leading from G. to the base of the Distomidæ gives off a short side branch upon which *Diazona* is found. This remarkable form,[1] although not upon the main axis, is probably the nearest genus now known to the ancestral form at G. which gave rise to most of the Compound Ascidians. *Diazona* has the Ascidiozooids still partially independent, their posterior ends only being embedded in the common investing mass. This form diverged from the main line just before the suppression of the internal longitudinal bars took place, as they are present in *Diazona* although absent in *Chondrostachys*,[2] the next genus which left the main axis.

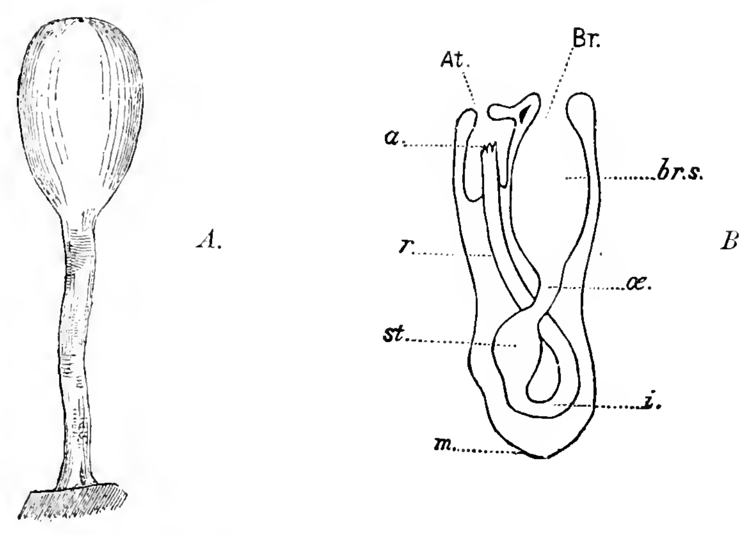


FIG. 22.—Diagrams of *Colella* in the Distomidæ.
A. shows the pedunculated colony, nat. size. *B.* shows one of the Ascidizooids magnified.

Farther along a side branch is found which has given rise to *Oxycorynia*, *Distaplia*,

[1] See Savigny, Mémoires, pp. 35 and 175; Forbes and Goodsir, *Trans. Roy. Soc. Edin.*, vol. xx. p. 307, 1851; and Della Valle, *Rend. d. R. Accad. d. Sci. Fis. Mat. Napoli*, Anno xxiii. p. 23, 1884.

[2] Macdonald, *Ann. and Mag. Nat. Hist.*, ser. 3, vol. i. p. 401, 1858.

and the various species of *Colella* (see Fig. 22). These are all typical Distomidæ, in which the alimentary and reproductive viscera form a mass, the abdomen, placed behind the thorax or branchial region of the body (Fig. 22, *B.*) As no post-abdomen is present, the antero-posterior elongation has evidently not gone so far as in the case of the Polyclinidæ, in fact very little change has taken place in the arrangement of the viscera since the two groups separated at G. In many of the Distomidæ (*e.g.* in the genera *Distaplia*[1] and *Colella*) the basal portion of the colony, consisting of test only, becomes greatly elongated to form a large peduncle, upon the summit of which the upper part of the colony containing the Ascidiozooids is borne (see Fig. 22, *A.*).

Farther on the main axis of the Distomidæ, after giving off at the point I. (table, p. 120, or p. 150), a branch leading to the Didemnidæ, the Diplosomidæ, *Cœlocormus*, and *Pyrosoma*, terminates in the genus *Distoma*, with its closely related form *Cystodytes*, as a short side branch. *Cystodytes*[2] is distinguished by a modification of the test, in which large disk-shaped calcareous spicules are produced in such a manner as to form investing capsules around the bodies of the Ascidiozooids.

The line leading onwards from I. (see table, p. 150) was occupied by a series of ancestral forms, in which, while the general characters of the Distomidæ were preserved, some important changes were effected in the test and in the reproductive organs. The test cells gradually acquired the property of producing spherical or stellate calcareous spicules; while the vas deferens assumed the spirally coiled form which is so characteristic of the Didemnidæ. This ancestral line gave rise to two branches, one (K. in table) leading with comparatively little change to the Didemnidæ and the Diplosomidæ as they are now known, and the other (L. in table) producing the curiously modified *Cœlocormus*, and eventually *Pyrosoma*.

The ancestral Didemnidæ forming the line K. must have divided into two series, those leading to the Didemnidæ proper and those leading to the Diplosomidæ. On the former, near the point of division, may be placed the side branch leading to *Eucœlium*, where the number of rows of stigmata in the branchial sac is greater than three or four, thus resembling most of the ancestral Distomidæ from which the Didemnidæ were derived. In the family Didemnidæ the power of producing calcareous spicules in the test has reached its greatest development, and the male reproductive organs have become concentrated to form a single large ovate testis around which the vas deferens is coiled spirally.

The genus *Didemnum* is less modified than *Leptoclinum*, and may be represented by a short side branch from near the ancestral forms of the family. In *Leptoclinum* the colony has become greatly flattened from above downwards so as to form in most cases a mere incrusting film in which the test is usually densely crowded with calcareous spicules.

[1] Della Valle, *Archiv. ital. d. Biol.*, tom. i. p. 193, 1881.
[2] Von Drasche, Die Synascidien, p. 18, Wien, 1883.

One result of this flattening of the colony in the more modified Leptoclinids is that there being no longer room for the Ascidiozooids to lie with their long axes at right angles to the upper surface of the colony, they have become modified in one of two ways. In some cases they have simply come to lie irregularly in the colony, being inclined at various angles to the surface; but in other cases an interesting change has taken place, the antero-posterior axis of the thorax has remained vertical, the primitive position, but the abdomen has become bent upon the thorax so as to point dorsally.[1] Such a change in the body of the Ascidiozooid would doubtless allow the thorax, and therefore the branchial sac, to remain of large size, while the colony was becoming gradually thinner and thinner; and in some species (*e.g. Leptoclinum moseleyi*), the flexure has gone to such an extent that the abdomen does not extend behind the thorax, but projects at right angles dorsally from its posterior end. Any further bending after this condition had been reached would be useless. It may be noted that this modification produces an arrangement of the Ascidiozooid which shows a superficial resemblance to that seen in the Botryllidæ when the abdomen seems to lie alongside the thorax. The two cases are really, however, entirely different, as there has been no flexure of the body in the Botryllidæ, and there is no included test or double fold of mantle in the angle between the thorax and the abdomen, as there is in the case of the modified Leptoclinids.

In the ancestral Diplosomidæ the reproductive organs have remained in a more primitive condition than in the Didemnidæ, and the vas deferens has become straight. The testes are usually two in number, and are therefore in an intermediate condition between the numerous spermatic vesicles of the ancestral Distomidæ and the single large testis of the Didemnidæ. The property of producing calcareous spicules in the test has become gradually lost in the Diplosomidæ. Spicules are still found in the upper layer of the colony in *Diplosomoides*,[2] but have disappeared in the genus *Diplosoma*. As a result the test has become softer and more transparent, and the system of canals and cavities in connection with the common cloacal apertures has become so increased as to greatly reduce the amount of test in the colony. *Diplosomoides* is less modified than *Diplosoma*, and may be represented by a side branch from the ancestral Diplosomidæ.

The line L. (table, p. 150), which diverged from the common ancestors (K.) of the Didemnidæ and Diplosomidæ, retained the ancestral condition of the male reproductive organs found in the Distomidæ along with the partially coiled arrangement of the vas deferens which became emphasised in the Didemnidæ. At the same time the colony apparently became detached, and its upper surface sank in so as to produce an axial cavity, the lining of which is really morphologically a part of the

[1] See this Report, Part II., pl. xxxvii. fig. 10.
[2] This Report, Part II. p. 309.

outer surface of the colony. This produces the ancestral form from which the remarkable *Cœlocormus huxleyi* (see Fig. 23, B.) was probably derived.

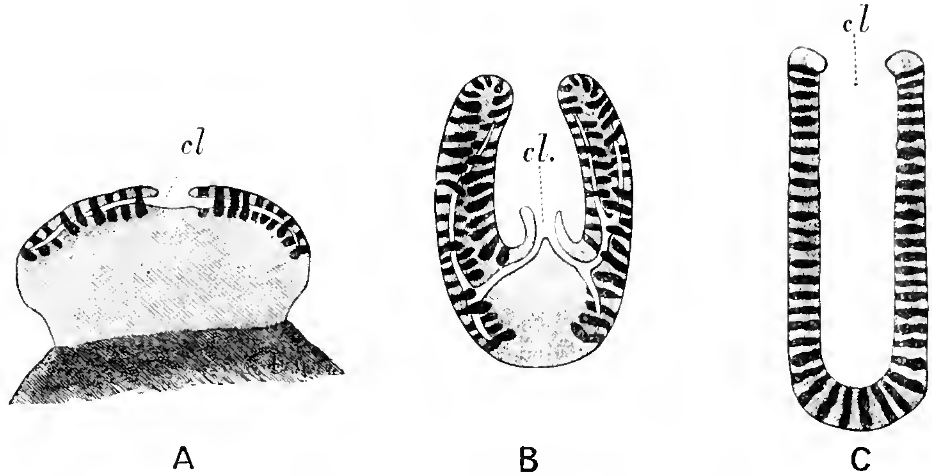


FIG. 23.—Diagrams showing the relations between A. a typical Compound Ascidian; B. *Cœlocormus*; C. *Pyrosoma*. In all cases the colonies are represented in longitudinal section, and *cl.* indicates the opening of the common cloacal cavity.

Cœlocormus is a most valuable transition form, between an ordinary Compound Ascidian (*e.g.*, one of the Distomidæ, Fig. 23, A.) and the remarkably modified *Pyrosoma* (Fig. 23, C.). It is not attached, but is probably not free-swimming. It has a large axial cavity, like that of *Pyrosoma*, opening to the exterior at one end of the colony (see Fig. 23, B.); but this cavity does not receive the atrial apertures directly as it does in the case of *Pyrosoma*, but by means of atrial passages like those found in many Compound Ascidians (compare A. and B. Fig. 23). There is a single large common cloacal aperture placed on a projection at the lower end of the axial cavity, and with this all the atrial apertures of the Ascidiozooids communicate by means of canals penetrating the common test.

From an ancestral form allied to *Cœlocormus* (Fig. 23, B.), *Pyrosoma* was, I consider, derived (see table, p. 150), by slight changes in shape, resulting in the formation of an elongated hollow cylinder, and by a modification in the relations of the Ascidiozooids, so that they came to open independently into the large axial cavity, which is thus virtually converted into a huge common cloacal cavity. *Pyrosoma* is free-swimming, and the Ascidiozooids have acquired light-producing organs placed laterally on their anterior ends. Uljanin[1] considers that *Pyrosoma* is related to the Compound Ascidians; but he places *Distaplia*—which I regard as a typical member of the family Distomidæ, allied to *Colella*—as the connecting form. I have already shown[2] that there is no essential difference in process of gemmation and in life history

[1] Fauna und Flora d. Golfes v. Neapel, Monogr. x., Doliolum.

[2] See before, under *Pyrosoma*, p. 24.

between *Pyrosoma* and the Compound Ascidians; and *Cœlocormus* certainly in the condition of the colony forms a link between *Pyrosoma* and such a genus as *Distaplia*. *Pyrosoma*, then, must be regarded as a highly modified form derived from the ancestral Didemnidæ, and much more closely allied to the ordinary Compound Ascidians, such as the Distomidæ and the Polyclinidæ, than to the other pelagic Tunicates, such as a colony of *Salpæ*.

In order to trace the evolution of the remainder of the Simple and Compound Ascidians,[1] it is necessary to return to the ancestral Ascidians allied to *Ecteinascidia* from which the line F. was derived. In these forms gemmation took place from the posterior end of the body, resulting in the formation of small colonies, possibly temporary only, in which, however, the Ascidiozooids were quite distinct, and were not embedded in a common test. The alimentary canal extended behind the branchial sac posteriorly, and the heart and the reproductive organs were placed alongside the intestinal loop. The branchial sac was provided with internal longitudinal bars, and the tentacles were simple.

From this point *Ecteinascidia* (see table, p. 150) was derived, and shortly afterwards the power of reproducing by gemmation so as to form colonies must have been gradually lost, since it is not found in the next group of Simple Ascidians, the Ascidiidæ.

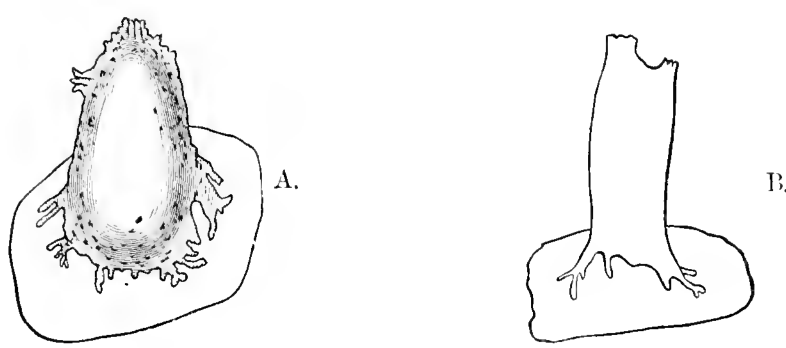


FIG. 24.—A. specimen of *Ascidia aspersa*; B. specimen of *Ciona intestinalis*, showing rudimentary stolons.

Probably the common species *Ciona intestinalis* is the nearest form known to the primitive Ascidiidæ. It resembles *Ecteinascidia* in most respects, but it is not pedunculated, and has not the power of reproducing by gemmation. In many specimens of *Ciona*, however, processes of the test containing blood-vessels are found attached to the posterior end of the body (Fig. 24, B). These closely resemble the stolons of the Clavelinidæ both in appearance and in structure, and there can be no doubt

[1] For further particulars in regard to the structure and relations of the Compound Ascidians discussed above, see Part II. of this Report.

that they are really rudimentary stolons, which are, however, not capable of producing buds, and are only made use of as adhering organs.[1]

In most of the other members of the family Ascidiidæ, these rudimentary stolons either become lost altogether or they acquire a new function, that of aiding in respiration, and become converted into an important system of blood-vessels ramifying through the test and terminating in numerous enlarged bulbs in its superficial layer (Fig. 25).

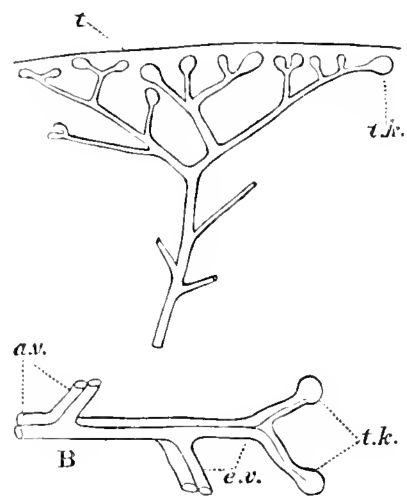


FIG. 25.—Diagram of the vessels in the test of *Ascidia mammillata*.

B. a small part of the system more highly magnified; *a.v.* afferent vessels; *e.v.* efferent vessels; *t.k.* terminal knobs; *t.* surface of the test.

This is a well-marked instance of the evolution of a system of organs performing an important function from a structure having originally an entirely different function. The process has, I believe, been as follows:—The bud-producing stolons of the Clavelinidæ lost their power of gemmation in the primitive Ascidiidæ, and the stolons became rudimentary. In *Ciona* and some other Simple Ascidiidæ they were made use of as adhering organs, until they gradually came to function slightly as respiratory organs by aiding in the oxygenation of the blood circulating in the test, and were then seized upon by natural selection as useful organs, and evolved into the system of vessels seen in *Ascidia mammillata* and other species. It would be possible to form a series of preparations showing all the transition forms between the bud-producing stolons of *Clavelina* (Fig. 19, p. 129), and the respiratory system of vessels in the test of *Ascidia* (Fig. 25); and *Ciona* (Fig. 24) may be regarded as the nearest form known to the point occupied by the ancestors in which the change of function took place.

