

that compresses and holds down the posterior margin of the carapace; the short fur on the post-orbital regions, extending on each side of the gastric region of the carapace, and repeated on the third and fourth somites of the pleon; and the strength, and more particularly the form of the several parts of the rhipidura or tail-fan, which is formed by the sixth pair of pleopoda and the telson.

The sixth pair of pleopoda is implanted on the ventral surface within the margin of the coxal plate and is directed anteriorly, and the outer plate is very much longer than the inner, and possesses a diæresis near its distal extremity. Although the outer or anterior plate is very much longer than the posterior, yet the latter equals the length of the posterior margin of the former, and their distal margins form a continuous line. The telson is quadrate, and the terminal or distal margin when depressed a little forwards is continuous with the posterior margin of the rami of the sixth pair of pleopoda, and this is capable of resting through its entire length against the floor on which the animal lies, and so enables it to creep backwards with considerable persistence and power.

The large chelate pereopoda differ on each side; each is furnished with long delicate spine-like teeth, but that on the left shows most probably the character and appearance of the normal chela, while that on the right exhibits an extensive deviation. The propodos has increased in size as a consequence of the powerful muscles necessary to sustain and carry the enormously long dactylos and pollex, which nearly equal the entire length of the animal; the form of the chela is that of two combs meeting, and it appears probable that when partially closed it has the power of raking the neighbourhood to a considerable distance, and so entrapping small animals and other material from which the blind creature has the power of selecting its food, which it carries to its mouth by means of its smaller chelate pereopoda, the larger ones from their length being incapable of that office. The mouth is furnished with a pair of powerful denticulated mandibles, that are evidently capable of crushing tolerably hard substances. The anterior lip is calcified, firm, and denticulate on the antero-external margin (Pl. VI. fig. c). The epistoma is horizontal or nearly so, and occupies a considerable space between the antennæ and the mouth, separating the phymacerite to a considerable distance from it. The phymacerite is very large, and is situated on the first or coxal joint of the second or outer pair of antennæ, which is short, broad, and separated from the body by a distinct suture.

This animal is intermediate in character between *Thalassina* and the Astacidæ, to which latter family Willemoes-Suhm first referred it under the name of *Astacus zaleucus*. Its nearest congener appears to be *Calocaris*, Bell, of the British seas, from which it differs in the third pair of pereopoda being minutely chelate instead of monodactyle, and in having no apparent organs of vision, instead of, as in *Calocaris*, having the "eyes rudimentary, sub-globose, without any pigment or cornea," which, when Bell described it in 1853, was a feature "unique in the whole of the higher forms of Crustacea." *Calocaris*

was first taken from the stomach of a flat fish by Mr. W. Thomson, and in 1845 by MacAndrew and Professor Forbes in Loch Fyne, at a depth of 80 fathoms, and more recently (1869) by G. O. Sars, in 150 fathoms of water, in several places off the coast of Norway,¹ in which situation it is fossorial in sandy mud. Living at such a depth, and being of fossorial habits, distinct vision would be useless, and this at once accounts for the rudimentary character of its eyes, the colour of which is entirely white. "The general colour [of the animal] is a delicate pink or pale rose, varying in depth in different parts."

Dr. v. Willemoes-Suhm in his account of *Thaumastocheles* (*loc. cit.*, p. 50), says: "*A. zaleucus*, came up on the swabs of the dredge, together with the large chelæ of another smaller specimen, the body of which was lost. The one we got had the red colour of all deep-sea Crustacea. It lived on a bottom of Globigerine ooze, evidently frequented by a great many animals. Several Sponges and seven Echinoderms (*Ophiomusium*, *Luidia*, *Archaster*, *Astrogonium*, *Cidaris*, and *Echinus*), a *Planularia*, *Mopsea*, and an *Isis*, several Annelids, and a *Sipunculus*, a *Galathea*, a Peneid, an *Arcturus*, and the fine Crustacean, to which was given the name of *Willemæsia crucifera*,—four Bryozoa, a *Dentalium*, and many small shells—finally, a fish probably belonging to the genus *Chauliodus*, were got in the same place with this extraordinary *Astacus*. Unfortunately, our stay in the West Indies was only a very short one. The few hauls, however, which we had near Sombrero Island and St. Thomas showed us that a great quantity of new and probably also interesting animals live there in moderate depths (300 to 400 fathoms)."

The specimen is a female, but without any ova attached.

¹ Undersøgelser over Hardangerfjordens Fauna; 1 Crustacea, af G. O. Sars (*Uoversigt K. D. Vid. Selekt. Forhandl.*, 1871):



FIG. 4A.—*Thaumastocheles zaleuca*, from a drawing by Dr. v. Willemoes-Suhm (natural size).

Group NORMALIA.

This group consists of those Trichobranchiate Macrura in which the branchiæ are well developed, and the pleon does not preponderate in importance over the carapace.

It consists of three tribes, that present peculiarly distinctive features, illustrated in their external form, their structural character, and development, as shown in the subjoined table :—

	Triba.	Family.	Genus.	Brephalos.
NORMALIA.	Synaxidea,	SCYLLARIDÆ,	<i>Ibaccus.</i> <i>Paribaccus.</i> <i>Pseudibaccus.</i> <i>Thenus.</i> <i>Scyllarus.</i> <i>Arctus.</i>	Phyllosoma.
		PALINURIDÆ,	<i>Linuparis.</i> <i>Panulirus.</i> <i>Palinurus.</i> <i>Palinostus.</i> <i>Synaxes.</i>	
	Astacidea,	ERYONIDÆ,	<i>Eryon.</i> <i>Eryoneicus.</i> <i>Eryonasticus.</i> <i>Polycheles.</i> <i>Pentacheles.</i> <i>Stereomastis.</i> <i>Willemæsia.</i>	Megalopa.
		HOMARIDÆ,	<i>Phoberus.</i> <i>Nephropsis.</i> <i>Nephrops.</i> <i>Homarus.</i>	
		ASTACIDÆ,	<i>Cambarus.</i> <i>Astacus.</i> <i>Astucoides.</i> <i>Parastacus.</i> <i>Paranephrops.</i> <i>Astacopsis.</i> <i>Engæus.</i> <i>Cherops.</i>	
	Stenopidea,	STENOPIDÆ,	<i>Stenopus.</i> <i>Spongicola.</i>	Zoea.

Tribe Synaxidea.

Branchiæ well developed, having mastigobranchial plates attached to all the pereopoda except the posterior pair. Podobranchia attached to all the mastigobranchiæ as distinct plumes. Arthrobranchiæ attached to the joints of all the pereopoda, and pleurobranchiæ to the walls of the four posterior somites of the pereion. First pair of antennæ terminating in two flagella. Second pair without any scaphocerite. Pereiopoda six-jointed, having no perfect chela. First pair of pereiopoda, but little larger than the

second, sub-chelate, the pollex never being produced beyond the length of the dactylos. The three following pairs monodactyle or imperfectly chelate. The posterior pair is more or less minutely chelate in the female, and monodactyle in the male.

This tribe consists of genera that differ widely in their external aspect, but are closely associated in structural affinities and development. Some are dorsally depressed, others are laterally compressed. Some have the ophthalmopoda projecting on an advanced somite, others have them lodged in orbits excavated in the frontal margin of the carapace. Some have the second pair of antennæ long and slender, while others have them reduced to a short discoid plate.

But they all agree in the following points:—the character of the branchiæ, the absence of a scaphocerite attached to the second pair of antennæ, in having only six joints to the pereopoda, in having no true chela, in having the ova very small, and in the Phyllosoma condition of the brephalos. The examination of an undescribed form which I have named *Synaxes*,¹ in which several features of these two families are combined, has induced me to arrange them all under one head. *Synaxes* has the antennæ of *Palinurus*, while the pereopoda are like those of *Scyllarus*, the carapace is like that of *Astacus*, and the pleopoda like those of *Scyllarus*. Having no means of knowing the character of the brephalos when it quits the ovum, and as both *Palinurus* and the Scyllariform genera have the young hatched in the megalopa stage, resembling Phyllosoma, I am induced, until future observation demonstrates the fact, to believe that the brephalos of *Synaxes* also resembles Phyllosoma. I therefore follow the arrangement of previous authors and place the tribe under two families, into which it naturally divides, Scyllaridæ and Palinuridæ.

Family SCYLLARIDÆ.

Carapace horizontally depressed. Eyes implanted in orbits excavated in the dorsal surface of the cephalon. Second pair of antennæ short, squamiform. The mandibles bearing a uniarticulate synhipod. Pereopoda simple, excepting the posterior pair of the female which is minutely chelate.

Ibaccus, Leach.

Geographical Distribution.—*Ibaccus incisus* has been recorded from New Holland and the adjacent seas; *Ibaccus antarcticus* from Japan and the coasts of Asia; and *Ibaccus parræ* from the Antilles. Stimpson found *Ibaccus novemdentatus* at Hong Kong. De Haan obtained *Ibaccus ciliatus* from Japan. *Ibaccus brevipes* was taken south of New Guinea; *Ibaccus alticrenatus* off New Zealand, and *Ibaccus verdi* was taken in the Atlantic.

No specimen of this genus, so far as I am aware, has ever been found fossil.

¹ *Ann. and Mag. Nat. Hist.*, ser. 5, vol. vii. p. 220, pl. xiv.

Ibaccus verdi, n. sp. (Pl. VII. fig. 2; Pl. VIII.).

This species bears a general resemblance to *Ibaccus incisus* (Péron) (*Ibaccus peronii*, Leach), but has the lateral margins of the carapace armed with seventeen teeth posterior to the cervical notch, and two small teeth on the angular cusp anterior to it. There are six teeth along the lateral margin of the third antennal joint, which does not slope inwardly so much as in *Ibaccus incisus*. The terminal scale has the distal margin fringed with nine strong short teeth in the female. In most other important points this species nearly resembles *Ibaccus incisus*.

The male differs from the female in having the distal margin of the terminal scale of the second antennæ smooth or slightly wavy, and in having the posterior pair of pereopoda terminating in a sharp pointed lanceolate dactylos (Pl. VIII. fig. o, ♂), whereas in the female the dactylos is short (fig. o, ♀), and impinges against a short and robust pollex, entirely wanting in the male.

The pleopoda also differ very much in the two sexes.

In the male none are attached to the anterior somite, but the four succeeding have a pair each, successively diminishing posteriorly (Pl. VIII. figs. p and q, ♂). They consist of two branches, flat, narrow, curved, and pointed, the outer branch being sharper than the inner, and more distinctly defined in the posterior than in the anterior pairs. The branches are not on the same line, but the inner articulates at the apex, and the outer laterally with the basal joint. The margins of both branches are fringed with numerous hairs that are longer and more abundant on the anterior pairs than on the posterior.

The female, like the male, has no appendage attached to the first somite of the pleon; the second (Pl. VIII. fig. q, ♀) bears a pair of large two-branched foliaceous plates, standing on small stalks. The three following pairs are likewise two-branched, but the outer branch is small and foliaceous, articulating with the stem near its base, whereas the inner is three-jointed, long, narrow, stiff, and articulates with the stem at the extremity, except for the slight squamose extension at its base. These are fringed with very long hairs, much longer than shown in the plate.

Habitat.—St. Vincent, Cape Verde Islands, July 1873, depth 7 to 20 fathoms. Length,¹ 130 mm. (5.25 inches).

Station 200, off Samboangan, Philippine Islands, October 23, 1874; lat. 6° 47' N., long. 122° 28' E.; depth, 250 fathoms; green mud. Length, 114 mm. (4.25 inches).

Although several species of this genus have long been known, it will not be without considerable advantage to analyse the structure of the various parts, in order to enable us to compare them with their homologues, in forms that are thought to be more or less congeneric.

¹ In measuring the Scyllaridæ, I have taken the length from the extremity of the larger antennæ to that of the telson.

The body of the animal is dorsally considerably depressed, so that the sharp lateral margins which correspond with the branchial region in *Panulirus*, *Willemasia* and *Eryon*, are thinned out to an extent equalling that of some of the Brachyura, and the cervical fossa, which in the Macrura is frequently so very conspicuous, and ends in a slight notch, is absent in this species, while the lateral notch is deepened to a very considerable extent, and widely separates the suborbital and hepatic regions from the branchial. The pleon is also much depressed, and the coxal plates on each side are extended outwards rather than downwards, and the entire aspect of the animal suggests that it has, through a series of generations, been compelled to live where it was necessary to extend itself, under a constant heavy pressure, against some resisting body.

The eyes are implanted in orbits that are deeply excavated in the dorsal surface of the cephalon; the angles, more especially the external, are considerably produced, so that the orbit makes about two-thirds of a circle, the margin of which is fringed with a copious blepharis. The infero-anterior margin of the orbit also is excavated in the frontal surface, so that a glimpse of vision might have been obtained beneath, when the eyes were ensconced within the depth of the orbit.

The first pair of antennæ (Pl. VIII. fig. *C*, *b*) possesses much of the character of those of the Brachyura. The three joints of the peduncle are moderately long, and the terminal flagella short, arising from the circumstance that the numerous articuli, more especially in the primary branch, are extremely short and closely compressed together, so that the membranous cilia are gathered together in a closely-arranged mass. At the base of the first joint, on the upper surface, is a small tubercle, behind which the foramen, protected by a bundle of small hairs, opens into the auditory chamber.

The second pair of antennæ (Pl. VIII. fig. *C*, *c*) is of peculiar form, and characteristic of this family. It consists of five joints. The first or coxal joint is closely fused with the ventral portion of the cephalon, and carries on the inferior surface a phymacerite, which is planted so near the oral aperture, that it is covered and protected by the organs attendant on the mouth. The somite that carries this pair of antennæ is visible at the base of the first pair on the upper or dorsal surface in the form of two small plates (Pl. VIII. fig. *C*) dove-tailed into the frontal margin on each side of what in a normal condition would be the rostrum; the anterior margin of the carapace and the upper surface of the first antennal somite appear to be fused, and by the generally depressed character of the animal, are brought into a horizontal position in the same plane. The posterior margin dips beneath the anterior margin of the carapace, and passing laterally, forms the floor of the orbit, whence it continues upwards to the orbital notch, thence outwards, forming the great antero-lateral angle of the carapace, and, being reflexed on itself, returns and unites with the ventral walls of the coxal joint of the second pair of antennæ. The second or basal joint articulates with the first, with very little movement, and impinges very closely against the external lateral walls of the first

antennal somite. The third joint articulates with the second, at points situated at the internal and external angles, and externally is produced into a thin scale of large size, reaching as far as the lateral angle of the carapace; the anterior and posterior margins are parallel, and the external lateral angles are anteriorly produced to a sharp point, and the posterior rounded off. The fourth joint articulates with the third at points near the middle of the margin of the dorsal and ventral surfaces; it is produced to a tolerably sharp angle or tooth on the inner surface, but none upon the outer. The fifth or distal joint articulates with the fourth by points situated at the inner inferior angle and the upper exterior angle; the joint is flattened and distended to a thin plate or scale that corresponds with the extent of the squamous portion of the third joint; its anterior margin is thickly fringed with hairs, and on the upper surface, near the base, just beyond the articulation with the previous joint, is a slight elevation studded with numerous small imperforate depressions which correspond with prominent points on the inside, that have slightly bulbous and roughened extremities, apparently adapted for the purpose of muscular attachment. On the external surface, in a corresponding position beneath, is a circular depression, the surface of which is covered with thick, short fur, consisting of hairs thickly fringed with long delicate cilia.

