

REPORT
ON THE
SCIENTIFIC RESULTS
OF THE
VOYAGE OF H.M.S. CHALLENGER
DURING THE YEARS 1873-76



UNDER THE COMMAND OF
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AND THE LATE
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AND NOW OF
JOHN MURRAY
ONE OF THE NATURALISTS OF THE EXPEDITION

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C O N T E N T S.

REPORT on the CRUSTACEA MACRURA dredged by H.M.S. CHALLENGER during the
years 1873-1876.

By C. SPENCE BATE, F.R.S., &c.

EDITORIAL NOTE.

THESE Plates illustrate the text of Mr. Spence Bate's Report on the CRUSTACEA MACRURA, and number in all 157—two of them illustrating Dr. Hoek's Appendix to the Report on a parasitic CIRRIPEID.

JOHN MURRAY.

CHALLENGER OFFICE, 32 QUEEN STREET,
EDINBURGH, *8th May* 1888.

EDITORIAL NOTE.

THE Report on the CRUSTACEA MACRURA, by C. Spence Bate, Esq., F.R.S., forming Part LII. of the Zoological Series of Reports, occupies the whole of the present volume, the text, which consists of 1032 pages with a large number of woodcuts, being bound up separately from the 157 lithographic plates. The collection was sent to Mr. Spence Bate in December 1877, so that the preparation of the Report has engaged his attention for over ten years. The Manuscript was received by me in instalments between the 9th December 1880 and the 20th March 1888.

An Appendix to this Report by Dr. P. P. C. Hoek treats of a parasitic CIRRIPEDE, *Sylon challengeri*, attached to a Macrurous Crustacean, *Spirontocaris spinus*. This Appendix is accompanied by 2 lithographic plates. The Manuscript was received by me on the 14th May 1887.

JOHN MURRAY.

CHALLENGER OFFICE, 32 QUEEN STREET,
EDINBURGH, 8th May 1888.

ERRATA.

Page xxxiii, line 8, for "*Cancrinus*" read "*Cancrinus*."

Page 7, line 16 from below, for "*Tripæa*" read "*Trypæa*."

Page 11, line 4, for "*Callocaris*" read "*Calocaris*."

Page 46, line 11 from below, for "*Callocaris*" read "*Calocaris*."

Page 88, line 6 from below, for "*gundulachi*" read "*gundlachi*."

Page 104, line 9 from below, for "*enthrix*" read "*euthrix*."

Page 219, line 17, for "*Euphausidæ*" read "*Euphausiidæ*."

Page 345, line 1 from below, for "*Sciacarus*" read "*Sciacaris*."

Page 497, line 3, for "*Plesionika*" read "*Nothocaris*."

Page 582, line 5 from below, for "*Caradina*" read "*Caridina*."

Page 644, line 5 from below for "Station 164A" read "Station 164B."

Page 644, line 4 from below, for "1200 fathoms" read "410 fathoms."

Page 644, line 3 from below, delete "associated with *Nothocaris rostricrescens*"

THE
VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY.

REPORT on the CRUSTACEA MACRURA collected by H.M.S. Challenger during
the Years 1873-76. By C. SPENCE BATE, F.R.S., &c.

PREFACE.

THE Crustacea Macrura brought home by the Challenger Expedition were placed in my hands for examination and description by the late Sir C. Wyville Thomson, and the progress of the work has gone on under Mr. John Murray, the present Director of the Challenger Publications. The specimens, which were obtained by the dredge, trawl, tow-nets, or by other means, number about 2000, and, arranged according to species and localities, are preserved in about 400 bottles. All these have been carefully examined, the relative numbers of the sexes in most cases determined, and the anatomy and structure of one or more specimens of each species studied and figured, except where the specimens were too few to allow of their being broken up and dissected.

In making both the descriptions and drawings I have always felt that I was dealing with specimens of more than ordinary interest, since they were in many instances obtained from localities which are not likely to be again explored for some time, and which are scattered over a vast area of the Atlantic, Pacific, and Indian Oceans. Here I wish to express my indebtedness both to Mr. T. Wemyss Fulton, M.B., of the Challenger Editorial Staff, and to Mr. J. C. Richards, the former for his aid in watching the Report through the press, and the latter for his careful rendering of my drawings on the stone.

During the cruise, which lasted over three years and extended to some 70,000 miles, Macrura were obtained at 140 of the 277 stations at which trawling or dredging took place, in depths varying from 20 to 3000 fathoms, or, including those collected by the tow-net, from the surface down to about four miles.

TABLE OF CONTENTS.

	PAGE
INTRODUCTION,	iii
NOMENCLATURE,	iii
MORPHOLOGY,	vii
GEOGRAPHICAL DISTRIBUTION,	lii
GENERAL OBSERVATIONS,	lxxix
 DESCRIPTION OF GENERA AND SPECIES,	 1
TRIOBRANCHIATA,	7
Aberrantia,	7
Normalia,	56
<i>Synaxidea</i> ,	56
<i>Astacidea</i> ,	100
<i>Stenopidea</i> ,	206
DENDROBRANCHIATA,	217
Normalia,	219
Aberrantia,	469
<i>Penæidea</i> ,	220
<i>Schizopoda</i> ,	470
PHYLLOBRANCHIATA,	473
Aberrantia,	473
Normalia,	480
<i>Crangonidea</i> ,	481
<i>Polycarpidea</i> ,	503
<i>Monocarpidea</i> ,	682
<i>Haplopodea</i> ,	883
 APPENDIX A,	 919
APPENDIX B,	927
INDEX,	929
 EXPLANATION OF PLATES.	

INTRODUCTION.

NOMENCLATURE.

Before entering upon the description of the structure of the many forms which I have to elucidate, it is necessary that the system of nomenclature which I have adopted should be clearly set forth and understood. It is the same as that which was used by Professor Westwood and myself in our History of the British Sessile-Eyed Crustacea, and which has since been extensively employed by naturalists.

I have invariably adopted the terms proposed by others when they appeared to possess clear homological value, and have only abbreviated most of those of Professor Milne-Edwards in order to avoid redundancy,—for example, in the terminology applied to the various joints of the oral and ambulatory appendages. Some of the terms in common use I have observed to be a frequent cause of confusion, even in printed descriptions, from their similarity in sound. I allude to the terms “endopodite,” “exopodite,” “apopodite” and “epipodite,”—the last three being applied to branches of the first, a fact which is not at all brought out by their respective names.

The nomenclature here employed appears to be of universal application to the whole of the Crustacea, and avoids the necessity for roundabout explanation, which so frequently destroys clearness of description.

In the definition and diagnosis of species I have confined myself to the systematic terms as given in the accompanying table, but when writing where less exactitude was necessary, I have generally used the more popular expressions.

The nomenclature of the parts is shown in the accompanying woodcut (Fig. I.) of an ideal Macrurous Crustacean, in which the appendages are represented of several characteristic forms.

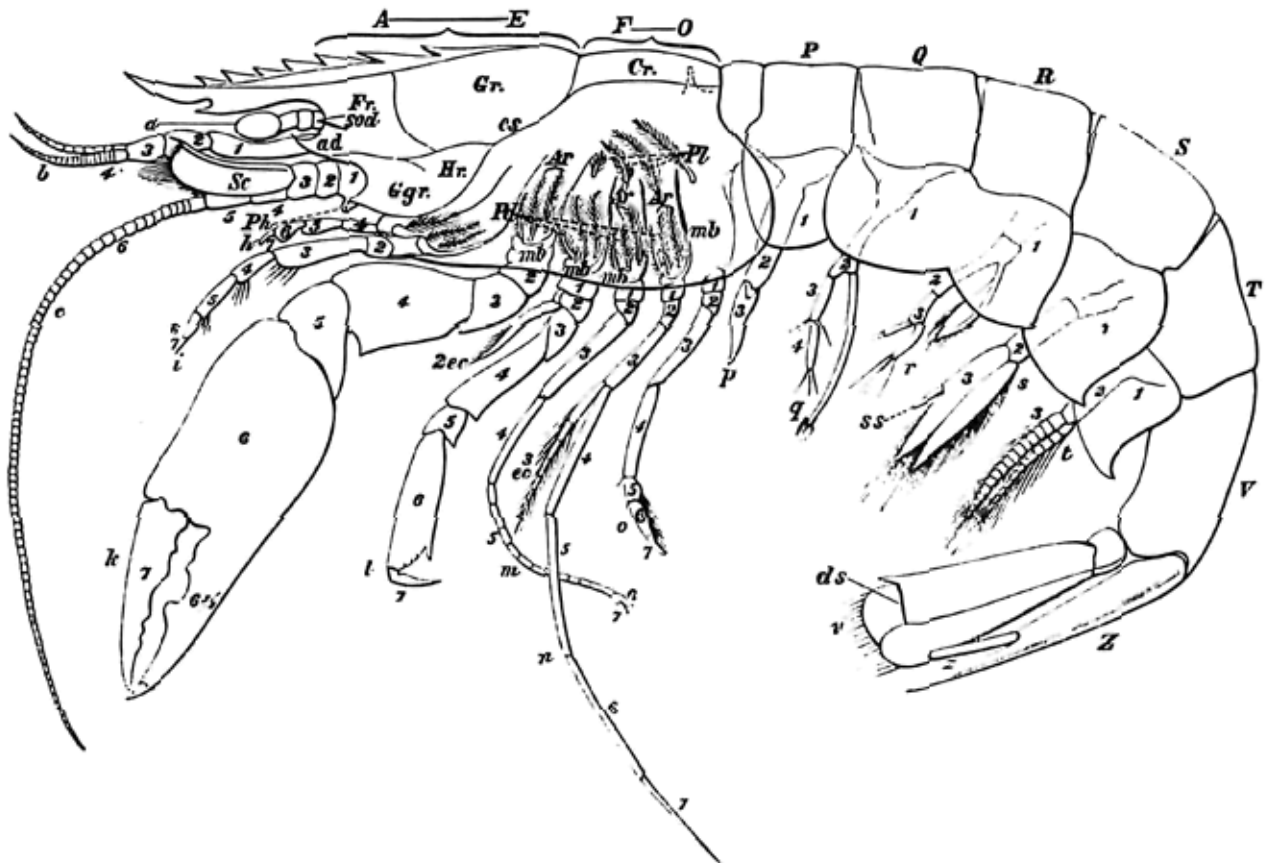


FIG. I.—Showing the nomenclature of the various parts.

Fr. Frontal region.
Gr. Gastric region.
Cr. Cardiac region.
Hr. Hepatic region.
Ggr. Antennal or green gland region.

A-E. Cephalic somites.
F-O. Thoracic or pereionic somites.
P-V. Pleonic somites.
sod. Supraorbital tooth.
ad. First antennal tooth.

- Ophthalmus, . . . Eye.
Ocellus, . . . A little eye, distinct from the main organ of vision.
a. Ophthalmopod, The appendage that supports the main organ of vision; it includes the eye, the peduncle, and the pedicle. Adapted from *Podophthalmus* (Stimpson).
Metope, . . . From μέτωπον, face, being that portion of the frontal surface in which the antennæ are situated (Huxley).
b. First antenna, . . . Or antennule.
Blepharis, . . . Fringe of hairs that surround the margin of the depression in which the eye lodges on the upper surface of the first joint of the first antenna; from βλεφαρίς, eyelash.
pc. Prosartema, . . . Appendage connected with the inner side of the first joint of first pair of antennæ; προσάρτημα, appendage.
stc. Stylocerite, . . . Style or large spine on outer margin of the first joint of the first pair of antennæ; στυλος and κέρασ.
c. Second antenna.
Sc. Scaphocerite, . . . Scale-like appendage of the second pair of antennæ (after Milne-Edwards).
Ph. Phymacerite, . . . Tubercle at base of second antenna, containing external orifice of the green gland; φῦμα, tubercle, and κέρασ.
An. Ancecerite, . . . A curved process attached to the peduncle of the second pair of antennæ in *Benthescymus*; from ἀγκή and κέρασ.
ca. Epistoma, . . . Osseous portion of the metope that lies immediately in front of the oral aperture (Milne-Edwards).
eg. Cheiloglossa, . . . Anterior lip. Membranous protuberance that lies in front of the mandibles and is continued under them; χείλος, lip, and γλῶσσα, tongue.

- ma.* Metastoma, . . . Posterior lip of authors. Membranous appendage that lies behind and over the mandibles (Huxley).
- d.* Siagon, . . . Mandible, *σιαγών*, a little jaw (after Westwood and Bate).
Synhipod, . . . Appendage attached to mandible; from *συναφής*, continuation, *ποῦς*, foot. This name is suggested as being homologically true. Popularly called "palp."
- ap.* Apophysis, . . . Internal process of the mandible (Huxley).
Psalistoma, . . . Cutting margin of the mandible; from *ψαλίς*, scissors, *στόμα*, mouth.
- e.* 1st siagnopod, . . . Or maxilla.
f. 2nd siagnopod, . . . Or maxilla.
g. 3rd siagnopod, . . . Or 1st maxilliped.
1. Coxa, . . . First joint of any appendage from *a* to *v* abbreviated from coxagnathite and coxapodite of Milne-Edwards.
2. Basis, . . . Second joint of any appendage from *a* to *v*, instead of basignathite and basipodite of Milne-Edwards.
3. Ischium, . . . Third do. do. ischiognathite and ischiopodite do.
4. Meros, . . . Fourth do. do. merognathite and meropodite do.
5. Carpos, . . . Fifth do. do. carpognathite and carpopodite do.
6. Propodos, . . . Sixth do. do. prognathite and propodite do.
7. Dactylos, . . . Seventh do. do. dactylognathite and dactylopodite do.
- ec.* Ecephysis, . . . Branch of any particular joint, from *ἔκφυσις*, as coxephysis, a branch springing from the coxa; basephysis, a branch springing from the base. The former is synonymous with epignathe and epipodite of Milne-Edwards, and sometimes with the podobranchia of Huxley, when it is connected with a branchial plume as in *Homarus*, &c. The latter (basephysis) is synonymous with exognathe and exopodite of Milne-Edwards, and is preferred because it more clearly identifies the true relative position of the structure homologically.
- mb.* Mastigobranchia, The branchial lash; from *μάστιξ*, whip, and *βράγχια*, gills. It is synonymous with epipodite and epignathe of Milne-Edwards, and sometimes part of the podobranchia of Huxley, and with apodemata, MacCoy, and flabellum of old authors.
- Pd.* Podobranchia, . . . A branchial plume attached to the coxa (Huxley).
Ar. Arthrobranchia, . . . A branchial plume attached to the membranous articulation between the coxa and the body of the animal (Huxley).
pl. Pleurobranchia, . . . A branchial plume issuing between the somites of the pereion (Huxley).
prk. Pereicleis, . . . Tubercle attached to the last somite of the pereion that secures the carapace posteriorly; from pereion and *κλείς*, bolt.
ptk. Peltecleis, . . . Tubercle attached to the posterior margin of the carapace; from *πέλτη*, shield, and *κλείς*, bolt.
plk. Pleocleis, . . . Tubercle attached to the first somite of the pleon, and precludes the carapace from being raised posteriorly.
ptm. Petasma, . . . Membranous development attached to the first pair of pleopoda in the male; from *πέτασμα*, a curtain.
Thelycum, . . . Structure on the ventral surface of the pereion peculiar to females; from *θελυκόν*.
- ss.* Stylambly, . . . A small process attached to the inner branch of the pleopod; from *στύλος*, style, and *ἀμβλύς*, blunt.
cc. Cincinnulus, . . . Small hooks attached to the stylambly, from *κικιννυλος*, a curl (Sars).
ds. Diæresis, . . . The division in the outer branch of the posterior or caudal pleopod; from *διαίρεσις*, division.
vz. Rhipidura, . . . The posterior pair of pleopoda and the telson, when these parts are developed as in the *Macrura*; from *ῥήπις*, a fan, and *οὐρά*, tail.
Z. Telson, . . . Terminal somite of the pleon.
Brepalos, . . . Name used for the young just as it quits the ovum, in whatever stage. Throughout the Report the somites are recognised by capitals, and the corresponding appendages by small letters.

SOMITES. APPENDAGES. SYSTEMATIC.		POPULAR.		DANA.		MILNE-EDWARDS: SOMITES.	
		Cephalothorax.		Oculus		Eye.	
A	a	Ophthalmopod,	Eye, Peduncle, and Pedicel.	Antenna I.	Antennule.		
B	b	1st Antenna,	1st Antenna.	" II	Antenna.		
C	c	2nd "	2nd "	Mandible	Protognathe.		
D	d	Siagon,	Mandible.	Maxilla I.	Deutognathe.		
E	e	1st Siagnopod,	1st Maxilla.	" II	Tritognathe.		
F	f	2nd "	2nd "	Maxilliped I.	Tetartognathe.		
G	g	3rd "	3rd " or 1st Maxillipede or Jawfoot.	" II.			
H	h	1st Gnathopod,	2nd "	" III			Protosomite,
I	i	2nd "	3rd "	Ped. Prehensile			Deutosomite,
K	k	1st Pereiopod,	1st Leg or Arm.	" "			I. Tritosomite,
L	l	2nd "	2nd "	" "		Thorax.	II. Tetartosomite,
M	m	3rd "	3rd "	" "			III. Pemptosomite,
N	n	4th "	4th "	" "			IV. Hectosomite,
O	o	5th "	5th "	" "			V. Hebdosomite,
		Abdomen.		Appendage I.			
P	p	1st Pleopod,	Swimmerets	" II.			
Q	q	2nd "	or	" III.			
R	r	3rd "	Abdominal	" IV.			
S	s	4th "	Appendages.	" V.			
T	t	5th "		" VI.			
V	v	6th "		" "			
Z	z	Telson.	...	" "			

CEPHALON.

PERRION.

PLEON.

MORPHOLOGY.

Milne-Edwards laid it down in his earlier writings that the type of the Decapod Crustacea consists of twenty-one somites, of which the anterior seven belong to the cephalon or head, the posterior seven to the pleon or abdomen, and the intermediate seven to the pereion or thorax.

Dana admits that there are normally twenty-one segments, and twenty-one corresponding pairs of appendages, the posterior seven of which belong to the pleon. But he says that of the remaining fourteen pairs, only five are subservient of locomotion, the other nine being organs of special sense or in relation to manducation and placed about the mouth. In reaching this conclusion, Dana was guided by the results of his examination of the Brachyura and higher Macrura, in which the nervous system is most highly centralised.

From the study of development as well as of the adult structure of the more simple forms of Crustacea, I previously adopted and maintained the view put forward by Milne-Edwards. But since then, from the examination of extensive series of Crustacea of all groups and types, and of many forms in different stages of development, I have been led to reconsider this conception of the structural relationship of the several parts.

If we turn to the development of the Synaxidea we find some of the most instructive examples of crustacean form. In this group the animal leaves the egg far advanced beyond the Zoea stage, and exists in what Anton Dohrn calls the Megalopa stage; although in character it is far below the form to which Leach originally gave that name, and which was ultimately shown to be an advanced stage of a young Brachyura. It is extremely thin and very translucent, and a more advanced form has been named *Phyllosoma* by Milne-Edwards. At the period when it is hatched it is about 2 mm. in length (Pl. XIIA. figs. 1, 2), and is distinctly divided into three separate parts. The anterior portion or cephalon is broad and shield-like, and represents the future carapace of the adult; the second portion or pereion is also broad and disc-like, and it was upon the characters of these two divisions that a supposed family was established by Milne-Edwards under the name of Bicurassés; the third portion or pleon is a narrow terminal process.

The cephalon consists of the ocular, the two antennal, the mandibular, and the first post-oral somite (Pl. XII B. fig. 1; Pl. XII C. fig. 2). The two anterior somites, as shown in the adult animal, are separate from those which form the large dorsal shield or carapace. Studying the development of the *Phyllosoma* still further in various species, we find that the succeeding somites are distinct from the cephalon and together compose the pereion; consequently the whole of the appendages attached to this division must be

pereionic, and it would therefore appear that there must be five somites (A to E) only belonging to the first division or cephalon, nine (F to O) to the second or pereion, and seven (P to Z) to the third or pleon.

In the mature forms the encroachment of one part on the other is so marked and conspicuous that several of the more crowded appendages lose their simple character and adapt themselves to the functions of those with which they are brought into closer affinity; thus the anterior pairs of pereiopoda, which are true feet in the simple forms, become hands, and then in still closer resemblance to the oral appendages, until in the more highly developed forms the second pair of gnathopoda loses its pediform character and becomes in the *Brachyura* little more than opercula, covering the mouth. Another fact brought out in the study of these and other immature forms during the progress of their development is that the carapace is structurally independent of the pereion, in which the somites are complete in the young condition, as may be seen in the series figured in Pls. XIIA., XII B., XII C., XII D., but that as the animal increases in size the carapace of the cephalon encroaches upon and covers over the surface of the pereion, the dorsal arc of which ceases to be formed; and thus the carapace appears as part of the pereion which it covers. But this is not always the case, for in the genus *Eucopia* nearly, if not all, the somites of the pereion are perfect, while the carapace overlies them all. In this case, however, the pereion is of a soft and membranous structure, and has therefore little protective value, whereas in the stronger forms, the carapace forming an efficient protection, the inner calcified structure of the somite is not wanted.

The carapace is also capable of fulfilling offices that simple somites could not carry out. It forms a great shield that is capable of protecting a greater or less portion of the animal, varying from the entire body in some of the *Brachyura* to but little beyond the cephalon in *Lucifer*.

This protective character is further exemplified in the *Macrura*, particularly in the fast swimming forms, by the development of a long rostrum at the anterior extremity, which is evidently intended to break the force of any body with which it may come into contact, and so protect the eyes and sensory organs from injury. The rostrum may also in some cases be used as a weapon of offence, the teeth that adorn it increasing its value in this respect; in some cases the latter have a retaining power, when, as in *Notho-caris spiniserratus* and *Odontolophus serratus*, the teeth are supplemented by numerous small reversed teeth attached to the others.