[1] See Prelim. Report on Chall. Tun., Part II., *Proc. Roy. Soc. Edin.*, vol. x. p. 719, 1880; and On the Evolution of the Blood-vessels of the Test in the Tunicata, *Nature*, vol. xxxi. p. 247, 1885.

From the main stem of the Simple Ascidians (see table, p. 150) close to *Ciona* several lines are shown diverging to the various groups of the Ascidiidæ. *Rhodosoma* was derived, I consider, from *Ciona*. It is a remarkable form,[1] in which the test on the anterior part of the body has been modified to form a hood which by muscular contraction can be shut down so as to cover both the apertures. One species of *Ciona*, *C. savignii*, from Japan, shows a tendency towards the modification of the test found in its extreme condition in *Rhodosoma*.

Two important lines from near *Ciona* have diverged to *Ascidia* and its allies on the one hand, and to *Corella* and its allies on the other (see table, p. 150). In *Ciona* the stomach and intestine form a simple loop extending slightly beyond the branchial sac, and the heart is a fusiform tube running antero-posteriorly alongside the stomach. In *Corella*[2] and its allies, however, the branchial sac has extended posteriorly so as to cause the alimentary canal as a whole to lie upon the right-hand side of the branchial sac, the stomach being anterior to the intestine, and the heart placed in front of the stomach. On the other hand, in the branch leading to *Ascidia* and allied genera the branchial sac must have extended downwards upon the right-hand side of the body so as to throw the alimentary canal to the left, and carrying the stomach with it, that organ has come to be placed behind the intestine, and the heart behind the stomach.

Pachychlæna and *Ascidiella* and other subdivisions of *Ascidia* may all be represented by short twigs springing from the line leading from the *Ciona*-like ancestor to the typical *Ascidia* (see table, p. 150). *Corynascidia*, on the other hand, belongs to the *Corella* branch; while *Abyssascidia*[3] is intermediate in structure between *Ascidia* and *Corella*, and is best represented by a short branch springing from near the base of the line leading to *Corella*, and not far from the point occupied by the common ancestors of all the groups of Ascidiidæ. The very remarkable *Chelyosoma*[4] is an extreme modification of a side branch from near *Corella*. As in the other Corellinæ, the stigmata in the branchial sac have become curved, while in the Ascidiinæ they are straight; but unlike any other Ascidiidæ, the test has become modified into a set of regularly-shaped horny plates, of which eight surround the branchial aperture and six the atrial. An approach to this condition of the test is seen in *Styela tessellata* and some other species of the Cynthiidæ.

The main stem of the Simple Ascidians beyond the ancestral Ascidiidæ leads to a great series of forms in which the branchial sac is highly developed, and has its surface largely increased by being thrown into a series of longitudinal folds. Before this

[1] See Lacaze-Duthiers, *Ann. d. Sci. Nat.*, sér. 5 (Zool.), tom. iv. p. 293, 1865.

[2] See Herdman, Notes on British Ascidians, *Journ. Linn. Soc. Lond.*, Zool., vol. xv. p. 274, 1880.

[3] For further details as to the relationships of the genera of the Ascidiidæ, see this Report, Part I. p. 285.

[4] Eschricht, *Dansk. Vid. Selsk. Afh.*, ix. p. 1, 1842; and Traustedt, *Vid. Medd. Nat. For. Kjøbenhavn*, 1879–80, p. 429.

change took place, however, a branch diverged from the main stem, and after considerable modification gave rise to the family of the Botryllidæ. In this long line of descent (N. in table, p. 150) the lost property of reproducing by gemmation was apparently regained, and as a result colonies were produced once more.

The Ascidiozooids in the ancestral Botryllidæ became completely embedded in a common test, but they remained in a short-bodied condition, the alimentary canal being placed alongside the thorax. The Ascidiozooids also, as the result of gemmation, became arranged in systems, and in each system all the atrial apertures have come to open into a centrally-placed common cloacal cavity (Fig. 26). The test

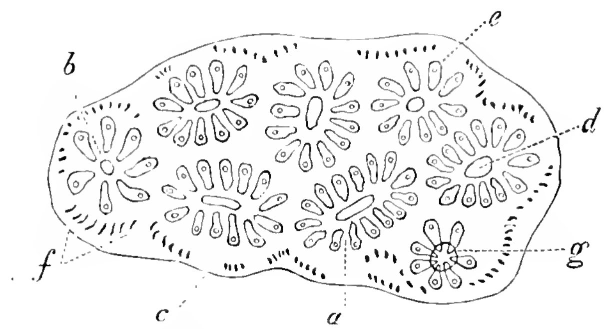


FIG. 26.—A colony of *Botryllus*. The Ascidiozooids are arranged in eight systems.

a, a large system formed of fifteen Ascidiozooids; *b*, a small system formed of seven Ascidiozooids; *c*, test; *d*, cloacal aperture; *e*, an Ascidiozooid; *f*, terminal knobs of vessels; *g*, a fully expanded cloacal aperture.

is penetrated in all directions by a well-developed system of blood-vessels with enlarged terminal bulbs in the superficial layer of the colony, forming an accessory organ of respiration.[1] This system is evidently the same as that found in the test of some of the Ascidiidæ, and has doubtless been inherited by the Botryllidæ from their ancestors amongst the Ascidiæ Simplices. The branchial sac in the Botryllidæ is well developed, and agrees with that of the Simple Ascidians from the point F. (table, p. 150) onwards in having well-developed internal longitudinal bars. The reproductive organs, finally, in the Botryllidæ are found in a condition which suggests the close connection with the ancestral Cynthiidæ shown in the table.

One of the new Compound Ascidians discovered during the Challenger Expedition, *Symplegma viride*, from Bermuda, is a remarkable form which unites the external appearance and general arrangement of colony characteristic of the typical Distomidæ, with the structure of branchial sac and dorsal lamina found only in the Botryllidæ and the Simple Ascidians. In the second part of this Report (p. 144), while pointing out the resemblance of *Symplegma* to the Botryllidæ, I placed the genus provisionally in the Distomidæ; but I am now inclined to regard it as being probably the

[1] See *Proc. Lit. and Phil. Soc. Liverpool*, vol. xxxix. p. 39, 1885.

termination of a side branch from the ancestral Botryllidæ which has undergone considerable modification (see table, p. 150).

Four generic groups are recognised amongst existing Botryllidæ. Of these, two (*Sarcobotrylloides* and *Polycyclus*) form thick massive colonies, while the other two (*Botryllus* and *Botrylloides*) form thin incrusting colonies. In *Polycyclus* and *Botryllus*, again, the systems are regular and stellate (Fig. 26); while in *Botrylloides* and *Sarcobotrylloides* the systems form irregular linear or branched arrangements. The Ascidiozooids vary in structure according to the shape of the systems. They are short and ovate, with the atrial aperture far from the anterior end of the body, where the systems are regular and stellate; while they are longer and more cylindrical, with the atrial aperture placed close to the branchial, in the forms with irregular or linear systems.

Probably these two opposite conditions of the systems and the Ascidiozooids characterised two branches into which the ancestral Botryllidæ divided (see table, p. 150). Both series had the colony of moderate thickness; but the one, that leading to *Botryllus* and *Polycyclus*, had the systems regular and the Ascidiozooids ovate; while the other, that leading to *Botrylloides* and *Sarcobotrylloides*, had the systems elongated and the Ascidiozooids cylindrical. Probably the first of these conditions was that which obtained amongst the more primitive Botryllidæ (those occupying the line N. before its division), since we find at the present day in young colonies of *Botrylloides* the systems often commencing in stellate forms like those of *Botryllus*, and then gradually elongating and branching to form the more complicated arrangements characteristic of *Botrylloides*.

The difference in the structure of the Ascidiozooids can readily be seen to be merely the result of the shape of the systems. When the system is stellate, each Ascidiozooid forms one of the rays of the star (see Fig. 26, p. 141), with the branchial aperture placed at the anterior end, the point farthest from the centre; and as the atrial apertures open into the common cloacal cavity in the centre of the system, they are necessarily placed far from the anterior end of the body. But when the systems become greatly elongated and branched, it is no longer possible for each atrial aperture to reach the common cloacal cavity, and consequently that cavity becomes prolonged into a series of canals, which penetrate all parts of the system running between the Ascidiozooids. As a result of this, it being no longer necessary for the Ascidiozooid to be stretched out in order to reach the common cloaca, the body comes to be more vertically placed, and the atrial aperture returns to its ancestral position near the anterior end.

Each branch of the Botryllidæ afterwards divided into two groups (see table, p. 150), in the first of which the colony became thinner and more of an incrusting film (*Botryllus* on the one hand, and *Botrylloides* on the other), while in the second the colony became thicker and more massive (*Polycyclus* in the one group, and *Sarcobotrylloides* in the other).

Returning now to the main axis of the Simple Ascidians, it is found to acquire the folded branchial sac soon after the separation of the ancestral Botryllidæ, and immediately after this, close to the point of division (M. in table) into primitive Cynthinæ and primitive Styelinæ, the genus *Bathyoncus* was given off as a side branch. The origin of this form may either have been (as shown in table) from the main axis before it divided, or from the branch of the Styelinæ not far along from the point M. *Bathyoncus*[1] is a deep-sea genus, in which the branchial sac has undergone that remarkable modification, already discussed (p. 133), which results in the total suppression of the fine interstigmatic vessels. It is closely allied in other respects to the primitive Styelinæ, and has simple tentacles. This peculiar modification of the branchial sac has not been met with in any of the true Cynthinæ, but it occurs in *Culeolus* and *Fungulus* amongst the Bolteninæ (see table, *Culeolus*, and Fig. 28, p. 147).

In the primitive Styelinæ the tentacles remained simple as they were in the ancestral Ascidiæ Simplices, and the number of folds in the branchial sac became limited to four on each side. The genus *Pelonaia*, which was formerly regarded[2] as a very abnormal Tunicate, differing in some important respects from all other Ascidians, is now known[3] to be an ordinary Simple Ascidian, and it was probably derived from the ancestral Styelinæ (table, p. 150). The folds in the branchial sac have disappeared in *Pelonaia*, but they are found in a more or less rudimentary condition in a number of species of the genera *Styela*[4] and *Polycarpa*.

Throughout the sub-family Styelinæ comparatively little modification has taken place. The tentacles never become branched, and the branchial sac remains in a simple condition, with four folds on each side. It is very interesting to find that even in those Styelinæ where the branchial folds become lost (e.g. *Styela oblonga*), it is still possible to make out indications of their former presence by means of the arrangement of the internal longitudinal bars and the sizes of the meshes and stigmata.

The reproductive organs consist of one or two long convoluted masses upon each side of the body in typical species of *Styela*, and of a large number of small rounded masses, called "polycarps," attached all over the inner surface of the mantle in the genus *Polycarpa*; but species are known which form a perfect series of gradations between these two conditions.[5] Probably both of them, as well as the form of genitalia found in the family Botryllidæ, are derived from an ancestral condition, which would be found

[1] This Report, Part I., p. 165.

[2] See Forbes and Hanley, Brit. Moll., vol. i. p. 42.

[3] M'Intosh, *Ann. and Mag. Nat. Hist.*, ser. 3, vol. xix. p. 414, 1867; and Traustedt, *Vid. Medd. Nat. For. Kjøbenhavn*, 1879–80, p. 418.

[4] On Individual Variation among Ascidians, *Proc. Lit. Phil. Soc. Liverpool*, vol. xxxvi. p. 315, 1882.

[5] See Sluiter, *Natuurkund. Tijdschr. v. Nederl. Indië*, Dl. xlv. pp. 188 and 228, 1886.

on the main stem of the Ascidiæ Simplices near to the point M. in the table, and which consisted of one or two hermaphrodite polycarps attached to the mantle on each side of the body. In some of the species of *Polycarpa* the polycarps, originally hermaphrodite, have become unisexual, and the ovaria and spermaria, as they may then be called, have assumed different characters.

The interesting little group of species composing the family Polystyelidæ, which have been variously regarded as Simple Ascidians belonging to the Cynthiidæ, and as Social Ascidians allied to *Clavelina*, have really, I believe, been derived from the Styelinæ, but should now be regarded as Compound Ascidians, since they seem to reproduce by gemmation so as to form colonies in which the Ascidiozooids are embedded in a common test. Most of the Polystyelidæ have their branchial sacs folded longitudinally, and they all possess polycarps on the mantle, which are in some cases unisexual, consequently there can be little doubt that they are derived from the immediate ancestors of the genus *Polycarpa*, after the separation of *Styela* (see table, p. 150).

The new genus *Chorizocormus*,[1] obtained during the Challenger Expedition at Royal Sound, Kerguelen Island, shows in a most instructive way how the transition from the ancestral *Polycarpa* to the colonial Polystyelidæ was effected. The colony of *Chorizocormus*[2] consists of a number of small rounded and irregularly-shaped masses joined by a creeping and branching stolon. In some cases each mass contains only one Ascidiozooid, and then it bears the closest possible resemblance to a *Polycarpa*, and is, of course, not embedded in any colonial test; but in other cases a number of Ascidiozooids are placed together in each mass, and they are then completely buried in the test, so as to form a true colony; and all intermediate forms between these two extreme conditions are also found.

Chorizocormus, then, is probably the nearest form known to the ancestral Polystyelidæ (see table, p. 150); while the species of *Thylacium*, *Polystyela*, and *Synstyela* form a series of gradations towards the complete colonies with a massive test found in the genus *Goodsiria* (see table). This genus,[3] which is found in the Straits of Magellan growing to a size of upwards of two feet in length, shows various intermediate conditions between distinct branchial folds like those of the Styelinæ, and a smooth branchial sac with no folds, like that found in the Botryllidæ.

In the genera *Thylacium* and *Polystyela* the Ascidiozooids project above the general surface of the colony, consequently these forms bear much the same relation to the other Polystyelidæ that the genus *Diazona* does to the typical Distomidæ. *Synstyela* and *Goodsiria*, the two most highly evolved forms of the family, have diverged in opposite directions (see table, p. 150). In *Synstyela* the colony has become thin and incrusting, while in *Goodsiria* the test is greatly enlarged,

[1] See this Report, Part II. p. 345. [2] See this Report, Part II., pl. xlvi. fig. 1.
[3] Cunningham, *Trans. Linn. Soc. Lond.*, vol. xxvii. p. 465, 1871; and this Report, Part II. p. 327.

thus rendering the colony thick and massive. In none of the Polystyelidæ have the Ascidiozooids come to be arranged in systems, and no common cloacal cavities have been formed,—the atrial apertures of all the Ascidiozooids open independently on the exterior of the colony. In this respect the colony is in the same stage of differentiation as that reached by most Distomidæ, while the other groups of Compound Ascidians (*e.g.* Botryllidæ, Polyclinidæ, Didemnidæ) have advanced a stage farther by the formation of systems with common cloacal cavities (see Fig. 26, p. 141).

It is possible that the family Botryllidæ may be more closely allied to the Polystyelidæ than I have shown in the table. The line N., in place of springing from the primitive Cynthiidæ, may possibly have been derived from the Polystyelidæ, near the point where *Goodsiria* and *Synstyela* diverged. In that case the evolution of the primitive Botryllidæ would consist in the gradual formation of systems in the colony, and the complete disappearance of all traces of folds in the branchial sac.

The primitive Cynthiidæ at the point M. (table, p. 150), after the separation of *Bathyoncus* and the ancestral Styelinæ, must have acquired compound or branched tentacles, as they were the common ancestors of the Cynthinæ, the Bolteninæ, and the Molgulidæ. At the same time, the folds in the branchial sac became more marked and increased in number. At or about the point O. in the table the important line of descent leading to the family Molgulidæ probably diverged, while the main branch was continued onwards to form the Cynthinæ.

In the ancestral Molgulidæ the branchial sac became still more complicated by the curving of the stigmata and the fine interstigmatic vessels so as to produce a series of more or less perfect spirals. The folds in the branchial sac remained of large size, and the compound tentacles became greatly branched. At the same time the test became prolonged into a number of branched hair-like processes, containing blood-vessels, and probably corresponding to the stolons of the Clavelinidæ. These processes have the power of taking up and attaching sand grains to their surfaces so as to form a sandy investment all over the body.