The epistoma is reduced to a minimum. The cheiloglossa which articulates with it, is calcareous anteriorly, and dips beneath the mandibles, which meet each other over it.

The mandibles (Pl. VII. fig. 2, *d*) are strongly denticulate at the incisive margin, and carry a rather long, slightly curved uniarticulate synhipod; the apophysis is long and rather slender, and continues beyond the articulation at the extremity into a strong calcareous process at an obtuse angle, that supplies the place of the usual muscular attachment, near the molar tubercle, and enables the mandibles to open and close.

The metastoma is a single, thick-lobed mass, that closes over and behind the mandibles and first pair of siagnopoda.

The first pair of siagnopoda (Pl. VII. fig. 2, *e*) consists of two thin curved branches, having the extremity rounded and fringed with strong spines that pass into hairs at the upper margin of the outer and the lower margin of the inner. The two branches are sub-equal, and the margins are parallel; at the base of the outer is a small fasciculus of ciliated hairs.

The second pair of siagnopoda (*f*) consists of a single truncated branch, stunted in form, and excavated at the extremity, supported by a large, somewhat fan-shaped mastigobranchial plate; the narrow portion is directed anteriorly, the whole forming an efficient operculum against the exit of the water, which it has the power to confine within the branchial chamber.

The third pair of siagnopoda (*g*) consists of two branches and a mastigobranchial plate. The outer branch is double and longitudinally angular, truncated at the apex, and is connected with the mastigobranchia, being articulated with it; the inner branch

is foliaceous, narrow, with parallel straight sides, terminating in a rounded extremity fringed with spines.

The gnathopoda are short, peculiar, but not abnormal. The first pair has the dactylos broad and spatuliform, fringed with a series of deeply-implanted stiff spines; the propodos is broad, short, and flat, as is the carpos, which has the outer margin long and curved, the inner short, and consequently, in articulating at one extremity with the meros, and at the other with the propodos, induces a sudden and permanent curve; the meros is broad, and longer than either of the other joints, fringed on the inner side with long hairs; ischium short and broad, and fused with the basis, which carries a tolerably long ecpysis, terminating in a multiarticulate lash, fringed with hairs; coxa short, and supporting a broad mastigobranchia, with a narrow rigid neck, on the anterior side of which is a short and rather small podobranchia, while at the membranous pleural articulation two arthrobranchiæ are attached, the anterior being small, not larger than the podobranchia, and the posterior is much larger and longer.

The second pair of gnathopoda has the dactylos long and slender, diagonally flattened, and fringed with spines: the propodos is not longer than the dactylos, rounded on the outer side, and flattened on the side nearest the mouth; the carpos is short, curved, and arched, articulating with the meros on the under side (or that nearest the mouth); the meros is longer than either of the other joints, having the distal extremity produced into a large, smooth lobe that projects beyond the carpos; inner margin flattened, against which the reflexed distal joint presses; upper surface engrailed at the inner margin; outer margin flattened to a thin serrate crest: the ischium is broad and flattened to a thin, smooth crest on the outer margin, thickened on the inner side to a double margin, the upper of which is smooth, the lower evenly denticulated, the intermediate space being hollow and smooth: the basis is short and narrow, attached to if not actually anchylosed with the ischium, which is thickened on the inner side, where the distal angle is produced to a broad obtuse point, while the outer is flattened and shortened to a process that supports a rigid two-jointed ecpysis, the basal joint of which is serrate on the outer surface, and multi-articulate and hairy on the distal: the coxa is broad and flat on the outer surface, and produced to an obtuse tooth or point on the inner anterior angle. It supports a broad, bat-shaped mastigobranchia projected on a slender stalk, to which is attached a podobranchia about half its length; and to the podopleural articulation are attached two, not very large arthrobranchiæ.

The first pair of pereiopoda is acuminate, and but slightly more robust than the succeeding pairs, even in the male. It carries a pointed bat-shaped mastigobranchia, supported on a slender stem, to the base of which is attached a podobranchia about the same length as itself; to the podopleural articulation are attached two arthrobranchiæ, of which the anterior is the smaller, and lies over the posterior. The three succeeding pairs of pereiopoda have the branchial plumes larger than the first, and have

a pleurobranchia springing from a fissure that defines a separation between the somites; the point of attachment is very low, not very much above the podopleural articulation.

The second and succeeding pereopoda are themselves rather more slender than the first pair, but this is chiefly due to the lower margin of the propodos being hollowed or excavate in all but the first. The third pair in the female carries the foramen of the vulva near the inferior podopleural articulation, in the form of a circular opening on a prominent elevation. The fifth or last pair of pereopoda in the male carries the foramen of the vas deferens on the antero-inferior angle of the coxa, and is much larger in diameter than that of the vulvar opening in a female of corresponding size. This last pair of pereopoda has no mastigobranchia or branchial plume, except a pleurobranchia, and this is implanted very near to the podopleural articulation.

The arrangement of the branchiæ may be best seen in the following table:—

Pleurobranchiæ,	.	.	...	...	...	...	1	1	1	1
Arthrobranchiæ,	.	.	...	2	2	2	2	2	2	...
Podobranchiæ,	.	.	...	1	1	1	1	1	1	...
Mastigobranchiæ,	.	.	...	1	1	1	1	1	1	...
				h	i	k	l	m	n	o

This species affords the only specimens of the genus taken elsewhere than along the Pacific coasts of Asia and the Australasian Islands. Hence the similarity that it bears to *Ibaccus incisus* (Péron) is the more remarkable, and, judging by the several figures and descriptions published, the differences are slight, except in the character and number of the dentations that arm the margins of the carapace and antennæ.

Ibaccus brevipes, n. sp. (Pl. IX. fig. 1).

This species resembles *Ibaccus verdi*, and is armed with seventeen small teeth along the lateral margin of the branchial region of the carapace; none or only a fine serrature on the outer margin of the anterior angle of the carapace; three or four along the outer margin of the posterior antennal plate; and six or seven along the distal margin of the anterior antennal plate.

The pleopoda are very small and biramose, the inner ramus supporting a comparatively large stylamblys.

Length, 67 mm. (2·7 inches).

Habitat.—Station 192, September 26, 1874; lat. 5° 49' 15" S., long. 132° 14' 15" E.; off the Ki Islands; depth, 140 fathoms; blue mud.

There is but one specimen of this species in the collection, and that a male, which bears all the characteristics of being immature; and had it been taken anywhere near

where *Ibaccus verdi* was obtained, it would without hesitation be pronounced to be an undeveloped male of that species, which in most of its characteristics it much resembles.

It is about two inches and a half in length; and although a male, has seven strong points or teeth on the distal margin of the anterior antennal plate, which in *Ibaccus verdi* is smooth in this sex, and has nine strong dental points in the female, the margin also being more rounded than in the male, which is also the case in *Ibaccus brevipes*, and may be consequent upon its undeveloped state, since the males approach more nearly to the general external characters of the female the younger they are.

The pleopoda (Pl. IX. fig. 1*q*) are apparently in a very immature condition, but they exhibit features that appear not to belong to any other species. They are extremely minute, being indeed quite rudimentary. Upon being examined under a moderate magnifying power, they are seen to have two branches, the inner supporting a small secondary lobe. Each branch, as well as the basal joint, is short, bulbous, free from hairs, and attached at the base by a small pedicle. The branches are shorter than the basal joint, and the inner carries a short, stout stylamblys. In most other details this species resembles *Ibaccus verdi*, except that it is scarcely half as large. The Ki Islands, Arafura Sea, and the Cape Verde Islands, whence the two forms have been obtained, are nearly antipodal to each other, being in corresponding degrees of latitude north and south of the equator.

Ibaccus alticrenatus, n. sp. (Pl. IX. fig. 2).

Antebranchial or cervical notch deep and broad. Lateral margin of the branchial region armed with eight teeth, of which the anterior is very large and the posterior rudimentary; none on the anterior angle of the carapace, which is produced to a point; none on the outer or lateral margin of the posterior plate of the second pair of antennæ, and five or six teeth of equal size, distantly separated from each other, on the distal margin of the anterior plate.

The pleon has the coxal plates converging laterally to a point more acute anteriorly than posteriorly. Length, including antennæ, 87 mm. (3.5 inches).

Habitat.—Station 167, west of New Zealand, June 24, 1874; lat. 39° 32' S., long. 171° 48' E.; depth, 150 fathoms; bottom, blue mud; two males, and two females bearing ova.

This species approximates in appearance somewhat to *Thenus orientalis*. It is widest at the anterior margin of the carapace, and gradually narrows to the last somite of the pleon. The antebranchial cleft is very deep and wide, and furnished on the posterior margin with a fringe of rather long hairs. The anterior margin of the carapace is crenated externally to the orbits, which are circular, rather large, open in front, and fringed round the margin with a closely-packed blepharis. The outer and inner angles of the orbit are

produced to a sharp point; the antero-lateral angle of the carapace also terminates in a pointed process, curved upwards and forwards, the posterior margin of which is perfectly smooth. The anterior angle or tooth of the lateral branchial margin is large, and extends to a level with the antero-lateral angle of the carapace. Those posterior to it decrease in size gradually, until they become at the eighth reduced to a rudimentary condition.

The pleon, with the exception of the first somite, which is the narrowest, gradually diminishes in width posteriorly. This is due chiefly to the relative size of the coxal plate which is appended to each somite. Each is produced laterally to a point; in each succeeding somite the postero-lateral margin becomes more prominent, and in the fifth bears a second angle or point. There is a small central tooth on the posterior margin in the median line of the fifth somite, and a crenated edge along the posterior margin of the sixth.

The animal is extensively covered with a thick fur, longest on the second pair of antennæ and along the anterior edge of the several teeth on the lateral margin of the carapace. On the dorsal surface of the carapace, as well as on the pleon, the surface is smooth, the hairs apparently having been rubbed off by friction. Examination of the surface that has been protected shows that the fur partakes more of a pilose than of a hairy nature. The posterior pair of pereopoda has the dactylos in the male flat, lanceolate, and fringed with small hairs; and it articulates at a right angle with the narrowest axis of the propodos. In the female the dactylos is shorter and more robust than in the male, and carries on the middle of the inner side near the base an elevated oval ridge fringed with a regular series of fine spines corresponding with a stout pollex, about two-thirds of the length of the dactylos, and similarly armed with minute hair-like spines.

The ova were numerous, of a yellow colour, but none of them sufficiently developed to show the character of the brephalos.

Observations.—The general aspect of the animal agrees with that of *Ibaccus incisus*, (Péron) (*Ibaccus peronii*), as given by Leach,¹ which differs slightly from the figure given by Desmarest,² and in the description of the armature as given by Milne-Edwards.³ In Leach's figure there are six teeth represented on the lateral branchial margin of the carapace, posterior to the antibranchial cleft. Desmarest says there are five, and his figure shows that the number includes the anterior branchial angle, but not the anterior angle of the carapace in advance of the branchial cleft. Milne-Edwards agrees with Leach in his description:—"Bords lateraux de la carapace très obliques et armés de sept dents, dont une seule située au devant de la grande, échancrure latérale, et formant l'angle antérieure." We might be inclined to consider our species as being only a variety of *Ibaccus incisus*, but for one or two differences of importance. The chief of these is found in the formation of the second (homologically the third) joint of the second pair of antennæ,

¹ Zool. Miscell., vol. ii. p. 162, pl. cxix.

² Consid. des Crust., p. 183, pl. xxi. fig. 2.

³ Nat. Hist. des Crustacés, t. ii. p. 287.

which widens out into a broad scale whose anterior margin is crenated in gradually lessening degree as it approaches the antero-lateral angle, where it becomes quite smooth. This angle is prolonged forwards to an acute point, in a line with the outer angle of the anterior margin of the carapace, from which the outer margin recedes acutely backwards without any serration. The distal margin of the anterior joint of the same antenna is armed with six teeth, which are widely separated except the two inner, which are closer together. In the female these teeth are longer and sharper than in the male.

The antebanchial or cervical notch is broader than in *Ibaccus incisus*, and the anterior angle of the carapace is narrower and sharper. Our specimens are all about three inches and a half in length, whereas *Ibaccus incisus* is about five inches and a half.

The teeth on the margin of the carapace, inclusive of the anterior angle, are nine, of which the posterior is small, and in one female specimen two others yet smaller are visible. Another feature is that the lateral margin of the fifth somite of the pleon has a posterior as well as an anterior tooth or angle. Milne-Edwards in his description says that the fourth joint (meros) of the "pates-mâchoires externes" (second pair of gnathopoda) is armed with spines on the external margin. In our specimen I should call it serrate, but this is also the condition of the ischium or the third joint on the inferior margin of the inner side, as well as to a greater degree that of the outer margin of the first joint of the basephysis of the same appendage.

On the dorsal surface in the median line is a slight elevation, scarcely worthy of the designation of a crest, that terminates in a small point or tooth at the posterior margin of the fifth somite. This species appears to be a form nearly allied to the next genus.

Thenus, Leach.

Thenus, Leach, Zool. Miscell.

Scyllarus, Fabr., Suppl., p. 399; Latr., Hist. Nat. des Crust., t. vi. p. 81; Desmarest, Consid. des Crust., p. 182.

Geographical Distribution.—There appears to be only one species of this genus, and that is recorded mostly from the Indian Seas. Sir Walter Elliot found it at Waltair, on the Madras coast, Dr. Percival Wright at the Seychelles, and our small specimen was taken in the Arafura Sea.

There has been no record, so far as I am aware, of any species having been found in a fossil condition nearer than *Thenops scyllariformis*, Bell, from the London clay.

Thenus orientalis, Rumph.

Thenus orientalis, Rumph, Mus., part 2, fig. D; Milne-Edwards, Hist. Nat. des Crust., t. ii. p. 286.

Cancer (Astacus) arctus, Herbst, t. xi. p. 80, pl. xxx. fig. 1.

Scyllarus orientalis, Fabr., Suppl. p. 399; Latr., Hist. Nat. des Crust., t. vi. p. 181: Encycl., pl. cccxiv.; Desmarest, Consid. des Crust., p. 182, pl. xxxi. fig. 1.

Habitat.—Station 188, Arafura Sea, south of New Guinea; September 10, 1874; lat. 9° 59' S., long. 139° 42' E.; depth, 28 fathoms; bottom, green mud.

The only specimen taken was about 25 mm. (1 inch) in length, and had all the pleopoda in a very feeble and immature condition; just budding. From its young and imperfect character I have not been able to determine the sex to which the animal belongs.

Arctus, Dana.

Scyllarus (part.), Fabr., de Haan, et Auct.

This genus was established by Dana to contain several species that differed from the typical *Scyllarus* in having the external antennæ separated widely from each other, in having no ephysis attached to the second pair of gnathopoda, and in having nineteen branchiæ instead of twenty-one, as exist in *Scyllarus*.

It corresponds with the fifth subgenus of De Haan's genus *Scyllarus*.

Geographical Distribution.—This genus is found sparsely all over the northern hemisphere, in the warm temperate regions. *Arctus ursus* is found on the European shores as far north as the south coast of Devon and Cornwall, and south as far as the Mediterranean. *Arctus pygmæus* and *Arctus immaturus* are from the Canary and Cape Verde Islands, and *Arctus orientalis* is from the Philippine Sea. *Arctus americanus* has been found on the western coast of North America, *Arctus vitiensis* in the seas about the Fiji Islands, and *Arctus sordidus*, and *Arctus haani* in the seas about Japan. There is among the late General Hardwick's drawings, in the possession of the Plymouth Institution, the figure of a species resembling *Arctus pygmæus*, specifically named *ceylonensis*, after the locality where it was found, but I am not aware of its having been described.