The rostrum is generally firmly fixed and rigid, but in one or two genera, such as *Pantomus* and *Rhynchocinetes* of A. Milne-Edwards, the rostrum has an articulation with the frontal margin of the carapace, and seems to have the power of movement to a slight extent in any direction at the will of the animal; this modification can be due only to one purpose, that of receiving the shock of an approaching enemy directly on its point rather than obliquely.

The teeth also that are placed upon the frontal margin of the carapace are probably less offensive than protective, since they generally are situated at points where muscular attachment is required, and the strength of the integumental tissue is by their presence increased.

Although the carapace has the capacity of being elevated posteriorly at the will of the animal, it is nevertheless generally kept in position by strong points of resistance, and these vary in form, position, and character in different families and perhaps in genera also. In *Palinurus* they exist as large, flat, button-shaped tubercles on each side of the pereion and are inserted into hollow cavities on the under surface of the carapace, and the power of retention is very great. To such a tubercle I have applied the name pereicleis, since it bolts the carapace to the pereion (Pl. XII. fig. 1, *Palinosytus*¹; fig. 2, *Panulirus*).

In other genera, such as *Thaumastocheles* (Pl. VI.), *Ibaccus* (Pl. VIII.), and *Pentacheles* (Pl. XVI. fig. 4), there is a process or tubercle on the pleon that overlaps the carapace, and keeps it in position. This I have named the pleocleis. In some few instances, as in *Willemasia*, the tubercle originates from the posterior margin of the carapace and lodges in a groove or hollow in the surface of the first somite of the pleon; this I have named the peltocleis. But in many genera the carapace is produced posteriorly on each side to a considerable extent, and while overlapping the first somite of the pleon is itself overlaid by the anteriorly projecting wings of the second somite.

The Branchiæ.—The great value of this power of securing the carapace is that it gives protection to the branchiæ which are placed beneath it.

Where the carapace does not exist, the branchiæ are of a more simple character and are generally pendent from the leg, as in the Amphipoda, or attached to other parts of the animal, as in the Squillidæ and Isopoda, or are absent altogether as in *Lucifer*. But in the well-developed forms of Macrura the branchiæ assume a higher character than mere appendages of the legs.

It is true that one pair (the podobranchiæ) belong to the first or coxal joint of the legs, and these are developed largely and most constantly in the normal group of the Trichobranchiate division, being absent only in two genera, and in some of the normal forms of the Dendrobranchiata, as in the genera *Benthesicymus*, *Aristeus*, and their near congeners; but they are absent in *Penæus*, *Sicyonia*, and *Sergestes*, and rudimentary in *Haliporus*.

In the Phyllobranchiate division the podobranchial plume is invariably absent from all the pereiopoda, but it is present—except in only a few genera, such as *Nika*, *Crangon*, and *Glyphocrangon*—on the first pair of gnathopoda, and in the fresh-water genus *Atya*

¹ A. Milne-Edwards having employed *Palinustus* for the name of a new Scyllarid, I have changed the name of my genus from *Paltnostus* to *Palinosytus*.

it is present on the second pair also; and these are never present without being attached to a mastigobranchial appendage. This is true of each separate division, both normal and aberrant, with the following exceptions:—viz., *Cheramus* in the Trichobranchiata, *Latreutes* and *Atya* in the Phyllobranchiata. Of these the two former are small specimens, and the mastigobranchia may have been overlooked, and it is present on the second gnathopod in *Atya*.

In the genus *Stereomastis* there is only one mastigobranchia, and that is attached to the second pair of gnathopoda and is in a rudimentary condition (p. 158, fig. 37); there are, however, four podobranchiæ attached to the anterior four pairs of pereopoda, but in this genus they are projected on a stalk and the mastigobranchia has become obsolete and the podobranchia reduced to a degree, which appears to be further advanced than is seen in *Pentacheles euthrix*, where the mastigobranchiæ exist as plates of exquisite delicacy.

In the family Astacidæ the majority of the genera are tabulated as having six pairs of podobranchiæ and only one mastigobranchia, *Cambarus* and *Astacus* having none; but the fact is that the mastigobranchia in this family is connected with the podobranchial plume throughout the whole of its length in the manner shown in Pl. XXVII. fig. 1, *pb*, and in fig. 1*m''*. This I think may be understood from a knowledge of the fact that in their development the mastigobranchial plate and the podobranchial plume commence in one sac, which afterwards divides by forming a branch that is without branchial filaments, as may be seen in Pl. XII B. fig. 4, *g*. But whether they be united or distinct from the branchial plume they fulfil the same office, that of separating one set of branchial appendages from another, and sending long serrate hairs between the filamentose rods, and thus keeping them free from undue lateral pressure, as may be seen in Pl. VII. figs. 1 and 1*bis*, and Pl. XXVIII. *pd.br*.

In many instances, especially where the podobranchiæ are not developed, the mastigobranchiæ are small; but though small they can scarcely be considered as rudimentary, seeing that they are developed upon a general plan, and that one of usefulness. In Pl. CVII. fig. *mb.*, and Pl. CVIII. fig. *i''*, where they are figured as developed with a hook at the extremity, varying in form, they reach only to the extremity of the next succeeding branchia, and sometimes, as in *Atya* (Pl. CXIX. fig. 1), they terminate in a brush of long hairs that penetrate between the plates of the different plumes.

The arthrobranchiæ, or those branchiæ attached to the membranous articulation that connects the legs with the body of the animal, are the most abundant and very constant throughout the Macrura. They appear to be present in all the genera alluded to in this Report, with the exception of *Pontophilus*, *Sabinea*, *Pontocaris*, *Nika*, *Paralpheus*, *Synalpheus*, *Latreutes*, *Hippolyte*, *Spirontocaris*, *Hetairus*, and *Pontonia*. There is only one arthrobranchia in *Alpheus*, and that is attached to the second pair of gnathopoda.

The pleurobranchiæ, if not the most numerous, are perhaps the most constantly

present, being absent only in those genera of the aberrant Trichobranchiata that approximate to the Anomural type; but, strange to say, *Cheiroplatea*, or the most Anomural form of the group, has three pairs of pleurobranchiæ.

These statements will, however, be better understood by an examination of the following tables, which are compiled from a large series of specimens of different species of the several genera:—

Tribe.	Group.	Family.	Genus.	Mastigobranchiæ.	Podobranchiæ.	Arthrobranchiæ.	Pleurobranchiæ.	
TRICHOBRANCHIATA	ABERRANTIA	PYLOCHELIDÆ, . . .	<i>Cheiroplatea</i>, . . .	...	...	10	3	
		THALASSINIDÆ, . . .	<i>Thalassina</i> , . . .	5	4	12	...	
		CALLIANASSIDÆ, . . .	{	<i>Callianassa</i> , . . .	1	...	10	...
				<i>Cheramus</i>, . . .	...	1	8	...
				<i>Scallasis</i>, . . .	...	...	9	...
		AXIIDÆ,	{	<i>Paraxius</i> , . . .	6	4	10	...
				<i>Eiconaxius</i> , . . .	6	4	8	...
		THAUMASTOCHEEIDÆ,		<i>Thaumastocheles</i> ,	6	5	10	4
		NORMALIA	SCYLLARIDÆ, . . .	<i>Ibaccus</i> , . . .	6	6	12	4
			PALINURIDÆ, . . .	{	<i>Panulirus</i> , . . .	6	6	10	4
	<i>Palinurus</i> , . . .				6	6	10	4
	ERYONIDÆ,		{	<i>Polycheles</i> , . . .	5	4	8	4
				<i>Pentacheles</i> , . . .	5	4	8	4
				<i>Stereomastis</i> , . . .	1	4	8	4
				<i>Willemassia</i> , . . .	5	4	8	4
	HOMARIDÆ,		{	<i>Phoberus</i> , . . .	6	6	10	4
				<i>Nephropsis</i> , . . .	6	5	8	4
				<i>Nephrops</i> , . . .	6	5	10	4
	ASTACIDÆ,	{	<i>Paranephrops</i> , ¹	1	6	11	4	
			<i>Astacopsis</i> , . . .	1	6	11	4	
<i>Cherops</i> , ¹ . . .			1	6	11	4		
<i>Astacoides</i> , . . .			1	6	9	1		
<i>Fingus</i> , ¹ . . .			1	6	11	4		
<i>Astacus</i>, . . .			...	6	11	1		
<i>Parastacus</i> , ¹ . . .			1	6	11	4		
<i>Cambarus</i> , ¹ . . .	...	6	11	...				
STENOPIDÆ,	{	<i>Stenopus</i> , . . .	7	1	11	6		
		<i>Spongicola</i> , . . .	6	1	12	6		

¹ According to Huxley.

Tribe.	Group.	Family.	Genus.	Mastigobranchiæ.	Podobranchiæ.	Arthrobranchiæ.	Pleurobranchiæ.
DENDROBRANCHIATA	NORMALIA	PENÆIDÆ,	<i>Penæus</i> ,	5	...	11	7
			<i>Pleoticus</i> , ¹	6	1	11	6
			<i>Artemesia</i> ,	4	1	11	6
			<i>Haliporus</i> ,	6	3	12	6
			<i>Sicyonia</i> ,	5	...	6	6
			<i>Hemipenæus</i> ,	5	4	11	6
			<i>Aristeus</i> ,	6	5	11	7
			<i>Hepomadus</i> ,	5	4	11	7
		<i>Benthesicymus</i> ,	6	5	12	6	
		<i>Gennadas</i> ,	6	5	12	7	
		SERGESTIDÆ,	<i>Sergestes</i>, . . . . .	...	...	...	4
			<i>Acetes</i>, . . . . .	...	...	...	9
			<i>Lucifer</i>, . . . . .	...	...	...	0
		PHYLLOBRANCHIATA	NORMALIA	CRANGONIDÆ,	<i>Crangon</i> ,	2	...	2	4
<i>Pontophilus</i> ,	2				1	...	6
<i>Sabinea</i> ,	2				1	...	6
<i>Pontocaris</i> ,	1				1	...	6
NIKIDÆ,	<i>Glyphocrangon</i>, . . . . .			...	...	4	6
	<i>Nika</i>, . . . . .			...	...	...	5
ALPHEIDÆ,	<i>Alpheus</i> ,			7	...	1	5
	<i>Paralpheus</i> ,			1	1	...	5
	<i>Synalpheus</i> ,			1	1	...	5
HIPPOLYTIIDÆ,	<i>Latreutes</i>, . . . . .			...	1	...	5
	<i>Hippolyte</i> ,			1	...	...	4
	<i>Spirontocaris</i> ,			5	1	...	5
	<i>Nauticaris</i> ,			6	1	6	6
	<i>Hetairus</i> ,			4	1	...	5
	<i>Chorismus</i> ,	4	1	1	5		
	<i>Merhippolyte</i> ,	6	1	5	6		
<i>Amphiplectus</i> ,	1	1	4	5			
PANDALIDÆ,	<i>Heterocarpus</i> ,	6	1	5	5		
	<i>Plesionika</i> , ²	6	1	5	6		
	<i>Nothocaris</i> ,	6	1	5	5		
	<i>Pandalus</i> ,	6	1	5	5		
	<i>Chlorotocus</i> ,	6	...	5	6		
	<i>Dorodotes</i> ,	6	1	6	5		
ATYIDÆ,	<i>Atya</i> ,	5	2	...	6		
PONTONIIDÆ,	<i>Pontonia</i>, . . . . .	...	...	...	4		

¹ The name *Philonicus*, which was originally given to this genus (p. 273), being preoccupied, I now substitute for it *Pleoticus*, from *πλειοτικός*.

² In *Plesionika spinifer* the numbers respectively are 1, 1, 5, 6.

Tribe.	Group.	Family.	Genus.	Mastigobranchiæ.	Podobranchiæ.	Arthrobranchiæ.	Pleurobranchiæ.
PHYLLOBRANCHIATA <i>continued.</i>	NORMALIA <i>continued.</i>	CARICYPHIDÆ, . . .	<i>Acanthephyra</i> , . . .	5	1	6	5
			<i>Oplophorus</i> , . . .	6	1	5	5
			<i>Campylonotus</i> , . . .	6	1	5	6
		PALEMONIDÆ, . . .	<i>Palæmon</i> , . . .	1	1	1	5
			<i>Bithynis</i> , . . .	1	1	1	5
			<i>Brachycarpus</i> , . . .	1	1	1	5
		NEMATOCARCINIDÆ, . . .	<i>Nematocarcinus</i> , . . .	6	1	5	5
			<i>Stochasmus</i>, . . .	...	...	...	...
		TROPIOCARIDÆ, . . .	<i>Notostomus</i> , . . .	5	1	5	6

The Ophthalmopoda.—Of the several somites that compose the body of the Decapod Crustacea, that which supports the organs of vision is the most anterior. This can be demonstrated by the course of the progressive development, even of the forms which depart most from a simple type, as well as by means of dissection, the most anterior branches given off from the cephalic ganglion going directly to the organs of vision. Theoretically, these organs are the lateral appendages of a somite which in many genera is not traceable; but among the Macrura it is frequently present in the form of a more or less distinct calcified bar, lodged between the inferior surface of the projecting front of the carapace and the tergal portion of the second or antennal somite (Pl. CXIII. fig. 1a-a), which sometimes is so much developed as to meet the advanced or rostral portion of the carapace, and thus enclose the first or ophthalmic somite within a channel. In such cases the ophthalmic somite frequently ceases to be a calcareous structure, and thus gives colour to the opinion held by many, among whom Claus and Fritz Müller¹ are the highest authorities, that the ophthalmopoda have no ocular somite, and therefore are not homotypical of the limbs attached to the other somites among the Arthropoda.

The ophthalmic somite as a distinct and limb-bearing segment is capable of being determined in several separate genera throughout the Crustacea, as, for instance, in *Squilla*, as shown by Milne-Edwards in his *Histoire des Crustacés*, and in *Palinurus vulgaris*.² In *Cancer pagurus* the ophthalmic somite exists distinctly separated from the others, but is enclosed as a calcareous bar, and hid within the first, or anterior,

¹ Facts and Arguments for Darwin, English Translation, p. 14, note 1, 1869.

² Brit. Assoc. Advancement of Science, 1877, Report on the Present State of our Knowledge of the Crustacea, pl. ii. fig. 8.

antennal somite, which in the Brachyura and Macrura is generally closely fused with the two succeeding.

The ophthalmopoda undergo various modifications of form throughout the order, but the most common condition is that of a pair of pyriform or subcylindrical appendages, the peduncles, each of which generally slightly enlarges towards the distal extremity, where it supports a reniform or hemispherical pigmented organ of vision, the ophthalmus; at the base the peduncle abruptly narrows and is supported on a slender pedicle, which varies in length, as may be observed by comparing that in the genus *Eretmocarid* (Pl. CXLV.) with that in *Palæmon* or *Astacus*, where the pedicle almost disappears. In *Alpheus* and its congeners, *Athanas* and *Cheirothrix* (Pl. XCVI. fig. 2a), the peduncle also undergoes diminution.

This pair of appendages is thus shown to be liable to undergo various changes in each of its parts, and these changes have a tendency to be associated more or less exclusively with the several divisions of the order.

Among the Trichobranchiata the ophthalmopoda are generally short and supported on a pedicle that is only sufficiently long to admit of the free motion of the peduncle, whereas the ophthalmus is generally hemispherical or reniform, the most normal condition being seen in *Homarus*, *Nephrops*, *Astacus*, and *Palinurus*, and the greatest departure may be found in the young of the last and in the aborted condition seen in *Willemæsia* and its congeners.

In the *Phyllosoma* shown on Pl. XIIA., whether it be the young of some one of the Palinuridæ or of the Scyllaridæ, the ophthalmopod, a short period after hatching, is projected on an extremely long pedicle, which is the more remarkable inasmuch as both in the brephalos condition (Pl. XIIA. fig. 1) as well as in the adult stage the organ is short and the pedicle reduced to the smallest condition consistent with free movement.

In *Phoberus* the ophthalmopoda are reduced to two small slightly movable processes, with a small globular ophthalmus, as they are also in *Nephropsis*, while in the aberrant genus *Thaumastocheles* they are absent altogether, or only represented by two small fixed calcified points.

During the expedition of the "Travailleur" A. Milne-Edwards took a species that he named *Richardina spinicincta*, in which the ophthalmopod is reduced to a sightless globe, surmounted by three strong teeth, and in a specimen of *Palinurus* he found that from the middle of the eye a multiarticulate appendage was produced.¹ According to Leydig² the eyes of *Cambarus pellucidus* (Tellkampf) have neither pigment, rods (bacilli), nor cones, and that while they differ in the adult condition from those in the more normal species, they are comparatively larger in the young than in the adult

¹ *Comptes rendus*, tom. lix, p. 710, 1864.

² *Untersuchungen zur Anat. und Histologie der Thiere*, 1883.

stage, a fact that is apparent in nearly all purblind species and is especially noticeable in *Alpheus* and *Willemæsia*, as may be seen by reference to Pl. LXXXIX. fig. 4, and Pl. XX. fig. 2.

In the several forms classified under the generic name of *Eryon*, the organs of vision appear to have become degenerated. In most specimens of the various fossil species, no trace of eyes has been detected. In the original specimens, as figured by Desmarest in his *Considérations générales sur la classe des Crustacés*, Pl. XXXIV. fig. 3, part of a biarticulate appendage is present on the frontal margin on each side, beyond the second pair of antennæ. If, as is possible, these are the remnants of the appendages that supported the eyes, I think we must come to the conclusion that they were projected at the extremity of a long or short pedicle.

In a specimen unearthed in 1882¹ from the Upper Lias strata of Calvados and described by M. Morière, the general features bear a resemblance to the *Willemæsia* of



FIG. II.—*Eryon calvadosii*, after M. Morière. Reduced one-half.

recent seas, excepting that in the Calvados specimen large organs of vision are conspicuous, or rather, I should say, that the orbits for the reception of the organs of vision are well preserved, and as M. Morière says of his specimen that "On aperçoit des pedoncles oculaires." These are situated on the fronto-lateral margins of the carapace, on the outer side of the second pair of antennæ, somewhat after the manner occasionally seen in some of the *Palinuridæ* and some of the *Scyllaridæ*; but it is more common among the *Brachyura* than the *Macrura*. The eyes are similarly situated, but not so largely developed in the *Willemæsia* group, in which they are moreover in a more marked state of degradation. In *Willemæsia* and its congeners, the ophthalmopoda are deeply

¹ Bull. Soc. Linnéenne de Normandie, sér. 3, tom. vii. p. 1, 10, pls. i., iii., 1883.

embedded in a fissure, varying in shape in different species, and are reduced in size and modified in form, the capacity of vision being confined to two small points, one on the upper or dorsal, and the other on the lower or frontal surface (Pl. XIII. fig. *a*), and in each it exists only to a limited extent, the organ being without the power of movement. Yet in the young, as may be assumed from the appearance of the embryo of *Willemacia* (Pl. XX. fig. 2), as observed previous to the escape of the brephalos from the ovum, the ophthalmopoda are globular in form, and distinctly pedunculated.

It is interesting to find in the same geological epoch some specimens of *Eryon* that are blind, and others with large and probably well-developed organs of vision. But it is not more remarkable than that living and adult specimens of *Cambarus* should be found with the ophthalmopoda in all stages of development, from the well-formed eyes of those that live in the waters of America that are open to the sun, to the blind forms dwelling in subterranean caves where light never penetrates. The loss of vision is not necessarily a disadvantage to a species, while its surroundings, both in relation to food and companionship with others necessary for its existence, are convenient, since sight is useless where there is no light and the absence of the organs of vision may lessen the risk to life while the conditions are permanent, but should these be withdrawn or vary, the want of sight must be detrimental in the struggle for existence and thus be a prelude to the extinction of a species.

The species of the Eryonidæ live at the bottom, where their food is abundant; for in the ancient as well as in the modern seas the myriads of organic forms constantly falling to the bottom from the extensive area of waters above in which they live, constitutes a continuous and unfailing supply of food that comes within their reach; and thus organs of vision are not necessary for the purpose of seeking food. Thus the Eryonidæ live and renew their species under conditions where other forms might perish.

I have previously remarked that the ophthalmopoda in the Eryonidæ are depreciated in character; but it should also be noticed that the departure in the recent genera takes place, as shown in Pl. XIII. *a*, in a direction that resembles that seen in *Benthesicymus* and *Gennadas* among the Dendrobranchiata (Pl. LVII. fig. 1*a*, and Pl. LIX. fig. 1). This is a point of considerable interest, since it is the only instance in which the secondary eye or ocellus is observable in the Trichobranchiata. In the division Dendrobranchiata the ophthalmopod is generally compressed, and the ophthalmus possesses a reniform shape, which in some species has the margin on the upper and inner surface projecting somewhat beyond its limit and forming an imperfect ocellus, or small secondary visual organs, so situated that it is capable of being useful as an organ of vision when the animal otherwise is at rest.

The ophthalmopoda in most of the species are projected at the extremities of a narrow transverse rod that probably represents the ophthalmic somite, and is sometimes

overlapped by a process from above and below, which covers it or encloses it within a groove, as has been previously described.

In *Aristeus semidentatus* the ophthalmus is hemispherical, and the peduncle suddenly narrows and tapers to the base. In *Penæus canaliculatus* the ophthalmopod is triarticulate and laterally compressed, the joints articulating with each other obliquely. It has rather a complicated appearance, having the ophthalmus situated obliquely at its extremity, the inner surface of which is flat, with a concave margin furnished with a small projecting pigmented process forming a connected imperfect ocellus near the middle of the arch (Fig. III.). In *Hepomadus glacialis* the ophthalmopod is pear-shaped and flattened; and at the angle formed between the cylindrical and compressed portions there is a small papilla. A similar but more important papilla

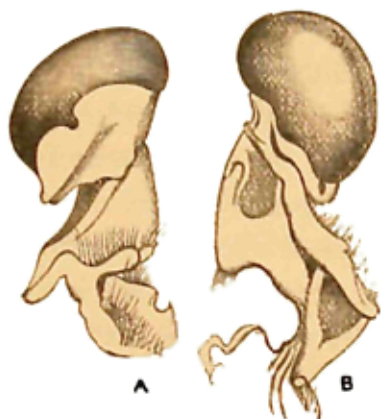


FIG. III.—*Penæus canaliculatus*. Ophthalmopod—
A inner, B outer surface.