The remarkable genus *Eugyra* was derived from these ancestral Molgulidæ (see table, p. 150), and has undergone modification and a slight degeneration. The stigmata have become more completely spirally coiled than in any other Molgulid, but the folds in the branchial sac have completely disappeared, while the internal longitudinal bars have been widened and flattened to form ribbon-like bands.

Amongst the species of the more typical Molgulidæ[1] a considerable amount of differentiation has taken place. In some forms (e.g. *Ascopera*, and some species of *Molgula*) the sandy investment and the hair-like processes of the test have been lost, while in others the body has become pedunculated. In some cases (e.g. *Molgula carpenteri*) the stigmata are not curved, and closely resemble those of the family

[1] See H. de Lacaze-Duthiers, *Arch. d. Zool. exper.*, tom. iii., 1874, and tom. vi., 1879.

Cynthiidæ. I am inclined to regard these as typical Molgulidæ which have reverted to the ancestral form of branchial sac, rather than as forms derived immediately from the common ancestors of Molgulidæ and Cynthiidæ at or near the point O., because they exhibit in all their other organs highly differentiated Molgulid characters.[1]

The ancestral Cynthiidæ after the separation of the primitive Molgulidæ (O. in table, p. 150) were continued onwards with little change to the Cynthinæ (the genera *Cynthia* and *Microcosmus*) of the present day. The remaining sub-family, the Bolteninæ, must be placed on a side branch which diverged from the early Cynthinæ. In this ancestral line a part of the test became enlarged and prolonged to form a well-marked peduncle (Fig. 27), thus leading to the genus *Boltenia*, while *Culeolus* and *Fungulus* are degenerate deep-sea forms characterised by that peculiar modification of the branchial sac (see Fig. 28) found in the more primitive *Bathyoncus*, and in *Pharyngodictyon* in the Polyclinidæ. In *Culeolus*, however, curious calcareous spicules are found strengthening the vessels of the branchial sac (Fig. 28, *sp.*).

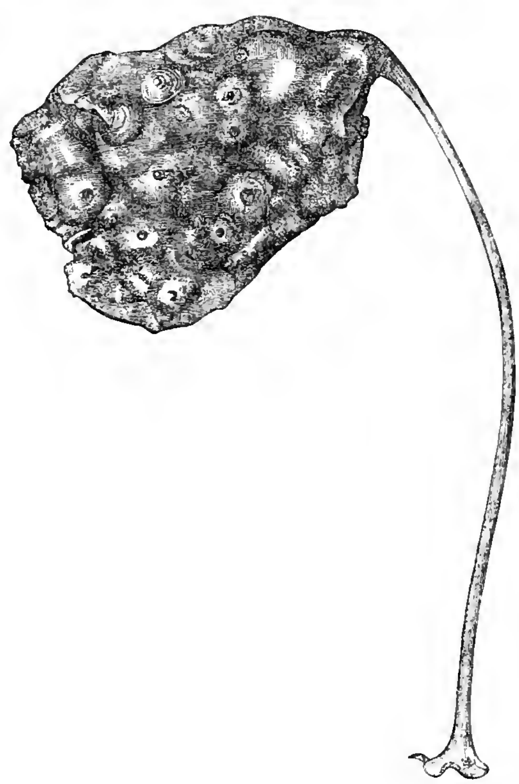


FIG. 27.—*Culeolus wyvillii.*

[1] See this Report, Part II. Appendix A., p. 402.

The number of lobes surrounding the branchial and atrial apertures is of considerable importance in classifying the Tunicata, but it is by no means obvious what it is that

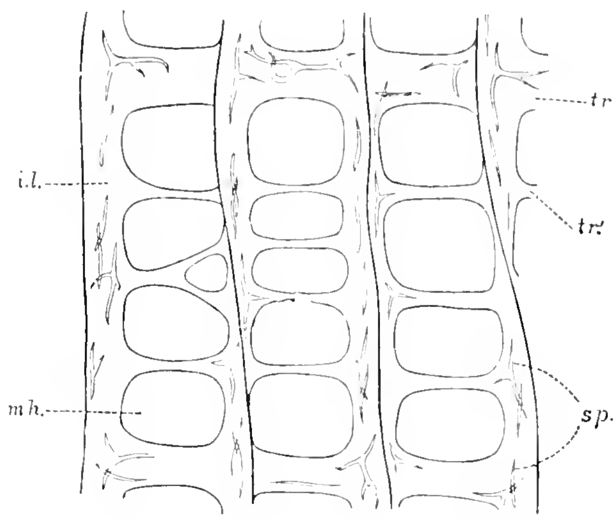


FIG. 28.—Part of the branchial sac of *Culeolus wyvillii*.
i.l. internal longitudinal bars; *mh.* mesh; *tr.* transverse vessels; *sp.* spicules.

determines the exact number of lobes, and why the number should become changed in certain groups.

In the Appendiculariidæ, and probably in the Prototunicata, the Protothaliacea, and the Protoascidiacea, the apertures were simply rounded or slightly bilabiate. In *Doliolum* they have become ten or twelve-lobed. In the Salpidæ and in *Octacnemus* they are circular or bilabiate; finally, in *Clavelina*, *Perophora*, and *Hypobythius*, all simple forms closely allied to the ancestral Protoascidiate occupying the point E. (table, p. 150), the apertures are simply rounded. In *Ecteinascidia*, however, a slight lobing of the apertures has commenced. In some cases it is not visible, in others six indistinct lobes around the atrial aperture, and seven or eight around the branchial aperture, can be made out.

In the great majority of the Compound Ascidians derived from the branch F. (table, p. 150) the branchial aperture is provided with six well-marked lobes, while the atrial may be six-lobed, or bilabiate, or simply rounded, or, finally, may be provided with a single very large anteriorly placed lobe known as the atrial languet. In one group of the Polyclinidæ, however, consisting of the genera *Parascidia*, *Fragarium*, *Circinalium*, and *Morchellioides*, the branchial aperture is very distinctly eight-lobed. In the remarkable *Cœlocormus*, again, the branchial apertures are five-lobed.

In nearly all the Ascidiidæ amongst Simple Ascidians the arrangement of the apertures which was seen obscurely in *Ecteinascidia* is very well marked: they have eight lobes around the branchial aperture and six around the atrial. In *Chelyosoma*, however, the branchial aperture is six-lobed, and in *Abyssascidia* the number has become greatly increased. In *Abyssascidia wyvillii* there are twelve or fourteen branchial and nine atrial. The Botryllidæ, like most other Compound Ascidians, have six-lobed branchial apertures. The ancestral Simple Ascidians in the neighbourhood of the point M. (table, p. 150) probably acquired four-lobed or cross slit apertures, since it is the general rule both in the Stylinæ and the Cynthinæ that both branchial and atrial apertures should have four lobes. The Polystyelidæ, like the Styelinæ from which they are derived, have both apertures four-lobed or quadrangular.

In both the side branches which arose from the ancestral Cynthinæ modification has taken place. In the Molgulidæ the branchial aperture has became six-lobed while the atrial has remained unchanged (*i.e.* has four lobes). In the Bolteninæ, finally, *Boltenia* has both apertures four-lobed, while *Culeolus* and *Fungulus* have the branchial aperture triangular and the atrial bilabiate.

From the distinctness of the lobes and the constancy of their number in most groups, there can be no doubt that the number of lobes around the apertures is of some importance to the Ascidian, and yet it is not easy to say what difference it makes whether there are six lobes or eight around the branchial aperture; and although it may possibly be an instance of correlation,—the lobes varying in accordance with the condition of some other part of the body,—still there is no known organ in the Ascidian which will account for all the variations. I have sometimes thought that the structure of the branchial sac might be the cause of the number of lobes in some cases; for example, in the Styelinæ, where the branchial and atrial apertures are always four-lobed, the branchial sac has always four folds upon each side; then, again, in the Botryllidæ, where there are six lobes around the branchial aperture, there are always three well-marked internal longitudinal bars upon each side of the branchial sac. But, on the other hand, in many cases there appears to be no connection between the structure of the branchial sac and the number of folds. Perhaps the most unaccountable case is that of the genera of Polyclinidæ derived from the ancestral form occupying the point H. (table, p. 150). In this little group, most closely related genera such as *Sidnyum*, *Fragarium*, *Morchellium*, and *Morchellioides* are found, some with six-lobed branchial apertures and others with eight lobes, while their branchial sacs and most of the other organs of the body are almost indistinguishable from one another.

Uljanin in his sketch of the phylogeny of the Tunicata [1] shows the Appendiculariidæ giving rise to the Simple Ascidians, from which three lines then diverge, one to *Salpa*, the second to *Doliolum* through *Anchinia*, and the third to the Compound Ascidians,

[1] Fauna und Flora des Golfes von Neapel., Monogr. x. Doliolum, p. 123, 1884.

from which he derives (1) *Pyrosoma* through *Distaplia*, (2) the Botryllidæ, and (3) the Social Ascidians through the Diplosomidæ and the Didemnidæ.

There are several points in that scheme which I cannot agree with. It seems to me that the passage from *Appendicularia mossi* through *Anchinia rubra* to *Doliolum*, and through the ancestral Doliolidæ to *Salpa*, is so natural and simple that it becomes very improbable that the Thaliacea have ever been fixed forms. It is extremely unlikely that they are, as Uljanin supposes, a group of Simple Ascidians, which after being fixed betook themselves again to a free-swimming mode of life and underwent great modification.

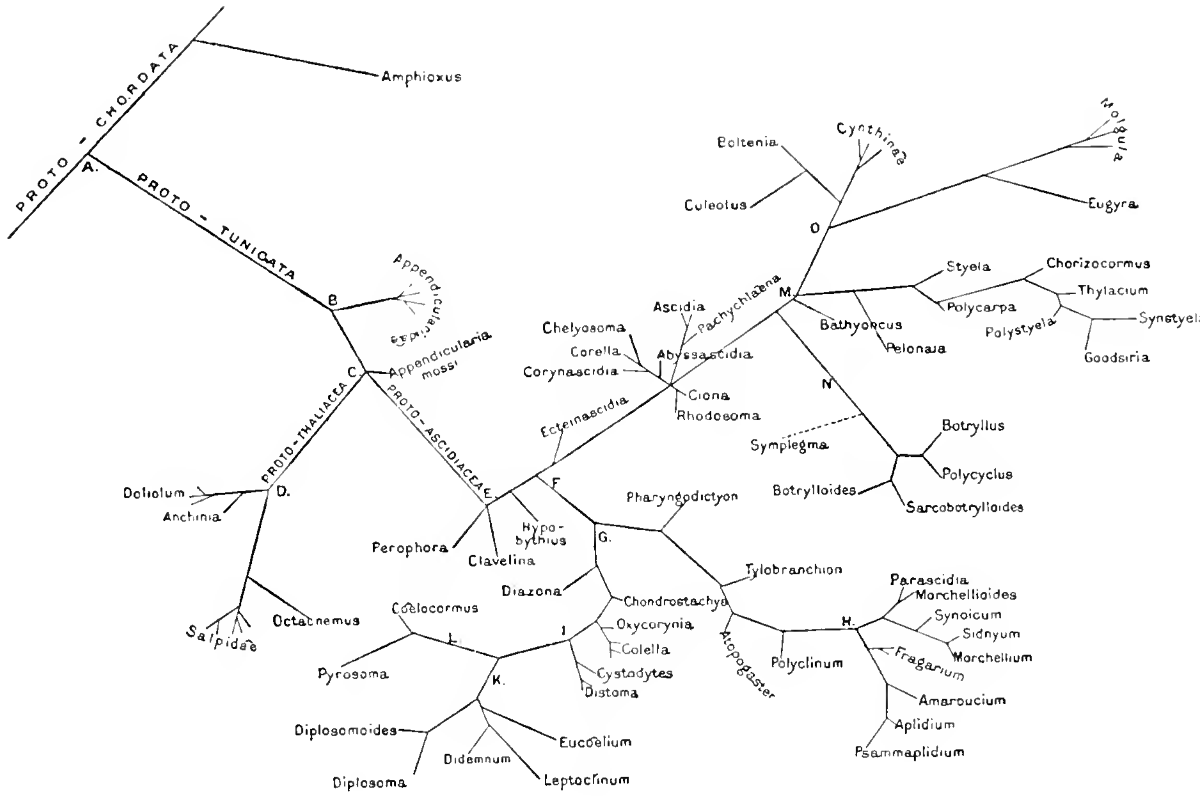
I think it is more probable that the Simple and the Compound Ascidians were both derived from a common ancestor, than that the Compound were evolved from the Simple; and I object strongly to Uljanin's view, that the Social Ascidians are a group derived from the Compound forms and having no close connection with the Simple Ascidians. This is opposed to all we know as to the very close relationship[1] between the Clavelinidæ and the Ascidiidæ. There can, I think, be no doubt after the examination of such a series of forms as *Diazona*, *Clavelina*, *Ecteinascidia*, and *Ciona*, that the Social Ascidians (Clavelinidæ) are intermediate between the least modified of the Simple Ascidians and the least modified of the Compound Ascidians, and ought therefore to be regarded as closely allied to the ancestral form from which both Simple and Compound Ascidians were derived (see E. in table, p. 150).

Finally, I may point out the two most important conclusions at which I have arrived, as the result of this investigation into the Phylogeny of the Tunicata :—

1st, *Pyrosoma*, although now a pelagic free-swimming organism, was derived from the fixed Compound Ascidians. The discovery of *Cœlocormus huxleyi* shows the relationship between *Pyrosoma* and the primitive Didemnidæ, and the latter were derived from the primitive Distomidæ; consequently *Pyrosoma* is directly related to the most typical of the Compound Ascidians.

2nd, The Ascidiæ Compositæ or Synascidiæ are polyphyletic, having been derived from the Simple Ascidians or their ancestors at three distinct points. The result of this is that the Compound Ascidians form three groups (see table, p. 150),—(1) the Polystyelidæ, (2) the Botryllidæ, and (3) the remainder, which are more nearly related to particular groups of Simple Ascidians than they are to one another.

[1] See this Report, Part I. pp. 237 *et seq.*; and Sluiter, *Natuurkund. Tijdschr. v. Nederl. Indie*, Dl. xlv. p. 160, 1886.



GRAPHIC REPRESENTATION OF THE PHYLOGENY OF THE TUNICATA.

The annexed scheme shows diagrammatically the probable phylogeny of the Tunicata. This group of animals is represented as being derived from the Protochordata (in the top left-hand corner of the page) at the point A., a little way below the position of *Amphioxus*. It branches out into a series of lines having a tree-like form, and representing the various ancestral and existing groups of Tunicata. The names at the ends of the lines stand for genera or small groups of genera. A few of the less important genera have been omitted. The letters A. B. . . . O. represent hypothetical ancestral forms of importance which can be partially reconstructed from our knowledge of existing forms. In most cases they are placed at points where two or more lines of descent diverged from one another.

In this Phylogenetic Table all existing forms are represented as being at the *ends* of branches or twigs. In no case has the line representing the evolution of one group been allowed to pass through another group. Finally, the whole figure may be regarded as a graphic representation of the present state of our knowledge as to the affinities of the various groups of the Tunicata.

APPENDIX A.

DESCRIPTION OF TWO NEW SPECIES OF SIMPLE ASCIDIANS.

The two specimens described below were sent to me after the publication of the second part of this Report. They both represent new species, and are referable, one to the genus *Abyssascidia* in the family Ascidiidæ, and the other to the genus *Styela* in the family Cynthiidæ. They were found in the Southern Ocean.

Abyssascidia vasculosa, n. sp. (Pl. XI. figs. 1–6.)

External Appearance.—The body is of an elongated ovate shape, with the anterior end narrower than the posterior. It is somewhat flattened dorso-ventrally, and was probably attached by a small part of the ventral edge. The apertures are placed far apart. The branchial is anterior and terminal. It is wide and is distinctly eight-lobed. The six-lobed atrial is nearly three-fourths of the way back. It is smaller than the branchial, and is placed on a well-marked tubular projection which is directed posteriorly. The surface is perfectly smooth. The colour is a clear transparent grey.