Thenops scyllariformis, recorded by Bell¹ as having been found in the London clay, exhibits scarcely a feature that is not common to *Arctus*.

Arctus sordidus, Stimpson (Pl. IX. fig. 3).

Arctus sordidus, Stimpson, Proc. Acad. Nat. Sci. Phil., January 1860; Prodromus, &c., p. 8; Crust. Macr.

Carapace as long as wide at the anterior angles. Median crest bicuspidate; anterior cusp close behind the frontal margin; second much more elevated and larger than the

¹ *Palæont. Soc. Trans.*, pl. vii.

first, having the anterior extremity on a line with the posterior margins of the orbits. A third point is scarcely elevated above the dorsal surface, and corresponds with the posterior margin of the cervical sulcus. The lateral crests traverse the inner wall of the orbits, and are furnished with two small teeth above the eyes and one a little remote posteriorly. The extraorbital crests form the lateral angles, which are produced anteriorly beyond the intero-orbital angles. Two teeth, formed rather by excavations in the margin than by projection of substance, exist along the lateral margin, one immediately posterior to the line of the orbits, the other at some distance posteriorly.

The somites of the pleon form dorsally an obtuse ridge, and the telson is slightly longer than broad, and terminate in a rounded membranous margin.

Length, male 70 mm. (2·8 in.); female 75 mm. (3 in.).

Habitat.—Station 192, off the Ki Islands, Arafura Sea; September 26, 1874; lat. 5° 49' 15" S., long. 132° 14' 15" E.; depth, 140 fathoms; bottom, blue mud.

The surface of the animal is protected by a very thick and short pilose substance, which is more conspicuous on the carapace than on the pleon, and gives it in its perfect condition a smooth velvety appearance, beneath which the integument is ornamented with small and slightly elevated prominences. These are arranged symmetrically on the carapace, while on the pleon they are so displayed that the interstices form symmetrical arborescent figures, the main branch of which traverses each somite from the lateral margin to the dorsal centre, but is not continuous across.

The telson is calcareous halfway down the lateral margins, where it terminates in two sharp points, whereas in the median line the calcareous portion does not extend beyond one-fourth. The membranous division penetrates into a deep excavation in the median line.

The eyes are implanted in large deep circular orbits, surrounded by a strongly-defined ridge.

The first pair of antennæ is slender, but the first joint is more robust than the others, it also widens at the base, on the upper surface of which may be distinctly seen a small semicircular notch or foramen, the entrance to the auditory apparatus.

The second pair of antennæ has the fourth or terminal joint fringed with five prominent cusps (the outer, which is the broadest, is hidden beneath the margin of the second joint), tipped with a small tubercle or point, and one smaller cusp on the inner margin, these are all fringed with ciliated hairs; the third joint is short and narrow, while the second is broad and flat, the diagonal ridge being conspicuous from the absence of the pilose covering rather than from its elevation; the anterior or inner margin has two pointed cusps or teeth, and so has the outer.

The first pair of pereopoda is short, thick, strong and simple. The second is similar, but longer and less robust. The third differs from the second in having a thin flat

marginal process extending from the carpal articulation to a sharp anteriorly-directed cusp or rudimentary pollex, and so forms with the dactylos an imperfectly sub-chelate appendage. The fourth pair is more slender than the third, and the fifth is slighter and shorter than the fourth, and in the male terminates in a simple styliform dactylos, while in the female it forms a small chela.

The anterior pair of pleopoda ($q, \text{♀}$) consists of two large pear-shaped, unequal, foliaceous plates, on a short basal joint in the female; while in the male ($q, \text{♂}$) the foliaceous plates are reduced in size. The three following pairs ($r, \text{♀}$) in the female consist of one very short basal joint supporting one long, slender, three-jointed branch, the ova carrier, and a small foliaceous plate, all being of the same relative proportions, whereas in the male ($r, \text{♂}$) the foliaceous plate is retained while the long three-jointed ramus is reduced to a rudimentary process, and decreases in size with each succeeding posterior somite.

Observations.—The distinction of this species from *Arctus ursus*¹ of the European seas is scarcely appreciable. Dr. Stimpson records his type specimen from Hong Kong, while those of the present collection were taken in Arafura Sea. Of the specimens brought home by the Challenger one was a male and two were females. The latter were slightly larger than the former, but they otherwise agree in their general aspect, except in the formation of the posterior pair of pereopoda.

Arctus orientalis, n. sp. (Pl. IX. fig. 4).

Carapace tuberculated along the median dorsal line and branchial regions, and also transversely along the posterior margin of the carapace and somites of the pleon. Anterior margin of the ultimate joint of the second antennæ furnished with five cusps; the antepenultimate with several small teeth on the inner and outer margins.

Length of male, 84 mm. (2.4 in.); female, 59 mm. (3.4 in.). Diameter of ovum, less than 0.3 mm. (0.012 in.).

Habitat.—Station 209, between Bohol and Zebu, January 22, 1878, lat. $10^{\circ} 14' \text{ N.}$, long. $123^{\circ} 54' \text{ E.}$; depth, 95 fathoms; bottom, blue mud; bottom temperature 71° F. Two specimens were got.

Female.—The length of the carapace is equal to the distance between the anterior extra-orbital angles; the median ridge is well defined, but not very prominent; the subrostral point is scarcely determinable; the gastric is more prominent, having, moreover, a small double tuberculation anterior to it; the posterior or post-cervical prominence is equal to the preceding, and continues in a line to the tuberculated ridge corresponding

¹ Dana having given to this genus the name of *Arctus*, I have thought it right to revert to the specific name of *ursus* instead of using that given to it by Herbst, t. xi. p. 83, pl. xxx. fig. 2, omitting the second name of *minor* for convenience.

with the anterior margin of the post-cardiac sulcus; the lateral longitudinal ridges are conspicuous but not very elevated, they are anteriorly smooth and posteriorly tuberculose, and except for the cervical depression, are continuous from the inner canthus of the orbits to the posterior margin of the carapace. The anterior extra-orbital angles are prominent and project considerably beyond the orbits, and the lateral margin of the carapace is divided by two depressions, the anterior corresponding to the cervical sulcus, the other posterior to it. The carapace generally is ornamented by a number of low tubercular prominences most abundant on the branchial, sub-hepatic and gastric regions; on the cardiac border they are regular and closely packed, while on the post-cardiac margins they are smaller and more regularly distributed; along the branchial regions they correspond in a line with the upper and lower margins, and disappear altogether on the lower or inflected surface.

The pleon is also tuberculated, the tubercles running transversely on each somite, from the median ridge to the coxal plates, in two parallel lines, and are generally smaller than the tubercles on the carapace.

The eyes are considerably within the lateral margins of the carapace.

The first joint of the first pair of antennæ reaches to the extremity of the second joint of the second pair, and has its base rather largely developed; the second joint reaches to the extremity of the terminal joint of the second pair, while the third is but little shorter than the preceding joint.

The second pair of antennæ has the fourth or anterior joint adorned with five cusps on the anterior margin, and a smaller on the internal, all of which are thickly fringed with hair. The first joint is narrow; the second has two large, and one or two less conspicuous teeth on the outer margin, and four or five small teeth on the anterior margin; the diagonal ridge is slightly curved and projects as far as, if not slightly beyond, the extremity of the most anterior cusp of the anterior joint; the whole surface being covered with a thick pilose fur. The ventral surface of the pereion is sparsely covered with short fur.

The first pair of pereiopoda is short, robust, and simple, adorned with a row of hairs along the upper and lower margins of the propodos.

The second pair is longer than the first, and has the propodos broad and flat; the upper surface is adorned with a row of hairs, as is also the lower margin; while on the latter the hairs continue along the same margin to the extremity of the basis.

The third pair of pereiopoda has the propodos broader and longer than the second, and is fringed with hairs on the upper and lower margins, as is also the upper margin of the dactylos on the inner and outer sides.

The fourth pair of pereiopoda is slender and longer than the third pair, having the dactylos very long and furred with long hairs on the upper margin.

The fifth or posterior pair is shorter than the fourth, equally slender, and terminates

in a well-formed chelate extremity in the female (*o*, ♀), of which the dactylos is longer than the pollex, and is also fringed with the hair on the upper surface.

The anterior pair of pleopoda is large, oval, and foliaceous. The others consist of a small outer foliaceous plate and a long slender three-jointed branch, which supports and carries the ova during gestation.

The male differs from the female in being about one-fourth smaller. It has the third pair of pereopoda with the propodos broad as in the female, but not so broad as the second pair, where, as in the female, it is larger; and the fifth pair has the dactylos long, slender, simple, and almost as long as that of the fourth (*o*, ♂).

The anterior pair of pleopoda is slender and foliaceous; the three following pairs are rudimentary, and decrease in size with each succeeding somite.

Arctus tuberculatus, n. sp. (Pl. X. figs. 1, 2).

Dorsal surface of the pleon furnished in the median line with a row of large nodulated tubercles, one corresponding to each of the four central somites, the second and third being very elevated, the latter conspicuously overhanging posteriorly, and laterally thickened.

Length, 50 mm. (2 in.).

Habitat.—Station 190, between New Guinea and Australia, September 12, 1874; lat. 8° 56' S., long. 136° 5' E.; depth, 49 fathoms; bottom, green mud.

Carapace quadrate, scarcely longer than broad. Median crest formed by a double line of tubercles, flanked by a longitudinal row on each side, and divided into four sections, the anterior or rostral, the gastric, cardiac, and post-cardiac. The gastric rises higher anteriorly than the rostral, and the cardiac higher than the gastric, from which it is separated by a deep cervical sulcus; gradually declining posteriorly it is separated from the post-cardiac section by another sulcus that traverses the carapace from the post-lateral angle on one side to that on the other. The median crest of the post-cardiac section is not elevated higher than the rostral section. On each side, commencing with the inner canthus of the orbits, a longitudinal ridge formed of strong tubercles extends to the posterior margin, being bisected by the deep cutting of the cervical sulcus a short distance behind the orbits. The outer or branchial region of the carapace is strongly marked with anteriorly directed tubercles, placed in longitudinal rows.

The pleon is marked by a tuberculated ridge that traverses the median line, reaching its highest level at the third somite, where it is produced into a large, tuberculated, laterally-compressed knob that extends anteriorly and posteriorly beyond its base and forms a distinguishing feature of the species. The central ridges on the fourth and fifth somites are of a similar character, but less important; there is no central ridge on the sixth.

The first somite is smooth, being, all but the elevated posterior margin, covered by the margin of the carapace when extended. The second somite is also smooth except for the central dorsal ridge and a deep sulcus traversing it from the boundary of the coxal plate transversely to the median ridge. The other somites correspond, but posteriorly the sulcus decreases and the smoothness is changed for a more tuberculated condition, which on the posterior margin increases to a regularly crenated edge, which is conspicuous in the fourth, fifth, and sixth somites. The lateral margins or coxal plates are tuberculated on the dorsal surfaces, and the posterior edges are slightly crenated. The telson is tolerably smooth and free from tuberculations; the anterior division is calcareous, the posterior is membranous.

The eyes are implanted in circular orbits fringed with small cilia.

The first pair of antennæ is slender and longer than the second.

The second pair of antennæ has the terminal joint fringed with seven prominent cusps, the smallest of which is on the inner margin, the others on the anterior. The penultimate joint is small and narrow, while the next is broad and diagonally produced to a point that projects on the outer side of the terminal joint and extends as far forwards as the extremity of the most anterior cusp. The prominent angle of the second joint is continuous with a strong ridge that extends to the base and separates the joint into two divisions, the outer of which is depressed, and has the margin fringed with four strong cusps.

The first pair of pereopoda is simple in form, short and robust. The three succeeding pairs are sub-equal and moderately long, while the fifth pair is shorter, more slender, and chelate in the female but simple in the male.

The anterior pair of pleopoda has two branches broadly laminar in the female, but long and narrow in the male. The second pair has one ramus, long, slender, and three-jointed, the other short and foliaceous in the female, gradually decreasing in size in each succeeding pair of appendages. In the male these same organs are little more than rudimentary.

Arctus immaturus, n. sp. (Pl. X. fig. 3).

Carapace generally smooth, but showing slight indications of a central ridge with a gastric projection. The cervical sulcus is obscure except where it deeply divides the lateral and branchial ridges on either side. The lateral ridges are broken into a row of narrow tubercles extending to the posterior margin of the carapace. A few imperfectly-developed tubercles are faintly visible under a lens on the genital and cardiac regions.

The pleon is smooth, with a slight central prominence, but without any arborescent configuration of the dorsal surface.

The eyes are implanted in circular orbits within the lateral margin, which is slightly serrate from the anterior to near the posterior angle of the carapace.

The first pair of antennæ has the first joint short, broad and conical, the second and third slender, the terminal joint reaching beyond the extremity of the second pair.

The second pair of antennæ have five cusps on the anterior margin and two on the inner, and is nearly free from cilia. The second or first free joint is armed on the outer margin with three points or teeth and three on the anterior margin, while the longitudinally-oblique ridge is slightly dentate.

The first pair of pereopoda is larger than the others, and the posterior has a large sharp, curved tooth (fig. 3") projecting backwards from the posterior angle of the coxal ridge of the podal socket of the ventral plate.

The three anterior somites of the pleon are without pleopoda, those of the second and third being either accidentally absent, or not yet developed. Those of the fourth and fifth somites consist of two long sub-foliaceous branches on a tolerably long stalk. The inner ramus carries a single stylamblys.

Length, 19 mm. (0.75 in.).

Habitat.—The specimen from which this description is taken was dredged off Cape Verde, but neither station nor depth are recorded.

Observations.—Two other specimens were taken off Gomera, one of the Canary Islands, in 75 fathoms of water, associated with *Arctus pygmæus*, with which they have several points in common, that suggest from their association that they might be the males of that small species. They agree in the general form of the second pair of antennæ, the absence of hairs being attributable to sexual variation or to having been worn away by friction and use. Both have minute specks of pigment, more especially on the plates of the second pair of antennæ, but they are considerably more conspicuous on *Arctus pygmæus* than on *Arctus immaturus*. The absence of dorsal ornamentation might also be attributed to sexual difference, but I am not aware of such variation to any great degree in the genus, though in *Ibaccus* the separation is quite as apparent and important.

The reason why I came to the opinion that *Arctus immaturus* is the young of some other form rather than the male of *Arctus pygmæus*, with which it almost corresponds in size, being but a little smaller, depends upon the structure and form of the pleopoda. In *Arctus pygmæus* these appendages agree in structure with those of the adult females of other known species; but in *Arctus immaturus* they agree more with the pleopoda of the males of other types than with those of any species of the genera.

The two sub-foliaceous plates, thickly fringed with long ciliated hairs, the inner of which carries a stylamblys, vary in the three specimens, and in one, apparently the most mature, it is half the length of the branch to which it is attached, and the extremity is covered with small cincinnuli, perhaps the rudimentary condition of hairs which in the females become the important points for the attachment of the ova.

Arctus pygmæus, n. sp. (Pl. X. fig. 4).

Female tuberculated on the cardiac region. Upper lateral margin of the branchial region marked with a row of tubercles. Somites of the pleon transversely furrowed, with anterior and posterior margins ornately scalloped.

Length, 22 mm. (0·875 in.).

Habitat.—Station VII_P, off Gomera, one of the Canary Islands, February 10, 1873; lat. 28° 35' N., long. 16° 5' W.; depth 78 fathoms; bottom, volcanic sand.