FIG. IV.—*Gennadas intermedius*. Ophthalmopod—
a', ophthalmus; *a''*, ocellus; *gn*,
optic ganglion.

may be found in *Benthesicymus* and *Gennadas*, which culminates in some, if not in all species into a prominently pointed tubercle, as shown in Fig. IV., having a small circular lens at its extremity (Pl. LVII. fig. 3*a*; Pl. LVIII. fig. 1*a*), to which a distinct branch of the optic nerve, originating in a ganglion at the base within the ophthalmopod, may be distinctly traced. This secondary organ consists of a single lens, is very translucent, and has no trace of pigment. It appears to be present only in deep-sea specimens, but it is not confined to those of the Dendrobranchiate division, inasmuch as a similar protuberance may be seen in *Bentheocaris* (Pl. CXXIII. figs. 3*a*, 4*a*), and in *Hymenodora* (Pl. CXXXVII.) among the Phyllobranchiata. This circumstance has induced me to believe that this pedicular ocellus may be an altered condition of the sessile ocellus so common among the species of the latter division, and traces of which

may be found in some genera of the Dendrobranchiata. In support of this view, I think further evidence can be produced to show that different groups of animals, when placed under similar conditions, tend to resemble one another in certain points of form and structure.

In the Phyllobranchiata the ophthalmopoda are generally short and pear-shaped, and crowned by a hemispherical ophthalmus composed of well-formed and numerous lenses, radiating above a floor of black pigment. The margin is sharply defined as a straight line on the inner, anterior, and outer surfaces, but is hollowed or concave on the posterior side, and in this hollow there is almost invariably present a well-formed pigmented ocellus, sometimes detached (Pl. CXXVI. fig. 6), but more commonly more or less in contact with the margin of the ophthalmus, and sometimes so closely united with it that it can only be traced as a slightly elevated and circular body within the surrounding pigment of the ophthalmus (Pl. CXXVI.), but in this case the facets of the latter form a distinct system of their own, being generally of less size and corresponding in position to their smaller circumference. These have, moreover, a series of lenses that in character appear to resemble those of the ophthalmus, but they are smaller in size, shorter, and therefore proportionately stouter in comparison to their length; a circumstance that would necessarily give them a different extent of visual range.

The position of this organ is such that it can only be brought into use under certain conditions, namely, first, when the ophthalmopoda are erect the ophthalmus has a range of vision in front, above, below, and at the sides, but only partially behind, so that the animal is blind to any danger that may reach it in the line of its own dorsum; second, when the animal is at rest, with the ophthalmopoda lying ensconced in the hollow in the first joint of the first pair of antennæ, where it is frequently covered more or less perfectly by numerous hairs, the ocellus alone is in a position to enable a watch to be kept.

Mr. John Murray has suggested that these, like the ocelli found on the body and appendages of some Schizopods, are phosphorescent organs, and although I have adopted this explanation in the body of this Report, I am induced from examination of the structure and consideration of the position of the organs to believe that they are probably useful as organs of vision under the previously suggested conditions, as I find this structure differs from that of the ophthalmus only in degree and not in character.

Besides the two compound eyes there exists a small unpaired organ in the median line, which is one of the earliest structures to appear in the embryonic life of the Macrura. It appears as a patch of black pigment in the median line of the frontal neural mass, which ultimately becomes the anterior or optic ganglia of the group that form the cephalic mass, and out of which the future ophthalmi are developed. It also exists in most of the Copepoda and in the early stages of many if not all the Macrura. It may be seen in the later embryonic stages of most of the Macrura, but appears to be lost in the Zoea stage when the ophthalmi assume their functional power, but in those forms in which the

development is undergone within the ovum until the embryo has reached the Phyllosoma or Megalopa stage, it exists in the newly hatched animal. Whenever the two kinds are found together, the oculus is the first formed, and therefore, according to Professor Hartog,¹ who has given considerable attention to the development and structure of this organ, it must be regarded as the primitive eye of the Crustacea.

By investigating the anatomy of *Cyclops* and *Diaptomus* by the method of sections, he has ascertained that this organ is much more complicated in structure than was previously supposed. He says that Claus has demonstrated that it is formed in all cases of a central pigmented mass, in which are half immersed three lenticular bodies or crystalline spheres—two lateral and one central.

The pigmented mass is structureless; the colouring granules are situated at the surface contiguous to the crystalline spheres. Each sphere is composed of radiating elements or optical bacilli, the inner ends of which are applied against the pigmented mass, while the peripheral segments contain a nucleus.

He describes the oculus as being situated upon the terminal process of the brain, from which the optic nerves originate, one for each sphere; the nerve, instead of penetrating into the pigmented mass, surrounds the outer surface of the crystalline sphere and penetrates directly not far from its posterior margin.

Claus has figured an analogous structure in the unpaired eye in the Phyllopoda² but has not indicated its true significance.

Dr. Hartog concludes that the unpaired eye, in all Crustacea that possess it, is composed of three simple eyes placed anteriorly to the brain, with reversed optical bacilli, receiving conductive fibres of the optic nerve upon their outer margin, and brought so close together that these pigmented or choroid layers are combined into a single mass.

Dr. Hartog further says that the eye which most nearly approaches the unpaired eye in Crustacea seems to be that of the Planaria, and that according to Justus Carrière,³ the structure of the two paired eyes in the Planaria is similar to that described by Dr. Hartog in the simple eyes united in the middle line of Crustacea. It is therefore, he says, more rational to refer the eyes of the Crustacea to such a primitive and ancestral group as the Turbellaria, than to seek direct approximation between higher groups.

It appears, therefore, that when the central eye is present in the embryo of the higher Macrura, as may be seen in that of *Crangon*, *Astacus*, *Palæmon*, and the Phyllosoma of the Palinuridæ (where it only exists as a deciduous organ, and disappears before the animal attains maturity), in most cases it is only represented by a mass of pigment and that the crystalline spheres are seldom developed. In Pl. XIIA. figs. 2, 4, a single sphere is shown in a specimen which was taken off Samboangan, in the Philippine

¹ De l'œil impair des Crustacés, *Comptes rendus*, t. xciv. pp. 1430-1432, 1882.

² Claus, Zur Kenntniss des Baues und der Entwicklung von *Branchipus stagnalis* und *Apus cancriformis*, *Abhandl. k. Gesellsch. Wiss. Göttingen*, 1873.

³ *Archiv f. mikrosk. Anat.*, Bd. xx. p. 160.

Sea ; it represents the cephalic neural mass with the oculus or the unpaired eye, with one crystalline sphere in the median line ; but this I have failed to observe in the newly-hatched specimen as shown in fig. 1 on the same plate, which was obtained direct from the ovum.

It appears, therefore, that when present, as it is frequently in the *Macrura* until the animal is well advanced in development, it only exists as the remains of a worn-out organ that belonged to an earlier condition of life, and which only attains its true characters in those animals that produce the brephalos in the Nauplius stage. This unpaired organ appears therefore to be, as Dr. Hartog says, analogous to those existing in the lower forms of life, such as the *Planaria*, and perhaps also may be compared with those found in the mantle of *Pecten* and in the tissues of Annelids.

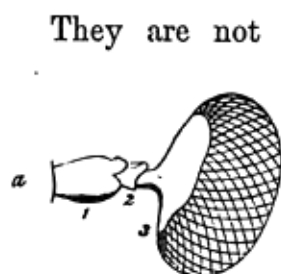


FIG. V.—Ophthalmopod of *Plesionika uniproduceta*.

They are not in any way homologous with those eyes that in the Crustacea are projected on each side of the first somite of the cephalon, and in the *Macrura* are placed at the extremity of a two- or three-jointed appendage as may be seen in Fig. V. and also in Pl. XIV. fig. 2, in *Eretmocarid longicaulis* and other species on the same plate, in which the organ of vision is projected on an appendage of two or three articulations, so that in *Eretmocarid* it considerably resembles the appearance of an antenna that has

the extremity modified for the purposes of vision, just as the antennæ on the homotypes of other limbs are modified for the purpose of touch, hearing, and smell.

In *Eretmocarid* the ophthalmopoda, as well as the first, and perhaps the second antennæ, are attached to, and appear to originate in, a lobe that is anterior to and distinct from the carapace, and which also supports the central oculus.

The First Antennæ.—The first antennæ form the second pair of appendages, and belong to the second theoretical somite ; but this somite is seldom recognisable as a distinct part, except in the Squilliform Crustacea, and to a less extent, as well as in an aberrant condition, in the Palinuridæ.

The late Professor Milne-Edwards, as a convenient means of defining the first from the second pair of antennæ, gave to the anterior the name of antennules, which many authors have adopted, but which I have not employed in this Report, because the numerical system appears to be both more consistent and of greater value, and the term is suggestive also of diminutiveness or inferiority. Generally the first antennæ is proportionally smaller than the second, but usually it is a highly organised structure, and increases in functional power as it diminishes in length.

The peduncle consists of three joints which terminally support two long and slender flagella, the outer of which must be regarded as of more importance than the inner, for it carries certain organs that are apparently essential to the welfare of the

animal, since they are invariably present, and undergo modifications with sexual and specific variations; the inner, on the other hand, is of less importance, and seldom varies except in relation to length, in some forms being reduced to a minimum, or, as in *Lucifer*, it is wanting altogether.

Although in all Decapod Crustacea the first pair of antennæ consists of a peduncle and one or more flagella, yet the organ undergoes modifications in the different orders.

In the Trichobranchiata it may be considered as typical of the Macruran form, such variations as exist being common to the other divisions.

The most simple form exists in the Synaxidea, of which that in the Palinuridæ may be taken as the most normal. In these the peduncle consists of long narrow cylindrical joints, projected on an exposed portion of the antennal somite, and terminating in two slender flagella of nearly equal length. The first or basal joint is generally longer than the others, and increases in diameter towards the articulation with the somite; within this enlarged portion an acoustic organ exists, that undergoes modifications in the different genera. In *Palinurus*, *Homarus*, and *Astacus* the perforation is long, narrow, and slit-like, the aperture being scarcely appreciable, and opens into a calcified chamber, more or less filled with particles of sand, which are voluntarily placed in position by the animal soon after casting its exuvium,¹ and although the joints of the peduncle are cylindrical or nearly so in *Palinurus*, *Ibaccus*, *Homarus*, &c., yet in some genera of the Astacidea they undergo certain modifications, as, for instance, in those animals in which they are laterally compressed, the approximating sides being flattened against each other, and this is carried to such an extent in some genera of the Eryonidæ (as in *Willemæsia*), that the inner margins are pressed together, forced upwards, and thus form a vertical ridge in the median line.

The second and third joints of the peduncle are of little importance, and apparently only serve as carriers of the terminal flagella. In the ordinary or most simple form they are merely cylindrical joints, but in some species they are broad and short, having the distal angles produced to strong teeth.

Each of the two flagella arises from its own distinct base at the extremity of the third joint, one obliquely above the other, that on the outer and upper side being the more robust, and built up of a number of short rings or articuli, which are more or less abundantly furnished with protective hairs or spines, and amongst them are always a considerable number of flexible membranous tube-like cilia, that vary somewhat in form corresponding with other generic characters.

These membranous cilia were, I believe, first pointed out by myself in a memoir On the Homologies of the Carapace and on the Structure and Function of the Antennæ in Crustacea,² in which it is stated that the cilia "are always larger than ordinary hairs,

¹ This was first pointed out by Dr. Farre in 1843, *Phil. Trans.*, vol. cxxxiii. pp. 233-242.

² *Ann. and Mag. Nat. Hist.*, July 1855.

but more delicate in structure. These vary in number and in thickness of clusters, but, as far as my experience goes, are invariably present on the upper antennæ."

More extended research has led to these membranous cilia, or rods, being regarded as sensory organs, but their exact function has not yet been definitely determined. In some genera they are extremely numerous and they are usually more abundant in the males than in the females. By Leydig they have been regarded as having an olfactory function, but M. S. Jourdain¹ says that they are each covered by a delicate chitinous layer and divided into a variable number of joints; the free end has the form of a truncate cone and bears a hyaline process, which probably has a sensory function; within the sheath is a granular substance, derived apparently from the dermal layer, or chorion, and a nerve fibril has been traced to its base. These sensory rods are variously distributed in the different groups, but when the flagellum is branched they occur in one of the branches only. And thus they are almost invariably present in the Macrura, since the first antennæ are almost invariably biflagellate. Among the Edriophthalma, on the other hand, it is frequently uniramous; but even here the second branch is almost universally present in a rudimentary condition in the young, and the structure of the membranous cilia is essentially the same as in the other orders, but their arrangement shows an immense number of variations. M. Jourdain says that the first pair of antennæ has no special movements, and the number of rods is not great, but my own experience is at variance with these assertions, for the Amphipoda always while swimming carry the flagella of the first pair of antennæ elevated in the water, and slowly waving about as if watching for impressions, while in the Brachyura and Anomura, and in those Macrura where the flagella are short, they are kept in a constant state of vibration. But I agree with M. Jourdain in the belief that while admitting the function of these rods, or membranous cilia, to be sensory, there is nothing in their structure to prove them to be specially devoted to the sense of smell.

M. Robin, in a memoir on the subject,² after reviewing M. Jourdain's observations on the sensory rods, says that in all cases we find a very delicate chitinous sheath, which is penetrated by an offshoot from the hypodermic layer, and which at its base is found to be in relation to a branch of the antennary nerve; the free end is truncated and carries a hyaline body, which appears to be comparable to the rods found at the ends of sensory organs. These may be known as the "poils à batonnet." The hairs are cylindrical in some cases, and then the chitinous cylindrical sheath is made up of a number of joints; the basal ones have thicker walls, and are shorter than those which are more distal. In other cases the hairs are stipitate and then the joints are ordinarily reduced to three, and the basal one, which is of some length, is constricted in its middle.

A detailed study shows that the former arrangement is confined to the Podoph-

¹ *Comptes rendus*, tom. xci. pp. 1091-3, 1880.

² *Journ. Anat. et Phys.*, tom. xvii. pp. 402-418, 2 pls., 1881.

thalmous Crustacea; the hairs are found in the young, though in less numbers than in the adult, and similarly, they are more numerous in the higher than in the lower forms. Although there seems to be no doubt that these organs respond to stimuli which are something else than tactile, we are not yet in a position to definitely assert that they have an olfactory function. The author concludes by remarking that the character of these parts has a value for the systematist. That all parts have a value for the systematist is true, but I can find little that is trustworthy in the appearance of the membranous cilia, or sufficiently distinct and constant to assist in the determination of species. It has been shown that these membranous rods exhibit distinct variations of form in certain different species; but it is equally certain that a large number of very distinct species have them of precisely similar form, and they are therefore valueless as a guide for the determination of specific alliance, although in some instances their variation is distinct in closely allied forms.

In the genus *Palinurus* the flagella are very short and the outer one is robust (Fig. VI., *b'*) when compared with the inner. It commences with a long and narrow articulus at the base, obliquely attached to the peduncle; the second is shorter and a little broader, the next four or five are gradually broader but irregularly longer, after which they decrease much in length, especially on the outer side, so as to produce a curve in the flagellum; then the articuli gradually narrow towards the extremity, where they become slightly elongated. From the commencement of the shortening articuli to those at the distal extremity the inner surface is flattened (Fig. VI., *b''*), the margins of the depressions being furnished with

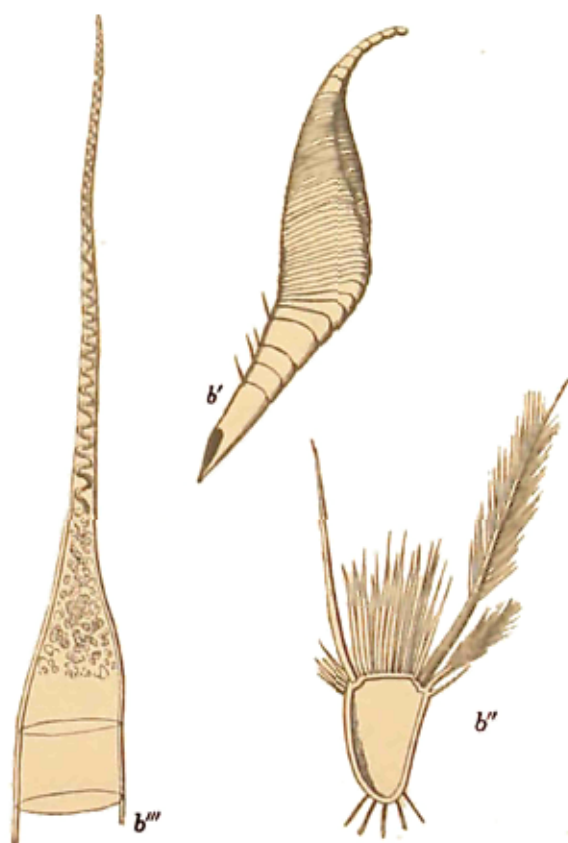


FIG. VI.—*Palinurus vulgaris*—*b'*, outer flagellum; *b''*, section of outer flagellum; *b'''*, distal extremity of a sensory cilium.

a row of long, straight, stiff, sharp-pointed spines, those on the one side being ciliated, those on the other smooth, and between the two there is a thick mass of membranous cilia that are much shorter than the marginal spines. These membranous cilia have the walls of extreme tenuity, and parallel to a considerable extent, when they suddenly narrow to a long and slender point (Fig. VI., *b'''*); these organs when treated with caustic potash exhibit an articulate structure in the body of the cilium, but in the slender extremity a delicate spiral condition exists.

In the genus *Panulirus*, where the flagella (Fig. VII., *b'*) of the first pair of antennæ

are long and slender, the brush of cilia is much more extensive and is carried nearer the distal extremity than in *Palinurus*. In this genus the lateral spines (Fig. VII., *b''*) are smooth on each side and curl over to meet one another and protect the membranous cilia that lie between. In this genus these organs (Fig. VII., *b'''*) have parallel sides and terminate in a rounded extremity, the apex of which, as M. Robin says, carries a hyaline body.

Mr. G. L. Gulland¹ traces out what he considers the genealogy of these hairs in the Crustacea, starting with a primitive seta, allied to a fringing seta, but not so flattened.

This ideal setæ stood over a wide canal; the lumen was closed, there was a single row of bristles on each side, and a nerve-ending attached to its base. Now these fringing setæ originated in one direction, and the sensory setæ originate in another; these were at first primary tactile setæ, which became modified in three directions, to give rise to auditory, olfactory, and tactile setæ. He does not in his paper discuss in detail the structure of the olfactory and auditory setæ, but restricts his observations to the consideration of the tactile and fringing setæ.

He furthermore remarks² that in addition to the sensory hairs "there is a ring of tactile setæ set rather far apart round the distal margin of each segment, the points of which are directed forwards; they are of the usual type, but very small, often not exceeding 0.1 mm. in length on the two or three most distal segments where the olfactory setæ are absent, the tactile setæ are longer and more



FIG. VII.—*Panulirus*. Antenna—*b*, outer flagellum; *b''*, section of same; *b'''*, sensory cilium.

numerous on the last segment." "On the third joint of the main stem there is one large group of tactile setæ on the outer margin at the base of the exopodite (outer flagellum),³ and one or two isolated setæ near it; on the inner margin is a row of fringed setæ, and all the setæ on the first and second joints are also of this kind, with the exception of a very few small tactile ones in the inferior margin of the triangular first joint. If the antennule be examined *in situ* the significance of this arrangement will be at once apparent; for it will be seen that only those parts which bear tactile setæ

¹ *Proc. Roy. Phys. Soc. Edin.*, vol. ix. p. 159, 1885-86.

² *Loc. cit.*, p. 160.

³ This cannot be homologous with the exopodite since it springs from the third joint, whereas the exopodite (basecephysis) springs from the second or basal joint.

are really external, and that these only could receive tactile impressions, since the other parts are covered by the eyes, the rostrum, squame of the antennæ, and the antennule of the opposite side. The fringing setæ along the margins of the surface which bears the opening of the auditory sac, as well as the close-set row of fringing setæ which cover the opening, act, doubtless, as strainers, and prevent the entrance of foreign bodies to that delicate organ."

Among the Dendrobranchiata the characteristic features of the first antennæ remain the same; that is, the peduncle consists of the same number of joints, and terminates in two slender flagella. But the first joint, instead of being cylindrical, is broad, flat, and deeply excavate on the upper surface for the reception of the ophthalmopod, which when at rest lies ensconced and protected by a fringe of hairs (the blepharis) that surrounds the excavation. In the genus *Sicyonia* the excavation is so deep that its floor becomes translucent. But whenever this is the case, the inner and outer margins become correspondingly thick and strong, the outer margin being armed with a long pointed process (stylocerite), often of considerable strength, and the inner margin with a long, slender, unjointed appendage, which I have named the prosartema, and which is confined to the genera of this division, and is not unfrequently reduced to a rudimentary and obsolete condition.

In *Penæus canaliculatus* the prosartema exists in the most perfectly developed form; it arises from the inner marginal wall near the base, and projecting forwards, overlies the ophthalmopod when the latter is at rest; the margins are fringed with hairs, and it reaches quite to the extremity of the first joint (Pl. XXXI. fig. b).

In *Penæus serratus* the prosartema is scarcely as long as in *Penæus canaliculatus*, the margins are fringed with hairs, and the stylocerite on the outer side is short and pointed.

In *Sicyonia carinata* (Pl. XLIII. fig. 3b) the prosartema is reduced to a rudimentary lobe thickly surmounted with hairs, and the stylocerite on the outer margin is long, slender, and pointed.

In the genus *Aristeus* the prosartema is little more than a rudimentary process fringed with hairs, and the stylocerite is produced to a length that passes beyond the distal extremity of the second joint of the peduncle.