Length, 3 cm.; greatest breadth, 1·5 cm.

The Test is thin and easily torn. It is smooth and glistening, and is perfectly transparent. It is richly provided with vessels which enter near the posterior end of the ventral edge and branch through all parts.

The Mantle is not strong. Its musculature is confined to the right side, where it forms a close but irregular network. The muscle bands are very numerous, but are not strong.

The Branchial Sac is very delicate. The transverse vessels are all of the same size. The internal longitudinal bars are very narrow. They are joined to the transverse vessels by large triangular flap-like connecting ducts. The papillæ at the angles of the meshes are large and of irregular shape. The stigmata are large, and the fine longitudinal vessels are relatively very narrow. There are about four stigmata in a mesh.

The Dorsal Lamina is a narrow membrane with a deeply cut edge. Every fourth projection is larger than the rest, and is continued across the membrane so as to look like a languet joined to its fellows by a serrated web.

The Tentacles are very numerous and extraordinarily long. They are of two sizes placed alternately.

The Dorsal Tubercle is in the form of a transversely flattened band crossing the anterior end of a deep triangular peritubercular area.

The Alimentary Canal is placed on the left side of the body in its posterior half. The œsophagus is long, the stomach small, and the intestine relatively short. The œsophagus is anterior to the intestine, and the whole canal forms a loop open dorsally.

The Reproductive Organs form a globular mass placed on the dorsal edge of the stomach and filling up the loop between the œsophagus and the intestine.

Locality.—March 3, 1874; Station 157; lat. 53° 55′ 0″ S., long. 108° 35′ 0″ E; depth, 1950 fathoms; bottom, Diatom ooze; surf. temp. 37°·2, bottom temp. 32°·1.

This is an important species which appears to be more nearly allied to *Abyssascidia* than to any other genus of the Ascidiidæ; and although it does not conform with all the characters of that genus as given in the first part of this Report (p. 193), I have considered it better to place it here in the meantime, than to form a new genus intermediate between *Abyssascidia* and *Ascidia* for its reception.

In external appearance (Pl. XI. fig. 1) it is like an *Ascidia*. It has an eight-lobed branchial and a six-lobed atrial aperture, and the latter is placed upon a posteriorly directed siphon like that of *Ascidia plebeia*, Alder. The vessels in the test are very numerous, and form a conspicuous feature (Pl. XI. fig. 1) as they are distinctly seen through the transparent test.

The body inside the test is greatly contracted, so as to appear only about three-quarters of the size necessary to fill its cavity (Pl. XI. fig. 2). The short wide branchial siphon and the long narrow atrial are readily seen. The viscera are placed upon the left side of the body, and the mantle on that side has no muscle bands. The long tentacles are seen projecting freely out of the branchial aperture (Pl. XI. fig. 2).

The branchial sac has a very loose and fragile appearance, the reason being that all the vessels are very narrow and the spaces between them large. The internal longitudinal bars are especially thin, but bear very large papillæ (Pl. XI. fig. 4), and are united to the transverse vessels by large membranous flaps. The general appearance of this branchial sac recalls that of *Abyssascidia wyvillii*.

The dorsal lamina is evidently formed of a series of languets (Pl. XI. fig. 5) which have been united by a membrane. In *Abyssascidia wyvillii*[1] there are short languets. The closely placed tentacles (Pl. XI. fig. 3) are remarkable for their great length, stretching easily for half their extent outside the branchial aperture. The smaller tentacles are exceedingly narrow. The conditions of the dorsal tubercle and peritubercular area are seen in Pl. XI. fig. 3. Probably the dorsal tubercle in *Abyssascidia wyvillii* is in much the same condition. The nerve ganglion is long and narrow.

The œsophagus commences about half-way down the dorsal edge of the branchial

[1] See this Report, Part I. p. 194. pl. xxvii. fig. 11.

sac, and runs ventrally in an undulating course (Pl. XI. fig. 2) to open into the anterior end of the stomach. The intestine, on emerging from the posterior end of the stomach, runs dorsally and posteriorly, also in an undulating course, to terminate near the posterior end of the body. The duct from the reproductive organs runs near the œsophagus to open into the peribranchial cavity close to the base of the atrial siphon. The arrangement of the viscera agrees with that of *Abyssascidia wyvillii* except that in that species they were placed upon the right side of the branchial sac. The arrangement of the alimentary canal, the relative positions of œsophagus and intestine, and the relations to the reproductive mass, are the same in the two cases.

The chief points in which the present species does not agree with the genus *Abyssascidia* as defined in the first part of this Report, are the number of lobes around the branchial and atrial apertures, and the relations of the branchial sac and viscera. This is a right-handed species, while *Abyssascidia wyvillii* is a left-handed species; but as both are represented by single specimens only, too much stress must not be put upon this difference, as one of them may possibly be a reversed individual. Left-handed specimens of *Ascidia* are sometimes found. Consequently I shall not modify the characters of *Abyssascidia* yet. Some other specimens may be found which will enable us to decide which condition is the normal one in the genus, and whether or not the present species belongs to *Abyssascidia*, or requires to be separated as the type of a new genus.

Styela sericata, n. sp. (Pl. XI. figs. 14–16).

External Appearance.—The body is of an elongated ellipsoidal form, with the anterior end slightly narrower than the posterior, and with the sides nearly equally convex. The body is apparently not attached. The apertures are sessile, four-lobed, and placed far apart. The branchial is anterior and terminal, while the atrial is placed on the dorsal surface fully three-fourths of the way to the posterior end of the body. The surface of the test is even, but is covered with long delicate silky processes which form a hairy investment, to which a few sand grains adhere. The colour is yellowish grey.

Length nearly 3 cm.; breadth, at middle of body, 1·3 cm.

The Test is thin but tough and leathery. Its inner surface is smooth and of a whitish colour. The outer surface is minutely roughened, and is covered with delicate hair-like processes of various lengths.

The Mantle is thin and adheres closely to the test. The musculature is delicate but close. The muscle bundles run in all directions.

The Branchial Sac is large and well developed. The folds are slight, being merely produced by the approximation of a number of internal longitudinal bars. There are eight or ten bars in such places. The meshes in the opener parts of the sac are elongated vertically, and contain about three to five stigmata each. The transverse vessels are of three sizes placed alternately. The stigmata are long and narrow, and are placed with regularity.

The Endostyle is wide and conspicuous. Its course is undulating.

The Dorsal Lamina is a plain membrane with a very irregular margin, and with a series of indistinct transverse ribs.

The Tentacles are very numerous. They are of two sizes placed alternately. The larger are very long and are closely placed.

Locality.—March 3, 1874; Station 157; lat. 53° 55′ 0″ S., long. 108° 35′ 0″ E.; depth, 1950 fathoms; bottom, Diatom ooze; surf. temp. 37°·2; bottom temp. 32°·1.

This species resembles a silkworm's cocoon in its external appearance. The shape is fairly regular and symmetrical (Pl. XI. fig. 14), and the surface is covered by a close investment of silky hairs. The longest of these are found near the anterior and posterior ends of the body, where they project 5 or 6 mm. from the surface of the test. Some of them, however, are very short. These hair-like processes are usually simple, but some of them branch occasionally. They are seen when highly magnified to be finely roughened all over their surfaces. Sand grains, Diatoms and fragments of Foraminifera and Radiolarian tests are attached to them here and there.

The apertures are cross-slit, and have slightly raised margins where no hairs are present (Pl. XI. fig. 14). The mantle has a number of brownish pigment cells scattered through it.

The folds of the branchial sac are exactly like those of *Styela oblonga* [1] and some other species of the genus. The stigmata vary in length, as in some cases they are not interrupted by the third or smallest order of transverse vessels (Pl. XI. fig. 15). The internal longitudinal bars are wide and ribbon-like, and they are rather irregular in their course.

The condition of the tentacles is very characteristic. The two orders are very different in size (Pl. XI. fig. 16), the smaller ones being very short and dark-coloured; while the larger ones are of great size, and are membranous and light-coloured.

The alimentary canal is relatively small. It lies at the posterior end of the body, on the left side of the branchial sac. The stomach has its walls thrown into closely-placed longitudinal folds. The ovaries are two in number, one on each side of the body. They lie in the posterior half, and run obliquely forwards and ventrally. Their anterior ends nearly touch the sides of the endostyle.

This species belongs to the same section of the genus as *Styela oblonga*, but differs notably from that and all other species of *Styela* in the peculiar condition of the test and in the arrangement of the tentacles.

[1] See this Report, Part I., p. 160.

APPENDIX B.

DESCRIPTION OF THE DORSAL TUBERCLE OF A LARGE SPECIES OF ASCIDIA FROM KERGUELEN ISLAND.

Amongst the Simple Ascidians from Kerguelen Island (January 20, 1874; Station 149D; lat. 49° 28′ 0″ S., long. 70° 13′ 0″ E.; depth, 28 fathoms; bottom, volcanic mud; surf. temp. 41°), I found a fragment, consisting of very little more than the test, of a very large specimen evidently belonging to the genus *Ascidia*. On account of its very imperfect condition, and of the absence of almost the whole of the body proper, it seemed useless to attempt to refer this fragment to its proper species; and as there was nothing unusual about the appearance of the test, there was no reason to describe it as a new species. Since the publication of the first part of this Report, however, on re-examining this large specimen I found some fragments of the mantle and branchial sac and other organs attached to the test in the region of the branchial siphon. Amongst these the dorsal tubercle attracted my attention as being in a most remarkable condition; so it was cut out and sectionised, with the results given below. I note the condition of the other parts so far as they could be made out, so as to aid in the future identification of the species. The specimen was probably between nine inches and a foot or so in length.

The Test is thick and cartilaginous. It is of a yellowish-grey colour.

The Mantle is strong and muscular.

The Branchial Sac is thick. The transverse vessels are closely placed, and all of the same size. The internal longitudinal bars are strong, and bear very large expanded papillæ at their intersections with the transverse vessels (Pl. XI. fig. 13). The meshes are much elongated transversely, so as to be five or six times as long as they are broad. The stigmata are numerous and rather small. They are arranged very irregularly, and there is a certain amount of minute plication in the wall of the sac (Pl. XI. fig. 13).

The Branchial Siphon is short, and there is only a very narrow zona præbranchialis.

The Tentacles are rather short and are not numerous. Their arrangement is disturbed in the middle line dorsally by the enormous development of the dorsal tubercle (Pl. XI. fig 7).

The Dorsal Tubercle has the form of a large transversely elongated sausage-like projection, occupying not only the whole of the peritubercular area, but extending across the prebranchial zone and pushing the tentacles anteriorly (Pl. XI. fig. 7). The anterior border of the tubercle is straight and the posterior gently curved, while both ends are rounded. The projection formed by the tubercle is very considerable, so that in transverse sections it forms roughly about three-fourths of a circle (Pl. XI. fig. 8). The whole surface of this greatly enlarged dorsal tubercle is smooth, but has a finely granular appearance and is soft and spongy to the touch. No traces of coiled horns, of apertures, or of any other markings are visible.

When thin transverse and longitudinal sections of the dorsal tubercle are examined under a low power of the microscope (× 50 diam.), it is seen that the entire free surface is covered by columnar epithelium, which is broken up by the very numerous narrow apertures of ciliated cavities leading into long narrow tubes embedded in the thickness of the tubercle (Pl. XI. fig. 9). I have estimated that there must be about 50,000 of these tubes and the same number of openings on the surface of the dorsal tubercle. The tubes do not penetrate to the centre of the mass, but form a broad zone, occupying nearly the outer half, which is clearly visible both to the naked eye (Pl. XI. fig. 8) and in the microscopic specimens (Pl. XI. fig. 9). The rest of the tubercle is composed of a mass of connective tissue continuous with that of the mantle below, and penetrated by a number of blood sinuses. Where this mass of connective tissue joins the mantle proper, muscle bands are found cut in various directions (Pl. XI. fig. 9, *m.b*), and at one side of the section is invariably found either one or two large nerves (Pl. XI. fig. 9, *n.*); but no nerve fibrils were found arising from these or distributed through the outer part of the organ.

Each opening on the surface of the dorsal tubercle leads into a globular or ovate cavity (the infundibulum, Pl. XI. fig. 10, *inf.*), from the opposite end of which a long more or less cylindrical tube leads down into the connective tissue. The walls of the infundibulum are formed of tall columnar cells which bear numerous large cilia. At the lower end of the ciliated infundibulum there is generally a marked constriction (see Pl. XI. fig. 10) separating off the glandular portion of the tube. Beyond the constriction the wall of the tube is formed of a delicate layer of squamous epithelium, inside which is found a layer of cubical or rounded cells with well-marked nuclei and granular contents. In many of the tubes the lumen is to a great extent filled up by masses and strings of these granular rounded cells (Pl. XI. figs. 10, 11, and 12), and in these cases a delicate network, formed of small cells with long much-branched processes, is found extending inwards from the outer squamous layer of the wall of the tube, and dividing the lumen into a number of imperfect sections or crypts in which the large gland cells are packed (Pl. XI. figs. 11 and 12). The connective tissue between and around the infundibula and the tubules consists of a clear homogeneous matrix, in which are embedded numerous small rounded and fusiform cells (Pl. XI. fig. 10, *c.t.*). Irregularly-shaped blood sinuses (*bl. s.*) are also present.

I regard this organ as corresponding to the conjoined subneural (or hypophysial) gland and dorsal tubercle of other Ascidians. In place of there being a branched tubular gland communicating by a single duct with the single ciliated opening of the dorsal tubercle, as in most Ascidians, or by a number of ducts with numerous secondary openings into the peribranchial cavity, as in *Ascidia mammillata*, there are in the present case a number of simple tubular glands each of which opens to the exterior by its own ciliated infundibulum.

Although this arrangement seems at first very different from that of a typical *Ascidia*, still there are intermediate forms known through which a passage can be traced. I described in 1882 [1] in the case of *Cynthia irregularis* a dorsal tubercle where more than one opening was present, and since then Sluiter [2] has described a similar condition in *Ascidia canaliculata* and in *Styela cryptocarpa*, while in *Boltenia pachydermatina*, as several investigators have pointed out, the surface of the large dorsal tubercle is broken up by ridges into a number of openings. Then again in *Ascidia mammillata*, as described by Julin [3] and by myself,[4] in *Ascidia marioni* according to Roule,[5] and in *Polycarpa sulcata* as shown by von Drasche,[6] the subneural gland has a number of ducts which open separately to the exterior,[7] thus leading to the present case, where each tubule of the gland has a separate ciliated opening on the surface of the dorsal tubercle.

Both on account of the comparative simplicity of this last arrangement, and also on account of its proximity to and direct connection with the free surface, the condition described above in this large *Ascidia* from Kerguelen is probably the nearest to the primitive condition of the organ; and it appears to indicate that the subneural gland and dorsal tubercle are derived from a group of simple tubular glands opening close together on the dorsal edge of the anterior end of the pharynx. Such an origin would tell equally against the recently expressed view [8] that the dorsal tubercle was originally an organ for aerating the central nervous system, and against the former theories that it was the duct of a cephalic renal organ, or a buccal sense-organ, or a combination of the two;[9] but would seem to support the opinion of Roule,[10] that the subneural gland and dorsal tubercle are to be regarded merely as a more or less complicated mucous gland and its duct.

[1] This Report, Part I. p. 141, pl. xvi. fig. 12.
[2] *Natuurkund. Tijdschr. v. Nederl. Indië*, Dl. xlv. pp. 174 and 210, 1885.
[3] *Archives de Biologie*, tom. ii. p. 214, 1881.
[4] *Journ. Linn. Soc. Lond.* (Zool.), vol. xvi. p. 530, 1882.
[5] *Ann. Mus. Hist. Nat. Marseille* (Zool.), tom. ii. p. 240, 1884.
[6] *Denkschr. d. k. Akad. d. Wiss. Wien*, Bd. xlviii. p. 379, 1884.
[7] The place of opening may be the peribranchial cavity (*Ascidia mammillata*), the branchial sac (*Ascidia marioni*), or the perituberculer area (*Polycarpa sulcata*).
[8] Lilian Sheldon, *Quart. Journ. Micr. Sci.*, vol. xxviii. p. 131, 1887.
[9] Herdman, *Proc. Biol. Soc. Liverpool*, vol. i. p. 22, 1887.
[10] Roule, *op. cit.*, p. 102, 1884.