Carapace longer than the width between the anterior extra-orbital angles. Sub-rostral point small; gastric and epigastric slightly elevated; the latter is continuous with a series of flattened tubercles that form the central ridge, broken only by the imperfectly defined cervical sulcus. The lateral ridges are strongly marked and elevated, commencing at the inner canthus of the orbit, and continuing unbroken to the cervical sulcus, posterior to which the ridge is continued in the form of a series of double tubercles to the latero-posterior margin of the carapace. The anterior extra-orbital angles are prominent, but in close contact with the wall of the orbit; the lateral margin shows no evidence of the cervical depression. The carapace is adorned by a number of flattened tubercles chiefly aggregated between the branchial and cardiac regions. On the former region they exist only as a row along the inferior margin, while on the cardiac border they traverse the width of the dorsal surface as two double rows separated by a narrow post-cardiac sulcus.

The pleon is smooth, with scarcely any median dorsal elevation, on each side of which an arborescent line of depression traverses the surface from the coxal margin to the central ridge, dividing the somite into two unequal portions, and terminating on the anterior margin near the centre, leaving between the two extremities a longitudinal ornamentation of flattened semicircular plates.

The eyes are round and near the lateral margins of the carapace.

The first pair of antennæ has the first joint tolerably robust, the others slender.

The second pair of antennæ has five cusps on the anterior and two small ones on the inner margins, copiously fringed with plumose hairs. On the inferior surface of the externo-posterior margin is a row of small cell-like organs. The second joint has the anterior margin dentate and two stronger teeth on the outer margin; the oblique ridge is strongly prominent, but does not extend so far as the anterior margin of the terminal joint.

The first pair of pereiopoda is robust; the three succeeding are sub-equal and cylindrical, without any enlargement of the propodos; the fifth pair is unfortunately broken from the basal joint in our unique specimen.

The first pair of pleopoda is, as in larger adult forms, foliaceous, and the succeeding pairs have one branch small and leaf-like, and the other rigid and styliform.

Observations.—This specimen carries a large number of ova containing embryos that are far advanced in development, a circumstance that has enabled me, after much trouble and care, to determine the form of the brephalos.

The ovum is about 0.3 mm. (0.012 in.) in diameter, and is perfectly round. By the aid of liquor potassæ I was able to make out the form of the eyes, since they were projected on long stalks. The outer or second pair of antennæ is small and cylindrical, but the first or inner pair I could not determine, nor the exact form of the carapace, and I am therefore doubtful whether it only covers and protects the cephalon as in the brephalos of *Palinurus*, or overlies the pereion also, as figured by De Haan in his species of *Phyllosoma guerini*, which has all the appearance of being a more advanced stage of a young *Scyllarus* or *Ibaccus*.

Three pairs of pereopoda are well advanced, and carry a baseopysis or branch springing from the extremity of the second or basal joint, which is also well developed in the two anterior pairs, but represented only by a small bud-like process in the third.

The pleon is short and rudimentary. The entire brephalos, when outstretched at the period of extraction from the egg, was about 0.5 mm. (0.02 in.) in length, measuring from the frontal margin between the eyes to the telson, and resembles the *Phyllosoma* of *Palinurus* in its general appearance.

This species was taken on the 10th of February 1873, in 78 fathoms of water, with two smaller specimens that I am inclined to consider as immature forms of another species, the reasons for which are given in the description of *Arctus immaturus*.

The temperature of the bottom water is not recorded, no temperature sounding having been taken at this station.

Family PALINURIDÆ.

Carapace longitudinally sub-cylindrical, ophthalmopoda having orbits only partially excavated in the cephalon, second pair of antennæ terminating in a long rigid multi-articulate flagellum.

This family forms the tribe of "Langoustiens," which contains but one genus *Palinurus*, and this Milne-Edwards has in his *Histoire des Crustacés* divided into two subgenera, "Langoustes ordinaires," of which *Palinurus vulgaris* is the type, and "Langoustes longicornes." This latter he again subdivides into—(1) those species which have the pleon transversely furrowed, of which *Palinurus guttatus* is the type; and (2) those in which the pleon is not furrowed, of which *Palinurus fasciatus* is the type.

More recently Dr. Camil Heller, in his volume on the Crustacea which were taken during the cruise of the frigate "Novara," has, like Milne-Edwards, arranged the species under one genus, which he places in two divisions, as follows—

I. Those corresponding to the "Langoustes ordinaires" of Milne-Edwards, including the subgenus *Palinurus* of Gray. This he again subdivides into—

A. Those which have the rostrum dilated, bipartite, having the processes flat, with the anterior margin spinulose, of which *Palinurus trigonus*, De Haan, (*Linuparis trigonus*, Gray) is the type.

B. Those which have the rostrum simple, acute, and spiniform. This division is again subdivided into—

A. Those which have the first pair of pereiopoda longer than the succeeding pairs—*Palinurus longimanus*, Edw.

B. Those which have the first pair of pereiopoda equal to or shorter than the succeeding pairs—

α. Those which have the somites of the pleon with a transverse furrow. This is again divided into—

α Those which have the lateral frontal horns unarmed above and denticulated below—*Palinurus vulgaris*.

β Those which have the lateral frontal horns unarmed above and below—*Palinurus lalandii*, Lam. ; *Palinurus frontalis*, Edw.

β. Those that have the somites of the pleon not transversely furrowed—*Palinurus hügelii*, Heller.

II. Those which correspond with the "Langoustes longicornes" of Milne-Edwards and the subgenus *Panulirus* of Gray. These he again divides into—

A. Those that have no transverse furrow on the pleon, the species of which are *Palinurus fasciatus*, Fabr. ; *Palinurus ornatus*, Bosc ; *Palinurus sulcatus*, Lam.

B. Those which have a transverse furrow.

A. The first antennal somite armed with two teeth—*Palinurus guttatus*, Latr. ; *Palinurus japonicus*, De Haan.

B. The first antennal somite armed with four teeth.

a. Four conical teeth remote.

a Teeth tolerably large, equidistant, and forming a quadrangle.

* Carapace spinose all over—*Palinurus spinosus*, Edw.; *Palinurus americanus*, Edw.

** Carapace spinose anteriorly, tuberculated posteriorly — *Palinurus interruptus*, Randal.

b Teeth minute, scarcely approximate on the median line, anterior and posterior much more distant—*Palinurus argus*, Latr.

β. Four conical teeth approximated and connected at the base—*Palinurus ehrenbergi*, Heller; *Palinurus penicillatus*, Olivier.

c. First antennal somite armed with eight teeth—*Palinurus dasypus*, Fabr.; *Palinurus burgeri*, De Haan.

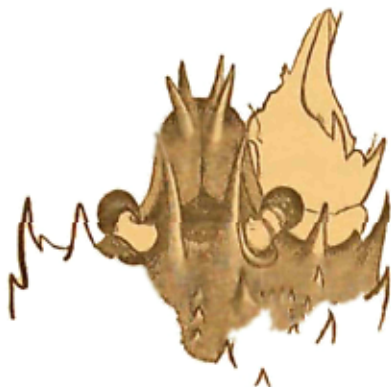
In the classification of the several genera which belong to this family the three authors, Edwards, Gray, and Heller have made the two great divisions dependent chiefly upon the one having a central rostrum to the frontal margin of the carapace, and the flagella of the first pair of antennæ short, while in the second there is no central rostrum and the flagella are long.

However, there appears to me to be a great natural distinction between the form known as *Palinurus lalandii*, Lam., in which the frontal rostrum is so far advanced and depressed as to unite it with the upper surface of the somite of the second pair of antennæ, thus enclosing the ophthalmic somite within an orbital chamber, instead of leaving it exposed as in *Palinurus vulgaris*, in which the rostrum is reduced to a short pointed process. This also appears to me to be the case in Heller's species of *Palinurus hügelii*, but since Heller has not mentioned it in his description, nor shown it in his figure, I am precluded from asserting this with confidence.

It appears therefore that *Palinurus lalandii* should form a separate genus (*Palinostus*) gradually leading to *Synaxes*, and so on to the family of Astacidæ, according to the arrangement here followed and indicated on p. 56.

Panulirus, Gray.

This name was given by Dr. Gray to that division of the genus which Professor Milne-Edwards designated "*Langoustes longicornes*." It consists of those species in which there is no central rostriform tooth, which have the ophthalmic somite exposed and

FIG. 5.—Dorsal view of *Panulirus*.FIG. 6.—Lateral view of *Panulirus*.

membranous, the first antennal somite produced considerably in advance of the frontal margin, which is generally armed with strong teeth in the adult (as shown in the accompanying woodcuts), and in which the terminal filaments of the first pair of antennæ are long and slender. This genus may conveniently be divided into :—

Those species that have no transverse groove on the pleon—

Panulirus fasciatus, Fabr.

„ *ornatus*, Bosc.

„ *sulcatus*, Lam.

Those that have a transverse groove on the pleon—

Panulirus guttatus, Latr.

„ *japonicus*, De Haan.

„ *spinosus*, M.-Edwards.

„ *americanus*, M.-Edwards.

„ *interruptus*, Randal.

„ *argus*, Lat.

„ *ehrenbergii*, Heller.

„ *penicillatus*, Olivier.

„ *dasypus*, Lat.

„ *burgeri*, De Haan.

Geographical Distribution.—There are a large number of species in this genus, but they are mostly confined to the Indian and Pacific Oceans, ranging from the Mauritius,

where *Panulirus ornatus* exists, as the most southern and western station, to the shores of India and Japan, where *Panulirus japonicus*, *Panulirus burgeri*, and *Panulirus fasciatus* are found.

Panulirus guttatus (Latreille).

Palinurus guttatus Latr., Ann. du Mus., iii. p. 393.

" " Milne-Edwards, Hist. des Crust., t. ii. p. 297, pl. xxviii. fig. 1.

"Antennular somite armed with two very large conical teeth sometimes preceded by two rudimentary spines. Carapace very spinous; two spines upon the median line of the gastric region, near the base of the rostral horns, and on each side of these last, upon the anterior border of the carapace, are two teeth nearly as large as they. Anterior border of the epistoma is armed with three subequal conical teeth, separated by a series of small teeth. Peduncle of the outer pair of antennæ very spinous below, second pair of pereopoda a little longer than the others. Pleon smooth and presenting near the middle of each somite a transverse piliferous groove, which is not interrupted upon the median line in the three first somites. The lateral horns of the pleon are produced to a single tooth. The colour of the animal is green with numerous circular yellow spots; penultimate joints of the pereopoda longitudinally striped with green and yellow.

"Length 7 to 8 inches.

"*Habitat*.—Antilles."—Milne-Edwards, *loc. cit.*

Panulirus guttatus, var. (Pl. XA.)

Antennular somite armed with two sharp conical teeth on the anterior border. Dorsal surface smooth; three small sharp teeth on the median line on the gastric region, and on each side two large supra-orbital teeth, (called rostral horns by Milne-Edwards) sharply pointed and directed forward above the base of the ophthalmopoda; behind these are two other important but not very large sharp teeth, and a row of smaller and gradually decreasing teeth, sharp at the point but large at the base, is continued to the posterior marginal suture of the carapace; these are more conspicuously determinable in the female than in the male. There is a large and well-developed tooth within the anterior margin, corresponding to the first antennal tooth in the typical structure, and another corresponding with the outer antennal tooth of the same ideal type; these two teeth are probably those that Milne-Edwards describes as being the two large teeth on the anterior border. The frontal margin of what Professor Milne-Edwards calls the epistoma, but which appears to be demonstrable as the first or coxal joint of the second pair of antennæ, is armed with three subequal conical teeth, separated by a series of four small teeth on each side of the central one. Peduncle of the outer antennæ armed with short spine-like teeth, more numerous on the upper surface than on the lower, which is also smoother. Second pair of pereopoda, a little longer than the others

Pleon smooth and presenting near the middle of each somite a transverse piliferous groove. That on the first somite corresponds with the posterior margin of the carapace; the hirsute line is anteriorly directed, and continuous from side to side. That on the second somite has the hairs directed posteriorly and is indented in the median line. The third is also indented in the male and interrupted in the female. The fourth and fifth are interrupted in both male and female, and the sixth is continuous and wavy. The lateral margin of the somites of the pleon is produced to a large, sharp, posteriorly curved tooth and a posterior rudimentary one.

The colour of the specimen, so far as I can judge from those preserved in spirits, is purple in the male and brown in the female, with numerous yellow spots on the pleon. All the joints of the pereiopoda, except the dactylos, are longitudinally striped with yellow lines.

Length of male, 190 mm. (7.5 in.).

Length of female, 150 mm. (6 in.).

Habitat.—St. Paul's Rocks, Atlantic Ocean, August 1873.

Specimens in the British Museum are recorded from West Indies, the Isle of France, and a variety from New Holland.

In the diagnosis of our variety I have compared it in detail with that of Milne-Edwards for the purpose of convenient reference.

The ophthalmic somite is rudimentary or only represented by membranous tissue, at the lateral extremities of which the ophthalmopoda are situated.

The first antennal somite is projected from the lower margin of the ophthalmic horizontally forwards, where it is armed with two anteriorly directed sharp-pointed teeth, whence the somite dips suddenly downwards and supports the first pair of antennæ. The second antennal somite cannot be differentiated from the carapace which overrides it.

The carapace is armed with two large supra-orbital teeth, one over each eye, sharply curved and anteriorly directed, also on the frontal margin a sharp and well-developed first and second antennal tooth. Posterior to and at the base of the supra-orbital tooth is a second well-developed tooth of similar character, but smaller, and between them are three small teeth longitudinally situated in the median line; over the surface of the carapace large-based and sharp-pointed teeth are sparsely scattered, and between them the surface is covered with large granulations, the anterior margin of each granule being furnished with a few anteriorly directed small hairs, which are more conspicuous on the female than on the male. The cervical groove is well-defined in the male but less so in the female.

The pleon is smooth and has the lateral margins produced to long teeth, one corresponding with each somite, added to which is a smaller tooth situated near the articulation with the succeeding somite. The sixth somite has the posterior margin dorsally fringed with numerous small teeth.

The telson is quadrate, with the base calcareous, longer at the sides than in the median line, posterior margins fringed with small teeth; posterior division membranous.

The ophthalmopoda are short and thick and united to the membranous somite by a narrow articulation.

The first pair of antennæ is smooth, slender and cylindrical. The first joint is the longest, the second the shortest, and the third is but little longer than the second; the terminal flagella are nearly as long as the peduncle, and together they equal the carapace in length. The entrance to the acoustic apparatus is by a diagonal fissure, protected by small hairs, on the upper surface at the base of the first joint.

The second pair of antennæ is a little longer than the entire animal. The first joint of the peduncle is fused with the metope, the second joint has only one sharp tooth below and two above, one being on each side of the posterior articulation; on the inner side an efficient stridulating organ exists (fig. c). The third joint is armed with several sharp teeth on the upper surface, but none that are important on the lower. This is also true with regard to the fourth joint. The flagellum is long, rigid, slender and tapering, it is armed with spines or sharp teeth situated in longitudinal and transverse rows, those on the upper surface are both larger and closer together than those on the lower.

The oral appendages correspond with those of the genus generally.

The pereiopoda are simple in structure and uniform in character; the first pair is the most robust, the second is the longest, the others gradually decrease in length and thickness. The dactylos of the anterior pairs is furnished with a thick brush of hairs that is continued in a couple of rows of fasciculi of the same character on the under surface of the distal extremity of the propodos.

In the female the posterior pair is peculiarly chelate. The propodos has a pollici-form process developed at the lower distal angle, which antagonises a similar process developed at the base of the lower surface of the dactylos; the two form a small but efficient chela, while the dactylos proper is produced as in the preceding, from which it differs only in being smaller in a proportion corresponding with those anterior to it.