Both these structures are useful for the protection of the ophthalmopod. The stylocerite does not exist in the Trichobranchiata, and only in a reduced condition in the genus *Sergestes*; while both it and the prosartema are absent in *Lucifer*.

In this division the second and third joints of the peduncle are shorter and stouter than the first; in many cases they assume a subcylindrical form, and they are occasionally armed by having the distal angles produced into teeth; but in all essential points these two joints are only of importance as being the supporters of the two flagella. In the genus *Penæus* the flagella are never extremely long, and are sometimes

very short, as in *Penæus canaliculatus*, where they are subequal in length and but little longer than the terminal joint of the peduncle; one is cylindrical and the other is flattened, and has the margins on the lower surface projecting above the middle portion. In *Aristeus* the flagella are very unequal in length, and very distinct in their cross-section, the inner being cylindrical, slender, and longer than the animal, while the outer is short and flat, with the margins thickened on the lower surface. In *Solenocera* the flagella are subequally long and have their margins parallel, one flagellum being cylindrical and the other longitudinally concave, and both truncate at their extremity; the cylindrical is the smaller, and when at rest lies in the hollow of the other in its entire length.

In *Haliporus* the flagella differ in the larger being flattened, but not fluted, and both terminate in gradually tapering extremities.

In *Sergestes* the secondary or inner flagellum is reduced to a small, almost rudimentary condition, as shown in Pl. LXXI. fig. *b*; but in the male another branch is given off, which is developed somewhat like a claw or retaining hook, varying in shape in different species. As this is only present in the male, it must be of value in its relation to sex, and must be of more importance than its simple character would seem to suggest.

According to my observation, in the specimens of this collection the membranous cilia, or sensory rods, are less numerous and less important among the Dendrobranchiata than in the other divisions.

In the Phyllobranchiata the first pair of antennæ is developed upon the same general plan as in the two preceding divisions; but it is flattened out and cupped to receive the ophthalmopoda. The prosartema is never present, but on the outer side the stylocerite is developed into a large, flattened plate, generally sharp-pointed, but sometimes, as in *Pandalus*, rounded instead of being styliform.

The acoustic apparatus in Crustacea has been extensively studied. Dr. von Hensen, in his memoir on the subject,¹ has described it in twenty-eight species, but that is a small number compared with those that have not been examined. The direction of the research appears to show that in the Trichobranchiata particles of sand take the place of otoliths, whereas in the Dendrobranchiata and Phyllobranchiata the latter are more constant, and certainly in a higher degree of development, as may be seen in the genera *Tozeuma* and *Anchistia*, in both of which the otolith is as well formed as in any of the Schizopoda or Sergestidæ.

Among the Macrura generally the first pair of antennæ terminates in two flagella, and, so far as my experience enables me to say, *Lucifer* is the only genus in which it terminates in a single flagellum (Pl. LXXIX. fig. *1b*).

The outer flagellum supports a number of membranous organs, which are generally massed together at the base, and are more abundant in the male than in the female; the

¹ *Zeitschr. f. wiss. Zool.*, Bd. xiii., 1863, pp. 319-412 (p. 18 sep. copy).

inner branch, on the other hand, is entirely free from these sensory appendages, and is generally smooth, slender, and flexible; it varies in length, being frequently much longer than the outer flagellum, and in other species it is considerably shorter. The constant presence of an organ of such simple character indicates that it fulfils some permanent function, which, I believe, consists in protecting and keeping clean the mass of membranous cilia attached to the outer flagellum. This idea receives support from a consideration of the relative positions of the two flagella, and from the fact that in *Pandalus modestus*, as may be seen in Pl. CXIV. fig. 4b, the inner flagellum has a tendency to curl spirally around the outer; when the flagella are long the membranous cilia are less aggregated, extending sometimes to the very extremity.

In the genera *Palæmon*, *Bithynis*, *Lyasmata*, and *Alpheus*, the outer or primary flagellum divides at a greater or less distance from its base into two branches of varying length, the basal part of which carries the sensory organs, while the other part is slender and unadorned.

According to Mr. Gulland, on the inner or secondary flagellum "the arrangement of the tactile setæ is the same, but there they are rather longer."¹

The Second Antennæ.—The third pair of appendages consists of the second antennæ. These are often very large and powerful organs, frequently adapted for weapons of offence. Each consists of two distinct portions, the peduncle and the flagellum. The peduncle has five joints in all the Macrura excepting the Synaxidea, in which there are only four, and the flagellum is composed of a series of short articuli which together form a long and slender flexible rod, generally gradually tapering from base to apex.

The most simple and characteristic form of the second antennæ is to be seen in the Palinuridæ, in which family also some of the most interesting and peculiar features in the antennæ of Crustacea are exemplified.

In *Palinurus*, the first or coxal joint is fused more or less perfectly with the somite to which it belongs, and with the ventral surface of the fourth mandibular somite. The under surface alone of the coxal joint is calcified, and near its posterior margin stands the phymacerite, a prominent tubercle, at the extremity of which is an opening closed by a very thin chitinous membrane.

This passage is in connection with the organ known as the green gland, which in this family is largely developed and is lodged both within the coxal joint and posterior to it within the cephalon. The function or nature of this organ has not been satisfactorily determined, but its anatomy has received the attention of naturalists, chiefly in the case of the Entomostracous Crustacea and the Amphipoda, and especially by Dr. Carl Grobben in a memoir on The Antennal Gland of the Crustacea.² According to this author the antennal gland is a renal organ with a saccular appendage and urinary passage. The

¹ *Loc. cit.*, p. 161.

² *Arb. Zool. Inst. Wien*, Bd. iii. Heft 1, p. 18, 1880.

urinary canal he considers as a long convoluted tube, which opens on the calcified projection or phymacerite.

Professor Huxley says in his work on the Crayfish¹ that—"The existence of guanin in the green gland rests on the authority of Will and Gorup-Besaniz,² who say that in this organ and in the organ of Bojanus of the fresh-water mussel, they found 'a substance the reactions of which with the greatest probability indicate guanin,' but that they had been unable to obtain sufficient material to give decisive results."

In a memoir read before the Royal Society, Dr. A. B. Griffiths gave an account of his chemical researches on the green glands of *Astacus fluviatilis*, in which he states that it is a true urinary organ, and that its secretion contains uric acid and very small traces of the base of guanin.³

More recently Herr Rawitz has given an account of his researches on the green gland of the Crayfish⁴ (*Astacus fluviatilis*). After giving an account of the researches of Leydig, Wassiliew, Grobben, and others, he describes the gland, which, like Huxley, he compares in shape to the fruit of the mallow, as consisting of three different substances, green, white, and yellowish-brown. The green structure appears to be the outer shell or skin, within which the two others are enclosed. It consists of homogeneous cells, with a delicate contour, containing a well-defined nucleus, and a few clear green pigment granules which have a tendency to collect and escape at one pole. The white substance is characterised by the absence of all pigment and by the shining appearance of the epithelium. The yellowish-brown substance owes its colour, not as Grobben says, to a disposition of irregular bodies of a yellowish-brown colour in the protoplasm, but to the presence of more or less intensely straw-coloured nuclei.

The products of secretion found in the white portion are round dull globules with a sharp contour line and of a transparent homogeneous appearance.

From a study of the general structure Herr Rawitz has arrived at the conclusion that the green gland consists not of a single much-coiled tube, but of two which unite just before the entrance to the sac; of these the longer tube forms the green and the mass of the white substance, while the second forms the yellowish-brown substance and a small portion of the white. There is never any direct communication between the green and the yellowish-brown substances. As to function, the author thinks that as yet, in the absence of a more complete physiological investigation, it is premature to conclude that the antennal gland of the Crayfish possesses the functions of a kidney.

On the outer side of this joint in *Palinurus* an involuted fold exists in the hard wall so as to form a fulcrum on which a process of the second joint rotates. Generally there

¹ P. 353.

² *Gelehrte Anzeigen d. k. Baierschen Akademie*, No. 233, 1848.

³ *Proc. Roy. Soc.*, pl. xxxviii. p. 187, 1885.

⁴ *Archiv f. mikrosc. Anat.*, Bd. xxix. p. 471, Taf. xxviii., xxix., 1887.

is one also on the inner side, but it is wanting in this genus on the first or coxal joint.

The second joint or basis, the basocerite of Milne-Edwards, has on the outer and lower angle a double-lobed calcified process corresponding with one developed on the first or coxal joint, and which rotates against it, by the single lobe of the latter, which is formed by a simple convolution of the hard wall, falling between the double lobe of the basal joint. On the inner side of the basal joint the articulating process is also developed, but there is no corresponding one on the coxa with which it can articulate. Probably this is primarily due to the fact of the large projection of the sternal portion of the first antennal somite precluding calcareous development in the inner walls of the coxal joint of the second pair of antennæ. The inner articulating process of the basal joint having no point of attachment has a free motion, and being pressed upwards, rests upon the anterior portion of the projected sternum of the first antennal somite; the attaching membranous tissue is consequently largely developed and overlies it also. On the inner surface of this membranous fold, between it and the sternal portion of the first

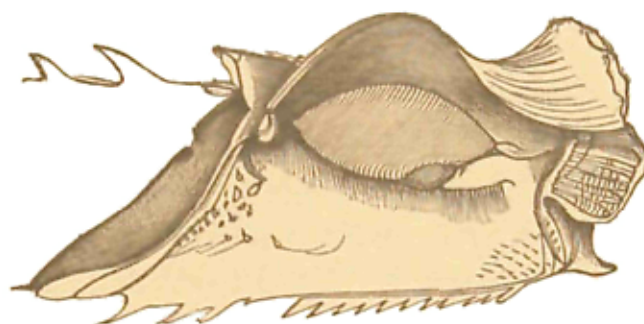


FIG. VIII.—*Palinurus vulgaris*. Basal joint of second antenna, showing stridulating organ.

antennal somite, just where it joins the concave surface of the hard wall of the antennæ, two small chitinous plates are developed; one is comparatively large, ovate, and obliquely striated with regularly corresponding lines, it is elastic in structure and opaline in appearance; the other is small, ovate, with a smooth surface, and amber coloured; below these, planted in a furrow, there is a line of thickly-set hairs. These structures form the stridulating organ (Pl. XA. fig. c), and the joint instead of being articulated at both extremities with the preceding as is usual in other forms, has the inner surface free and capable of being played forwards and backwards over the smooth wall of the first antennal somite, thus producing a sound that may be heard at a distance, even when produced artificially after death.

The fact that the common rock-lobster possesses the power of making a sound by means of the antennæ has long been known to our fishermen. It was mentioned by Dr. Leach in his *Malacostraca Podophthalma Britannica*, but the sound-producing structure was first described by Dr. Karl Möbius in 1867.¹ More recently it has been

¹ *Archiv f. Naturgesch.*, Jahrg. xxxiii. p. 73, 1867.

described and figured by Professor T. J. Parker,¹ who says that Mr. Saville Kent remarked in *Nature*² upon the shrill squeaking sound emitted by living specimens of *Palinurus vulgaris* when handled, this sound being due, according to Mr. Kent, to the friction of the abdominal somites; and Mr. Parker suggested that the noise referred to may possibly have been produced by the apparatus described.

Dr. Möbius attributes the sound made to the action of innumerable close-set minute hairs inclined with their points upwards, situated on the lower surface of the flap, which plays over the lateral ridge of the antennular sternum; but with regard to the statement that it is the friction of the flap, and not of the pad, which produces the sound, Mr. Parker³ says that he has "removed the flap entirely without any sensible diminution of the noise. The mere observation of the parts while in action is enough to show the true state of things: when looked at from the front it is very evident that the flap exerts hardly any pressure upon the ridge, as, indeed, from the fact that it is a soft structure supported only along one edge, it could scarcely be expected to; while the pad, on the other hand, is completely flattened out against the smooth surface, and in the most perfect contact with it." Mr. Parker also remarks:—"In the matter of histiological structure, the pad does not differ from other chitinous membranes, being formed of fine superposed horizontal laminae, marked by a vertical striation. It is, however, of unusual thickness; and its horizontal laminae have, for some distance down, a varying appearance, corresponding with the ridges into which the surface is raised. The stridulation is almost equally audible in water and air." I have produced it with specimens taken out of spirits, but it soon wore off. Dr. Möbius and Mr. Lloyd heard it in the Hamburg Aquarium; and Mr. Parker observed the sound and the movement of the antennæ producing it in a specimen brought alive to the Biological Laboratory of the School of Mines.

A similarly formed stridulating organ exists in the genus *Panulirus*, but in the closely allied genus *Palinosyrtus* the inner articulating process is attached, and works as a movable hinge, and there is consequently no stridulating organ; nor is there any in the genus *Synaxes*.

This second joint of the peduncle is peculiar throughout the whole of the Macrura, in having attached to it an articulating appendage, the scaphocerite, excepting in the tribe Synaxidea, and in the genus *Nephropsis* among the Homaridæ. In the family Scyllaridæ, the first joint is fused with the cephalon and the third is peculiarly produced on the outer side to form an elongated plate; the fifth, which represents the flagellum, is produced in this family in the form of a large, broad, thin, disc-like plate.

In the Astacidæ, of which *Homarus* is the most perfect type, the scaphocerite exists probably in its most normal condition, and has a rigid external margin produced to a

¹ *Proc. Zool. Soc. Lond.*, pp. 298, 442, 1878.

² *Nature*, November 1877.

³ *Loc. cit.*, p. 443.

sharp point, and the inner side flattened out to a thin foliaceous plate, broad at the base and gradually narrowing to its extremity, or to near the apex of the outer margin which is generally separated from it as a free process.

It is, however, amongst the Dendrobranchiata that this appendage is seen in its fullest development. In *Penæus*, *Aristeus*, &c., it is large and broad, with a small tooth on the outer margin. In *Benthesicymus* and other deep-sea forms it is broad and of extreme tenuity, having only the feeblest representation of the external marginal tooth. In *Sicyonia*, on the contrary, the outer margin is intensified to a strong and powerful sharp-pointed spine, and the inner foliaceous plate is reduced considerably in size and thickness.

In the Phyllobranchiata the scaphocerite is longer than in the Trichobranchiata, but not so broad generally as in the Dendrobranchiata. In some genera, as *Oplophorus*, it is produced to a sharp point by the strengthening of the outer margin and the reduction of the foliaceous plate of the inner side.

If we judge of the utility of the scaphocerite by its structure, there can be little doubt that when developed as a large foliaceous plate it is of much value in helping to maintain the animal upright when swimming, preventing it from falling into an inverted position as seen in the Amphipoda and other Crustacea, where it does not exist or is only feebly represented, as in some of the Astacidea.

When it is produced to a sharp point, as in *Sicyonia* (Pl. XLIII. fig. 3c''), *Oplophorus* (Pl. CXXVII. fig. c), *Acanthephyra* (Pl. CXXV. fig. 1c), *Thalassocaris* (Pl. CXVII. fig. 1c), &c., it is evidently used as a weapon of offence. In these genera the teeth affixed to the outer extremity of the second joint of the peduncle, which are generally of little importance, are developed to a greater extent, and fulfil an important office by guiding the scaphocerite into a corresponding groove, where they support it. In some instances, as in *Sicyonia*, they lock it into a fixed position, and thus increase its power as a weapon of offence. In the Astacidæ, where it is sharp-pointed and strong, it is too short to be useful as an offensive weapon, and probably is of value only in protecting the sensory organs.

In *Hemipenæus* the scaphocerite is very large and broad, and the outer distal tooth is small; and in some specimens the distal margin is considerably thickened, and the hairs are wanting; this condition appears rather to be the result of some exceptional state than a normal condition (*vide* p. 304). I am inclined to believe that this organ may be used for such a purpose as that of disturbing the muddy bottom over which it lives, with the object of procuring food, and that the constant gentle friction so produced would first remove the marginal hairs, and then induce such irritation as to cause this



FIG. IX. — Second antenna. *Phc*, phymacrite; 1, 2, 3, 4, 5, joints of peduncle; *Sc*, scaphocerite; 6, flagellum.

thickened condition of the margin. Both the specimens in which this condition has been observed are males. It is not impossible that it may have been produced by rubbing against objects during pursuit of the female, but in this case we should expect some similar condition in other genera, and I know of none.

I have recently had the opportunity of seeing the extensive and well-preserved series of specimens collected by Professor A. Milne-Edwards during the voyage of the "Talisman,"¹ among which he drew my attention to a species of *Aristeus*, in which the scaphocerite of all the adult males had the foliaceous extremity produced in length to a considerable degree (Fig. X.). It would seem as if this condition might be valuable as not interfering with the speed of the male when in chase of the female, and perhaps of grasping her when caught.



FIG. X.—*Aristeus coralinus*, A. Milne-Edwards. Scaphocerite.

Figure c on Pl. L. shows the scaphocerite previous to its having undergone much change; but a slight emargination, which is not a constant feature, demonstrates the area in which the abnormal thickening takes place in older male specimens.

In some of the younger stages, such as may be seen in those of *Sergestes* (*Elaphocaris crassus*, Pl. LXI. fig. 4c; *Platysaccus crenatus*, Pl. LXIII.; and *Elaphocaris*, pp. 354, 359), and in the Zoea of *Alpheus* (Pl. LXXXIX. fig. 4e), the scaphocerite exists as a cylindrical multiarticulate appendage, fringed with ciliated hairs attached to each articulus on one side only, which demonstrates its homotypical relation with the basephysis of the pereionic and pleonic appendages. From this condition it gradually passes into the uniaarticulate squamose plate of the normal scaphocerite, the only exception being in the genus *Atya*, in which a diæresis crosses the middle of the scaphocerite (Pl. CXVI.).

The third joint of the peduncle in all *Macrura* articulates with the second by two corresponding tubercles, one on the inner, and one on the outer margin; the inner being considerably the more advanced, gives the articulation an oblique direction.

The fourth joint articulates with the third by similar processes on the upper and lower margins; and the fifth joint articulates with the fourth by processes on the inner and outer sides. Thus the peduncle is capable of being moved in every direction by the powerful muscles situated at the base, the range of movement being considerably increased by the alternating articulations, and the correspondingly alternate positions of the muscles of each succeeding joint.

The fifth joint is generally short, constantly anchylosed with the fourth, or so rigidly

¹ I cannot here pass over the opportunity of acknowledging the great courtesy of Professor A. Milne-Edwards in sending over to me at Plymouth the beautiful specimen in order that I might have the opportunity of making the drawing from which the above figure was taken.

attached as not to be independent of it; in many it is fused with it and cannot be demonstrated as distinct. This is the case for instance in *Sergestes*. One thing, however, is invariably constant, that however few the joints of the peduncle may appear, that which supports the scaphocerite is always the second.

At the extremity of the peduncle a flagellum is attached which is generally long and slender; its length varies from half to three or four times that of the animal. Sometimes it is short, and in the Scyllaridæ it is squamose and discoidal, and in the fossil form *Cancerinos claviger*, Münster, from the Upper White Jura of Bavaria, it is short, robust, and club-shaped; but this reduction of length is generally due to the shortness of each articulus. The margins are occasionally armed with a series of more or less important spines, so that in the Palinuridæ these organs become effective as a means of protection. As a rule, however, they are smooth and free from hairs or spines, and by their great length sweep the water in search of objects, the character of which they seem to appreciate by the sense of touch.

In the genus *Crangon* they are used to assist in concealing the animal beneath the bottom, by playing over the dorsal surface, and drawing particles of sand over the back so that it becomes covered from view.

In *Palinurus* they are strong and rigid, being capable of use as weapons of offence or defence.

The Mandibles.—The mandibles are the appendages attached to the fourth somite, and consist of a large angular joint supporting two or three other joints of rudimentary character, that vary in number and form according to generic distinction.

The joint of which the mandible proper consists is the homotype of the coxa of the crustacean leg, differentiated to fulfil certain specialised functions; and it possesses very similar characters throughout the whole of the higher orders. It is deeply implanted in the body of the animal by a thin broad process of a concavo-convex form (apophysis), the muscles of which are inserted by strong calcified tendons on the inner anterior margin and at the extremity of the apophysis, the other extremity of the muscles being attached, either to the dorsal surface of the carapace or else to its lateral wall just behind the hepatic tooth. At the points of the mandible opposite to those where the tendons are attached two hinges exist, on which the appendage swings in performing the action of opening and shutting.

The anterior or distal extremity of the joint is modified to form a grasping or cutting portion and a grinding process; the former is broad, thin, and of a more or less concavo-convex form, while the latter is stout, cylindrical, and truncate, the truncate extremity being furnished with numerous small teeth and spines of variable form and power. For the sake of clearness of description, I have in this Report named the grasping or cutting portion the psalstoma, on account of its scissor-like mode of

meeting its opponent; and the grinding portion the molar process, on account of its chewing function. At the base of this process, where it is connected with the psalstoma, there originates a small articulated appendage, which I have designated the synaphipod, because I believe it to be formed of those joints that morphologically represent the distal continuation of the crustacean limb. This part is frequently known as the palpus of the mandible, a term that implies an unknown portion of the appendage. This term is also frequently applied to that part which I describe as the ecephysis, a branch of the basis or second joint of the crustacean leg, and it is clear that they

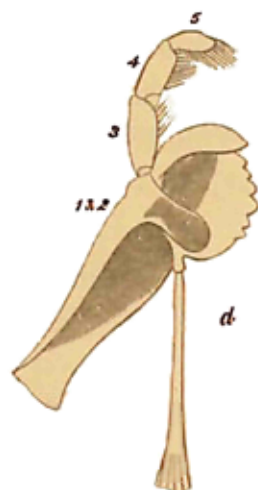


FIG. XI.—Mandible.

cannot be either homotypical or homological parts, since they proceed, one from the coxa, the other from the basis of the typical leg. Furthermore, this appendage, like all true or permanent parts, is not developed in the early or immature stages; whereas the basecephyses or appendages of the second joint are always developed first, and in many families, particularly among the Trichobranchiata, they only exist as deciduous organs, being thrown off in the later moults of the mature animal.