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The figures in dark type indicate the page on which the genus or species is described.

EXPLANATION OF THE PLATES.

ALL the Plates were lithographed by Mr. Huth, Edinburgh, from my pencil drawings, with the exception of figures 1 to 5 on Plate X., for which I am indebted to Professor H. N. Moseley.

The following were the powers of the microscope used by me in making most of the drawings for the Plates (the abbreviations are made use of in the explanations of the figures).

S. 1 = Swift's 1 inch objective, magnifying about 50 diameters.
S. $\frac{1}{4}$ = " $\frac{1}{4}$ " " 230 "
S. $\frac{1}{6}$ = " $\frac{1}{6}$ " " 330 "
Z. $\frac{1}{12}$ = Zeiss' $\frac{1}{12}$ objective (oil immersion), magnifying about 950 diameters.

LIST OF THE ABBREVIATIONS.

a.	Anus.
at.	Place of attachment.
ap.	Lateral appendage of ganglion.
at.	Atrial aperture.
at.l.	Lobes round atrial aperture.
at.m.	Atrial muscles.
bl.	Bladder cells in test.
bl.s.	Blood sinus.
br.	Branchial aperture.
br.f.	Longitudinal folds in branchial sac.
br.l.	Lobes round branchial aperture.
br.m.	Branchial muscles.
br.s.	Branchial sac.
br.si.	Branchial siphon.
c.cl.	Common cloacal aperture.
c.d.	Connecting duct.
c.ep.	Cubical epithelium.
c.gr.	Ciliated grooves on dorsal lamina.
c.m.	Masses of phosphorescent cells.
c.t.	Connective tissue.
d.l.	Dorsal lamina.
d.m.	Dorsal muscles.
d.t.	Dorsal tubercle.
ec.	Ectoderm.
emb.	Embryo.
en.	Endostyle.
g.	Reproductive organs.
g.d.	Duct of reproductive organs.
gl.t.	Glandular tubules of dorsal tubercle.
i.	Intestine.
i.l.	Internal longitudinal bars of branchial sac.
inf.	Infundibula of dorsal tubercle.
l.	Languet.
l.v.	Longitudinal vessels.
m.	Mantle.
m.b.	Muscle bands.
m[1] to *m*[9]	Muscle bands.

n.	Nerve.
n.g.	Nerve ganglion.
o.	Ovum.
oc.	Sense organ.
œ.	Œsophagus.
op.	Optic (?) organ.
ov.	Ovary.
p.	Papilla of branchial sac.
p.a.	Peritubercular area.
p.br.	Peribranchial cavity.
pig.	Pigment mass.
p.p.	Peripharyngeal bands.
ret.	Network of stellate cells.
s.	Stolon.
sg.	Stigmata of branchial sac.
s.gl.	Subneural gland.
s.o.	Sense organ.
sp.	Spines.
sp.c.	Spherical gland cells.
sph.	Sphincter muscle.
sq.	Squamous epithelium.
st.	Stomach.
t.	Test.
t.c.	Small cells in test.
t.m.	Matrix of test.
tn, tn′.	Large and small tentacles.
tr, tr′.	Large and small transverse vessels of branchial sac.
t.p.	Process of test.
tes.	Testis.
v.d.	Vas deferens.
visc.	The visceral mass.
z.	Prebranchial zone.

PLATE I.

PLATE I.

Figs. 1–3. *Pyrosoma atlanticum.*
Figs. 4–21. *Pyrosoma giganteum.*

at. Atrial aperture.
c.m. Masses of phosphorescent cells.
en. Endostyle.
i. Intestine.
i.l. Internal longitudinal bars.
m.b. Muscle bands.
n.g. Nerve ganglion.
œ. Œsophagus.
p.p. Peripharyngeal bands.
sph. Sphincter muscle.
tn. Tentacles.
tn'. Large ventral tentacle.
t.c. Test cells.
tr. Tranverse vessel of branchial sac.

Fig. 1. Section of open end of colony of *Pyrosoma atlanticum* from off Cape Verde, showing condition of diaphragm; natural size.

Fig. 2. Circle of tentacles from Ascidiozooid of same colony (S. $\frac{1}{4}$).

Fig. 3. Part of longitudinal section of same colony, showing atrial apertures opening into common cloacal cavity (S. 1).

Fig. 4. Section of open end of colony of *Pyrosoma giganteum* from off Cape Verde, showing condition of diaphragm; natural size.

Fig. 5. Part of section through the surface layer of test of same (S. $\frac{1}{4}$).

Fig. 6. Part of section through deeper part of test of same (S. $\frac{1}{4}$).

Fig. 7. Part of branchial aperture of Ascidiozooid of same (S. $\frac{1}{4}$).

Fig. 8. Branchial apertures and processes of test of same; natural size.

Fig. 9. Free edge of diaphragm of same, showing numerous muscle bands (S. 1).

Fig. 10. Part of last more highly magnified (S. $\frac{1}{4}$).

Fig. 11. Muscle fibres from mantle of same (S. $\frac{1}{4}$).

Fig. 12. Part of branchial sac of same (S. 1).

Fig. 13. Part of branchial sac, showing irregularity (S. 1).

Fig. 14. Part of internal longitudinal bar of same (S. $\frac{1}{4}$).

Fig. 15. Part of transverse vessel of same (S. $\frac{1}{4}$).

Fig. 16. Edges of one of stigmata of same (S. $\frac{1}{4}$).

Fig. 17. Part of branchial sac of same (S. $\frac{1}{4}$).

Fig. 18. Anterior end of Ascidiozooid of same, from branchial sac (S. $\frac{1}{4}$).

Fig. 19. Part of anterior end of branchial sac of same, from side (S. 1).

Fig. 20. Some of the phosphorescent cells of same (S. $\frac{1}{4}$).

Fig. 21. Alimentary canal of a young Ascidiozooid of same (S. 1).

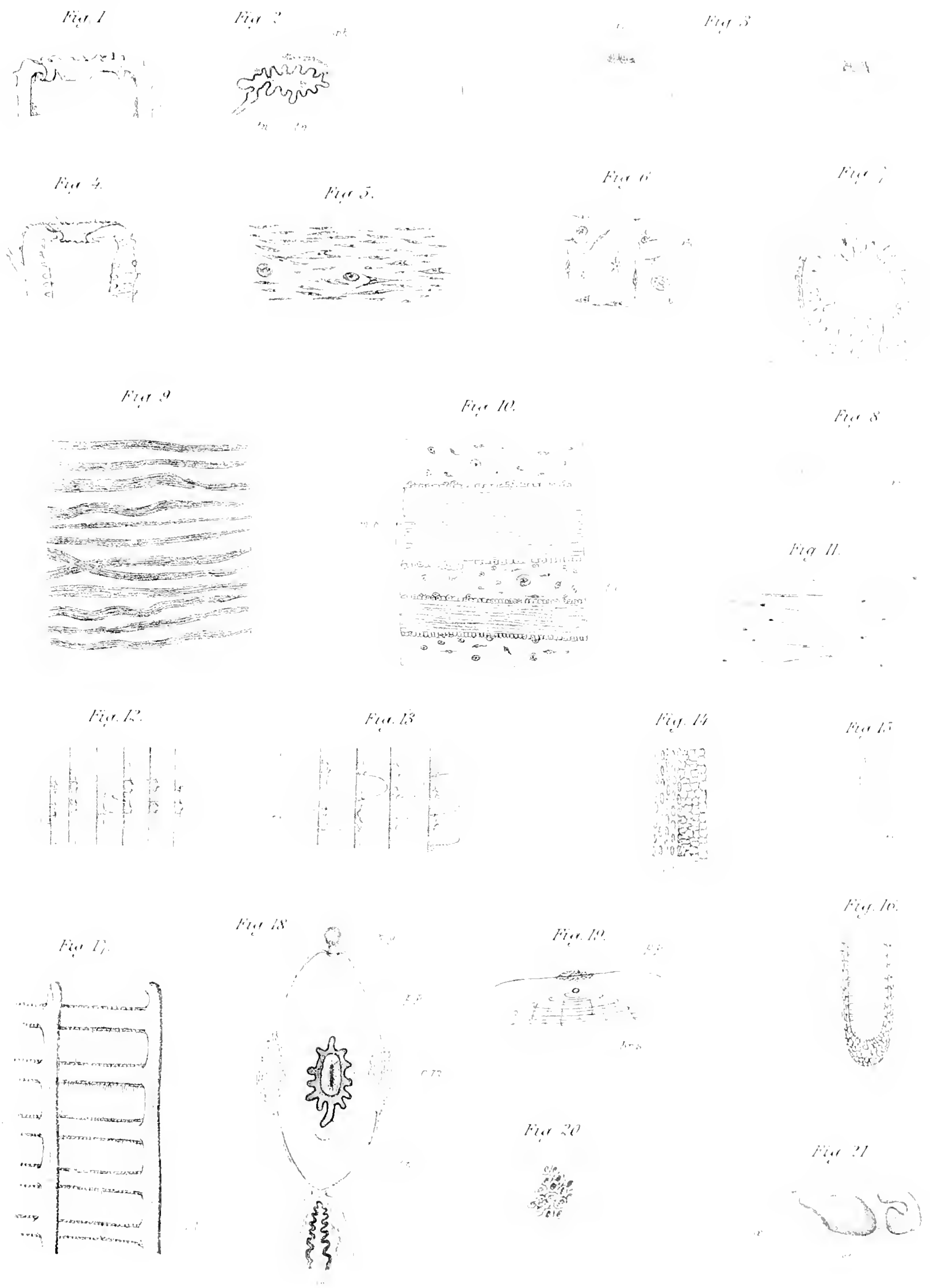
Fig. 1
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Fig. 8
Fig. 11
Fig. 12
Fig. 13
Fig. 14
Fig. 15
Fig. 17
Fig. 18
Fig. 19
Fig. 16
Fig. 20
Fig. 21

PYROSOMA.

PLATE II.

PLATE II.

Figs. 1–7. Young colonies of *Pyrosoma*.
Fig. 8. *Pyrosoma elegans* (?).
Figs. 9–15. *Pyrosoma spinosum*, n. sp.

at. Atrial aperture.	*m.b.* Muscle band.
br. Branchial aperture.	*n.* Nerve.
c.cl. Common cloacal aperture.	*n.g.* Nerve ganglion.
d.t. Dorsal tubercle.	*s.gl.* Subneural gland.

Fig. 1. Very young colony of *Pyrosoma*, from Atlantic, April 12, 1876; slightly enlarged.

Fig. 2. Closed end of same colony in surface view (S. 1).

Fig. 3. Open end of same colony in surface view (S. 1). A^1–A^4. Areas occupied by the four Ascidiozooids.

Fig. 4. Optical section through the middle of same colony, showing four young Ascidiozooids (S. 1).

Fig. 5. More advanced young colony of *Pyrosoma* from surface of South Atlantic; natural size.

Fig. 6. Diagram showing the arrangement of the Ascidiozooids in this colony, as seen from closed end. A^1–A^4. Four large central Ascidiozooids; B^1–B^8. Eight smaller ones at open end; C^1–C^4. Four smallest ones at closed end.

Fig. 7. Same colony magnified (Ross' binocular, $1\frac{1}{2}$ in.).

Fig. 8. Small colony of *Pyrosoma elegans* (?) (specimen B.) from the West Pacific, March 16, 1875; natural size. 1, 2, 3, 4 indicate the positions of the four Ascidiozooids forming the closed end of the colony.

Fig. 9. Part of the surface of *Pyrosoma spinosum*, n. sp., showing the spines; natural size.

Fig. 10. Three spines and branchial apertures of same; enlarged.

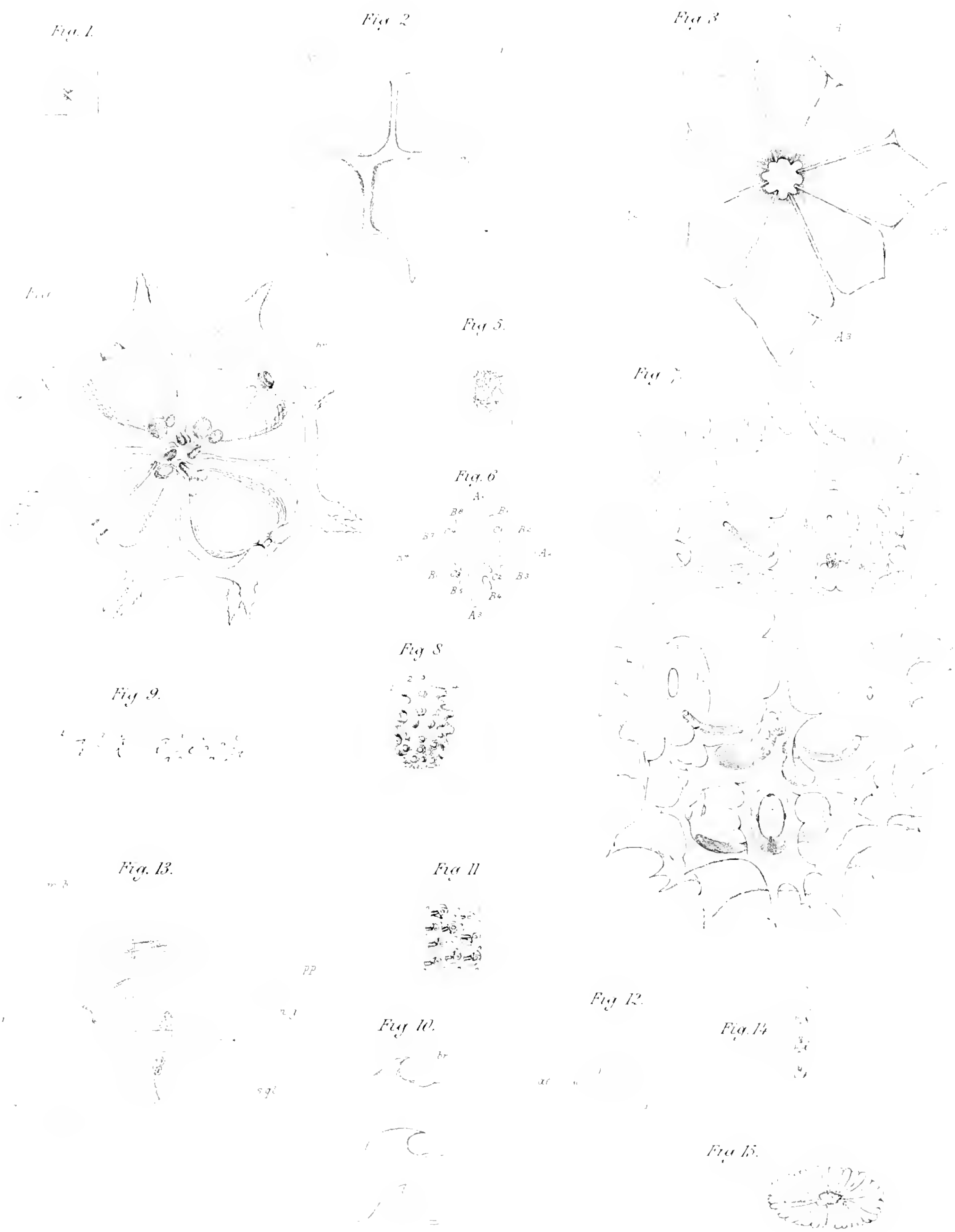
Fig. 11. Small part of surface of *Pyrosoma spinosum*, showing anterior ends of Ascidiozooids; natural size.

Fig. 12. Part of internal surface of colony of same, preserved in picric acid, showing the atrial apertures; natural size.

Fig. 13. Nerve ganglion and neighbouring parts of *Pyrosoma spinosum;* highly magnified (Zeiss' obj. D., oc. 4).