In the male the anterior three pairs have the upper distal extremity of the meros unarmed, and the last two furnished with a strong tooth.

In the female this tooth exists on all the pereiopoda. At the base of the first or coxal joint, close to the articulation with the plastron, is the foramen of the oviduct, which is very minute.

In the male the posterior pair of pereiopoda possesses in the same situation a large opening that is increased in size by the nearer portion of the joint being enlarged into a process projecting on the inner side.

In the male there are two small calcified tubercles on each side of the median line at the posterior margin of the pereion, which are absent in the female.

There are no pleopoda attached to the first somite, while each of the four following

carries a broad foliaceous pair, which is single in the male, and double-branched in the female, in which the inner branch is triarticulate, the first joint stout and cylindrical, the second short and foliaceous on the outer side, while the third is long, slender, and terminates in a few hairs. It is this inner branch that carries attached to it the numerous bundles of minute ova which in this one animal cannot number less than 60,000.

The posterior pair of pleopoda form the outer plates of the caudal fan and are broad and equally foliaceous.

Our specimens consist of one male and three females, only one of which was carrying ova. On the females, particularly on one, there is a large mass of black pigment uniformly deposited on each side on the ventral surface of the posterior somite of the pereion, the object of which I do not quite understand, but assume that it may be of similar nature to the white patches that are to be found attached to the same parts in the female of *Astacus* at the conclusion of the rutting season.

Panulirus angulatus, n. sp. (Pl. XI. figs. 2, 3, 4).

Lateral walls of the carapace perpendicular, forming right angles with the dorsal surface; the angular ridges are prominent and very strongly serrate with three or four large teeth, the first being the largest, and anterior to the cervical suture, posteriorly to which they are of less importance, gradually lessening as they reach the posterior margin; on the gastric region are two rows of these small teeth; in the central line behind the cervical suture, is an elevated boss or lobe surmounted by three strong teeth, the posterior, which is broken in our specimen, being the largest; behind these in the same line is another boss or lobe with two teeth. Each somite of the pleon in the median line supports two or three teeth on an elevated ridge, of which the central of those on the second and third somites are the most conspicuous and prominent.

The specimen is undoubtedly a young animal, being only 36 mm. in length (1.5 inches) exclusive of the antennæ.

Habitat.—Station 219, March 10, 1875; lat. $1^{\circ} 54'$ S., long. $146^{\circ} 39' 40''$ E.; Eastern Pacific, north of New Guinea; depth, 150 fathoms; bottom, coral mud; associated with *Sicyonia lævis*.

The carapace between the armature anteriorly to the cervical suture is smooth, but granulated rather coarsely posterior to it; the condition on the lateral walls is similar, but the granulations posteriorly to the cervical suture run in parallel lines, radiating from the upper anterior angle just behind the cervical suture. The teeth along the lateral angle increase in size as they advance towards the anterior margin to the upper and inner canthus of the orbit, where the terminal tooth overhangs the eye, forming the upper surface of an imperfect orbit. There are no teeth between the supra-orbital teeth on the frontal margin, and none on the antennal somites.

The ophthalmopoda are short and stout, placed at the extremity of slender attachments which are not enclosed in a calcareous somite, but continue exposed in the median line.

The first pair of antennæ has the first joint long, the second short, and the third about half the length of the first; the flagella are subequal in length, the inner being rather the longer and more slender, while the outer, slender towards the extremity, becomes bulbous towards the base.

The second antennæ are very long and rigid organs, the peduncular portion being especially rigid, and the articulation between the third and fourth joints being oblique by two-thirds the length of the fourth joint; the first and second joints are fused together and support a phymacerite that is covered by the extremity of the second pair of gnathopoda.

The mandible carries a small slender two-jointed synhipod, the basal joint of which is long, the distal one short and pointed.

The first pair of gnathopoda is short, and carries a basephysis that reaches considerably beyond the extremity of the dactylos.

The second pair of gnathopoda is long, slender, and serrate on the inner and lower margins, and carries a basephysis, the basal joint of which reaches to the extremity of the ischium, and the terminal flagellum to the extremity of the carpos.

The pereopoda are in our unique specimen all lost, having been broken off at the basi-coxal articulation, excepting the last pair, which is long and slender, the meros being strong and distally armed with a strong tooth on the inner angle; the carpos is long and continuous with the propodos, which is nearly three times as long and terminates in a straight and pointed dactylos.

On the under or ventral surface, the posterior somite of the pereion is armed with a sharp tooth in the median line. The first somite of the pleon is transversely armed with four teeth; the second, third, fourth, and fifth, with two each, all on their posterior margins; the sixth has two on the anterior margin, six (three on each side, of the median line) near the centre, and four on the posterior margin.

The pleopoda are small, but not more so than usual in the male, as is this specimen; although the animal is very small, it appears to have arrived at its mature form.

Panulirus penicillatus (Olivier) (Pl. XII. fig. 2).

Astacus penicillatus, Olivier, Encycl., t. vi. p. 343.

Palinurus penicillatus, Milne-Edwards, Hist. des Crust., t. ii. p. 299; Olivier, Encycl., t. viii. p. 174.

Habitat.—Our specimen was purchased in the market at Papiete, Tahiti. Specimens in the British Museum are recorded from the Fiji Islands and the New Hebrides, where the native name is "Trichivaing." H. Milne-Edwards gives the Indian Ocean for its locality; and Professor A. Milne-Edwards says that it has been taken at the Mauritius.

There can be little doubt, I think, that this specimen, which is a male about nine inches in length, belongs to this species. It possesses the chief character given by Milne-Edwards. "Anneau antennulaire armé de quatre dents coniques très grosses, divergentes et réunies à leur base en faisceau." It also corresponds much in colour, for although our specimen has been several years in spirits, it is still beautifully marked with purple, blue, green, brown, and yellow, as in Lamark's description of *Palinurus versicolor*, which Milne-Edwards considers to be identical, and the legs are marked with longitudinal stripes.

Though the geographical distribution of this species appears to be very extensive, it seems to be chiefly limited to the southern and warmer seas. In the British Museum there is a specimen supposed to be from the Red Sea, but this perhaps may be *Palinurus ehrenbergi*, Heller, to which it bears some resemblance.

The branchial arrangement of this species corresponds more nearly with that of the European form *Palinurus vulgaris* than with that of *Palinostus* (*Palinurus*) *lalandii*, a circumstance showing that small branchial variation has generic value.

The mastigobranchiæ are without the peculiar curve or notch that exists in those of *Palinostus* (*Palinurus*) *lalandii*, except in the case of the third siagnopod, which is longitudinally rigid and bent or notched at the extremity, folds backwards through its whole length and enfolds the podobranchial plume, as may be seen in Pl. XII. fig. 2.

The arrangement of the branchiæ is shown in the following table :—

Pleurobranchiæ,	.	.	.	...	...	...	1	1	1	1
Arthrobranchiæ,	.	.	.	1	1	2	2	2	2	...
Podobranchiæ,	.	.	.	1	1	1	1	1	1	...
Mastigobranchiæ,	.	.	.	1	1	1	1	1	1	...
				h	i	k	l	m	n	o

Observations.—It is in this species that the interesting transformation of the ophthalmopod into an appendage resembling an antenna was observed by Prof. A. Milne-Edwards and described by him.¹ He says, "guided by theoretical considerations, zoologists regard the movable eye-stalks, the appendages of the mouth, and the legs of Crustacea, as being analogous organs (*organes analogues*), resulting from secondary modifications, impressed on different members of a series of appendages of the same order which represent each other mutually in the organism as a whole; but hitherto these ideas were not supported by any fact which could be brought as evidence of the possibility of the production of these various physiological instruments from one and the same anatomical element.

"One such teratological case which I have observed in a Langoustes, *Palinurus penicillatus* (Olivier), demonstrates the truthfulness of these ideas introduced into science by Savigny, and developed by M. H. Milne-Edwards."

¹ *Comptes rendus*, t. lix. p. 710.

"On the right side, the appendages of this large Crustacean present nothing abnormal; the protocephalic member or appendage of the first ring of the head usually forms an ocular peduncle; the deutocephalic member consists of an antennule, and the appendage of the third somite is the large or external antenna. On the left side, the second and third appendages are symmetrical; but the ophthalmic somite carries instead of an eye, a long multiarticulate filament, resembling the terminal flagellum of an antenna. The ophthalmopod has been preserved in its ordinary character at the base: even at its extremity a rudimentary cornea exists, from the centre of which the flagellum to which I allude originates and extends to the length of about four centimetres. It is multiarticulate and furnished with hairs upon the superior and terminal portion, like the inferior flagellum of the antennule.

"I know of no other example of a transformation of this kind among the Crustacea or other Articulata. A number of monstrosities occur in the formation of dactyli or phenomena of the same kind; but I have never seen an appendage present its normal form on one side of the body and revert on the opposite side to the characters of another organ. The interesting point to which I desire to draw the attention of zoologists is not only the novelty of the occurrence, but also because it shows that in the animal kingdom a kind of phenomena similar to those that we see in vegetables often exists.

"When a leaf is transformed, it may be into a bract, a sepal, or a petal, &c., or when a petal or a stamen may mutually revert to a leaf-like condition, these transformations realise in the animal as well as in the vegetable kingdom, the theoretic view relative to the fundamental origin of parts susceptible to a reversion of different characters, and on this subject I may recall the fact that among certain Crustacea, the dactylos of the first pair of pereopoda becomes normally multiarticulate and antenniform. The genus *Mastigopus* of M. Stimpson offers us a remarkable example."

Palinurus, Fabricius.

The genus, as restricted by Dr. Gray and Dana, is here confined to those species which Milne-Edwards ranges under the head of "*Langoustes ordinaires*," in which the most apparent characteristics are the presence of a small central rostriform tooth or tubercle that overhangs but does not cover or enclose the ophthalmic somite, which is generally calcareous, the form of the somite of the first pair of antennæ which is anteriorly produced and laterally compressed in front (as shown in the accompanying woodcuts taken from the type of the genus), and the shortness of the flagella belonging to the first pair of antennæ.

Geographical Distribution.—The genus as restricted in this description appears to be confined to the northern hemisphere, *Palinurus vulgaris*, which is the type, is found on

the European shores including those of the Mediterranean. *Palinurus longimanus* comes from the West Indies. *Palinurus trigonus*, v. Siebold, from Japan, belongs to Gray's genus *Linuparis*, no species of which is in the Challenger collection.

FIG. 7.—Dorsal view of *Palinurus vulgaris*.

FIG. 8.—Lateral view of same.

The nearest approach in geological time is the little *Palinurina pygmæa* described by Münster, from specimens found in the upper White Jura of Bavaria, and *Palinurus longipes*, Münster, from the Lias of England and the lithographic stone of Solenhofen.

Palinostus,¹ n. gen.

This genus consists of those species that have the rostrum anteriorly produced so as to reach beyond the ophthalmic somite, and by its connection with the somite that carries the second pair of antennæ forming a channel for the protection of the ophthalmic

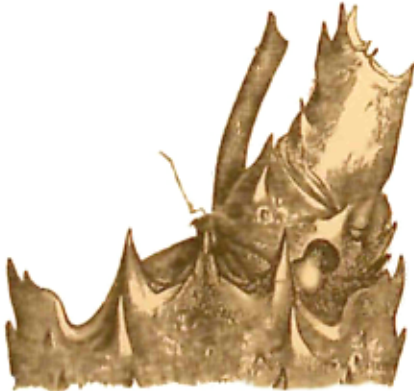
FIG. 9.—Dorsal view of *Palinostus lalandii*.

FIG. 10.—Lateral view of same.

somite. The somite that carries the first pair of antennæ is not produced beyond the extremity of the rostrum (see accompanying woodcuts, figs. 9, 10). First pair of antennæ furnished with two short flagella. *Palinostus lalandii* (Lamarck), *Palinostus frontalis*, (Milne-Edwards), *Palinostus hilgellii* (Heller).

¹ Παλινστροφος, returning or going back, from a tendency to return to a form of Macrura in which the rostrum is common; chosen from a desire to secure a name that approximates in sound to that which it previously possessed.

Geographical Distribution.—This restricted genus as far as known belongs to the southern hemisphere. *Palinostus lalandii* ranges from the Island of Tristan da Cunha to the Cape of Good Hope; *Palinostus frontalis* is found on the coast of Chili, and *Palinostus hügelii* was taken in the Indian Ocean.

Palinostus lalandii (Lamarck) (Pl. XI. fig. 1; Pl. XII. fig. 1).

Palinurus lalandii, Lamarck, MS., in Museum, Jardin des Plantes.

„ „ Milne-Edwards, Hist. des Crust., t. ii. p. 293.

„ „ on Pl. XI. fig. 1; Pl. XII. fig. 1.

Rostrum depressed and rapidly narrowing anteriorly to the apex, which has a tendency to curve upwards; just within the apex are planted two vertical processes (fig. 10, p. 85) that securely grasp the rostrum on each side. These calcified processes originate in the anterior wall of the ophthalmic somite, which proceeds in a direct line beyond the vertical processes, and terminate in an obtuse point on each side of the central line, corresponding in length to the rostrum.

In *Palinurus* and *Panulirus*, the first antennal somite is largely developed and forces the second pair of antennæ widely apart; in *Palinostus lalandii* it is reduced in size and forced down below the second pair of antennæ, which meet and articulate above it. The first or coxal joint, in all species of this family, is closely impacted and anchylosed with the anterior wall or metope of the cephalon, and meets its fellow in the median line beneath the rostrum; it sends forth a process that articulates with a similar one projecting from the lower and outer angle of the second joint; the upper and inner angle of the same joint articulates with a process which projects anteriorly from the first antennal somite, below the rostral points. This articulation is wanting in both *Palinurus* and *Panulirus*, and instead of it, the process of the antenna projects above and carries a membranous fold over the antero-lateral walls of the largely developed first antennal somite, under which lies the stridulating organ. This organ is absent in *Palinostus*.

The first pair of gnathopoda has only six joints, the meros and ischium being probably fused together into one which is short, thick, and scarcely longer than broad. The carpos is short, triangular, and articulates laterally and bends suddenly; the propodos is broad and the dactylos short and wide; the basal joint of the baseophysis is nearly as long as the mero-ischial joint, and terminates in a long slender flagellum.

The second pair of gnathopoda consists of seven joints, the meros and ischium being free and articulated near the centre; the carpos articulates at the extremity; the propodos is narrow, increasing slightly in length towards the distal extremity, which is excavated to receive the long, narrow, and obtuse dactylos. The whole appendage is fringed with long hairs on the inner and distal surfaces.

The basephysis is short, the extremity of the flagellum reaching to half the length of the meros. The mastigobranchia is broad, bifid, and supports a slender full-plumed podobranchia.

The branchiæ generally consist of large and well-developed plumes, arranged as in the annexed table :—

Pleurobranchiæ,	.	.	.	...	...	...	1	1	1	1
Arthrobranchiæ,	.	.	.	...	2	2	2	2	2	...
Podobranchiæ,	.	.	.	1	1	1	1	1	1	...
Mastigobranchiæ,	.	.	.	1	1	1	1	1	1	...
				h	i	k	l	m	n	o

The mastigobranchiæ have a peculiar notch or bend in the outer or posterior margin; in that of the second gnathopoda it is increased to a deep cleft. This curve or excavation may be only a specific feature, but inasmuch as it does not exist in *Palinurus vulgaris*, it may be of generic value, a point that can only be determined when other species are examined.