In some species of the higher forms of the Entomostraca, such as *Pontella*, *Notodelphys*, and *Doropyges*, the two appendages are both present in the same animal, but this may also be observed in an immature condition in some species of the higher groups. It is not developed at all until the animal approaches its adult state, and in some genera it never makes its appearance, while in others it is only in an enfeebled and rudimentary condition. When in its most characteristic form, it lies, when at rest, folded within the hollow formed by the closing of the two scissor-like blades of the mandibles, and when in action it is apparently used as a means of assisting to carry the food into its position between the molar processes, and perhaps also, particularly in those species in which they are thickly covered with hair, of being used for the purpose of keeping the parts within its reach clear, or free from undesirable material.

This part of the mandible varies in the number of its joints; there are never more than three, frequently less, and sometimes, as has been said, it is absent altogether.

Throughout the Astacidea the synaphipod is almost invariably composed of three joints, the exceptions being the genus *Arctus* and the Eryonidæ, in the former of which it has only one, and in the latter two joints.

In the Dendrobranchiata it is generally very long and well developed, but consists, I believe invariably, of two joints only; and in those species in this division in which, in this Report, the mandible is figured without a synaphipod, it is probably because the specimen is an immature animal.

In the Phyllobranchiata there is a greater degree of variation, and this appears to lie, so far as my observation goes, in the presence of a three-, two-, or one-jointed synaphipod,

or in its absence altogether, even in the adult stage; in every case where it is present it is reduced in size or rudimentary.

In *Palæmon*, *Pandalus*, *Nauticaris*, and *Heterocarpus* it is three-jointed; in *Paralpheus* it is one-jointed; in *Alpheus*, *Synalpheus*, and *Spirontocaris* it is two-jointed; in *Hippolyte* it is wanting, as it is also in *Crangon*, *Nika*, *Gnathoptylus*, *Lysmata*, *Pontonia*, *Atya*, *Caridina*, *Ephyra*? (de Haan not Roux), and *Pasiphæa*.

The psalistoma is very variable in form in different species or genera. In its most characteristic form it appears as a large concavo-convex blade, with a more or less serrate margin which is generally rounded. In some genera the shape of this part is modified; in others it is diminished more or less conspicuously in size; while in others it disappears altogether. The greatest variation exists perhaps in the Phyllobranchiata, and it is rarely present when the synnaphipod is absent. The molar process, on the other hand, exists, I believe, universally throughout the higher Crustacea, as a well-developed organ, and it may be seen in the genus *Crangon* and some near allies without connection with the psalistoma or synnaphipod, which generally form parts of the normal mandibles of the Macrura (Pl. LXXXVI. fig. 1*d*).

In *Crangon* and most of the Phyllobranchiata the mandibles are deeply inserted within the oral aperture, whereas in the Trichobranchiata, more especially in the Palinuridæ, they are placed at the entrance of the oral tract so superficially that the outer surface of the apophysis is exposed and frequently matted with short hairs.

The First Siagnopoda.—The first pair of siagnopoda, frequently known as the first pair of maxillæ, is perhaps amongst the most unchanging of the appendages. It consists generally of three branches, which are always small and of great tenuity; two of the branches, are directed inwards, these are broad and spoon-shaped, and have the inner margins fringed with hairs, more or less densely packed, these hairs often increase in strength without gaining in length, assuming a smooth and spine-like condition. The third branch is very thin, and is the one which varies most in form, but only within narrow limits; sometimes it is two-jointed, never more; it is always directed outwards, and is seldom furnished with more than one or two hairs, which, however, are frequently long.

Among the Scyllaridæ the first siagnopod has never more than two branches, and these correspond to one another and are directed inwards, both being tipped with short spines or hairs.

This pair of appendages lies close against the mandibles, hugging them on the outer side of the metastomata; and they appear to be useful in preventing the escape of food from the lateral angles of the mouth, and to be of little use for any other purpose.



FIG. XII.—First Siagnopod.

It is almost impossible to determine the homotypical relation of the several joints in comparison with those of the true Crustacean leg, but it appears to me that the two inner branches belong to the coxa and basis, and that the external branch is an ephysis of the second joint.

These five pairs of appendages belong to the great dorsal shield, and are the true cephalic appendages, the following pairs belonging to the pereion.

The Second Siagnopoda.—The second pair of siagnopoda is large, variable in form, situated on the outer side of the first pair, but a little behind it, and planted at the anterior exit of the branchial chamber. It generally consists of three or four branches, two of which are short, broad, and foliaceous, while the third is cylindrical and rod-like, and one is long, broad, and membranous.



FIG. XIII.—Second Siagnopod.

The first joint is generally broad and short, the inner margin being thickly fringed with ciliated hairs; this joint I take to be the homologue of the coxa of the theoretical leg. The second joint frequently resembles the first in form and general appearance and is similarly furnished with hairs, but it is usually bilobed, and the marginal hairs are simple; the third branch is short and cylindrical, and tipped with one or two hairs; on the outer side is the broad and membranous plate that I take to be the homotype of the mastigobranchial plate of the pereiopoda; it is liable to vary in form and size, but that belonging to *Spirontocaris spinus* is illustrative of the most normal type (Pl. CVII. fig. *f*).

In *Homarus* this pair of appendages consists of three branches or joints, of which the two inner are double and foliaceous, the outer being single and tapering. In *Astacus* the same conditions exist, but there is added on the outer side a broad and leaf-like plate of semi-membranous character, and this I believe is the homotype of the mastigobranchia attached to the pereionic appendages.

In *Stenopus* and *Spongicola* this appendage is formed on the same plan, but in these two genera the outer plate or mastigobranchia is produced posteriorly as well as anteriorly, but is ciliated most abundantly on the anterior margin.

Passing on to the Dendrobranchiata we find this latter condition continued, but the anterior branches are shorter and broader, as in *Penæus*, *Sergestes*, and *Sicyonia*; the first and third branches having a tendency to become rudimentary.

In the Phyllobranchiata the same structure exists, but with a greater variation of parts. The first joint generally carries the branch on the inner side, although as in *Athanas* and *Alpheus* it may be seen only in a rudimentary condition; the second joint is bifid as among the Trichobranchiata, but differs somewhat in form, being deeply

cleft in *Palæmon*, broad and scarcely cleft in *Alpheus*, *Pandalus*, and unbranched in *Crangon*, *Gnathophylum*, and *Nika*, in which genera the third branch exists as a single obtusely pointed process, and on the outer side the mastigobranchial plate projects posteriorly, sometimes in a broad and leaf-like form, and sometimes as a long and narrow process; it is generally fringed with a series of long hairs that appear to have the power of sweeping the branchial chamber to the most distant limits.

The Third Siagnopoda.—The third pair of siagnopoda, or maxilliped, as we see it in *Homarus*, is composed of four joints, of which the first has no branch; the second consists of a broad and foliaceous plate having the inner margins fringed with cilia; the third is long and narrow, with a tendency to break up into joints, and beyond this there is a long two-jointed branch, the distal joint being multiarticulate. In the freshwater genus *Astacus* the structure is very similar, but the first joint is produced to a short and rudimentary plate fringed with cilia on the inner margin.

In *Palinurus* the two inner joints are more reduced; the third is short, rudimentary and single-jointed, and the fourth consists of two long slender joints, of which the second is multiarticulate; on the outer margin beyond this joint is an appendage that is rudimentary in *Palinurus vulgaris*, two-jointed in *Palinosytus lalandii*, and in *Palinurus* (?) *japonicus*, where it is sufficiently developed to demonstrate its relationship to the mastigobranchial plates of the pereopoda.

In the genus *Hetairus* (Pl. CIX. fig. 2g) it is developed so that the true nature of the several parts can be demonstrated. The first joint is broad and foliaceous, and on the posterior margin supports a large plate, divided by an opaque line across the middle dividing it into two parts, suggestive of one being the elementary stage of a branchial plume, the other of a mastigobranchial plate. The next joint supports a long filamentary branch and resembles a basephysis of the pereopod, differing from it in having a large foliaceous plate developed at its base; beyond are two cylindrical joints forming the continuation of the true limb.

In *Plesionika* (Pl. CXIII. fig. 1g) the morphology is still more clearly advanced, and shows the double-lobed mastigobranchia divided into two distinct foliaceous plates, connected at the base, just as may be seen in Pl. XII B. fig. 4g; in *Phyllosoma* the branchial plume exists as two simple sacs, but within one the branchia is forming, while the other retains the simple features of the mastigobranchia.

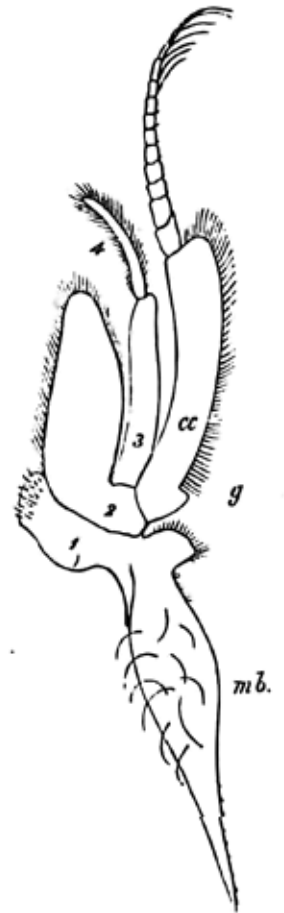


FIG. XIV.—Third Siagnopod.

In some genera, such as *Thaumastocheles* (Pl. VII. fig. 1g), *Willemæsia* (Pl. XVIII. fig. g), *Pentacheles* (Fig. 21, p. 107), and *Polycheles* (Fig. 32, p. 125), what I take to be the basephysis is developed at the extremity in the form of a freely movable leaf-like plate, which probably quivers under the action of the expiratory current from the branchial chamber.

In *Pasiphæa* a similar condition also exists, but in a more rudimentary state, as shown on Pl. CXXI. fig. 1g.

The First Gnathopoda.—The first pair of gnathopoda assumes a more leg-like character than either of the preceding appendages, but it is not entirely pediform until we come to the aberrant Schizopoda, and the still more distant Amphipoda.

It is generally formed of five joints, but in some genera there are six, and in a few, as in *Nephrops thomsoni* (Pl. XXVI. h), there are seven joints. In general character it is usually short, wide and thin, the three distal joints being reflexed on the inner side, and the dactylos is generally broad and flat. The larger the number of joints the narrower they are, and the more pediform is the whole appendage; but when the joints lessen in number, the reduction is made by the coalescence of the meros and ischium, and sometimes the basis also, into one, and by the absorption or loss of the dactylos. Attached to the basis is an ephysis that is generally long and two-jointed, the distal joint being multiarticulate; sometimes it is only single-jointed, as in *Oplophorus* (Pl. CXXVII. fig. 1h) and in *Nephrops*, where it puts on a somewhat rudimentary appearance. I do not remember an instance in which it is altogether absent, unless it be so in *Pasiphæa* (Pl. CXXI. fig. h). The coxa almost universally has a mastigobranchial plate attached, which is generally of small size and varies in form, and has very constantly a branchial plume attached to it, and occasionally a second or arthrobranchial plume attached to the membranous articulation.

In the Astacidæ branchial filaments are attached to the outer surface of a large membranous plate that appears to resemble the mastigobranchia.

The Second Gnathopoda.—The second pair of gnathopoda is more perfectly pediform than the first, but varies to a greater extent in the number of its joints. In the Trichobranchiata it consists of seven joints, in, I believe, every genus, not excluding the Stenopidæ. This circumstance is the more remarkable in the Palinuridæ and the Scyllaridæ, as in these two families all the pereopoda have only six joints each.

In the Dendrobranchiata there are also seven joints; and as the leg becomes longer and more slender in its gradual passage from *Penæus*, through *Haliporus*, *Sergestes*, and *Lucifer*, it assumes more closely the character of the succeeding simple legs.

In the Phyllobranchiata the number of joints is generally limited to five, this diminu-

tion being due to the coalescence of the meros and ischium into one, and the absence of the dactylos.

In *Glyphocrangon* (Pl. XCII. fig. *i*), *Spirontocaris* (Pl. CVII. fig. *i*), and *Nauticaris* (Pl. CVIII. fig. *i*) there appear to be only four joints, a fact that is due to the fusion of the basis with the ischium and meros.

The coxa of this appendage I believe invariably supports a small and rudimentary mastigobranchia, but it only in certain forms carries a podobranchial plume which is attached to this pair of gnathopoda in all the Trichobranchiata, excepting the family Eryonidæ.

In the Dendrobranchiata it is absent in *Penæus* and its nearer congeners, but it is present in the deep-sea forms, such as *Aristeus*, *Benthescymus*, and its near allies; and it is rudimentary in *Haliporus*.

In the Phyllobranchiata there never is a branchial plume attached to this pair of appendages, excepting in the fresh-water genus *Atya*.

This same appendage has an ephysis almost universally attached to the basis, although in some instances, as in *Spongicola*, it is reduced to a rudimentary condition (Pl. XXVIII. fig. *i*), and sometimes it is wanting altogether as in *Nauticaris marionis* (Pl. CVIII. fig. *i*).

In this division the apical termination is generally truncate and armed with spines; in some genera, as in *Pontonia*, *Acanthephyra*, *Palæmon*, and *Paralpheus*, it tapers to a point; in *Notostomus* it is obliquely truncate and pointed, while in *Nematocarcinus* it is spatuliform.

The First Pereiopoda.—The first pair of pereiopoda varies very considerably in form, power, and function. In all the genera of the Trichobranchiata it is the largest and most powerful of the pereiopoda, and excepting in the Synaxidea, and their parallel representatives the Haplopodea among the Phyllobranchiata, it is always chelate, and in these tribes it is frequently subchelate. It is often of too great a length to be of use as an organ for carrying food to the mouth; I believe it is generally only capable of being used for the purpose of holding food while the smaller hands are tearing it off, and carrying it to the mouth. In this way the Prawns and Lobsters feed. I also believe that the great weight adds to the power of the first pair of pereiopoda, and is of further value in assisting to retain or steady the animal, when, by its seizing some fixed body; it is thus prevented from being easily floated away.

It is, I think, by observing the habits of animals in ordinary conditions, that we are enabled to appreciate the value of extraordinary forms in exceptional circumstances. Thus in *Thaumastocheles zaleuca* the first pair of pereiopoda, with its long comb-like fingers, is perfectly useless for conveying food to the mouth, and can only aid the animal in the way that the Prawn uses its long second pair of feet, and the Soldier Crab

uses its larger hand, by holding its food while the smaller carries it to the mouth. We may suppose that the blind *Thaumastocheles*, resting upon a bed of Globigerina or Diatom ooze, can, by raking the surface of the mud, fill the long comb-like hand with multitudes of minute animals more or less adapted for its food; that then the smaller hands gather up the larger and more suitable portions, and carry them to the mouth. It is interesting to learn that a near ally of *Thaumastocheles zaleuca* appears to have existed so far back as the Cretaceous formation, in the species *Stenocheles esocinus* of Fritsch and Kafka;¹ but whether this was also a blind animal or not I do not know.

In the Dendrobranchiata the first is the smallest of the three chelate pairs characteristic of the division, one of which is large; the first is moreover the shortest, and appears from its relative length to be capable of reaching the mouth.

It is also noticeable in this division, that in those genera in which there is a downward tendency from the normal form and power, the change takes place at each extremity of the pereion. The first pereopod is the first to become enfeebled, as may be seen in the Sergestidæ, in which the first has lost its chelate structure, and yet retains a grasping or holding power in the peculiar adaptation of the carpo-propodal articulation; while at the posterior extremity of the pereion the fifth pair has become little more than rudimentary, and the fourth is much diminished in importance and value.

In the Phyllobranchiata the first pair of pereopoda varies greatly in relative form and size, being sometimes the largest, as in *Alpheus*, but more commonly very much the smallest, as in the Palæmonidæ; again, as in the Crangonidæ, it is reduced to a subchelate condition, in consequence of the polliciform angle of the propodos being reduced to a small tooth-like point, as in *Crangon* and its immediate congeners. In *Glyphocrangon* this point is altogether absent, and in *Nika* the change in structure differs on the two sides, this pair being simple on one side and chelate on the other. In the Pandalidæ it exists as a pair of simple pointed legs, styliform in appearance.

In the freshwater genus *Atya* this pair of pereopoda is developed into a kind of brush to provide the mouth with supplies of fine mud on which the animal lives. The extremity of both the finger and thumb is provided with a tuft of long bristles, which, when the hand is open, form a kind of fan which retains the fine mud; when the hand is closed, the bristles are closed around the mud, compressing it into a pellet, which is passed into the mouth with great rapidity.²

The Second Pereiopoda.—The second pair of pereopoda varies much in some families and but little in others. All through the Trichobranchiata it is chelate and only of moderate proportions, being much smaller than the first and as large as or larger

¹ Die Crustaceen der Böhmischen Kreideformation, 1887.

² Fritz Müller, *Kosmos*, Bd. viii. p. 117, 1881.

than the third; it has the carpos single-jointed, which is also the case in the Dendrobranchiata, the only difference being that in this division the second resembles the first, but is slightly larger and a little longer, corresponding in size between the first and second pairs.

We find that this is continued, but to a less degree, in the Sergestidæ, in which family the second pair corresponds more nearly with the third than with the first.

In the Phyllobranchiata the several variations of form are more marked and in stronger contrast. In the genera belonging to the families of the Nikidæ, Alpheidæ, Hippolytidæ, and Pandalidæ it is long, slender, minutely chelate, and has the carpos multiarticulate, the articuli varying in number and length in various species or genera.

In the Crangonidæ it is short, slender, and feeble, and the carpos is not multiarticulate, and this is also the case in all the genera belonging to the Palæmonidæ, only here it is larger and often very much longer than the first pair; so it is in *Typton*, *Pontonia*, and *Oodeopus*, while it differs in *Nematocarcinus* in being small and having the carpos long and slender, and not multiarticulate.

The differences between the multiarticulate condition of the carpos and those in which it is uniarticulate is so marked that I have separated them into two tribes, under the names of the Polycarpidea and Monocarpidea. In the Haplopodea all the legs are uniform.

The Third Pereiopoda.—The third pair of pereiopoda is chelate in all the genera of the Trichobranchiata, except in the group Synaxidea, in which none of them are chelate except the posterior in the females, the first being only subchelate in some genera. This part is generally small and subequal to, or smaller than, the second pair.

This chelate condition also exists in some of the aberrant forms, but in others, as in *Thalassina*, *Eiconaxius*, &c., it is simple. In the family Stenopidæ the third pair is large and chelate, having the hand long and slender in *Stenopus*, broad and thick in *Spongiicola*, and in each longer than the preceding, thus acquiring the character and appearance of the Dendrobranchiata, whilst in the compressed rostrum it much resembles in external appearance the Phyllobranchiata.

In the Dendrobranchiata this pair is the largest and the longest of the chelate feet, and is universally formed on the same type as the two preceding. In the Sergestidæ it is chelate, but only minutely, as it is also in *Lucifer*, and in both cases it is buried in a brush of hairs. I have not had an opportunity of examining it in *Acetes*.

In the Phyllobranchiate forms the third pair of pereiopoda is universally simple.

In the Crangonidæ it is long, slender, and styliform; in the Nikidæ it resembles the succeeding and is less styliform than in the Crangonidæ. It is also styliform in the Pasiphæidæ but comparatively less so than in the Crangonidæ. In several genera

it is short and sickle-shaped, and sometimes biunguiculate, as in some species of the Alpheidæ and Hippolytidæ.

The Fourth Pereiopoda.—The fourth pair of pereiopoda undergoes little change throughout the entire order of the Macrura except in a few of the aberrant Anomura, and in the family of the Eryonidæ, in which they are chelate in several of the genera, as in *Polycheles*, *Pentacheles*, *Eryoneicus*, and *Willemæsia*. It is among the most constant in form and simple in character; it is absent only in the depreciated forms of *Acetes* and *Lucifer*, and even here it is the last to disappear. In the genus *Stenopus* the propodus is reduced to a multiarticulate condition, but is not enfeebled as in *Benthæcetes*, Smith, and the dactylos terminates in a biunguiculate extremity.

The Fifth Pereiopoda.—The fifth pereiopoda is a characteristic pair of appendages in many genera. It is, moreover, functionally an important pair, since it contains the termination of the internal portions of the male organs of generation, the extremity of the vas deferens passing through an orifice in the coxal joints (Pl. XV. fig. 30 and Pl. XIX. fig. o). In *Pentacheles* and *Willemæsia* it is chelate in both males and females. In the Scyllaridæ and Palinuridæ, Homaridæ and Astacidæ, it is chelate in the females only; and appears to be functionally so formed to assist in rupturing the ovisac and liberating the brephalos from the ova.

In the Trichobranchiata it is frequently simple in the male and chelate in the female.

In the Dendrobranchiata it is always simple in form, but has a tendency to become long, slender, and enfeebled; in some genera it is multiarticulate and filamentous, as in *Benthæcetes*; in *Sergestes* it becomes rudimentary in character, and in *Acetes* and *Lucifer* disappears altogether.

Throughout the Phyllobranchiata it is formed on the same general plan as that of the fourth pair, but varies in some genera in having the dactylos short; it is generally simple, but there are many genera in which the dactylos is reduced to a minute condition and attenuated in form.

In some genera, as in *Diaphoropus*, the fifth pair is developed to a very great length, far exceeding that of the preceding pairs. Unfortunately we only know the species of this genus in their young condition, so that although in the specimens of *Diaphoropus versipellis* (Pl. CXVII. fig. 3) it has a form approximating to that of the adult, yet it evidently has to undergo one more change before it reaches the permanent stage. This great size, which is chiefly due to the length of the limb and the diameter of the coxal and basal joints, appears to belong to other genera, such as *Anebocaris* and *Eretmocaris*; but in the specimens of these genera the appendage is unfortunately wanting, the only part preserved being the large coxal joint (Pl. CXLV.).