Fig. 14. Ciliated cells from branchial sac of same; highly magnified (Zeiss' obj. D., oc. 4).

Fig. 15. Testis and vas deferens of *Pyrosoma spinosum* (S. 1).



W. A. Herdman del.
F. Huth Lith[r] Edin[r]

PYROSOMA.

PLATE III.

PLATE III.

Doliolum.

at. Atrial aperture.	m^1–m^9. Muscle bands.
at.l. Atrial lobes.	*n.g.* Nerve ganglion.
br. Branchial aperture.	*o.* Œsophagus.
br.l. Branchial lobes.	*p.p.* Peripharyngeal bands.
d.t. Dorsal tubercle.	*s.* Stolon.
en. Endostyle.	*sg.* Stigmata.
i. Intestine.	*st.* Stomach.

Figs. 1–6. Diagrams showing the position of the endostyle and the extent of the branchial sac in various species of *Doliolum*. 1–8. Muscle bands; *en.* Endostyle; *sg.* Stigmata of branchial sac.

Fig. 1. *Doliolum krohni*, n. sp.

Fig. 2. *Doliolum gegenbauri*, Uljanin.

Fig. 3. *Doliolum tritonis*, Herdman.

Fig. 4. *Doliolum challengeri*, n. sp.

Fig. 5. *Doliolum ehrenbergi*, Krohn.

Fig. 6. *Doliolum affine*, n. sp.

Fig. 7. Alimentary canal of specimen of *Doliolum ehrenbergi* obtained in the North Atlantic, May 12, 1876 (S. 1).

Fig. 8. Specimen of *Doliolum affine* obtained in the South Pacific, October 19, 1875, from dorsal surface (S. 1).

Fig. 9. Blastozooid of *Doliolum* sp., obtained in Bass Strait, April 2, 1874, from dorsal surface (S. 1).

Fig. 1

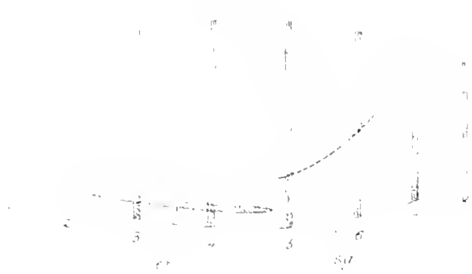


Fig. 2

Fig. 3.

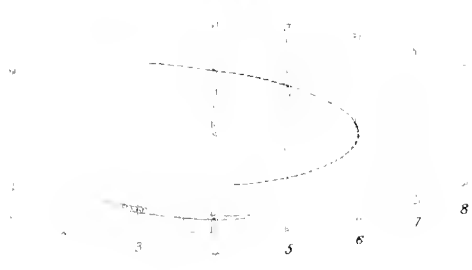


Fig. 4.

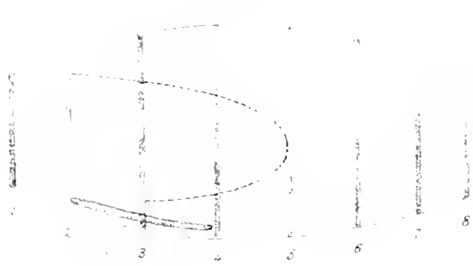


Fig. 5.

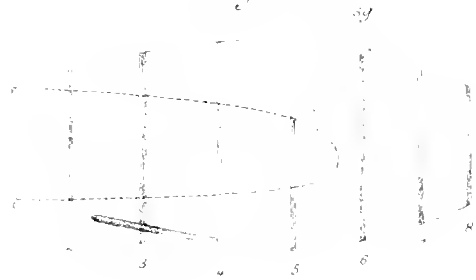


Fig. 8.

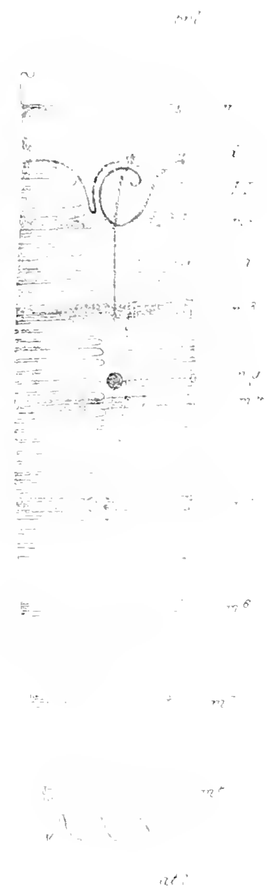


Fig. 9.

Fig. 7.

Fig. 6.

W. A. Herdman del.

DOLIOLUM.

PLATE IV.

PLATE IV.

Figs. 1–8. *Salpa costata-tilesii.*
Fig. 9. *Salpa* sp. (?), n. sp.

at. Atrial aperture.
br. Branchial aperture.
d.l. Dorsal lamina.
en. Endostyle.
l. Languet.
visc. Thickened test over the visceral mass.
p.p. Peripharyngeal bands.

Fig. 1. *Salpa costata-tilesii* (specimen A.) from left side; half natural size.

Fig. 2. Horn-like process of same; natural size.

Fig. 3. Specimen C. of same, from Station 230, seen from anterior end; natural size.

Fig. 4. Same specimen seen from posterior end; natural size.

Fig. 5. Part of surface of test of same species; enlarged.

Fig. 6. Part of dorsal lamina of same; magnified (S. 1).

Fig. 7. Anterior extremity of endostyle of same; enlarged.

Fig. 8. Anterior end of dorsal lamina and neighbouring parts of same; enlarged.

Fig. 9. *Salpa* sp. (?), n. sp., from left side; half natural size.

Fig. 1.

Fig. 2.

Fig. 9.

Fig. 8.

Fig. 3.

Fig. 5.

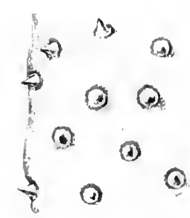


Fig. 4.

Fig. 7.

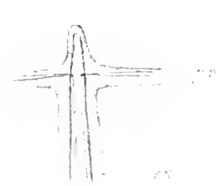
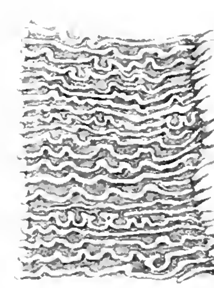


Fig. 6.



S A L P A.

PLATE V.

PLATE V.

Figs. 1–10. *Salpa echinata*, n. sp.
Figs. 11–15. *Salpa mollis*, n. sp.

at. Atrial aperture.
br. Branchial aperture.
br.l. Edge of branchial aperture.
d.d'. Dorsal ridges of test.
d.l. Dorsal lamina.
d.t. Dorsal tubercle.
en. Endostyle.
l. Lateral ridges of test.
m.b. Muscle band.
n.g. Nerve ganglion.
p.p. Peripharyngeal bands.
v.v'. Ventral ridges of test.
visc. Visceral mass (nucleus).

Fig. 1. *Salpa echinata*, from the dorsal surface; natural size.

Fig. 2. Same from right side; natural size.

Fig. 3. Same from ventral surface; natural size.

Fig. 4. Another specimen of same species from right side; natural size.

Fig. 5. Outline of section through posterior wider part of body of same, showing the position of the echinated ridges; natural size.

Fig. 6. Outline of section through anterior narrower part of body of same, showing position of echinated ridges; natural size.

Fig. 7. Arrangement of dorsal parts of 1st, 2nd, and 3rd muscle bands of same species; enlarged.

Fig. 8. Part of dorsal lamina of same; magnified (S. 1).

Fig. 9. Anterior part of branchial sac and neighbouring organs of same; enlarged.

Fig. 10. Visceral mass (nucleus) of same species; enlarged.

Fig. 11. *Salpa mollis*, with test removed, from dorsal surface; natural size.

Fig. 12. Same from ventral surface; natural size.

Fig. 13. Part of surface of test of same, showing echinated ridges; natural size.

Fig. 14. Part of a section through the same test, to show the height of the ridges and spines; natural size.

Fig. 15. Dissection of the anterior end of the body of the same species, showing the various organs; slightly enlarged.

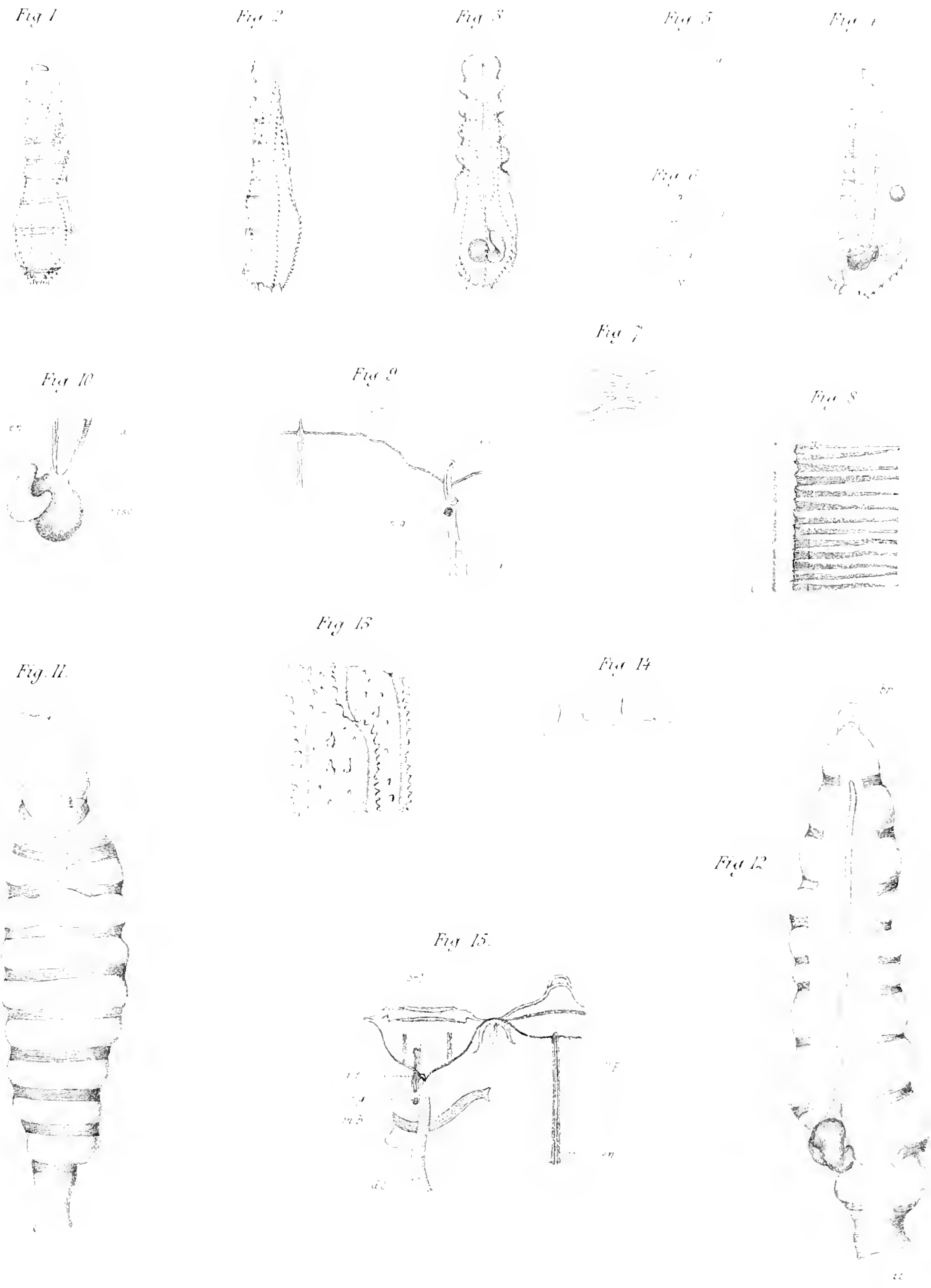


Fig. 1
Fig. 2
Fig. 3
Fig. 5
Fig. 4
Fig. 6
Fig. 7
Fig. 10
Fig. 9
Fig. 8
Fig. 13
Fig. 11.
Fig. 14
Fig. 12
Fig. 15.

S A L P A.

PLATE VI.

PLATE VI.

Figs. 1–4. *Salpa musculosa*, n. sp.
Figs. 5–12. *Salpa runcinata-fusiformis*.

at. Atrial aperture.
at.m. Atrial muscles.
br.m. Branchial muscles.
c.gr. Ciliated grooves on dorsal lamina.
d.l. Dorsal lamina.
d.m. Dorsal muscles.
d.t. Dorsal tubercle.
emb. Embryo.
en. Endostyle.
m.b. and 1–10. Muscle bands.
n.g. Nerve ganglion.
pig. Pigment.
p.p. Peripharyngeal bands.
visc. Visceral mass.

Fig. 1. *Salpa musculosa*, from the ventral surface; natural size.

Fig. 2. Outline of section of same; natural size.

Fig. 3. Dissection of same, showing the muscle bands and various organs; slightly enlarged.

Fig. 4. Anterior part of last; more enlarged.

Fig. 5. *Salpa runcinata-fusiformis*, aggregated form, from Antarctic, Station 152; seen from dorsal surface; natural size.

Fig. 6. *Salpa runcinata-fusiformis*, aggregated form, variety, from North Atlantic, April 26, 1876; natural size.

Fig. 7. Same species, dissection of anterior dorsal part; × 2.

Fig. 8. Part of dorsal lamina ("gill") of solitary form of same species (S. 1).

Fig. 9. Small part of edge of last; highly magnified to show ciliated grooves, etc. (S. $\frac{1}{6}$).

Fig. 10. Ciliated cells from last.

Fig. 11. Dorsal tubercle and neighbouring parts of *Salpa runcinata-fusiformis*, aggregated form (S. 1).

Fig. 12. Arrangement of muscle bands in *Salpa runcinata-fusiformis*, aggregated form; from South Atlantic, February 12, 1876 (S. 1).

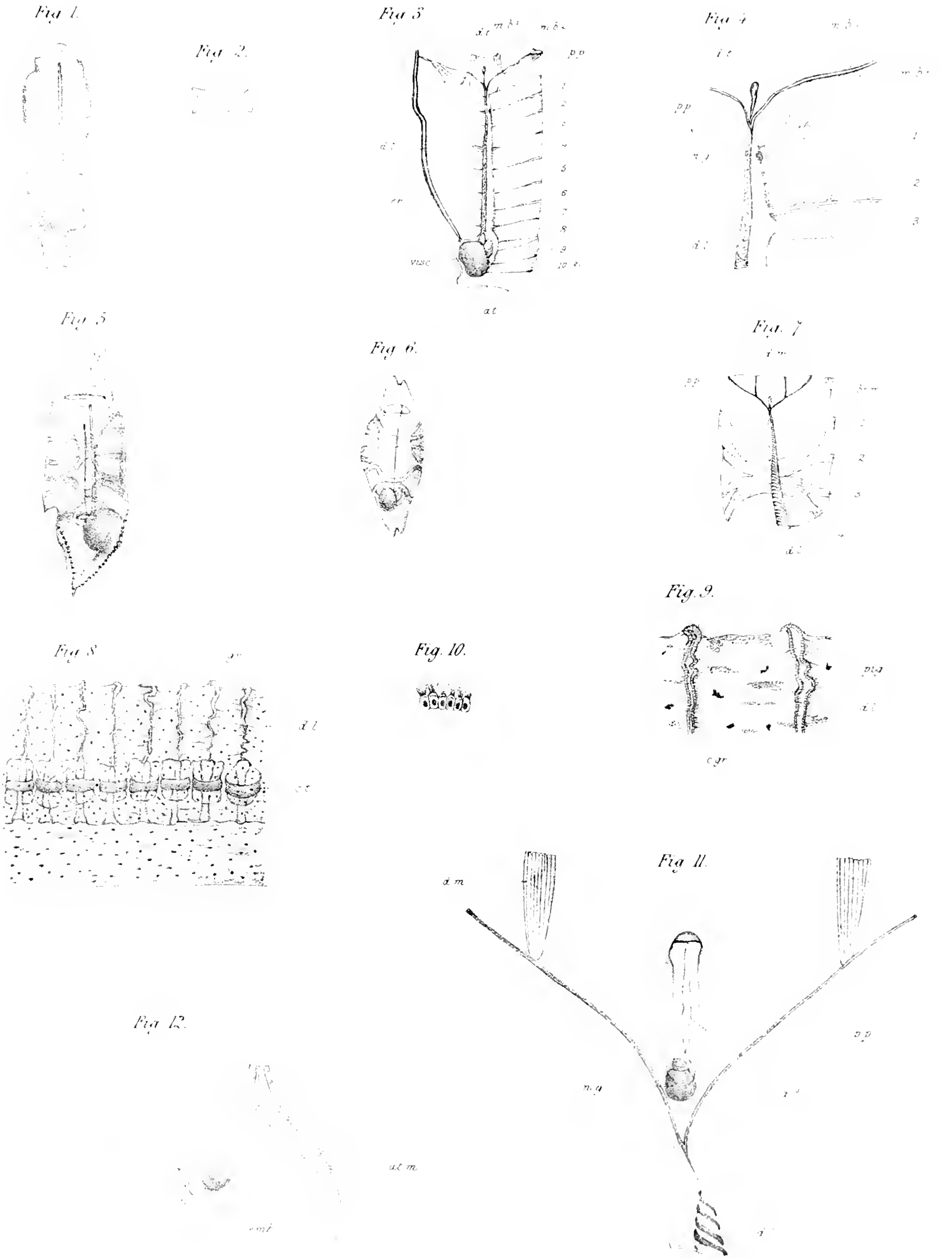


Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6.
Fig. 7.
Fig. 8.
Fig. 9.
Fig. 10.
Fig. 11.
Fig. 12.
pp
visc
at
dl
pig
cgr
dm
ng
atm

SALPA

PLATE VII.