Habitat.—Station 135c, October 17, 1873; lat. 37° 25' 30" S., long. 12° 28' 30" W.; off Nightingale Island, Tristan da Cunha; depth, 100 to 150 fathoms; bottom, hard ground, shells, gravel. One specimen.

Length 248 mm. (10 in.).

This species has been described under the name of *Palinurus lalandii* by Professor Milne-Edwards, from a specimen of Lamarck's preserved in the museum, but, as far as I am aware, it has never been figured.

Two small specimens of what I believe to be the young of this species were taken from the screw of the Challenger the day after she left the Cape of Good Hope. The armature and ornamentation correspond with those of the adult. The specimen is about 25 mm. in length, and appears to be perfectly formed in all except its sexual characters. No foramen or opening could be detected on the coxa of either the third or fifth pair of pereiopoda, whereas in the adult it is very conspicuous, more especially in the male, where it is elevated on a prominent tubercle implanted close to the pleural articulation.

This small animal is one of considerable interest, inasmuch as it shows that *Palinurus* arrives at its complete external form when it has only grown to an inch in length, having by that time undergone all its morphological changes. The brephalos having quitted the ovum in a Megalopa stage, in the form known as *Phyllosoma*, about 1.5 mm. or 2 mm., in length, assumes the outward shape of its parent by the time it has reached the length of one inch.

Yet, while I write, I have before me a *Phyllosoma* nearly an inch long, in which all the characters of the brephalos as it quits the ovum of *Palinurus* are present, excepting the addition of new limbs. The question must therefore arise, whether our knowledge of

these animals is sufficient to warrant us in stating that all *Phyllosomæ* are the young of *Palinurus*, or some allied genus; if so, it is certainly remarkable that the brephalos undergoes no change while it continues to grow from the tenth of an inch to an inch in length, and that it then should undergo an immediate alteration, changing from a thin, translucent animal, to one thick, solid, and perfectly robust.

Synaxes, Spence Bate.

Synaxes, Spence Bate, Ann. and Mag. Nat. Hist., ser. 5, vol. vii. p. 220.

This genus consists of those species in which the rostrum is produced anteriorly beyond the extremity of the somite that carries the first pair of antennæ, and unites with that of the



FIG. 11.—Dorsal view of *Synaxes*.

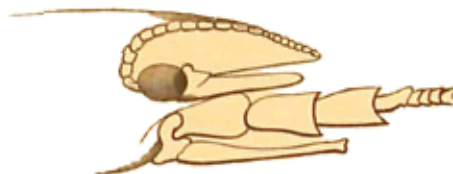


FIG. 12.—Lateral view of *Synaxes*.

second pair of antennæ so as to make a perfect orbit, and covers the ophthalmic somite as shown in the annexed woodcuts. The first pair of antennæ carries two short flagella.

Synaxes hybridica, Spence Bate.

Synaxes hybridica, Sp. B., loc. cit., p. 220, pl. xiv. figs. 1-6.

No specimen in the Challenger collection.

Habitat.—West Indies.

Observations.—*Palinurellus*, v. Martens, according to that author differs from *Synaxes* in having the posterior pair of pereopoda chelate in the female, and Boas in his *Studier over Decapodernes Slægtskabsforhold*, p. 183, considers it as the most primitive form of the *Palinuridæ*, and therefore nearer *Homarus*.¹

Palinurellus gundulachi, Martens, was taken off Cuba.

Aræosternus, De Man, Professor Martens² considers to be the same as *Palinurellus*.

Aræosternus wieneckii, De Man, was taken off Sumatra.

Geological Range.—The genus *Palinurina* was established by Munster for species

¹ K. Dansk. Vidensk. Selsk. Skr., Rk. 6, Bd. i., 1880; Zool. Record, 1881, Crust. p. 20.

² Zool. Record, 1881, Crust. p. 20.

found in the lithographic stones of Solenhofen and the lias of Southern England, it has the flagella of the first pair of antennæ long, and all the pereipoda subequal, the first pair not longer or more chelate than the others.

Palinurina pygmæa, Münst., *Palinurina longipes*, Münst., and *Cancerinus claviger*, Münst., evidently belong to this family, and probably also *Archæocarapus bowerbankii*, M'Coy, from the London clay; the last is remarkable for the length of the first pair of subchelate pereipoda and the prominent rostriform character of the frontal margin of the carapace.

DEVELOPMENT OF THE PALINURIDÆ.

The species belonging to the genera of this tribe are among the largest of the Crustacea Macrura, measuring as they frequently do some two feet or more in length. But although their dimensions are so great, yet their ova are among the smallest, measuring less than 1 mm. in diameter. As in most instances when the ova are small, their number is correspondingly large.

The young when it quits the egg measures 1.5 mm. from between the ophthalmopoda to the posterior extremity of the pleon. The legs, of which one single and four double branched pairs are already well-developed and longer than the animal, and previous to being hatched lie longitudinally rolled up, passing anteriorly between the ophthalmopoda and reaching over the dorsal surface of the animal to the posterior extremity of the cephalon. When it quits the ovum and throws off the first embryonic covering it appears in the form of what was long believed to be a perfect animal, the *Phyllosoma*. At this period, in specimens that I have taken from the ova of British species (Pl. XIIA. fig. 1), the central ocellus is very conspicuous, and placed between the ophthalmopoda which are largely developed and distinctly pedunculated, the ophthalmus being large and massive, and the peduncle rapidly narrowing to a slender attachment. The two pairs of antennæ are only uni-branched, and as yet do not appear to be articulated. The mandibles are present and perhaps one of the siagnopoda.

The pereion is not covered by the carapace but consists of six somites dorsally fused together, and carries five pairs of pereipoda, of which the first is small, slender and uni-branched; the others are biramose, the second branch, articulating with the distal extremity of the basis, is multiarticulate, consisting of six subequal joints including the two basal, which are homologous with the coxa and basis.

The pleon is short, showing at the sides the divisions which mark the number of its somites.

Unfortunately the young are very difficult to rear, and although they have been occasionally hatched in artificial aquaria,¹ none have yet been known to pass into the second stage of development.

¹ The late Mr. Alfred Lloyd informed me that in the aquarium at the Crystal Palace the young of the *Palinurus* when first hatched hung in the water as a cloud in the form of an inverted pyramid for some time—two days, if I remember correctly—and then gradually dispersed.

No doubt there are large numbers in the sea, and these are occasionally taken, but though the adult is common¹ on our south western coast, yet the *Phyllosoma* form has only been taken occasionally as solitary specimens. In the warmer latitudes they have been more frequently captured, from the length of 1.5 mm. to that of 30 mm., but these being from different as well as distant localities are undoubtedly the young of different species or perhaps even genera.

The smallest, and as we may suppose the youngest form (Pl. XIIA. fig. 2), taken by the Challenger off Samboangan, is about 1.5 mm. in length, corresponding to that of the young when it quits the egg. It differs from the more immature form (fig. 1) that I have taken from the ovum of the European species, in having the vitellus entirely absorbed, and in having the various hairs that fringe the appendages liberated from the embryonic case and freely extended. The central eye or ocellus is distinct; close behind (fig. 4) and connected with it, is a small circular transparent body that I take to be a lens, posterior to this again and lying transversely is a narrow line of rigid integument that I take to be the ventral surface of the first or ophthalmic somite. It extends from the base of one ophthalmopod to that of the other, where it probably blends with the membranous articulation. The ophthalmopod is long and cylindrical, and suddenly expands at the base of the ophthalmus. On each side of the median line, a little posterior to the ventral ridge of the first somite, are two small bodies that appear to be the nuclei of a mass of nerve matter that surrounds them. This neural substance passes back in two gradually narrowing lines, one on each side of the oral apparatus, from whence I was not able to trace it until it reaches the pereion, where it reappears in the form of three double lobes corresponding with the three posteriorly developed pairs of pereopoda. The mandibles possess a rigid character and a long calcified tendon that extends nearly to the base of the second pair of antennæ. I have not been able to determine whether the synhipod be present, neither can I determine in this solitary specimen whether the first pair of siagnopoda be developed. The first pair of pereopoda consists of a small, unbranched, well-formed appendage, it has only six joints, very short, and terminates in a sharp pointed dactylos.

The second pair is also six-jointed, it is very much longer than the first, is biramose, and terminates in a long and slender dactylos.

The third and fourth pairs of appendages are seven-jointed and resemble each other, except that I could only determine the presence of a long spine-like tooth at the distal extremity of the ischium in the third pair, whereas in the fourth there is a prominent one present on the basis, ischium and meros also. There is, moreover, a small branch attached to the coxa; this is homologous with the mastigobranchia in the adult animal, and exists on the third and fourth pairs of pereopoda, but not, so far as I could deter-

¹ The late Mr. Laughrin of Polperro informed me that one man took, a short time since, as many as sixty-four in one night off Kedgwith near the Lizard, and frequently as many as fifty.

mine, on any of the others. The pleon is short and without any evidence of possessing appendages.

The specimen next in size is from the Celebes Sea (Pl. XIIA. fig. 3) and is 7 mm. in length. That is, it has increased in dimensions about five times without any very great variation in form or growth of parts, and as there is in the development of separate species of the same genus and generally in different genera of the same family the same structural characters, I shall consider the several specimens taken as being successive stages in their relation to each other. The ocellus is still very distinct, and the ophthalmopoda have increased in length considerably and become biarticulate, one articulation at the base and the second at the root of the ophthalmus, which is long and pear-shaped. The first pair of antennæ is biarticulate but not biramose. The second shows evidence of becoming so, but not very conspicuously; at its base a series of cells are arranged in the form of a circle, and behind this the green gland appears in an incipient stage. The hepatic lobes, which in the previous stages were large and few, are here increased in number and arranged in a series of cæca symmetrically disposed on each side of the carapace, and which empty themselves into a longitudinal duct that is united with the main viscera near the stomach and above the oral apparatus.

The mandibles are distinctly visible, sharp-pointed, and enclosed between the cheiloglossa and the metastoma or posterior lip, behind which, and clasping it closely, the first pair of siagnopoda is visible, in form somewhat resembling that of the adult. The distance from this latter organ to the anterior margin of the pereion is considerable, corresponding as this does with the posterior margin of the cephalon. At the anterior angle of the pereion is a pair of biarticulate appendages, short and rudimentary, the second joint being shorter than the first. Near this is a second small but well-developed pair of unbranched five-jointed limbs, a few hairs existing on the two terminal joints; this is the first pair of gnathopoda. The next and three following pairs resemble each other; they are biramose, rather longer than the animal, seven-jointed and carry a long basecphysis. The next succeeding, or seventh pair of appendages is short and feeble, being in an immature condition; it is four-jointed and carries a small basecphysis. Posterior to this pair and situated in the angle formed by the union of the pleon with the pereion there is a small vesicle, the germ of another pair of appendages. The pleon is small and without any evidence of the future appendages.

The next specimen, and one which has the appearance of being the young of the same or a closely allied species, is from the West Pacific, and is about 14 mm., or double the length of the preceding (Pl. XII B. figs. 1-3).

The central eye has become reduced in size. The ophthalmopoda are two-jointed.

The first pair of antennæ has become four-jointed and biramose, the smaller branch springing from the distal extremity of the third joint. The second pair of antennæ is five-jointed and exhibits on the metope or ventral surface near the base of the antennæ a

small circular foramen, the rudiment of the future phymacerite, connected with which is the incipient green gland. The appendages of the mouth are assuming the permanent form, but as yet I have not been able to determine the future synhipod, but the calcified tendon is seen as a long thread reaching to the second pair of antennæ. The first pair of signopoda, so far as I can make out, is the only pair of oral appendages yet present.

The small two-jointed appendage attached to the anterior angle of the pereion is still a feeble and unimportant organ. The next in succession is unbranched and pediform, but appears not to have increased in length or in importance.

The next five pairs are of the same relative value. The penultimate pair has increased until in size and appearance it resembles the preceding pairs, while the ultimate still remains in the form of a small elongated vesicle, to the proximal extremity of which small muscles are attached. It is more distant from the angle that is formed by the union of the pereion with the pleon than in the form shown in fig. 3, Pl. XIIA.

The pleon exhibits on the ventral surface five pairs of marginal papillæ that increase but little in size posteriorly until the sixth pair, which is more developed and exhibits signs of being pendulous and bilobed.

The next specimen was taken off Kandavu, one of the Fiji Islands, and is 15 mm. in length.

The difference between this specimen and the preceding is very slight, none being appreciable in the progressive development, but the carapace is somewhat broader in proportion to its length, which is probably due to its being the young of an approximate or variable species.

Our next specimen in point of size, was taken at the Cape Verde Islands. It is 22 mm. in length, or 7 mm. longer than the previous one which was taken off the Fiji Islands. It differs little in structure, but the oral appendages have approached nearer to the pereion, and the other pairs assimilate to those of the preceding stage except the posterior pair of peripoda which have increased in length but are still unbranched, biarticulate, and in an immature condition. The pleopoda are all produced as biramose appendages, the branches being each attached to a small basal joint. The posterior pair is the largest, as might be anticipated from its earlier appearance and future condition. The pleon has increased from 1 to 4 mm. in length.

The other specimens in the collection are from St. Thomas Island, West Indies. There are three of the same species, one of which is 15 mm. in length and corresponds in development with the preceding; another is 30 mm., and the third is 35 mm. in length; a fourth specimen (Pl. XIIc. fig. 1) evidently belongs to another species. None of these probably are the young of those species which are known in the more western longitudes, but their study must throw some light upon the relative growth of parts during the development of the animal.

The length of the smallest of these specimens is double that of the largest of the preceding, and consequently we should expect to find a considerable amount of progressive change,

but, remarkable as it may seem, this is not the case. Had these West Indian specimens been taken in the eastern seas, we should have been prepared to consider them as being of some known species obtained there, from their resemblance in all important features.

The central eye has become relatively small and appears to be connected with the carapace, or perhaps more correctly speaking is situated behind the somite that carries the ophthalmopoda. The ophthalmopoda, slightly decreasing in their comparative length, are still two-jointed, and are now distinctly attached to a somite that is separated from the carapace. The first pair of antennæ has the two flagella in an embryonic condition varying little from that seen in the last preceding description. The second pair of antennæ has four distinct joints, the three basal are subequal, the fourth is longer than the three preceding, slightly tapering, and commencing at its base to be divided into annuli. Upon the metopal surface of the carapace an ovate foramen exists, the connection of which with the green gland is apparent, and at its side is a second glandular body, smaller and of different structure. Near this, on the wall of the carapace, may be seen the feathery extremity of the long and slender calcified tendon that raises and closes the mandible, to which it is attached on the under side near the upper extremity of the apophysis. The metastoma exists as two circular foliaceous plates, behind which may be seen the two foliaceous branches of the first oral appendages, which as yet are immature. The stomach is becoming visible above and posterior to the oral apparatus, behind which it is mostly hidden. The distance of this from the next succeeding pair of appendages is proportionally less than in the preceding specimens, but even now it is equal to half the distance of the oral apparatus from the frontal margin of the carapace. The next in succession is the small pair that in the preceding specimens corresponds to the anterior angle of the pereion. It now consists of a basal joint, to which are attached a large and a small foliaceous plate. The next succeeding pair of appendages still retains the unbranched pediform character, but is furnished with a strong spine at the extremity of the propodos besides a few less important hairs. This spine is as thick and as long as the dactylos and gives the appendage a chelate appearance, which is probably a specific rather than a developmental character. The three next succeeding pairs retain the same character as in the younger and more early stages. The pleon has increased in length a little, and all the pleopoda are present as pedunculate biramous appendages, agreeing in character with the permanent form, but still immature; the cilia that fringe the margins being yet undeveloped, and a small notch existing where the future stylamblys will be. The posterior pair as yet merely repeats the form, but is larger and has a small prominence on the outer ramus, where the future external tooth will be situated; this is still more prominent in the underlying dermal tissue that is apparent beneath the surface.