In the Phyllobranchiata the great degree of degradation which is seen in some genera

of the Dendrobranchiata does not appear to take place in this pair, but rather in the penultimate pair, as in *Pasiphæa* (Pl. CXL. fig. 1*n*).

The First Pleopoda.—The first pair of pleopoda is an important pair of organs, deviating from the normal form seen in those posterior to it, and being utilised to assist the male to a greater or less extent in the act of copulation.

It frequently varies very considerably in form in the two sexes, but it is most pronounced in the males, in which, however, it shows considerable differences in form in different genera and families, but more decidedly in the several divisions into which the Macrura are divided.

The normal condition of the appendage is that of two foliaceous branches attached to the extremity of a basal joint, which is articulated to the inner wall of the plates that project on each side of the pleonic somites; these, so far as I know, have never received a special name, but are generally considered to be the lateral projections of the several somites. A similar condition of structure exists in the Edriophthalma, and since in these there is no carapace covering the pereion and shielding the branchiæ from accident, the first joint of the legs is produced in a similarly squamose manner, overlapping and protecting the branchiæ, situated pendent on the inner side.

I believe that this is precisely the condition of the great lateral plates on the pleon in the Macrura; an idea that I have long entertained, and which, I believe, is capable of demonstration by well-grounded arguments.

That the two rami are homotypical of the exopodite and the endopodite of the pereionic limb, as described by Milne-Edwards—or, as I have preferred to call them, of the pereiopod and its basephysis (or in plain English the leg with the branch of its second joint) is, I believe, universally accepted as theoretically true; but the large overlapping lateral plate is figured and described as part of the somite by Milne-Edwards in his great work *Histoire naturelle des Crustacés*, while it is omitted in his later memoir on the morphology of the Decapod Crustacea.¹

In the different genera the second or basal joint of the appendage is seen to creep (as it were) down the side of the large scale often nearly as far as its lower margin; this is apparent in several species of *Alpheus* where it is largely developed, especially in the females as a protection for the ova. In some specimens of an undescribed genus recently taken in the "Talisman" by M. A. Milne-Edwards these lateral plates are so largely developed in the females that they wrap over and cover the ova as in a marsupial pouch. In other genera, as *Sergestes* and *Lucifer*, they are reduced to a minimum, having the pleopoda articulating at the extreme margin of the lateral wall. This we might suppose to be liable to occur in such genera as these, in neither of which are ova ever

¹ Observations sur le squelette tégumentaire des Crustacés décapodes et sur la morphologie de ces animaux, *Ann. d. Sci. Nat.*, sér. 3, t. xvi. pp. 221–291, pls. 8–11, 1851.

attached to the pleopoda. But large squamose plates exist also in *Penæus* and its congeners, which also so far as known never carry ova.

If we turn to *Apseudes*, that anomalous little genus, which appears in its general character and condition to be rather a Macruran than an Isopod, we find this lateral plate distinctly recognisable as a joint articulating with its somite, and with the basal joint which supports its two branches attached at its extremity.

It appears to me that what is true of a small Crustacean is also true of a large one, and this interpretation is most consistent with the homology of these parts.

If the ecephysis or exopodite be a branch of the second joint, as it is acknowledged to be, then it is clear that the part generally denominated the peduncle of the pleopod must be the second joint, that is the basis, and not the coxa, or the branches arising from it cannot be the homologues of the basecephysis; or, finally, the branches springing from the first joint or coxa of the pereopoda must also be homologically the same as those which spring from the second joint or basis; which is absurd, since it would make the exopodite and the epipodite, or as I have named them, the basecephysis and mastigobranchia, homologous with each other.

The pleopoda undergo various modifications of form, the three anterior more or less after one type, the three posterior after another; the first pair in the female varies but little from the succeeding which carry the ova, and what change there may be is in the direction of depreciation.

In the Trichobranchiata in the female it is very much reduced in character, and sometimes, as in the Astacidæ, it is almost rudimentary; whereas in the male of the same species it is a large and powerful organ adapted for its special purpose.

In *Astacus* it is developed into an almost cylindrical tube, but in the genera belonging to the family of the Eryonidæ it forms rather a broad spoon; and judging from what we have observed of the habits of the higher forms, as exhibited in *Carcinis manas*, in which the extremity of the vas deferens is projected into folds of the first pair of pleopoda and inserted into the female, so in these, although in a less perfect manner, the pleopod may be utilised to similarly direct same organ to the entrance of the oviduct.

In *Ibaccus*, and I believe in all the Synaxidea, the first pair of pleopoda is wanting in both male and female, but in the Stenopidæ it is well developed, but only single-branched, and utilised in the female as an egg-carrier.

In the Dendrobranchiata even a greater change takes place in the male, and one that is well worthy of close consideration.

The inner branch is transformed into a very thin membranous plate, which I have called the petasma, and which is capable of very large extension; it generally lies folded longitudinally in a narrow compass, and is frequently studded at the proximate margins with hooks and teeth which vary in form; its minor differences are so numerous and

its general form so constant, that when fully developed it is a good and invariable test of specific character.

In *Lucifer* I have been able to follow the development of this organ throughout its various changes, from the very early form to the adult stage, with more completeness than in any other genus. Thus, when the animal is but 5 mm. in length, the petasma is present in the form of a bud; when the animal is 10 mm. long it has increased to a considerable degree, and when it has reached the adult stage it is about 12 mm. or half an inch long, the petasma is fully developed (Pl. LXXX. fig. 1, and *p.t.m.*). This organ may be seen varying (Pl. LXXXII.) from the simplest condition to that of the more perfect form through various genera; and is universally present in the adult as a pair of large veils which become linked together in the median line and form a curtain that stretches across the pleon between the limbs from one side to the other.

Whether this veil is constantly present in the adult male, or only at certain periods when required, I am not prepared to assert, but I am inclined to believe that the latter is the more likely case, if we may judge from certain specimens of *Aristeus* in the collection. For instance, on Pl. XLV. figs. 1, 2, and *p* are shown to exist in different degrees of immaturity, although the animals from which they were taken are all fully grown and well-developed males.

When displayed to the full extent they form a curtain, as may be seen in *Gennadas parvus* (Pl. LVII. fig. *p.p.*), in which they extend from the pleopod on one side to that on the other, being connected in the median line by a series of small cincinnuli (fig. *p.*"), and attached on each side by a small pedicle to near the middle of the basal joint of the pleopoda. It may be also seen in a similar condition, but more irregular in form, in *Sergestes atlanticus* (Pl. LXIX. fig. *p.p.*). On Pl. XXXIX. fig. 2" it is also shown in a folded condition, in *Pleoticus mülleri*; but perhaps its true value and importance may best be understood from an examination of the structure as it is shown in *Pleoticus pectinatus* (Pl. XXXVIII. fig. *p.p.*). Here the petasma is extended and united in the median line. The curtain is seen to be attached by a small pedicle to near the middle of the inner side of the basal joint of the pleopod, its margins are extended vertically to the central body of the curtain, which forms a groove in the middle; near the middle of the lateral margins are two excavated spaces, into which the fifth pair of pereopoda fall when required, and beyond them are two enlarged lobes with hollow apices, the object of which is not clear, unless it be to assist in clutching the fifth pair of pereopoda when pressed down; beyond the lobes the margins are fringed with a series of long, curved, comb-like teeth, that are capable of securing a hold on the female when the animals are brought into contact.

From what we know of the means of fertilization in *Lucifer*, and from what Sars has shown in his Report on the Schizopoda of the Challenger collection,¹ I think we may

¹ Zool. Chall. Exp., part xxxvii. p. 74.

assume from the similar character of the petasma in the male *Lucifer*, and in the Penæidæ, that the means adapted for impregnating the female in *Lucifer* is also that in the Penæidæ. It has been long known, but only of late years demonstrated by Dr. Semper, and more recently by Professor Brooks, that spermatophores are developed by the male (Pl. LXXX. figs. 1, 2; Pl. LXXXI. figs. 3, 4), and at certain periods when required are liberated; that these are taken up and held until required, probably only for a limited period, and then projected and retained inserted in the female until the ova are impregnated, as shown on Pl. LXXXI. fig. 1♀ and 2♀. Since the petasma exists in all those Macrura which are known to impregnate the females by means of spermatophores, it is fair to assume that this organ, which shows a remarkable correlation of parts in relation to a special function, fulfils the office in a manner nearly as suggested.

In the males of many genera, and in the females of most of the Macrura that belong to the Phyllobranchiata, there is commonly present, on the inner margin of the inner branch, a long, blunt, style-like appendage, that I have named stylamblys, the apex of which, instead of being sharp, is crowned with numerous small hooks with enlarged points, which have been termed cincinnuli. The hooks are similar to those attached to the inner margin of the petasma on each side.

The Second Pleopoda.—The second pair of pleopoda is generally a modification of the type of the first, in the direction of those that are posterior to it. The branches are more normal in form, but the outer carries a stylamblys that is furnished with numerous small hooks or cincinnuli. In some genera, as *Sicyonia*, the inner branch is developed into an imperfect petasma (Pl. XLIII. fig. 2q). In *Penæus serratus* the inner branch, instead of being a broad and thin membranous plate, is long and narrow, somewhat like the outer one, and is furnished at the base with two globular organs (Pl. XXXVII. fig. 1q).

In *Callianassa* and its near ally *Cheramus* (Pl. I. fig. 2q) the first pair of pleopoda is generally absent, or reduced to a rudimentary condition; the second and third are long and slender, the inner ramus being cylindrical and biarticulate, while the outer is long and slender, and also biarticulate, the first joint being extremely long, and the distal one extremely minute; but this condition belongs more to the female than to the male, in which they are smaller and more simple (Pl. VIII. figs. q♀ and q♂; Pl. XIX. figs. q♀ and q♂). These distinctions are common throughout the Synaxidea, as well as in many of the aberrant genera.

In the Phyllobranchiata, the inner exists as a submembranous branch, somewhat like that of the Dendrobranchiata, but it differs in the two sexes, being a little broader in the males, and having the margins free from cilia. It varies in different genera or sometimes even in different species of the same genus, as may be seen in *Nemato-carcinus*, in which it may be compared with the same organ as seen in *Oplophorus*.

The Third Pleopoda.—The third pair of pleopoda likewise exhibits some of the characteristics of those preceding, but in many genera, and more especially in those in which the anterior pairs depart less from the common type, it differs but little from those that follow. This and the following two are the chief egg-carriers in the Trichobranchiata and Phyllobranchiata, although in some genera they may be found on the second, and in *Stenopus* a few ova are attached to the first pair.

The Fourth and Fifth Pleopoda.—These pairs are generally only broad and leaf-like appendages.

The Sixth Pleopoda.—The sixth pair of pleopoda is the only feature that is invariably constant, existing in a more or less perfect form throughout the whole of the Macrura.

Its articulation with the somite differs from the preceding by the reduction of the large coxal plate to a rudimentary condition, and in its being placed at the posterolateral angles. The basal joint, instead of being long as in those anterior to it, is short, and the terminal branches are generally broad and leaf-like, but in some instances slender and style-like, as may be seen in *Thalassina* (Pl. III.), in *Cheiroplatea* (Pl. I. fig. v.v), and in other aberrant forms through the Anomura, where it may be seen in a rudimentary condition in the cancriform genera.

In the course of development it is the first appendage present of those that belong to the pleon, and it appears almost simultaneously with the antennæ, while the pereopoda are yet in an incipient condition, and the other pleopoda are visible only as immature buds.

The basis, or peduncular joint, is short, and the two branches generally bear a strong resemblance to each other, although each of them possesses features peculiar to itself. The inner branch is generally the more flexible, and has the two margins similar and fringed with hairs, whereas the outer is generally slightly longer than the inner; the outer margin is smooth and strengthened by a strong rib, and is ciliated with hairs on the inner side and distal extremity only; it is divided by a diæresis, or transverse line of articulation. This feature is one that is very general in the Macrura, being present, so far as my experience teaches me, in each division, and absent only in the genera that belong to the families Palinuridæ, Scyllaridæ, and Eryonidæ.

In the Dendrobranchiata the diæresis is, I believe, universally present; but in some genera, as *Benthescymus* and *Gennadas*, it is imperfect in character, although, even in these, a small bundle of muscular tissue occupies the position where the line of diæresis should be (Pl. LV. fig. 1r), thus demonstrating by its presence that previously there existed an articulation between the two parts; the muscles, ceasing to be of use, have gradually diminished in size and value. This pair of appendages bears a considerable analogy to the second pair of antennæ, the outer branch representing the scaphocerite; and to add to this comparison we find in the Atyidæ that the scaphocerite is furnished with a diæresis of similar character.

In some genera of the Schizopoda, which are aberrant Macrura, the inner branch is furnished with an otolith, similar to that which we find in the first joint of the peduncle of the first pair of antennæ in some of the Phyllobranchiata. The analogy that it bears to the first pair is moreover apparent in the filamentary character it assumes in *Tanais* and *Apsœudes*, in the latter of which it exhibits the unusual feature of two filamentose branches, which is the normal condition of the Macrural antennæ.

The Telson.—The terminal or twenty-first somite—the seventh somite of the pleon—undergoes considerable degrees of modification throughout the several families of the Macrura.

In most genera the telson appears to be useful as being the resting-place of the sphincter muscles that surround the terminal extremity of the alimentary canal, which is capable of being controlled by them. It is also useful in directing and steering the animal in its passage through the water, and appears to be longest in those species that possess the greatest power of rapid movement.

All these animals possess the power of doubling up the posterior somites against the ventral surface of the pleon, and then, by boldly striking out, dart to a considerable distance.

In some genera, or even families, the telson is posteriorly rounded, as in the Astacidæ; in others it is anteriorly hard and calcareous and posteriorly soft and membranous, as in the Synaxidea, a circumstance that is suggestive of a distinct relationship of the two parts, the anterior which carries the anus belonging to the normal somite, while the posterior portion represents its appendages. This idea is still more strongly suggested in the genus *Cheiroplatea*, where the separation of the posterior from the anterior division is clearly defined by a distinct membranous articulation, and the posterior portion is divided into two lateral lobes.

In *Glyphocrangon* the telson is not only a long and slender appendage but it is one that from its character and power must be a formidable weapon of offence. It is developed in the form of a long, slightly curved, triangular bayonet, grooved along the upper surface, and capable of being firmly fixed or unlocked at will.

The contraction of the extensor muscle forces the ball-like portion at its anterior dorsal margin beneath the frontal surface of the preceding somite, and draws the dorsal process at the base of the telson into contact with the vertical margins at the posterior extremity of the sixth somite, and by the same action the lateral bolts are forced against the curved margin of the projecting lateral process on each side; by these means the telson is so securely locked in position that it is difficult to dislodge it when so fixed (Fig. XV.). To add to its power as a weapon of offence the sixth somite is attached to the fifth by a similarly formed articulation, which is also easily capable of being locked in position, and the fifth somite is united with the fourth by a modification of the same

kind, but less capable of resistance than the other two. These three somites therefore support each other, and by acting in concert when drawn up beneath the ventral surface of the animal, and then forcibly struck out, must be capable of inflicting a very severe wound.

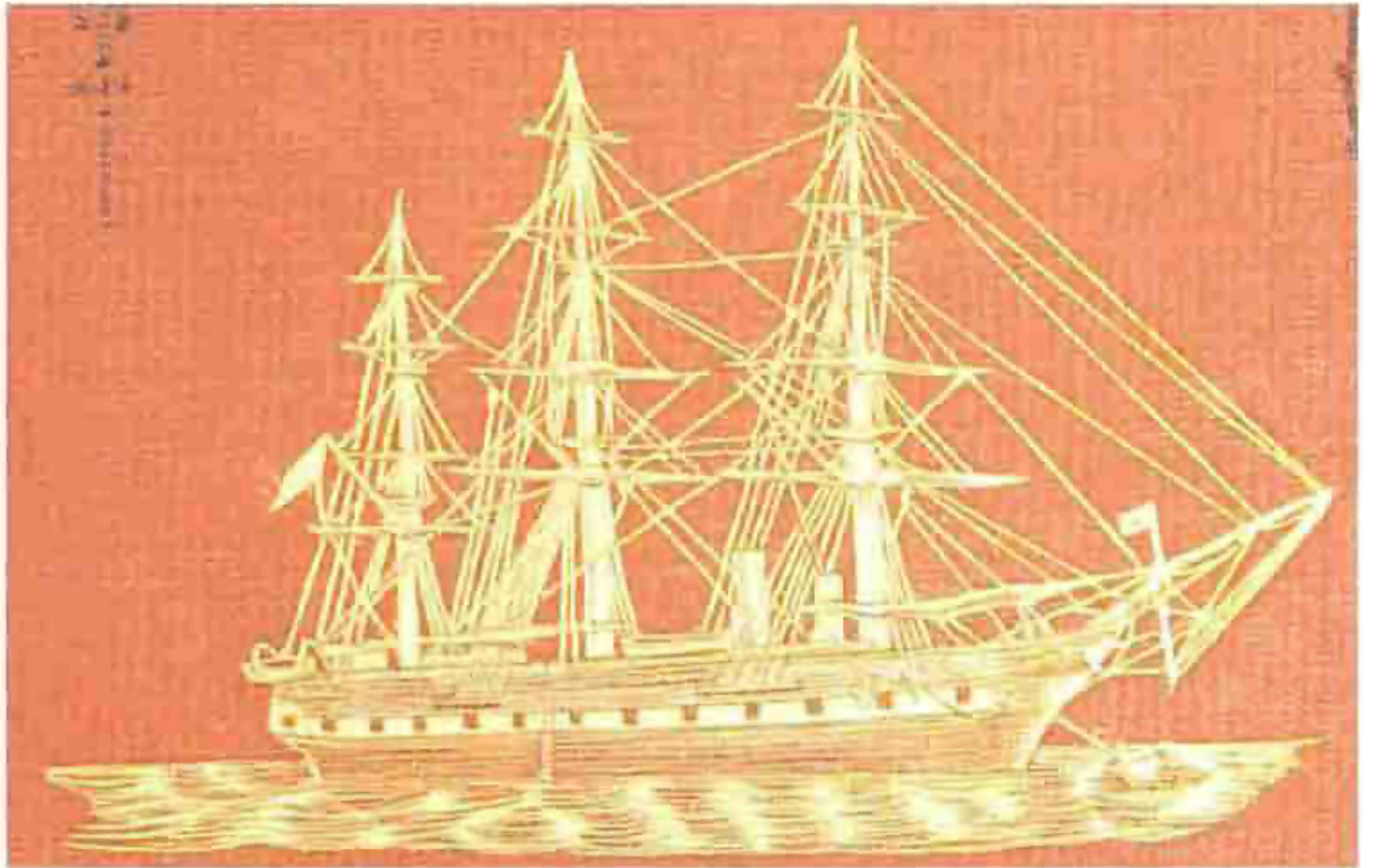
There seems to be a curious correlation between the length of the telson and the length



FIG. XV.—*Glyphocrangon*. T, fifth somite of the pleon; V, sixth somite of the pleon; Z, telson.

of the rostrum. When the telson is long and slender the rostrum is also long and slender, and when the telson is short the rostrum is never long, and is frequently very short, or wanting, as in *Crangon* and the *Synaxidea*. The rostrum by its length appears to afford protection to the ophthalmopoda and the antennæ, and the telson, by its rigidity and length, likewise affords protection to the lateral appendages of the rhipidura.

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H.M.S. CHALLENGER

GEOGRAPHICAL DISTRIBUTION.

LIST OF LOCALITIES AT WHICH MACRURA WERE OBTAINED, WITH THE SPECIES TAKEN AT EACH.

STATION VII^P. February 10, 1873; lat. 28° 35' N., long 16° 5' W.; off Gomera, Canary Islands; depth, 78 fathoms; bottom, volcanic sand. Dredged.

Arctus pygmæus (1 ♀).

STATION 13. March 4, 1873; lat. 21° 38' N., long. 44° 39' W.; Mid-north Atlantic; depth, 1900 fathoms; bottom, Globigerina ooze; bottom temperature, 36°·8. Dredged.

Willemæsia leptodactyla (1 ♀).

| *Bentheocaris stylostratis* (2 ♀ ♂).

STATION 23. March 15, 1873; lat. 18° 24' N., long. 63° 28' W.; off Sombrero Island, West Indies; depth, 450 fathoms; bottom, Pteropod ooze. Dredged.

Callianassa occidentalis (1).

| *Thaumastocheles zaleuca* (2).

Cheramus occidentalis (1).

| *Polycheles crucifera* (1).

Benthescymus pleocanthus (1 ♀).

STATION 24. March 25, 1873; lat. 18° 38' 30" N., long. 65° 5' 30" W.; off Culebra Island; depth, 390 fathoms; bottom, Pteropod ooze. Dredged.

Platybema rugosum (1 ♀).

| *Leptochela serratorbita* (1).

St. Thomas, West Indies; shallow water.

Sicyonia carinata (1).

| *Alpheus bermudensis* (1 ♀).

Leptochela serratorbita (1).

Bermuda; shallow water.

Stenopus hispidus.

| *Alpheus bermudensis* (3 ♀ ♂).

Between Bermuda and the Azores. Surface.

Gennadas intermedius. | *Brachycarpus savignyii.*

North Atlantic. April 1873. Surface.

<i>Mastigopus suhmi.</i>	<i>Latreutes ensiferus</i> (100). On Gulf-weed.
<i>Sergestes edwardsii.</i>	<i>Hippolyte bidentatus</i> (2 ♂ ♀). On Gulf-weed.
<i>Sergestes atlanticus.</i>	<i>Palæmon natator</i> (113). On Gulf-weed.
<i>Sergestes ovatoculus.</i>	
<i>Sergestes penerinkii.</i>	
<i>Lucifer typus.</i>	
<i>Lucifer reynaudii.</i>	

STATION 40. April 28, 1873; lat. 34° 51' N., long. 68° 30' W.; depth, 2675 fathoms; bottom, blue mud. Dredged.

Acanthephyra purpurea (1). | *Acanthephyra sicca* (1).