PLATE VII.

Figs. 1–9. *Salpa cordiformis-zonaria.*
Fig. 10. *Salpa cylindrica.*

ap.	Lateral appendage of ganglion.	*n.*	Nerves.
d.l.	Dorsal lamina.	*n.g.*	Nerve ganglion
d.t.	Dorsal tubercle.	*oc.*	Sense organ.
m.	Mantle.	*p.p.*	Peripharyngeal band.
1, 2.	Muscle bands.		

Fig. 1. *Salpa cordiformis-zonaria*, aggregated form, from the North Atlantic ("Knight-Errant" Expedition; natural size).

Fig. 2. Another specimen of same; natural size.

Fig. 3. A third specimen of same; natural size.

Fig. 4. Specimen of the solitary form of same species, from Station 166; natural size.

Fig. 5. Part of a specimen of *Salpa cordiformis-zonaria*, aggregated form, showing three embryos (S. 1).

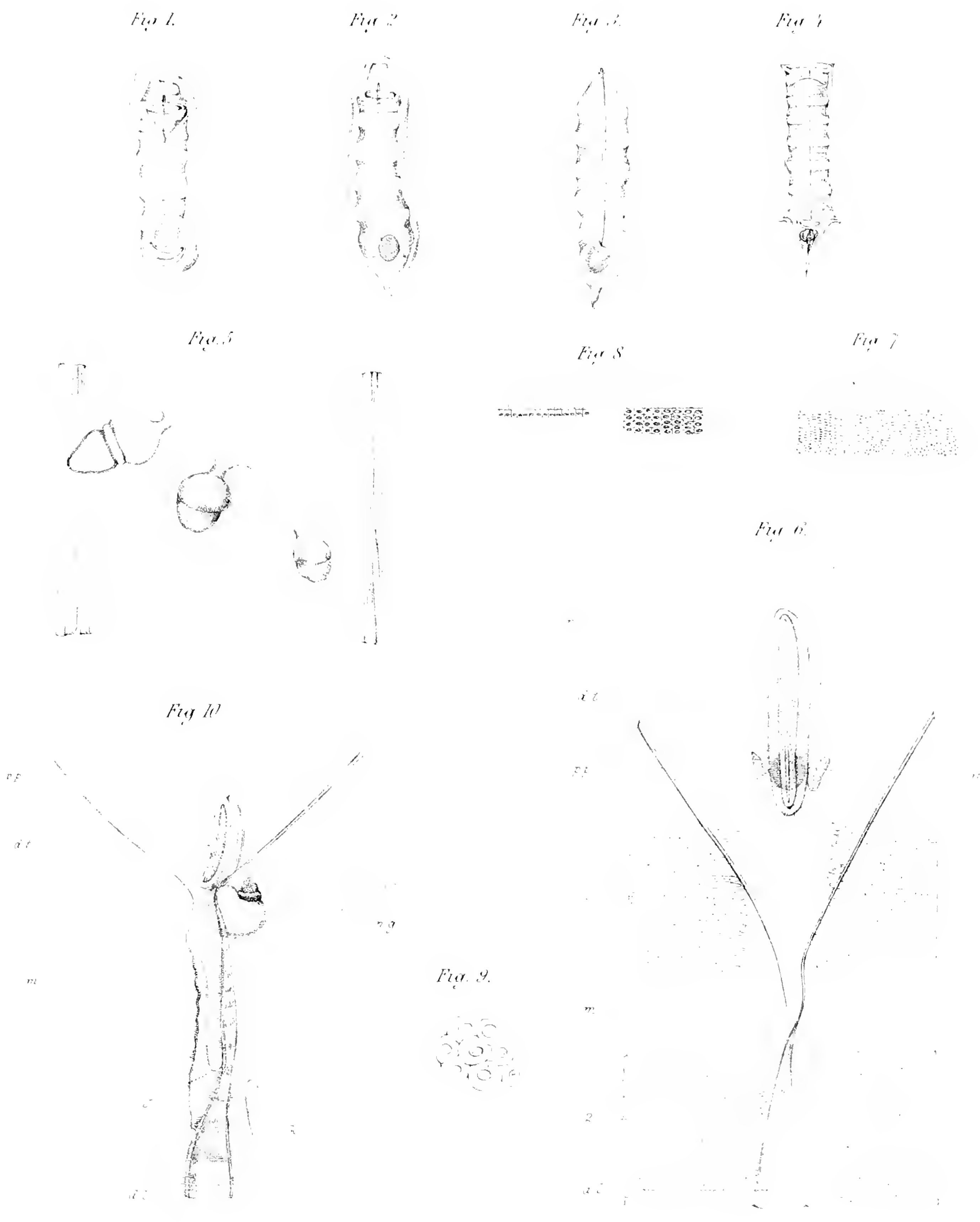
Fig. 6. Part of specimen of *Salpa cordiformis-zonaria*, aggregated form, from the South Atlantic, March 9, 1876, showing dorsal tubercle, nervous system, and neighbouring parts (S. $\frac{1}{4}$).

Fig. 7. Part of the side of the dorsal tubercle of same specimen; highly magnified (S. $\frac{1}{6}$).

Fig. 8. Edge of last; still more highly magnified (Z. $\frac{1}{12}$).

Fig. 9. Large cells, forming the lateral appendages of the nerve ganglion (see fig. 6); highly magnified (S. $\frac{1}{6}$).

Fig. 10. Dissection of part of *Salpa cylindrica*, aggregated form, showing dorsal tubercle, nerve ganglion, etc. (S. $\frac{1}{4}$).



SALPA.

PLATE VIII.

PLATE VIII.

Figs. 1–10. *Salpa democratica-mucronata.*
Figs. 11–15. *Salpa nitida*, n. sp.

ap.	Lateral appendage of nerve ganglion.	*d.t.*	Dorsal tubercle.	*p.p.*	Peripharyngeal bands.
at.	Atrial aperture.	*ec.*	Ectoderm.	*s.o.*	Sense organ.
at.m.	Atrial muscles.	*en.*	Endostyle.	*sp.*	Spines on test.
bl.	Bladder cells.	*m.*	Mantle.	*t.*	Test.
br.	Branchial aperture.	1–7.	Muscle bands.	*t.c.*	Test cells.
br.m.	Branchial muscles.	*m.b.*	Small muscle bands.	*t.m.*	Test matrix.
d.l.	Dorsal lamina.	*n.*	Nerves.	*t.p.*	Process of the test.
		n.g.	Nerve ganglion.	*visc.*	Visceral mass.
		op.	Pigmented optic (?) organ.		

Fig. 1. Part of *Salpa democratica-mucronata*, solitary form; from South Atlantic, March 3–5, 1876, showing the very long tuberculated process (S. 1).

Fig. 2. Posterior end of young specimen of *Salpa democratica-mucronata*, solitary form; South Atlantic, February 12, 1876, showing the short processes (S. 1).

Fig. 3. One of the sucker-like processes of the mantle of last, seen in optical section (S. 1).

Fig. 4. Posterior end of *Salpa democratica-mucronata*, aggregated form; seen from dorsal surface; Bass Strait, April 2, 1874 (S. 1).

Fig. 5. Part of test of *Salpa democratica-mucronata*, solitary form; showing the minute spines (S. $\frac{1}{6}$).

Fig. 6. Process from the body of a young specimen of *Salpa democratica-mucronata*, solitary form; South Atlantic, February 12, 1876, showing the ectoderm, and the migration of cells into the test (S. $\frac{1}{6}$).

Fig. 7. Some of the ectoderm cells; more highly magnified (Z. $\frac{1}{12}$).

Fig. 8. Cells, in a young embryo of *Salpa democratica-mucronata*, which will later become muscle fibres (S. $\frac{1}{4}$).

Fig. 9. Muscle band in a somewhat older embryo (S. $\frac{1}{4}$).

Fig. 10. Same; more highly magnified (S. $\frac{1}{6}$).

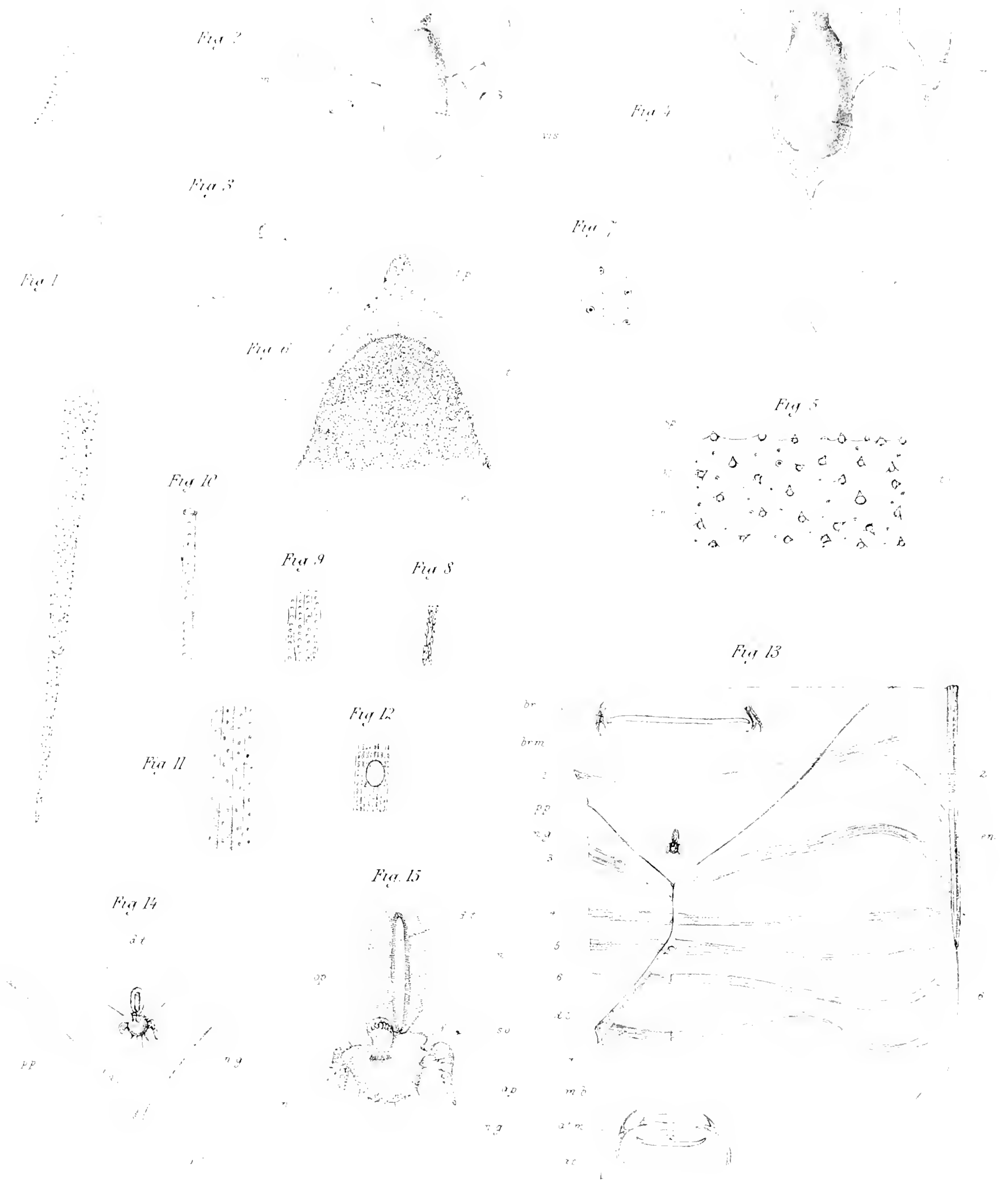
Fig. 11. Part of a muscle band from *Salpa nitida* (S. $\frac{1}{6}$).

Fig. 12. Small part of a muscle fibre of same; more highly magnified (Z. $\frac{1}{12}$).

Fig. 13. Dissection of *Salpa nitida*, from the Pacific, March 16, 1875, showing the arrangement of the muscles and other organs (S. 1).

Fig. 14. Anterior dorsal part of last, enlarged (S. 1).

Fig. 15. Dorsal tubercle, nerve ganglion, &c., of last; more highly magnified (S. $\frac{1}{6}$).



W.A. Herdman del.

F. Huth, Lith! Edin!

SALPA.

PLATE IX.

PLATE IX.

Figs. 1–8. *Salpa quadrata*, n. sp.
Fig. 9. *Salpa scutigera-confœderata.*

br.l. Branchial lobes.
d.l. Dorsal lamina.
d.t. Dorsal tubercle.
en. Endostyle.
en.l. Lip of endostyle.
m. Mantle.
m.b. Muscle bands.
n.g. Nerve ganglion.
p.p. Peripharyngeal band
t. Test.
visc. Visceral mass.

Fig. 1. *Salpa quadrata*, from the right side, enlarged.

Fig. 2. Anterior end of the same, from the left side, enlarged.

Fig. 3. Dissection of the anterior part of the same; × 2½.

Fig. 4. Part of last; more highly magnified (S. 1).