The next largest specimen is from the same locality as the preceding, St. Thomas in the West Indies, and is 35 mm. in length. The appendages have very nearly the same relative proportion; the pleon is still short, being only 7 mm., or one-fifth of the

entire length of the animal; the posterior pair of pereopoda is still very short, being only 4 mm. long as compared with 30 mm., the length of the first pair, which is the only one not broken, and which is generally but little more than half of the second and third. Up to this stage, the most advanced in the collection, the animal still retains its *Phyllosoma* condition, without the slightest sign of any branchial structure whatever. The nervous system gradually becomes more definite in character but as yet the pereionic ganglia are distinct from each other both longitudinally and laterally. The cerebral mass consists of three lobes, the frontal and two lateral. The former supplies the organs of vision, the latter send large branches to the antennæ, while one or two small branches there subdivide and go to the antennal gland, which in this larger specimen appears to consist of a number of thick-walled convoluted chambers or cavities.

From the cephalic ganglia two long slender nerves go directly back to the oral apparatus, which they pass, one on each side, and continue until they enter the pereion, where they enlarge and unite to form a long wavy mass, from which small lateral branches are given off apparently to join the gnathopoda and the anterior appendages which, as yet, are in an immature condition. Passing from this ganglionic mass, the neural cord divides and forms double ganglia, in three successive pairs, which go respectively to the three anterior pairs of pereopoda. The next supplies the fourth pair but differs from all the preceding in consisting of four ganglionic masses forming a quadrangle.

The fifth pair of pereopoda is as yet in a very immature condition, but whether from injury to the specimen in mounting or from some other cause, I can find no corresponding ganglionic centre. Whether the posterior or quadrangular group of ganglia supplies it I could not determine, although I am induced to believe it does, but the space between this and the next ganglion was obscure.

The next and following ganglia differ from the preceding in being spherical and in having no central division; they are close together, and each ganglion is nearly as large as the somite that it supplies is long; there are only five ganglia, and these correspond to the five anterior somites of the pleon; none were visible in the sixth joint and telson.

The next specimen is evidently the young of another species, and agrees closely with that which Milne-Edwards has described and figured under the name of *Phyllosoma stylicornis*,¹ but it has the cephalon narrower anteriorly and proportionally longer (Pl. XIIc. fig. 1). It is 30 mm. in length, and was taken off St. Thomas Island, West Indies, in the month of March, whereas that of Milne-Edwards is recorded from the Indian Ocean. Its most remarkable feature is, that although it is one of our largest specimens, the pleon is not more than 1 mm. in length, and none of the pleopoda are present except the posterior pair, and these are in a rudimentary stage. On the other hand all the pereopoda are as far advanced as those of the preceding specimens, and the posterior pair is very much more so, and stands at the extremity of the posterior angle of the

¹ Hist. des Crust., vol. ii. p. 483, pl. xxviii. figs. 1-7.

pereion which is considerably more extended than in the preceding specimens, and leaves the pleon embayed in a fork of considerable depth.

The eyes are supported on long, slender, bi-articulate ophthalmopoda. The first pair of antennæ has the peduncle tri-articulate and supports two flagella, of which the larger is furnished with a number of membranous cilia, which I believe to be auditory in their function; the smaller is slender and in an incipient condition: the second pair of antennæ is short, tapering, and multi-articulate; at its base, situated within the margin of the carapace, is the foramen of the future phymacerite, and leading up to it the cellular substance of the green gland, whose walls appear more delicate than those of the preceding species: the oral apparatus is hard and firm, and the long, slender calcified tendon of the mandible is threadlike and extremely delicate: the first pair of siagnopoda is two-branched, curved and armed with several strong spines, some of which are fringed with minute pointed processes, and the whole apparatus is in close contact with the anterior extremity of the pereion, the anterior angle of which supports a small two-jointed appendage similar to that which we found at earlier stages in the other specimen; on the outer side, also, there exists a small rudimentary process which is not seen in either of our other specimens, and which Milne-Edwards figures¹ as being the incipient stage of "les mâchoires de la deuxième paire et la première paire de pattes-mâchoires"; the next as well as the five succeeding pairs, appears to be in a similar condition to those of the preceding example, but the seventh or ultimate pair is considerably longer and quite equals in size the largest of the preceding, a circumstance that is more dependent upon specific than upon developmental differences, since the specimens of other species which are larger in size have their posterior pair in a much more immature condition.

Again, in this present specimen the pleon is in a very immature condition, none of the pleopoda being beyond the early budding stage except the posterior pair, and that but slightly advanced.

DEVELOPMENT OF THE SCYLLARIDÆ.

The foregoing paragraphs contain an account of the development of the Palinuridæ, so far as the specimens in the present collection enable me to trace it; but some others in my possession, which were obtained on the coast of Coromandel, by Sir Walter Elliot, still further illustrate the progressive changes in the genera of the Scyllaridæ.

The specimens appear to me to be identical with that described by Desmarest under the name of "*Phyllosoma larges-cornes*," and by Leach as *Phyllosoma laticorne*, but which from the character of its antennæ appears to belong rather to the Scyllaridæ than to the Palinuridæ. The progressive development of the young of the two families is probably so nearly similar, that the history of one would be the repetition of the other. Our specimens, which are numerous, are only 16 mm. in length, or about half that of the

¹ *Loc. cit.*, pl. xxviii. fig. 3, c.d.

largest of the specimens previously described, yet in many parts they have advanced further in characteristic development (Pl. XIIc. fig. 2).

The ophthalmopoda are still long and biarticulate, the stalk being long, slender and cylindrical, the eye at its extremity being long and pear-shaped.

The first pair of antennæ affords evidence of its permanent form; it has a peduncle of three subequal cylindrical joints which terminate in two short flagella, the inner of which is slender and cylindrical, while the outer is flatter, broader and sharply pointed, and on the convex side supports a few membranous cilia.

The second pair of antennæ is three- or four-jointed. The joints appear within an outer case that is less articulated (Pl. XIIb. fig. 4c). The first is short and cylindrical, the second is long, flattened, and produced to a sharp point at the outer distal angle, the third is short and cylindrical, and the fourth or last is flat, wide and produced to a point. Within the outer integument, which is next to be shed, the structure exhibits the appearance of a series of narrow lobes at the margin similar to those that we see in *Scyllarus* and *Arctus*. The distance of the antennæ from the oral apparatus is a little less than half the length of the animal, and is occupied by distinctly formed hepatic lobes arranged in a beautifully radiating series of branches. The mandibles are smaller than in the preceding specimens, but the calcified tendon is long, slender, and feeble as compared with those of the preceding specimens. I could detect no synhipod, and the apophysis is broad and of extreme tenuity.

The first pair of siagnopoda (Pl. XIIb. fig. 4e) is two-branched, and lies closely attached to the double lobed *metastoma*; the two branches are tipped with three or four hairs on each, which from their relative proportion appear like important spines; the second pair of appendages (fig. 4f) is in the form of a flat oblong plate, and corresponds with that of the adult; two small branches are also visible within a common outer sac.

The next pair (fig. 4g) is in a very incipient stage, and consists of a simple elongated sac, without exhibiting any evidence of its future condition. An example of this is likewise seen in *Phyllosoma brevicorne*, Leach,¹ which induces me to think that both forms belong to a genus of *Scyllaridæ*.

The next pair of appendages (fig. 4h), which I believe corresponds with the first pair of gnathopoda, is developed in the form of a true leg; it is only five-jointed, and carries a long sub-cylindrical branchial sac attached to the coxa or first joint; the second joint is long and cylindrical, except for a small lobe or projection that exists on the outer surface, one-third distant from the coxal joint; the next two joints are subequal and of the same diameter as the last, whereas the one or perhaps two terminal become suddenly smaller and tapering, terminating in a fine spine: the next pair of legs corresponds to the second pair of gnathopoda; it is pediform, long, slender, and in all our specimens is broken off more or less shortly; attached to the coxa is a single subcylindrical branchial sac. The next four pairs are also broken off, but the fragments remaining in the bottle show

¹ Milne-Edwards, *Hist. des Crust.*, vol. ii. p. 482.

them to be pediform, cylindrical, biramose, terminating in a strong and sharp dactylos, and furnished at the base with two subcylindrical vesicular branchiæ: the seventh or terminal pair of pereiopoda is considerably shorter than the others, it is five-jointed and furnished neither with branchia nor ecphysis.

Anteriorly the pleon corresponds in width with the posterior portion of the pereion and tapers a little towards the caudal extremity. The external angle of each somite is posteriorly rounded, and the telson approaches the form of that in the permanent or adult stage,—being rounded and membranous at the extremity, and armed on each side with a small sharp tooth. The pleopoda as yet are in an immature condition, consisting of a stout peduncle and two slender subcylindrical rami, except the posterior, which has the peduncle short and the branches broad and foliaceous, making with the telson a well-formed rhipidura.

In neither of the specimens that belong to the *Palinuridæ* have I seen any trace of a branchial organ, but in those of the *Scyllaridæ* I find them attached to all the legs from the first pair of gnathopoda to the penultimate pair of pereiopoda, the ultimate, as in the adult stage, being without any. Not only are they attached to the legs but some are attached to the walls of the pereion also. Examination with a higher power shows that those attached to the coxæ of the legs are double-branched, while all the others are single, but in pairs. Examination of the structure demonstrates that within these sacs the future branchiæ exist in the form of trichobranchiate plumes, excepting in those attached to the coxæ of the legs. These consist of two sacs attached at the base to one stalk; one of these sacs contains a branchial plume, the other a branchial lash; the one becomes the podobranchia, the other the mastigobranchia. The other sacs are evidently the arthrobranchiate and pleurobranchiate plumes in an incipient state.

Turning now to a very different stage of the young *Palinurus*, there will be found in this Report one or two specimens that have reached the permanent form, and are 27 mm. or scarcely more than one inch in length.

Sir Walter Elliot captured at Waltair, on the coast of Coromandel, a specimen of *Palinurus* that was only 18.25 mm. in length. It was smooth and opaline, with antennæ three times its own length. All its appendages were well-developed, and there is little doubt that it was the young of some probably known species.

If we compare this with the length of the large *Phyllosoma* of *Palinurus*, we find that the smallest adult form is nearly half an inch shorter than the largest immature form, and that the largest immature form has not yet sufficiently advanced in development to possess branchiæ; that the pleon, which in the adult condition is more than half the length of the animal, is still in a rudimentary condition, the pleopoda as well as the rhipidura being only in the early stage of gemmation (Pl. XIIc. fig. 1).

Judging, however, by the analogy of what we do see in the *Phyllosoma* of the closely allied form of *Scyllarus*, we may safely infer that, corresponding with the development of

the pleon, the carapace gradually projects from the cephalon over the pereion, and the several appendages assume a more permanent character without any sudden change of parts.

Phyllosoma furcicaudatum (Pl. XIIb. fig. 1).

This specimen, taken at St. Vincent on the 26th April 1876, at the surface, is 6.5 mm. long, and has a peculiar form of caudal termination to the pleon, from which I propose to name it, until its relation to the adult form is determined.

In general appearance it corresponds to the more advanced form taken off the coast of Malabar by Sir Walter Elliot, and I believe it to be a younger stage of some genus of the Scyllaridæ, and as several specimens of *Ibaccus* have been found in that locality, it is not improbable that it may be the young of that genus.

The ophthalmopoda are long, but do not extend laterally as far as the margins of the carapace: the ophthalmus is pear-shaped and about one-third of the length of the ophthalmopod.

The first pair of antennæ is slender and carries a short branch at the base of the outer flagellum which supports at the apex a few membranous cilia; the second pair of antennæ is longer than the first, slender, and armed on the outer side, at about one-fourth its length from the base, with a strong tooth-like process, which in a stage further advanced is probably developed into the outer marginal angle of the great squamiform joint of the peduncle; the rest of the appendage appears from its multiarticulate condition to resemble the long flagellum in the other families of the Macrura.

The second pair of siagnopoda exists in the form of a short squamose plate.

The third pair consists of a small circular tubercle.

The gnathopoda and the four anterior pairs of pereopoda correspond with those of the more mature forms in all excepting what may be specific characters. The Cape Verde specimen is armed with large teeth attached to the several joints of the pereopoda near the articulations. In the specimen from Waltair, in which the legs are free from this kind of armature, there are no branchiæ yet developed, and the posterior pair of pereopoda is still in an incipient stage of gemmation.

The pleon is remarkable; it shows no sign of segmentation, and terminates in two long tooth-like processes, one at each posterior angle, each process being firm, rigid, and nearly as long as the pleon.

Phyllosoma verdense (Pl. XIIb. fig. 2z).

Habitat.—Taken at St. Vincent, Cape Verde Islands, on April 26, 1876, at the surface. Length 2.5 mm. to 3 mm.

Two specimens of this species were taken associated with *Phyllosoma furcicaudatum*. For temporary convenience I shall designate them after the locality at which they were taken, although I believe that they are the same species at different ages. The smaller one is little larger than the length of the brephalos when it quits the ovum. The second corresponds in all respects excepting that it is a little more developed. They both resemble *Phyllosoma furcicaudatum* in all the appendages that are developed, excepting the ophthalmopoda, antennæ, and pleon.

The ophthalmopoda have the peduncle and the ophthalmus subequal in length, the latter is pear-shaped and articulated with the peduncle.

The first pair of antennæ is single-branched, cylindrical, and nearly one-third the length of the carapace.

The second pair resembles the first both in size and length.

The second pair of siagnopoda is biarticulate, but small and rudimentary (Pl. XIIb. fig. 2f).

The third is not yet present.

The two pairs of gnathopoda and the three anterior pairs of pereiopoda are well developed, and correspond nearly with those of *Phyllosoma furcicaudatum*, excepting in having the dactyli comparatively longer, as well as the several spinous teeth upon the respective joints also.

The fourth pair is present in the form of incipient buds, while the fifth pair is not as yet represented.

The pleon is feeble, cylindrical, and terminates at the external lateral angles with a small tooth and a minute hair (Pl. XIIb. fig. 2z).

Phyllosoma philippinense (Pl. XIIb. fig. 3).

Habitat.—Taken off the Philippine Islands, October 23, 1874.

Length 2 mm.

This species corresponds very closely with that taken off Samboangan, and is no doubt closely related to it. It differs somewhat in the form of the ophthalmopoda, as represented in the plate, but I am inclined to believe that those of *Phyllosoma samboangense* are altered in form from the manner of preservation. All the appendages are similarly developed and show the same characteristic features, except that the posterior pair of the developed pereiopoda, which correspond to the third pair in the adult, has no basecephysis, but has on the posterior margin, one-third from the coxal articulation, a strongly formed tooth-like process; the morphological value of which is yet to be determined.

The pleon is slightly tapering, and terminates on each postero-lateral angle with a small tooth (Pl. XIIb. fig. 3z).

This species and that from Samboangan are doubtless the same, although the caudal termination is rounded in the latter, and bifid in *Phyllosoma philippinense*; the basecephysis is absent from the third pair of pereopoda.