STATION 42. April 30, 1873; lat. 35° 58' N., long. 70° 35' W.; surface temperature, 65°. Surface.

Sergestes atlanticus (1).

STATION 45. May 3, 1873; lat. 38° 34' N., long. 72° 10' W.; south-east of New York; depth, 1240 fathoms; bottom, blue mud; bottom temperature, 37°·2. Dredged.

Gennadas parvus (1 ♂). | *Orphania tenuimana* (1).

STATION 49. May 20, 1873; lat. 43° 3' N., long. 63° 39' W.; south of Halifax; depth, 85 fathoms; bottom, gravel, stones; bottom temperature, 35°. Dredged.

<i>Sabinea septemcarinata</i> (22 ♀ ♂).	<i>Hetairus gaimardius</i> (1 ♀).
<i>Hippolyte projecta</i> (1 ♂).	<i>Hetairus tenuis</i> (1 ♂).
<i>Spirontocaris spinus</i> (many ♂ ♀).	<i>Hetairus debilis</i> (15).
<i>Pandalus fulcipes</i> (2 ♀ ♂).	

STATION 57. May 30, 1873; lat. 32° 11' 7" N., long. 65° 3' 20" W.; off Bermuda; depth, 690 fathoms. Dredged.

Nephropsis rosea.

STATIONS 62 and 63. June 18, 19, 1873; lat. 35° 7' to 35° 29' N., long. 50° 53' to 52° 32' W. Surface, among Gulf-weed.

Sergestes atlanticus (3 ♂ ♀). | *Hippolyte bidentatus* (1 ♀). Female with ova.

STATION 84. July 18, 1873; lat. 30° 38' N., long. 18° 5' W.; near the Canary Islands; surface temperature, 71°. Surface.

Stochasmus exilis (1).

STATION 87. July 21, 1873; lat. 25° 49' N., long. 20° 12' W.; off the Canary Islands; depth, 1675 fathoms; bottom, rock. Dredged.

Acanthephyra purpurea (1). | *Eryoneicus cæcus*¹ (1).

Hymenodora mollicutis (1 ♂).

South Atlantic, March 1876.

Amphion provocatoris (1).

Off Cape Verde Islands. Surface.

Arctus immaturus (1).

Sergestes edwardsii (April 26, 1876).

Athanas veloculus (2).

Diaphoropus longidorsalis (1) (April 26, 1876).

Oodeopus gibbosus (April 26, 1876).

Hectarthropus tenuis (April 26, 1876).

Eretmocaris stylostris (April 26, 1876).

Eretmocaris corniger (April 26, 1876).

St. Vincent, Cape Verde Islands; 7 to 52 fathoms.

Ibaccus verdi.

Phyllosoma furcicaudatum.

Phyllosoma verdense.

Sicyonia sculpta (1).

Sergestes dissimilis.

Alpheus edwardsii.

Alpheus cristidigitus (19 ♀ ♂).

Alpheus edwardsii (10 ?).

Amphion provocatoris (1).

San Iago, Cape Verde Islands; fresh-water stream.

Atya sulcatipes.

Atya serrata.

Caridina typus.

STATION 101. August 19, 1873; lat. 5° 48' N., long. 14° 20' W.; near Sierra Leone; depth, 2500 fathoms; bottom, blue mud; bottom temperature, 36°.4. Trawled.

Gennadas parvus (1).

STATION 103. August 22, 1873; lat. 2° 52' N., long. 17° 0' W.; surface temperature, 77°. Surface.

Sergestes oculatus (1).

¹ A second and much larger species has been since taken by Professor A. Milne-Edwards during the voyage of the "Talisman."

STATION 104. August 23, 1873; lat. 2° 25' N., long. 20° 1' W.; depth, 2500 fathoms; bottom, Globigerina ooze; bottom temperature, 36°·6. Trawled.

<i>Haliporus lævis</i> (2 ♀).	|	<i>AcanthePHYRA kingsleyi</i> (1 ♂).
<i>Hymenodora mollicutis</i> (1 ♀).		

STATION 106. August 25, 1873; lat. 1° 47' N., long. 24° 26' W.; depth, 1850 fathoms; bottom, Globigerina ooze; bottom temperature, 36°·6. Trawled.

<i>Haliporus lævis</i> (1 ♂).	|	<i>Sergestes oculatus</i> (4).
<i>Gennadas intermedius</i> (1).	|	<i>Sergestes longispinus</i> (1).
<i>AcanthePHYRA acanthitelsonis</i> (1 ♂).		

Tropical Atlantic. Surface.

<i>Lucifer typus</i>.	|	<i>Sergestes parvidens</i> .
<i>Lucifer reynauidii</i>.	|	<i>Peteinura gubernata</i> , at night.

STATION 107. August 26, 1873; lat. 1° 22' N., long. 26° 36' W.; depth, 1500 fathoms; bottom, Globigerina ooze; bottom temperature, 37°·9. Trawled.

<i>AcanthePHYRA acanthitelsonis</i> (1 ♂).		<i>AcanthePHYRA brevirostratis</i> (2).
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St. Paul's Rocks. Surface.

<i>Panulirus guttatus</i> (3 ♀ 1 ♂).		<i>Lucifer reynauidii</i> .
<i>Lucifer typus</i> .		<i>Alpheus minus</i> (2 ♀).
<i>Sergestes oculatus</i> (6).		

STATION 113A. September 2, 1873; lat. 3° 47' 0" S., long. 32° 24' 30" W.; off Fernando Noronha; depth, 7 to 25 fathoms; bottom, volcanic sand and gravel.

<i>Artemesia longinaris</i> (1).		<i>Alpheus minus</i> (1 ♀).
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STATION 120. September 9, 1873; lat. 8° 37' S., long. 34° 28' W.; off Pernambuco; depth, 675 fathoms; bottom, red mud. Trawled.

<i>Gennadus parvus</i> (1 ♀).	|	<i>Notostomus brevirostris</i> (1).
<i>Glyphocrangon aculeata</i> (1 ♀).	|	<i>Hymenodora mollis</i> (1 ♀).

STATION 122. September 10, 1873; lat. 9° 5' S., long. 34° 50' W.; off Barra Grande; depth, 350 fathoms; bottom, red mud. Trawled.

<i>Amphiplectus depressus</i> (2 ♀).	|	<i>Plesionika semilævis</i> (16).
<i>Plesionika uniproducta</i> (2 ♂ ♀).	|	<i>Nothocaris geniculatus</i> (17 ♀ ♂).
<i>Campylonotus capensis</i> (2 ♂).		

STATION 126. September 12, 1873; lat. 10° 46' S., long. 36° 8' W.; depth, 770 fathoms; bottom, red mud. Trawled.

Acanthephyra edwardsii (2 ♂ ♀)

Off Bahia; from 7 to 22 fathoms.

Sicyonia carinata.

| *Alpheus minus* (3 ♀ ♂).

Alpheus intrinsecus (1 ♀).

South Atlantic, October 5, 1873; about lat. 28° S., long. 27° W. Surface.

Sergestes longicollus.

STATION 133. October 11, 1873; lat. 35° 41' S., long. 20° 55' W.; near Tristan da Cunha; depth, 1900 fathoms; bottom, Globigerina ooze; bottom temperature, 35°·4. Trawled.

Willemæsia leptodactyla (1 ♀).

| *Benthesicymus altus* (3 ♂).

Hemipenæus spinidorsalis (2).

Benthesicymus mollis (1).

Aristeus armatus (1 ♂).

Pontophilus gracilis (1 ♀).

Benthesicymus iridescens (2 ♀ ♂).

Notostomus murrayi (1).

Hymenodora mollicutis (2 ♂ ♀).

STATION 135C. October 17, 1873; lat. 37° 25' 30" S., long. 12° 28' 30" W.; Nightingale Island, Tristan da Cunha; depth, 110 fathoms. Dredged.

Palinosytus lalandii (1).

STATION 137. October 23, 1873; lat. 35° 59' S., long. 1° 34' E.; depth, 2550 fathoms; bottom, red clay; bottom temperature, 34°·5. Dredged.

Gennadas intermedius (1 ♂).

| *Sergestes profundus* (1 ♀).

STATION 142. December 18, 1873; lat. 35° 4' S., long. 18° 37' E.; Agulhas Bank; depth, 150 fathoms; bottom, green sand; bottom temperature, 47°. Dredged.

Merhippolyte agulhasensis (5 ♂ ♀).

| *Pandalus modestus* (3).

Chlorotocus incertus (1).

STATION 144A. December 26, 1873; lat. 46° 48' 0" S., long. 37° 49' 30" E.; off Marion Island; depth, 69 fathoms; bottom, volcanic sand. Dredged.

Nauticarion marionis (67 ♀ ♂).

STATION 145. December 27, 1873; lat. $46^{\circ} 43' 0''$ S., long. $38^{\circ} 4' 30''$ E.; off Marion Island; depth, 140 fathoms; bottom, volcanic sand. Dredged.

<i>Nauticaris marionis</i> (3).	|	<i>Chorismus tuberculatus</i> .
<i>Campylonotus capensis</i> (6 ♂ ♀).		

STATION 145A. December 27, 1873; lat. $46^{\circ} 41'$ S., long. $38^{\circ} 10'$ E.; off Marion Island; depth, 310 fathoms; bottom, volcanic sand. Dredged.

Chorismus tuberculatus (15 ♀ ♂).

STATION 146. December 29, 1873; lat. $46^{\circ} 46'$ S., long. $45^{\circ} 31'$ E.; near Marion Island; depth, 1375 fathoms; bottom, Globigerina ooze; bottom temperature, $35^{\circ} \cdot 6$. Trawled.

<i>Petalidium foliaceum</i> (4 ♀).	|	<i>Caricyphus angulatus</i> (1).
<i>Glyphocrangon podager</i> (1 ♀).		<i>Nematocarcinus proximatus</i> (2 ♀).

STATION 147. December 30, 1873; lat. $46^{\circ} 16'$ S., long. $48^{\circ} 27'$ E.; depth, 1600 fathoms; bottom, Diatom ooze; bottom temperature, $34^{\circ} \cdot 2$. Trawled.

Hymenodora duplex (1 ♀).

STATION 152. July 11, 1874; lat. $60^{\circ} 52'$ S., long. $80^{\circ} 20'$ E.; depth, 1260 fathoms; bottom, Diatom ooze. Trawled.

Nematocarcinus lanceopes (3 ♀ ♂).

STATION 156. February 26, 1874; lat. $62^{\circ} 26'$ S., long. $95^{\circ} 44'$ E.; depth, 1975 fathoms; bottom, Diatom ooze. Trawled.

Hymenodora mollicutis (1 ♂).

STATION 157. March 3, 1874; lat. $53^{\circ} 55'$ S., long. $108^{\circ} 35'$ E.; depth, 1950 fathoms; bottom, Diatom ooze; bottom temperature, $32^{\circ} \cdot 1$. Trawled.

Hymenodora mollicutis (2 ♂).

South of Australia; March 1874. Surface.

<i>Sergestes dorsispinalis</i> .		<i>Sergestes laterodentatus</i> .
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STATION 159. March 10, 1874; lat. 47° 25' S., long. 130° 22' E.; depth, 2150 fathoms; bottom, Globigerina ooze; bottom temperature, 34°·5. Trawled.

<i>Gennadas parvus</i> (1).	|	<i>Sergestes atlanticus</i> (3 ♀).
<i>Petalidium foliaceum</i> (1 ♀).	|	<i>Acanthephyra sica</i> (2 ♂).
<i>Hymenodora glauca</i> (1 ♂).		

STATION 162. April 2, 1874; lat. 39° 10' 30" S., long. 146° 37' 0" E.; off East Moncœur Island; depth, 38 fathoms; bottom, sand and shells. Dredged.

<i>Alpheus gracilipes</i> (2).		<i>Leptochela robusta</i> (16 ♀ ♂).
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Australia, off Cape Howe; April 3, 1874. Surface.

<i>Icotopus arcurostris</i> (2).		<i>Zoontocaris galatheæ</i> .
<i>Diaphoropus versipellis</i> , at night.	|	<i>Oodeopus serratus</i> .

Australia, Port Jackson. Surface.

<i>Penæus canaliculatus</i> , var. <i>australi-</i>	|	<i>Sergestes armatus</i> .
<i>ensis</i> (3 ♀).	|	<i>Lucifer typus</i> .
<i>Penæus gracilis</i>.	|	<i>Palæmon affinis</i> (16 ♀).
<i>Aneboecaris quadroculus</i> (1), at night.		

Sydney, Paramatta River, N.S.W. Fresh-water.

<i>Astacopsis spinifer</i>.	|	<i>Astacopsis sydneyensis</i> .
<i>Astacopsis paramattensis</i> .		

Sydney.

Sergestes parvidens.

STATION 164B. June 13, 1874; lat. 34° 13' S., long. 151° 38' E.; off Port Jackson depth, 410 fathoms; bottom, green mud. Trawled.

Plesionika semilævis (2).

STATION 165. June 17, 1874; lat. 34° 50' S., long. 155° 28' E.; off Sydney; depth 2600 fathoms; bottom, red clay; bottom temperature, 34°·5. Dredged.

Pontophilus profundus (1 ♂).

STATION 166. June 23, 1874; lat. 38° 50' S., long. 169° 20' E.; off New Zealand depth, 275 fathoms; bottom, Globigerina ooze; bottom temperature, 50°·8. Trawled.

<i>Nephrops thomsoni</i> (1 ♀).		<i>Pandalus magnoculus</i> (9 ♀ ♂).
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STATION 167. June 24, 1874; lat. 39° 32' S., long. 171° 48' E.; off New Zealand; depth, 150 fathoms; bottom, blue mud. Trawled.

Ibaccus alticrenatus (2 ♂ 2 ♀). | *Pandalus magnoculus* (14 ♀ ♂).

STATION 167A. June 27, 1874; lat. 41° 4' S., long. 174° 19' E.; off New Zealand; depth, 10 fathoms; bottom, mud. Dredged.

Brachycarpus audouinii (1 ♀).

STATION 168. July 8, 1874; lat. 40° 28' S., long. 177° 43' E.; off New Zealand; depth, 1100 fathoms; bottom, blue mud; bottom temperature, 37°·2. Trawled.

Benthesicymus brasiliensis (2 ♀). | *Pontophilus gracilis* (6 ♂ ♀).
Acanthephyra sica (4 ♀ ♂).

Wellington, New Zealand.

Sergestes parvidens.

STATION 169. July 10, 1874; lat. 37° 34' S., long. 179° 22' E.; off New Zealand; depth, 700 fathoms; bottom, blue mud; bottom temperature, 40°. Trawled.

Pontocaris propensalata (1). | *Nematocarcinus serratus* (1).
Pleoticus lucasii. | *Nematocarcinus hiatus* (1).
Acanthephyra sica (3 ♀ ♂).

STATION 170. July 14, 1874; lat. 29° 45' S., long. 178° 14' W.; off the Kermadec Islands; depth, 520 fathoms; bottom, volcanic mud; bottom temperature, 43°. Trawled.

Eiconaxius parvus. | *Benthesicymus altus* (1).
Polycheles helleri (1). | *Sergestes kroyeri* (1 ♀).
Pentacheles euthrix. | *Plesionika semilævis* (6 ♀ ♂).
Haliporus obliquirostris (many ♀). | *Acanthephyra sica* (1 ♂).
Hemipenæus semidentatus (3 ♀ ♂). | *Acanthephyra brachytelsonis* (4 ♀ ♂).

STATION 170A. July 14, 1874; lat. 29° 45' S., long. 178° 11' W.; near the Kermadec Islands; depth, 630 fathoms; bottom, volcanic mud; bottom temperature, 39°·5. Trawled.

Pentacheles euthrix (2 ♀). | *Acanthephyra sica*.
Eiconaxius parvus. | *Acanthephyra brachytelsonis* (4).

STATION 171. July 15, 1874; lat. $28^{\circ} 33' S.$, long. $177^{\circ} 50' W.$; north of the Kermadec Islands; depth, 600 fathoms; bottom, hard ground; bottom temperature, $39^{\circ} \cdot 5$. Trawled.

<i>Eiconaxius kermadeci.</i>	|	<i>Glyphocrangon regalis</i> (1 ♂).
<i>Hemipenæus semidentatus</i> (1 ♀).	|	<i>Acantheephyra brachytelsonis</i> (1).
<i>Aristeus semidentatus.</i>	|	<i>Nematocarcinus undulatipes</i> (3 ♂).
<i>Benthesicymus iridescens.</i>	|	<i>Nematocarcinus gracilis</i> (1).
<i>Benthesicymus altus.</i>	|	<i>Stylodactylus discissipes</i> (2 ♀ ♂).
<i>Stylodactylus orientalis</i> (1 ♀).		

STATION 172. July 22, 1874; lat. $20^{\circ} 58' S.$, long. $175^{\circ} 9' W.$; off Nukalofa, Tongatabu; depth, 18 fathoms; bottom, coral mud. Dredged.

Alpheus avarus (2 ♂).

STATION 173. July 24, 1874; lat. $19^{\circ} 9' 35'' S.$, long. $179^{\circ} 41' 50'' E.$; off Matuku, Fiji Islands; depth, 315 fathoms; bottom, coral mud. Dredged.

<i>Thalassina scorpionoides</i> (1).	|	<i>Aristeus rostridentatus</i> (3 ♀).
<i>Polycheles baccata</i> (1).	|	<i>Benthesicymus brasiliensis</i> (1 ♂).
<i>Pentacheles euthrix</i> (1 ♂).	|	<i>Sergestes atlanticus</i> (1 ♂).
<i>Penæus rectacutus</i> (5 ♀).	|	<i>Glyphocrangon regalis</i> (1 ♂).
<i>Penæus serratus</i> (1).	|	<i>Plesionika semilævis</i> (7 ♂ ♀).
<i>Pasiphæa cristata</i> (1 ♀).		

Levuka, Fiji Islands.

<i>Betæus malleodigitus</i> (1 ♀).		<i>Betæus microstylus</i> (1).
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STATION 174B. August 3, 1874; lat. $19^{\circ} 6' 45'' S.$, long. $178^{\circ} 17' 0'' E.$; off Kandavu depth, 255 fathoms; bottom, coral mud. Trawled.

<i>Benthesicymus altus.</i>	|	<i>Nematocarcinus paucidentatus.</i>
<i>Nematocarcinus gracilis.</i>	|	<i>Nematocarcinus tenuirostris.</i>

STATION 174C. August 3, 1874; lat. $19^{\circ} 7' 50'' S.$, long. $178^{\circ} 19' 35'' E.$; off Kandavu depth, 610 fathoms; bottom, coral mud; bottom temperature, 39° . Trawled.

<i>Pentacheles gracilis</i> (1).	|	<i>Oplophorus longirostris</i> (1 ♀).
<i>Stereomastis auriculata</i> (1).	|	<i>Nematocarcinus gracilis</i> (2 ♂).
<i>Benthesicymus altus</i> (1).	|	<i>Nematocarcinus paucidentatus</i> (1).
<i>Nematocarcinus tenuirostris</i> (2 ♀).		

Fiji Islands. Surface.

Penæus canaliculatus (many ♀ ♂).
Lucifer reynaudii.
Thalassocaris danæ (1). August
 11, 1874.

Thalassocaris stimpsoni (2). August
 11, 1874.
Oodecopus duplex.
Oodecopus serratus.

Off Kandavu, Fiji Islands.

Thalassinia scorpionoides.
Stenopus hispidus.

Caricyphus serratmarginis (1).
 August 11, 1874.

Kandavu. Fresh-water.

Bithynis lar (23 ♂ ♀).

Ovalau, Fiji Islands. Fresh-water rivers.

Bithynis lar.

STATION 175. August 12, 1874; lat. 19° 2' S., long. 177° 10' E.; Fiji Islands; depth, 1350 fathoms; bottom, Globigerina ooze; bottom temperature, 36°. Trawled.

Glyphocrangon acuminata (22 ♀ ♂).

STATION 176. August 15, 1874; lat. 18° 30' S., long. 173° 52' E.; off the New Hebrides.

Nematocarcinus productus.

STATION 177. August 18, 1874; lat. 16° 45' S., long. 168° 7' E.; off the New Hebrides; depth, 130 fathoms; bottom, volcanic sand. Dredged.

Hemipenæus tomentosus (1 ♀).

New Hebrides. Surface.

Penæus gracilis.
Sergestes rinkii.
Sergestes ancylops.

Lucifer reynaudii.
Oodecopus serratus.
Oodecopus armatus.

Oodecopus duplex.

Between Api and Cape York. Surface.

Rhomaleocaris hamulus.

Hectarthropus compressus (1).

STATION 181. August 25, 1874; lat. 13° 15' S., long. 151° 49' E.; depth, 2440 fathoms; bottom, red clay; bottom temperature, 35°·8. Trawled.

Benthesicymus brasiliensis (1 ♂).

Acanthephyra sica (1).

STATION 184. August 29, 1874; lat. 12° 8' S., long. 145° 10' E.; near Torres Strait; depth, 1400 fathoms; bottom, Globigerina ooze; bottom temperature, 36°. Trawled.

<i>Penæus velutinus</i> (2).	|	<i>Benthescymus altus</i> (1).
<i>Penæus serratus</i> (1).	|	<i>Pontophilus gracilis</i> (1 ♂).
<i>Aristeus armatus</i> (3 ♂ ♀).	|	<i>Tropiocaris tenuipes</i> (1 ♂).
<i>Benthescymus brasiliensis</i> (4 ♀ ♂).	|	<i>Hymenodora rostrata</i> (1 ♂).

Cape York.

<i>Sergestes corniculum</i>.	|	<i>Oodeopus geminidentatus</i> .
<i>Pontonia meleagrina</i> . (Presented to the Challenger at Sydney.)	|	<i>Oodeopus armatus</i> .
	|	<i>Oodeopus intermedius</i> .
	|	<i>Oodeopus duplex</i> .

Albany Island, Cape York.