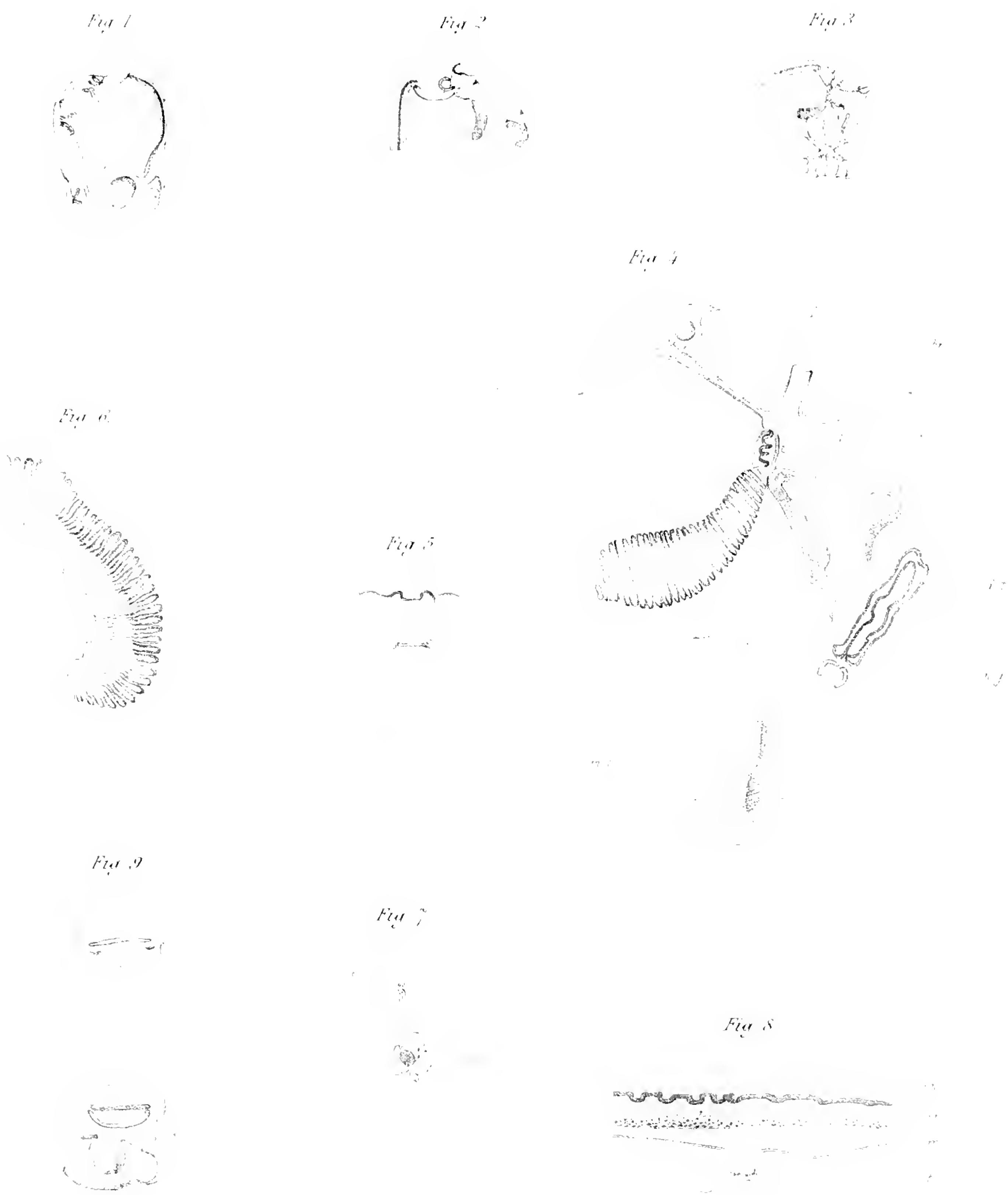
Fig. 5. Dissection of the dorsal part of the posterior end of the body of same; × 6.

Fig. 6. Posterior part of dorsal lamina of same (S. 1).

Fig. 7. Visceral mass and posterior part of endostyle of same, from dorsal side; × 1½.

Fig. 8. Part of endostyle and neighbouring parts, showing diverticulum of ectoderm and mantle into test (S. 1).

Fig. 9. *Salpa scutigera-confœderata*; aggregated form, enlarged.



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F. Huth, Lith. Edin.

SALPA

PLATE X.

PLATE X.

Figs. 1–5.[1] *Octacnemus bythius*, Moseley.
Figs. 6–18. *Octacnemus* sp. (?).

a.	Anus.	*h.m.*	Horizontal membrane.	*s.gl.*	Subneural gland.
ad.	Place of attachment.	*m.*	Mantle.	*s.o.*	Sense organ.
at.	Atrial aperture.	*m.b., m.b'.*	Muscle bands.	*st.*	Stomach.
br.	Branchial aperture.	*n., n'.*	Nerves.	*t.*	Test.
br.s.	Wall of branchial sac.	*n.g.*	Nerve ganglion.	*t'.*	Thickened test.
d.t.	Dorsal tubercle.	*o.a.*	Œsophageal aperture.	*tes.*	Testis.
en.	Endostyle.	*ov.*	Ovary.	*visc.*	Visceral mass.

Fig. 1. *Octacnemus bythius*, Moseley, from the lower surface; natural size.

Fig. 2. The same from the upper surface; natural size.

Fig. 3. Visceral mass of same; enlarged.

Fig. 4. Nerve ganglion, &c., of same; magnified.

Fig. 5. Arrangement of some of the muscle bands of the same; enlarged.

Fig. 6. *Octacnemus* sp. (?), from upper (anterior) surface; natural size.

Fig. 7. Posterior dorsal part of same seen from the side, to show the probable place of attachment (*ad.*), and the projection containing the viscera; enlarged.

Fig. 8. Section along one of the conical processes of same; natural size.

Fig. 9. Dissection of same, showing the visceral mass, &c.; natural size.

Fig. 10. Anterior surface of visceral mass, showing nerve ganglion, &c.; enlarged.

Fig. 11. Nerve ganglion and neighbouring parts: magnified (S. 1).

Fig. 12. Part of test on upper surface; highly magnified (S. $\frac{1}{6}$).

Fig. 13. Part of mantle, showing arrangement of the fine muscle bands (S. 1).

Fig. 14. The arrangement of the larger muscle bands in the conical processes; enlarged.

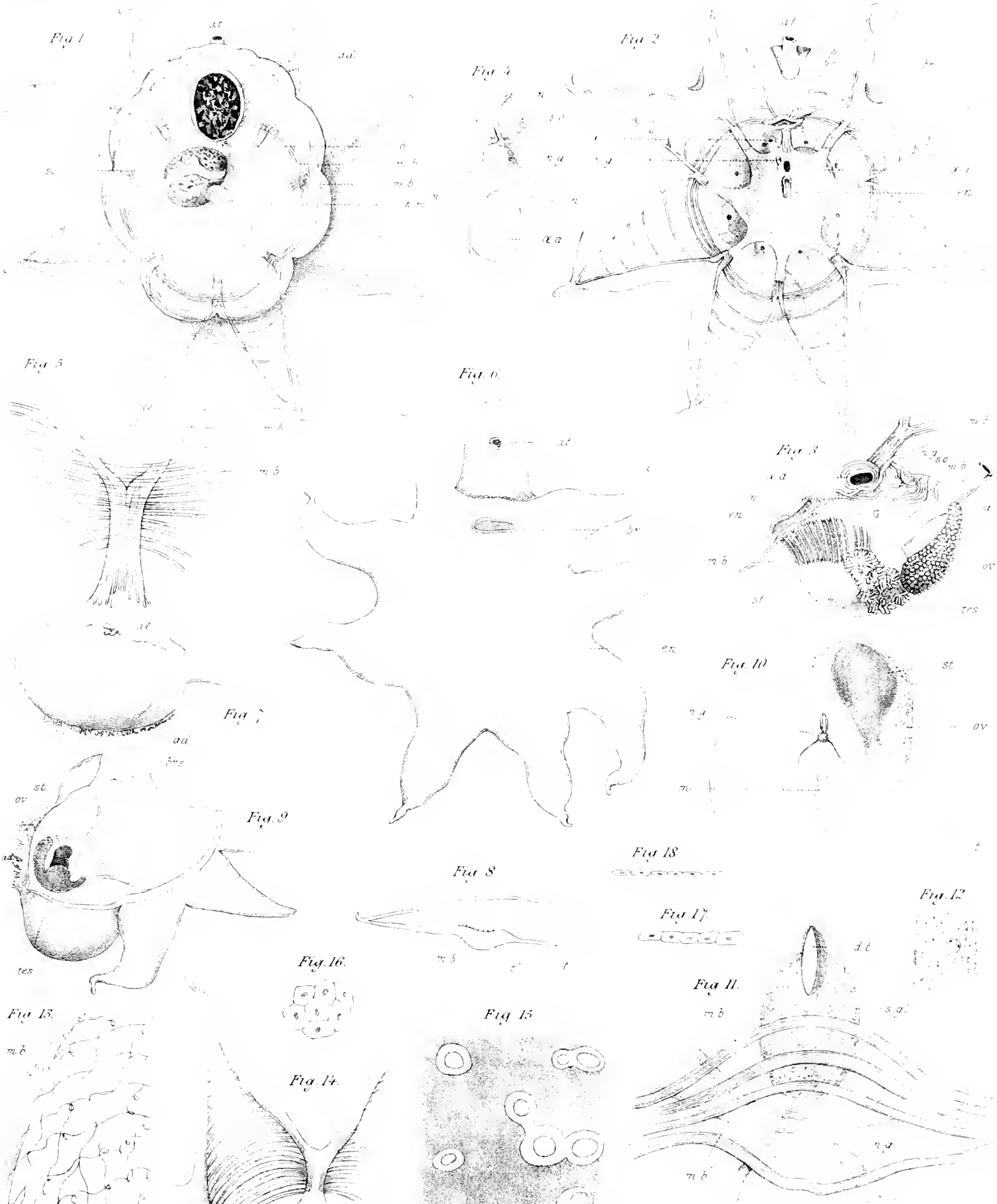
Fig. 15. Part of the posterior wall of the branchial sac (horizontal membrane); magnified to show the circular depressions (S. 1).

Fig. 16. Squamous cells covering the general surface of last; highly magnified (S. $\frac{1}{6}$).

Fig. 17. Cubical cells along edges of the depressions, in surface view; highly magnified (S. $\frac{1}{6}$).

Fig. 18. The same cells in profile view; highly magnified (S. $\frac{1}{6}$).

[1] These figures are from the original drawings, for the use of which I have to thank Professor Moseley.



H. N. Moseley & W. A. Herdman del.

OCTACNEMUS.

PLATE XI.

PLATE XI.

Figs. 1–6. *Abyssascidia vasculosa*, n. sp.
Figs. 7–13. *Ascidia* sp. (Dorsal tubercle, &c.).
Figs. 14–16. *Styela sericata*, n. sp.

a. Anus.
at. Atrial aperture.
bl.s. Blood sinus.
br. Branchial aperture.
br.s. Branchial sac.
br.si. Branchial siphon.
c.d. Connecting ducts.
c.ep. Cubical epithelium.
c.t. Connective tissue.
d.l. Dorsal lamina.
d.t. Dorsal tubercle.
g. Reproductive organs.
g.d. Duct of reproductive organs.
gl.t. Glandular tubules of dorsal tubercle.
i. Intestine.
i.l. Internal longitudinal bars.
inf. Infundibula of dorsal tubercle.
l. Languet.
l.v. Longitudinal vessels.
m. Mantle.
m.b. Muscle bands.
n. Nerve.
n.g. Nerve ganglion.
œ. Œsophagus.
p. Papilla of branchial sac.
p.a. Peritubercular area.
p.p. Peripharyngeal band.
st. Network of stellate cells.
sg. Stigmata.
sp.c. Spherical gland cells.
sq. Squamous epithelium.
st. Stomach.
tn, tn'. Tentacles.
tr. Transverse vessels.
z. Prebranchial zone.

Fig. 1. *Abyssascidia vasculosa*; natural size.

Fig. 2. Body of same with test removed, from left side; natural size.

Fig. 3. Dorsal tubercle, tentacles, &c., of same; magnified (S. 1).

Fig. 4. Part of branchial sac of same, from inside; magnified (S. 1).

Fig. 5. Part of dorsal lamina of same; magnified (S. 1).

Fig. 6. Alimentary canal and reproductive organs of same; natural size.

Fig. 7. The dorsal tubercle and neighbouring parts of a large *Ascidia* from Kerguelen Island; natural size.

Fig. 8. The same parts seen in longitudinal vertical section; natural size.

Fig. 9. An antero-posterior section of the dorsal tubercle; magnified (S. 1).

Fig. 10. Small part of last; highly magnified, to show the ciliated infundibula, glandular tubule, connective tissue with blood sinuses, &c. (S. $\frac{1}{6}$).

Fig. 11. The cæcal end of one of the glandular tubules; highly magnified (S. $\frac{1}{6}$).

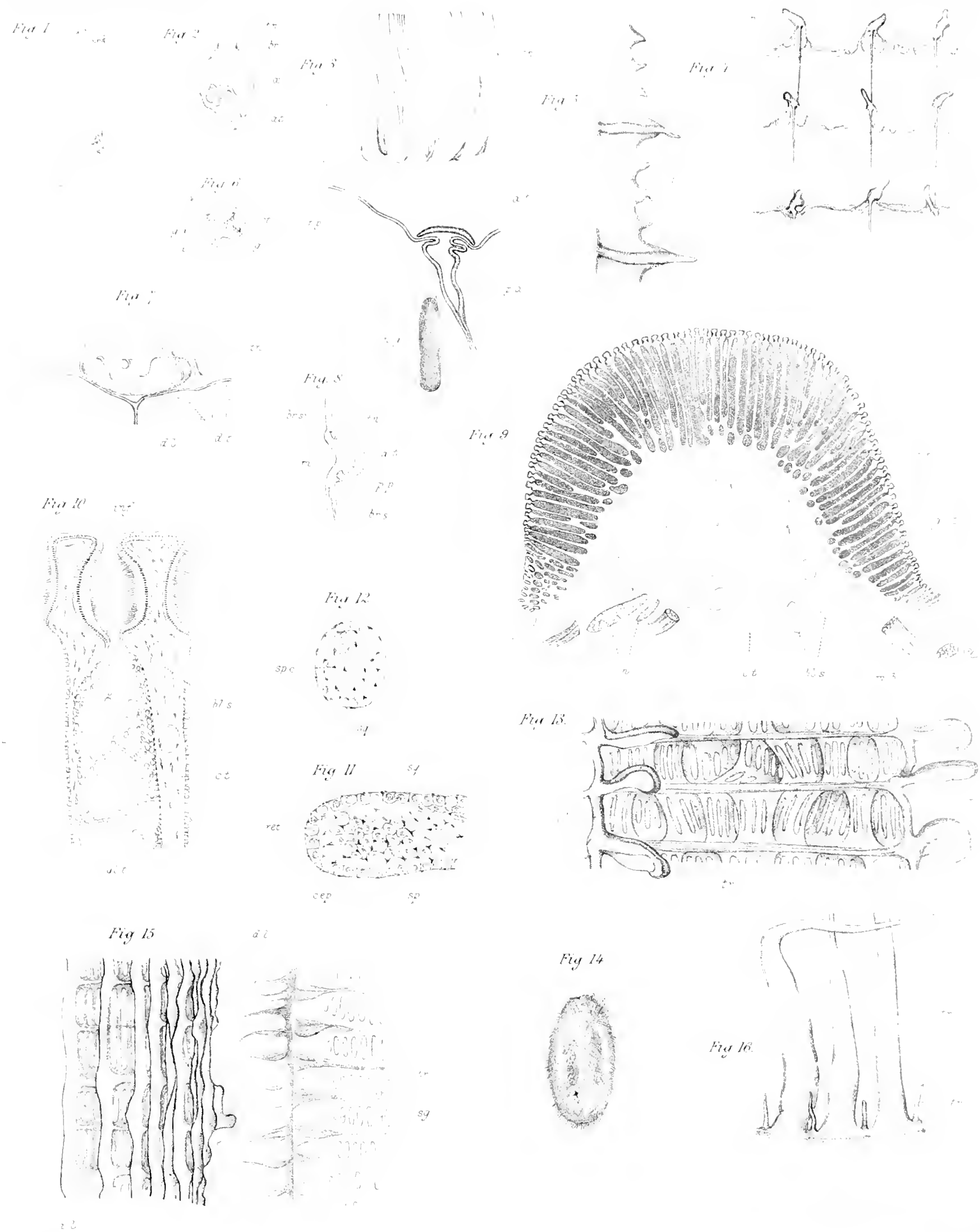
Fig. 12. Transverse section of a tubule filled with cells; highly magnified (S. $\frac{1}{6}$).

Fig. 13. Small part of the branchial sac of the same specimen of *Ascidia*; magnified (S. 1).

Fig. 14. *Styela sericata*; natural size.

Fig. 15. Part of the branchial sac and dorsal lamina of the same; magnified (S. 1).

Fig. 16. The large and small tentacles of the same; magnified (S. 1).



Figs 1-6, ABYSSASCIDIA VASCULOSA, n sp — Figs 7-13, ASCIDIA, sp

Figs 14-16, STYELA SERICATA, n sp