<i>Alpheus avarus</i>.	|	<i>Betæus microstylus</i> (1).
<i>Alpheus crassimanus</i>.	|	<i>Paralpheus diversimanus</i> (2 ♂ ♀).

STATION 186. September 8, 1874; lat. 10° 30' S., long. 142° 18' E.; Flinders Passage, Cape York; depth, 8 fathoms; bottom, coral mud. Dredged.

<i>Penæus velutinus</i> (2).	|	<i>Alpheus acutofemoratus</i> .
<i>Cheirothrix parvimanus</i> (1).	|	<i>Paralpheus diversimanus</i> (6 ♀ ♂).
	|	<i>Synalpheus falcatus</i> (6 ♀ ♂).

STATION 187. September 9, 1874; lat. 10° 36' S., long. 141° 55' E.; Torres Strait; depth, 6 fathoms; bottom, coral mud. Dredged.

Penæus velutinus (2 ♀).

STATION 188. September 10, 1874; lat. 9° 59' S., long. 139° 42' E.; Arafura Sea; depth, 28 fathoms; bottom, green mud. Trawled and dredged.

<i>Cheramus orientalis</i> (1).	|	<i>Penæus anchoralis</i> (7 ♂ ♀).
<i>Thenus orientalis</i> (1).	|	<i>Plecticus pectinatus</i> (1 ♂).
<i>Penæus monodon</i> (2).	|	<i>Sicyonia lancifer</i> (1).
<i>Penæus velutinus</i> (43).	|	<i>Dorodotes levicarina</i> (2 ♂).
<i>Penæus incisipes</i> (7).	|	<i>Nematocarcinus proximatus</i> (15 ♂ ♀).

STATION 190. September 12, 1874; lat. $8^{\circ} 56'$ S., long. $136^{\circ} 5'$ E.; Arafura Sea; depth, 49 fathoms; bottom, green mud. Trawled.

<i>Arctus tuberculatus</i> (2).	|	<i>Penæus anchoralis</i> (2 ♂).
<i>Penæus velutinus</i> (19).	|	<i>Penæus fissurus</i> (3 ♂ ♀).
<i>Penæus incisipes</i> (1).	|	<i>Pontocaris pinnata</i> (3 ♀ ♂).
<i>Nothocaris binoculus</i> (4 ♀ ♂).		

Arafura Sea.

<i>Penæus anchoralis</i> (1 ♂).	|	<i>Lucifer reynaudii</i> .
<i>Lucifer typus</i>.	|	<i>Alpheus avarus</i> .
<i>Alpheus neptunus</i> (1 ♀).		

STATION 191. September 23, 1874; lat. $5^{\circ} 41' 0''$ S., long. $134^{\circ} 4' 30''$ E.; off the Arrou Islands; depth, 800 fathoms; bottom, green mud. Trawled.

<i>Phoberus tenuimanus</i> (1).	|	<i>Merhippolyte orientalis</i> (1).
<i>Nephropsis suhmi</i> (1).	|	<i>Acanthephyra acutifrons</i> (1 ♂).
<i>Haliporus neptunus</i> (2).	|	<i>Proctes biangulatus</i> (1).

STATION 192. September 26, 1874; lat. $5^{\circ} 49' 15''$ S., long. $132^{\circ} 14' 15''$ E.; off Papua; depth, 140 fathoms; bottom, blue mud. Trawled.

<i>Arctus sordidus</i> (2).	|	<i>Penæus philippinensis</i> (2 ♂).
<i>Ibaccus brevipes</i> (1).	|	<i>Nothocaris rostricrescentis</i> (1).
<i>Pontocaris propensalata</i> (1 ♂).	|	<i>Pleoticus lucasii</i> (1 ♀).

STATION 194. September 29, 1874; lat. $4^{\circ} 34' 0''$ S., long. $129^{\circ} 57' 30''$ E.; off Banda Island; depth, 200 fathoms; bottom, volcanic mud. Dredged.

<i>Cheiroplatea cenobita</i> (1 ♀).	|	<i>Acanthephyra angusta</i> (2).
<i>Hemipenæus semidentatus</i> (1 ♀).	|	<i>Acanthephyra sica</i> (4).
<i>Glyphocrangon regalis</i> (1 ♀).	|	<i>Acanthephyra armata</i> (1 ♂).
<i>Heterocarpus dorsalis</i> (2 ♀).	|	<i>Acanthephyra brachytelsonis</i> (2).
<i>Heterocarpus lævigatus</i> (1 ♂).	|	<i>Nematocarcinus undulatipes</i> (1 ♀).

STATION 194A. September 29, 1874; lat. $4^{\circ} 31' 0''$ S., long. $129^{\circ} 57' 20''$ E.; off Banda Island; depth, 360 fathoms; bottom, volcanic mud. Trawled.

<i>Eiconaxius acutifrons</i> (1).		<i>Cheiroplatea cenobita</i> (1).
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STATION 195. October 3, 1874; lat. $4^{\circ} 21'$ S., long. $129^{\circ} 7'$ E.; off Banda Island; depth, 1425 fathoms; bottom, blue mud; bottom temperature, 38° . Trawled.

<i>Dorodotes reflexus</i> (1 ♂).	|	<i>Nematocarcinus productus</i> (1 ♀).
<i>Notostomus longirostris</i> (1 ♂).		

Banda Island. Fresh-water.

Bithynis lar (3 ♀).

Amboina.

Scallasis amboinæ (1).*Nika processa* (1 ♀).

Celebes Sea.

Oodeopus longispinus. October 1874.

STATION 196. October 13, 1874; lat. 0° 48' 30" S., long. 126° 58' 30" E.; near the Philippine Islands; depth, 825 fathoms; bottom, hard ground; bottom temperature, 36°·9. Trawled.

Haliporus neptunus (3 ♀ ♂).*Oplophorus typus* (1 ♀).

STATION 198. October 26, 1874; lat. 2° 55' N., long. 124° 53' E.; near the Philippine Islands; depth, 2150 fathoms; bottom, blue mud; bottom temperature, 38°·9. Trawled.

Pontophilus gracilis (2 ♀).*Nematocarcinus altus* (1 ♂).*Acanthephyra longidens* (1 ♂).*Notostomus patentissimus* (1 ♀).*Notostomus perlatus* (1 ♂).

Philippine Islands. Surface.

Phyllosoma philippinense.*Lucifer typus*.*Lucifer reynaudi*.

STATION 200. October 23, 1874; lat. 6° 47' N., long. 122° 28' E.; off Sibago, Philippine Islands; depth, 250 fathoms; bottom, green mud. Trawled.

Ibaccus verdi (1).*Heterocarpus ensifer* (2 ♂).*Haliporus equalis* (7 ♀).*Plesionika semilævis* (16 ♀ ♂).*Hemipenæus virilis* (2 ♂).*Plesionika brevirostris* (1 ♀).*Hemipenæus tomentosus* (2 ♀).*Palæmonella orientalis* (1).*Pontophilus junceus* (1 ♀).*Nematocarcinus undulipes* (15 ♀ ♂).

Off Sibago, Philippine Islands; October 23, 1874.

Sestertius duplicidentis.*Latreutes unidentatus*.*Parathanas decorticus* (1). 80 fathoms.*Kyptocaris stylofrontalis* (1).*Latreutes planus* (1).*Anebocharis quadroculus* (1).*Oodeopus serratus*.

Off Basilan Strait, October 23, 1874. Surface.

<i>Aneboecaris quadroculus</i> (5).	|	<i>Hectarthropus exilis</i> .
		<i>Hectarthropus expansus</i> .

STATION 201. October 26, 1874; lat. 7° 3' N., long. 121° 48' E.; Basilan Strait; depth, 82 fathoms; bottom, stones, gravel. Trawled.

<i>Penæus philippinensis</i> (27 ♀ ♂).		<i>Nothocaris ocellus</i> (2 ♀ ♂).
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Off Samboangan, Philippine Islands.

<i>Lucifer typus</i> .		<i>Alpheus crinitus</i> (1 ♂).
<i>Sestertius duplicidentis</i> .		<i>Caricyphus cornutus</i> (1).
<i>Bithynus lar</i> (4 ♂ ♀).		Fresh-water.

Mindanao, Philippines.

<i>Zoontocaris approximus</i> .		<i>Bithynis lar</i> . Fresh-water.
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STATION 203. October 31, 1874; lat. 11° 6' N., long. 123° 9' E.; off Panay, Philippines; depth, 20 fathoms; bottom, mud. Trawled.

<i>Penæus indicus</i> (1).	|	<i>Penæus incisipes</i> (4).
<i>Penæus monodon</i> (2).	|	<i>Alpheus leviusculus</i> (1 ♀).

STATION 204A. November 2, 1874; lat. 12° 43' N., long. 122° 9' E.; off Tablas Island; depth, 100 fathoms; bottom, green mud. Trawled.

<i>Nephrops thomsoni</i> (1 ♂).		<i>Penæus fissurus</i> (1).
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STATION 204B. November 2, 1874; lat. 12° 46' N., long. 122° 10' E.; off Tablas Island; depth, 115 fathoms; bottom, green mud. Trawled.

Penæus fissurus (2 ♀).

STATION 205. November 13, 1874; lat. 16° 42' N., long. 119° 22' E.; off Luzon Island; depth, 1050 fathoms; bottom, blue mud; bottom temperature, 37°. Trawled.

<i>Haliporus lævis</i> (1 ♀).	|	<i>Dorodotes reflexus</i> (2 ♀ ♂).
<i>Benthesicymus pleocanthus</i> (2 ♀ ♂).	|	<i>Nematocarcinus productus</i> (6 ♀ ♂).
<i>Benthesicymus altus</i> (1 ♀).	|	<i>Hymenodora rostrata</i> (1 ♂).

STATION 206. January 8, 1875; lat. 17° 54' N., long. 117° 14' E.; off Luzon Island; depth, 2100 fathoms; bottom, blue mud; bottom temperature, 36.5. Trawled.

Gennadas parvus (♀).

China Sea, off Luzon. Surface.

<i>Sergestes intermedius.</i>	|	<i>Caricyphus turgidus</i> (1).
<i>Sergestes reynaudii.</i>	|	<i>Anebocaris quadroculus</i> (1).

Off Hong Kong; depth, 10 fathoms.

<i>Alpheus rapax</i> (1 ♂).		<i>Nauticaris unirecedens</i> (1 ♀).
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STATION 207. January 16, 1875; lat. 12° 21' N., long. 122° 15' E.; off Tablas Island, Philippines; depth, 700 fathoms; bottom, blue mud; bottom temperature, 51°·6. Trawled.

<i>Hemipenæus gracilis</i> (6 ♀ ♂).	|	<i>Heterocarpus gibbosus</i> (1).
<i>Sergestes japonicus</i> (2 ♀).	|	<i>AcanthePHYRA media</i> (2 ♀ ♂).
		<i>Oplophorus brevirostris</i> (1).

STATION 208. January 17, 1875; lat. 11° 37' N., long. 123° 31' E.; off Manilla; depth, 18 fathoms; bottom, blue mud. Trawled.

<i>Alpheus crinitus</i> , Dana (1 ♀).	|	<i>Alpheus spiniger</i> , Stimpson (1 ♀).
		<i>Alpheus biunguiculatus</i> (2 ♀).

Zebu Harbour.

<i>Parathanas immaturus.</i>		<i>Anebocaris quadroculus</i> (3).
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STATION 209. January 22, 1875; lat. 10° 14' N., long. 123° 54' E.; off Zebu, Philippines; depth, 95 fathoms; bottom, blue mud; bottom temperature, 71°. Trawled and dredged.

<i>Arctus orientalis</i> (2 ♀ ♂).	|	<i>Penæus fissurus</i> (10 ♀ ♂).
<i>Spongicola venusta</i> (many ♀ ♂).	|	<i>Penæus rectacutus</i> (1 ♀).

STATION 213. February 8, 1875; lat. 5° 47' N., long. 124° 1' E.; south of the Philippines; depth, 2050 fathoms; bottom, blue mud; bottom temperature, 38°·8. Trawled.

<i>Hemipenæus spinidorsalis</i> (1).	|	<i>Alpheus minus</i> (1).
<i>Aristeus armatus</i> (1).	|	<i>AcanthePHYRA acutifrons</i> (1 ♂).

STATION 214. February 10, 1875; lat. $4^{\circ} 33' N.$, long. $127^{\circ} 6' E.$; south of the Philippines; depth, 500 fathoms; bottom, blue mud; bottom temperature $41^{\circ} \cdot 8$. Trawled.

<i>Pentacheles lævis</i> (1 ♀).	|	<i>Acantheephyra brachytelsonis</i> (3).
<i>Benthesicymus altus</i> (3 ♂).	|	<i>Acantheephyra acutifrons</i> (1).
<i>Heterocarpus alphonsi</i> (14 ♀ ♂).	|	<i>Nematocarcinus undulatipes</i> (3 ♂ ♀).
	|	<i>Nematocarcinus tenuirostris</i> (5).

STATION 215. February 12, 1875; lat. $4^{\circ} 19' N.$, long. $130^{\circ} 15' E.$; near the Philippine Islands; depth, 2550 fathoms; bottom, red clay; bottom temperature, $35^{\circ} \cdot 4$. Trawled.

Hymenodora glauca (1).

STATION 218. March 1, 1875; lat. $2^{\circ} 33' S.$, long. $144^{\circ} 4' E.$; north of New Guinea; depth, 1070 fathoms; bottom, blue mud; bottom temperature, $36^{\circ} \cdot 4$. Trawled.

<i>Paraxius altus</i> (1).	|	<i>Glyphocrangon granulosus</i> (2 ♀ ♂).
<i>Polycheles helleri</i> (1).	|	<i>Nematocarcinus tenuipes</i> (1 ♂).
<i>Pentacheles obscura</i> (1).	|	<i>Nematocarcinus intermedius</i> (2 ♀ ♂).

STATION 219. March 10, 1875; lat. $1^{\circ} 54' 0'' S.$, long. $146^{\circ} 39' 40'' E.$; north of New Guinea; depth, 150 fathoms; bottom, coral mud. Trawled.

<i>Panulirus angulatus</i> (1).	|	<i>Plesionika spinipes</i> (8 ♂ ♀).
<i>Penæus philippinensis</i> (10 ♂ ♀).	|	<i>Plesionika unidens</i> (4 ♂ ♀).
<i>Sicyonia lævis</i> (1).	|	<i>Stylodactylus bimaxillaris</i> (1 ♀).

STATION 220. March 11, 1875; lat. $0^{\circ} 42' S.$, long. $147^{\circ} 0' E.$; north of New Guinea; depth, 1100 fathoms; bottom, Globigerina ooze; bottom temperature, $36^{\circ} \cdot 2$. Trawled.

<i>Gennadas parvus</i> (3 ♀).		<i>Oplophorus typus</i> (1 ♀).
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North of New Guinea. Surface.

<i>Sergestes corniculum</i> .		<i>Sciacaris telsonis</i> .
<i>Sergestes læviventralis</i> .		<i>Amphion zoea</i> .

STATION 227. March 27, 1875; lat. $17^{\circ} 29' N.$, long. $141^{\circ} 21' E.$; surface temperature, $79^{\circ} \cdot 2$. Surface.

Eretmocaris longicaulis (1).

STATION 230. April 5, 1875; lat. 26° 29' N., long. 137° 57' E.; south of Japan; depth, 2425 fathoms; bottom, red clay; bottom temperature, 35°·5. Trawled.

<i>Gennadas parvus</i> (1 ♂).	|	<i>Acanthephyra sica</i> (2 ♂).
		<i>Tropiocaris planipes</i> (1 ♀).

Japan.

Penæus canaliculatus, var. *japonicus*.

Off Yokoska, Japan; depth, 5 to 20 fathoms.

<i>Crangon vulgaris</i> .		<i>Alpheus longimanus</i> (4 ♀).
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STATION 232. May 12, 1875; lat. 35° 11' N., long. 139° 28' E.; *Hyalonema*-ground, off Japan; depth, 345 fathoms; bottom, green mud; bottom temperature, 41°·1. Trawled and dredged.

<i>Benthescymus altus</i> (1).	|	<i>Heterocarpus alphonsi</i> (1 ♂).
<i>Gennadas parvus</i> (4 ♀ ♂).	|	<i>Acanthephyra brachytelsonis</i> (3 ♀ ♂).
<i>Sergestes atlanticus</i> (1 ♀).	|	<i>Systellaspis lanceocaudata</i> (1).
<i>Glyphocrangon hastacauda</i> (1 ♀).	|	<i>Nematocarcinus tenuipes</i> (6 ♂ ♀).

STATION 233. May 17, 1875; lat. 34° 39' N., long. 135° 14' E.; Bay of Kobé, Japan; depth, 8 fathoms; bottom, mud. Dredged.

<i>Penæus velutinus</i> (21).	|	<i>Alpheus longimanus</i> (4 ♀ ♂).
<i>Crangon affinis</i> , de Haan (8 ♀).	|	<i>Alpheus longimanus</i> (4).

STATION 233A. May 19, 1875; lat. 34° 38' N., long. 135° 1' E.; off Japan; depth, 50 fathoms; bottom, sand. Dredged.

<i>Crangon affinis</i> (4 ♀).	|	<i>Nauticaris futilirostris</i> (1).
		<i>Leptochela gracilis</i> (2 ♀ ♂).

STATION 233B. May 26, 1875; lat. 34° 18' N., long. 133° 35' E.; depth, 15 fathoms; bottom, blue mud. Trawled.

Crangon affinis (4 ♀ ♂).

(?) STATION 234. June 3, 1875; lat. 32° 31' N., long. 135° 59' E.; off Japan.

<i>Penæus velutinus</i> (2 ♀).		<i>Alpheus avarus</i> (1 ♀).
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STATION 235. June 4, 1875; lat. 34° 7' N., long. 138° 0' E.; south of Japan; depth, 565 fathoms; bottom, green mud; bottom temperature, 38°·1. Trawled.

<i>Penæus tenellus.</i>	|	<i>AcanthePHYRA sica</i> (2 ♀ ♂).
<i>Benthescymus altus</i> (4 ♀ ♂).	|	<i>Nematocarcinus tenuipes</i> (6 ♂ ♀).
<i>Gennadas parvus</i> (♀).	|	<i>Notostomus japonicus</i> (1 ♂).

STATION 236. June 5, 1875; lat. 34° 58' N., long. 139° 29' E.; south of Japan; depth, 775 fathoms; bottom, green mud; bottom temperature, 37°·6. Trawled.

<i>Sergestes prehensilis</i> (1 ♂).	|	<i>Pasiphæa amplidens</i> (1).
<i>AcanthePHYRA brachytelsonis</i> (1 ♀).	|	<i>Pasiphæa acutifrons</i> (1).

STATION 237. June 17, 1875; lat. 34° 37' N., long. 140° 32' E.; near Yokohama; depth, 1875 fathoms; bottom, blue mud; bottom temperature, 35°·3. Trawled.

<i>Aristeus armatus</i> (1 ♀).	|	<i>Nematocarcinus productus</i> (1 ♀).
<i>Hepomadus glacialis</i> (1 ♀).	|	<i>Nematocarcinus parvidentatus</i>
<i>Gennadas parvus</i> (1 ♀).	|	(9 ♂ ♀).
<i>Glyphocrangon rimapes</i> (1 ♀).	|	<i>Nematocarcinus longirostris</i>
<i>Nematocarcinus proximatus</i> (1 ♀).		(10 ♀ ♂).

Off Yokohama.

<i>Penæus velutinus</i> (6 ♂ ♀).		? <i>Thalassocaris stimpsoni</i> (1). Surface.
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North-west Pacific.

<i>Sergestes corniculum.</i>		<i>Eretmocaris rimapes.</i>
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West Pacific.

<i>Sergestes semiarmis.</i>		<i>Lucifer typus.</i>
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North Pacific.

<i>Sergestes edwardsii.</i>		<i>Lucifer typus.</i>
<i>Amphion reynaudii.</i>		

STATION 245. June 30, 1875; lat. 36° 23' N., long. 174° 31' E.; depth, 2775 fathoms; bottom, red clay; bottom temperature, 34°·9.

Hymenodora rostrata (1). In tow-net at 1700 fathoms.

STATION 246. July 2, 1875; lat. $36^{\circ} 10' N.$, long. $178^{\circ} 0' E.$; depth, 2050 fathoms; bottom, Globigerina ooze; bottom temperature, $35^{\circ} \cdot 1$. Trawled.

Aristeus armatus (1 ♂).

STATION 250. July 9, 1875; lat. $37^{\circ} 49' N.$, long. $166^{\circ} 47' W.$; depth, 3050 fathoms; bottom, red clay; bottom temperature, 35° . Trawled.

Benthescymus pleocanthus (2 ♂). | *Gennadas parvus* (1).

STATION 254. July 17, 1875; lat. $35^{\circ} 13' N.$, long. $154^{\circ} 43' W.$; surface temperature, 72° . Surface.

Aristeus (young).

North Pacific; July 20, 1875.

Sergestes ancylops.

STATION 256. July 21, 1875; lat. $30^{\circ} 22' N.$, long. $154^{\circ} 56' W.$; depth, 2950 fathoms; bottom, red clay; bottom temperature, $35^{\circ} \cdot 2$. Dredged.

Sergestes armatus (1).

STATION 257. July 23, 1875; lat. $27^{\circ} 33' N.$, long. $154^{\circ} 55' W.$; surface temperature, $76^{\circ} \cdot 5$. Surface.

Sergestes oculatus (1).

Off the Sandwich Islands.

Sergestes parvidens.

| *Lucifer* (young).

Sergestes ventridentatus.

| *Lucifer reynaudii*.

North Pacific, August 21, 1875.

Sergestes oculatus.

Honolulu; fresh-water rivers.

Atya bisulcata (100 ♀ ♂).

| *Bithynis grandimanus*.

Honolulu (reefs).

Alpheus lævis (1 ♂).

Off Honolulu; depth, 18 fathoms.

Alpheus prolificus (1 ♀).