These two species, moreover, correspond closely with two taken off the Cape Verde Islands, in the Atlantic, that are of the same size and of similar condition of development. I am inclined to believe that both forms belong to the same genus as *Phyllosoma furci-caudatum*, and this probably is generically related to some species belonging to the Scyllaridæ, and probably to the genus *Ibaccus*.

Tribe **Astacidea.**

Family ERYONIDÆ.

Cephalon dorsally depressed, having no rostrum. Lateral margin of the carapace horizontally compressed and serrate; broader than the pleon. Eyes wanting or abnormal; first pair of antennæ supporting two multiarticulate flagella. Second pair having a scaphocerite, and a long multiarticulate flagellum. Gnathopoda pediform. Pereiopoda seven-jointed; first three pairs chelate; posterior pair reversed, chelate occasionally in the female, smaller than preceding. Pleopoda, except the first and sixth pair, having a stylamblys. Outer branch of sixth pair without a diæresis. Telson tapering.

Observations.—Professor Camil Heller in 1863 described in his “Crustaceen des südlichen Europa,” under the name of *Polycheles typhlops*, a small Crustacean, of which he only had a male specimen, found in the collection of the Museum at Vienna. It was supposed to have been taken in the Mediterranean, somewhere near the island of Sicily.

Its interest appears to have been much overlooked by naturalists, until Sir Wyville Thomson published, in *Nature*, May 15, 1873, ten years after Camil Heller's description, some notes by Dr. v. Willemoes-Suhm of the Challenger, upon a closely allied form that was dredged on the 4th of March preceding in the middle of the North Atlantic, at a depth of 1900 fathoms or rather more than 2 miles from the surface. To this animal the describer gave the name of *Deidamia leptodactyla*, the generic name of which was afterwards withdrawn, because it was found to have been given previously by Dr. Clemens to a genus of North American Lepidoptera, and the name *Willemæsia*, out of compliment to the ill-fated naturalist of the Challenger, was given to it by Dr. Grote in 1873.¹

The great depth from which it was dredged, a depth that was previously believed to be barren, if not of all life, certainly of animals so high in the scale of existence, the apparent absence of the power of vision, and the relationship of the animal to forms of Crustacea that were supposed to have been extinct since the period of the Liassic Limestone of England and the Upper White Jura of Bavaria, gave a considerable degree of interest to the discovery. Shortly afterwards a second smaller species in shallower, but still

¹ *Nature*, vol. viii. p. 485.

deep water was taken off Sombrero, one of the eastern group of West Indian Islands, at a depth of 450 fathoms, which, from its general resemblance to the fossil genus *Eryon*, excited peculiar attention, and subsequently the Challenger obtained from even greater depths and in very distant localities many specimens that very closely resembled one another in general appearance. Since then species have been taken by Professor Agassiz in the West Indian Seas, and in the Mediterranean by Professor A. Milne-Edwards.

Detailed examination of the specimens from the several localities demonstrated that however closely they may resemble one another in external form, they yet exhibit important variations showing that they are not so intimately allied as appearances might suggest.

In some the external arrangement of the numerous teeth and spines varies without any modification of the structural form, whereas in others the external characters appear to be fixed and the internal structure undergoes a considerable amount of important variation.

The chief anatomical feature, and one from which all the other peculiarities of form arise, is its flattened and dorsally depressed character, particularly at the anterior extremity, where the frontal margin is so closely compressed upon the antennæ that they are flattened at the base, and implanted almost in the same horizontal line, while the ophthalmopoda are forced between the second antennæ and the external lateral angle of the carapace, so that the utility of the organ of vision is reduced to a minimum. In the genus *Willemæsia* the ophthalmopoda appear to be obsolete, and in *Eryoneicus* to be entirely absent. The antero-lateral angle of the carapace in this group of Crustacea is represented by what Stimpson has called the "spina antennalis" in the more cylindrical and common forms. This angle, which is not appreciable in *Astacus* and *Homarus*, and only represented by a short tooth in *Palinurus*, is produced to a marked degree in *Arctus* and *Ibacus*, where, in the latter especially, it is carried to a very considerable extent outwards. But in *Polycheles* and in *Arctus*, instead of being directed laterally outwards, it is produced in the same manner, forwards and outwards. The orbit being in a similar position, and formed in a similar way, in the Scyllaridæ and Eryonidæ, the consequence is the degradation of the organs of vision and the reduction of size and alteration of form of the orbit, which in some species of the Eryonidæ results in the almost total suppression of the ophthalmopoda.

Ranging from the anterior or antennal tooth, the line of anatomical depression produces a lateral crest that longitudinally defines the dorsal from the ventral surfaces of the carapace; it resembles the lateral margin of the carapace in the Brachyura, but is not homologous with it. In the Brachyura the marginal angle corresponds with the external angle of the orbit, or, according to Stimpson's nomenclature, the "angulus orbitæ externus;" the antennal angle, or "spina antennalis," being carried under, forms the inferior margin of the orbit, whereas in *Polycheles* the inferior surface of the orbit is imperfect, the eye appearing dorsally in a cleft between the frontal and the anterior

angle of the antennal regions, and ventrally between the upper surface of the second antenna and the under surface of the antennal region (Pl. XIII. figs. *abc*).

The dorso-lateral margin of the carapace forms an angular ridge, and is divided more or less distinctly into three portions in separate species. These divisions correspond to those seen in the Scyllaridæ, as exemplified most clearly in *Arctus orientalis* (Pl. IX. fig. 4); the anterior represents the line of the cervical fossa, while the posterior may be called the siagnotic fossa, as the space between the two is occupied by the siagnos, or mandible, and may well be termed the siagnotic region. This latter sulcus, although strongly defined in some species both in the Scyllaridæ and in the Eryonidæ, is in others less appreciable, and disappears in *Ibaccus*, and is determinable only by an analytic examination in the Astacidæ.

These several divisions of the carapace in the animals belonging to the Willemœsian group are defined by a series of sharply-pointed teeth that differ in number and vary in size and proportions in different species, and may safely be used as a convenient and fairly reliable sign of specific structural difference.

In the dorsal median line there is a longitudinal carina more or less important, culminating in strong teeth on each somite of the pleon, and taking the unusual direction of pointing forwards. It commences on the frontal margin of the carapace, and terminates in the anterior extremity of the telson. On the carapace it is scarcely more prominent than a small ridge that in some species is only granulated. It is generally armed with teeth on the posterior margin of the cervical sulcus, the gastric region, and the frontal margins, where one or more generally stand in an oblique position behind the edge, which is not produced to a point or rostrum as in *Astacus*, &c. These teeth correspond with those in the same position, and further resemble them in being sometimes double in *Arctus* and allied genera, but are more robust. One peculiar feature in the external structure of these animals is the manner in which the first somite of the pleon interlocks with the carapace. In *Polycheles* and *Pentacheles* a tubercular process (peltecleis) of the posterior margin of the carapace projects obliquely backwards (Pl. XVI. fig. 4), and overlaps the anterior margin of the first somite of the pleon, while the lateral extremity of the first somite, or that portion which is laterally external to the tubercular process of the carapace, is directed forwards, and overlaps the posterior marginal angle of the carapace.

In the genus *Willemœsia* the interlocking is different. There the peltecleis, instead of overlapping the anterior margin of the first somite of the pleon, projects into a hollow socket beneath the anterior margin of the same somite, and acts as a bolt and joint (Pl. XX. fig. 1). In the Scyllaridæ there is no peltecleis, but the anterior lateral margin of the first somite of the pleon overlaps the posterior lateral angles of the carapace, and so securely holds it down.

In the Palinuridæ a lateral process of the first somite of the pleon overlaps the

posterior margin of the carapace. There is no peltecleis attached to the carapace, but a tubercular process, different in form but fulfilling the same purpose, is attached to the pleura of the posterior somite of the pereion, just above the articulation of the last pair of pereopoda, and behind the base of the pleurobranchia, and may be called a pereicleis, as it serves to bolt down the carapace to the pereion, which it does very effectually by being inserted into a hollow formed in the internal surface of the carapace, which fits closely beneath the overhanging margin.

All the somites of the pleon articulate with each other by means of a lateral process produced from the anterior edge of one somite articulating into a cup or hollow situated in the latero-posterior margin of the preceding somite. The anterior half of each somite is smooth and adapted to be retracted beneath the preceding somite when the animal is extended, and the overlying margin of each is furnished with a small fine fringe of cilia that protects the sub-internal division from the introduction of any fragments of foreign and irritating matter.

The rhipidura or tail-fan is large and well developed, and the powerful muscles of the pleon evidently enable it to strike with considerable force, so as to allow the purblind creature to dart backwards with great rapidity on the most sudden alarm.

The eyes are carried on an ophthalmopod in *Polycheles* and *Pentacheles*, which is altered in character (Pl. XVI. fig. 3c, a) and rigidly attached to the cephalon on the inner side, while it is only closely compressed and covered by, but not fused with, the antero-lateral angle of the carapace on the outer side. The base of the ophthalmopod is lodged in an irregular orbit, which has a tendency to a slight degree of variation of form that is useful in assisting to determine species.

The first pair of antennæ (fig. 1c, b.) in the several genera is formed on the same type. The tendency to specific variation in this appendage is mostly limited to the alteration of the crest-like process that is formed by the broad and thin exterior of the inner margin of the first or coxal joint. In *Eryoneicus* it is reduced to a prominent tooth, whereas in other genera the extended surfaces of this joint meet in the median line, and by pressure against each other force themselves upwards and form a central crest-like ridge. This crest is variously fringed with teeth and hairs, and is sometimes pointed and sometimes rounded in front. In the interior of this joint is situated the acoustic apparatus (Pl. XIX. b. a.c.), which consists of a calcareous chamber connected by a calcified channel to the upper surface, where there is a long and narrow fissure guarded by strong teeth, which varies in number in different species, or they may be absent, as in the genus *Willemæsia*. The other two joints, as well as the flagella, appear to exhibit no great degree of variability, as the segments are always cylindrical, and the flagella unequal in length to a degree that is common to all the recent family.

The second antenna (Pl. XIX. c.) varies little from the general external character seen in the Macrurous type of Crustacea. But what variation there is appears to be peculiar to the group. There are only four joints forming the peduncle; the scaphocerite,

apparently articulates with the second, a circumstance demonstrating that the second and third are fused into one more solidly in the *Macrura* generally, but the most singular feature is the peculiar form and proportion of the phymacerite (Pl. XVII. c. o.p. and Pl. XIX. c. o.t.). The first joint or coxa of the antennæ articulates freely with the metope, a circumstance that distinctly separates it from the *Palinuridea*, and from its inferior or ventral surface a hollow calcified tubercle springs, as is common in all the *Macrurous*



FIG. 13.—Phymacerite of *Stereomastis suhmi*.

types, but in this family this tubercle or phymacerite is produced to a considerable length, it is turned inwards and then curves upwards and presses its extremity strongly against the under surface of the first antenna, where it is received into a depression. The extremity of the phymacerite is closed by a membrane of delicate appearance, and there seems to be no free opening; but in a specimen of *Stereomastis suhmi* that I closely and carefully examined, there appears to be near the centre a crescentic line that may be a fissure, as shown in the accompanying illustration, although I could not demonstrate it to be so. Around this fissure, which was situated near to one extremity, there existed, parallel to the outer open margin of the tubercle, a band of more solid structure divided at the top and bottom. Whether this be a kind of sphincter muscle for the purpose of closing the crescentic orifice, I am not prepared to say. The margin is generally fringed with more or less conspicuous hairs.

The oral cavity is large and spacious, but capable of being entirely closed by membranous tissue which forms an anterior and a posterior fleshy protuberance; the former passes under the mandibles anteriorly, and apparently fulfils the functions

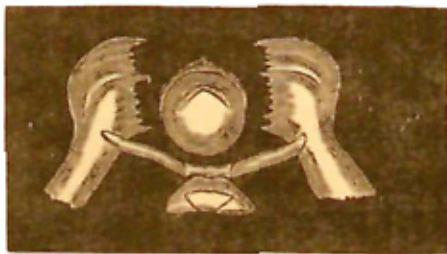


FIG. 14.—*Pentacheles enthrix*. "Mandibles, with anterior and posterior lips. Between them the oral aperture and two feeler-like appendages, mandibles without palpus. Enlarged four times." From a drawing and note by Willemoes-Suhm.



FIG. 15.—*Pentacheles enthrix*. "One of the points of the feeler-like appendages magnified 4th power. The chitin-layer is removed in order to show the reticular tissue which fills up the inner structure. Three small glandular masses are shown in the skin, of which no doubt others are to be found all over the organ." From a drawing and note by Willemoes-Suhm.

of a tongue and lip, and may be conveniently named the cheiloglossa, while from the hinder portion of the posterior lip a membranous base with a lateral process (Pl. XX. d''), the metastoma, is produced on each side; it is long, tapers to a blunt point, and clasps the mandibles closely round the constriction at the base of the psalisiform blade.

In Willemoes-Suhm's figure they are shown as existing anterior to the metastoma as if not part of the same. A short œsophagus leads to a widely-distended stomach, which appears to be little more than a simple sac of large proportions that opens into a second or pyloric chamber (Pl. XIX. *plc*), whose upper or dorsal surface is armed with four large serrate plates, two of which, curved inwards, are attached to the surface, while a smooth calcareous plate lies on the lower surface. The pylorus passes into a straight alimentary canal that terminates at the anterior or broader part of the telson, as shown in the annexed illustration.



FIG. 16.—“The chitinous teeth in the stomach; besides these there is, at the spot where it joins the alimentary canal, a thick chitinous skin strongly corrugated, that appears almost as if it were hairy. In the alimentary canal I found only mud.” From *Pentacheles euthrix*. From a drawing and notes by Willemoes-Suhm.



FIG. 18.—“Mandible with palpus, magnified about $\times 4$,” from *Pentacheles euthrix*. From a drawing by Willemoes-Suhm.

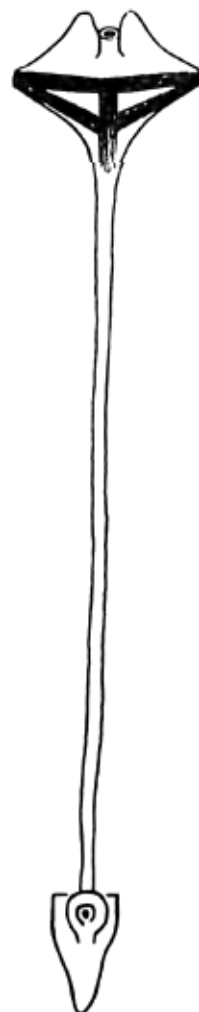


FIG. 17.—“Posterior portion of stomach with alimentary canal and telson,” from *Pentacheles euthrix*, $\times 2$. From a drawing by Willemoes-Suhm.

The contents of the stomach, as well as that which I found in the mouth of another specimen taken at a distant locality, were such materials as are found in the *Globigerina* ooze. That which I found in the stomach consisted of the remains of animals much crushed, while that taken from the mouth consisted chiefly of unbroken *Globigerinæ*.

The siagones or mandibles (Pl. XX. *d.d*) overlie the entrance to the mouth, and consist of two large concavo-convex blades, boldly serrate at the impinging margins; these two psalisiform blades meet in the median line and overlap each other like scissors. The

serrate margin is divided into three portions defined by a tooth that is larger and more powerful than the rest, each portion looking in a different direction, as shown in the figure (Pl. XVIII. *d*). In many Crustacea, perhaps in most, a massive tuberculated ridge or molar process traverses the base from the posterior to the anterior margin. In this family this process is smooth, and consists of a slender ridge, with the anterior extremity of which a two-jointed synhipod articulates, the second joint of which is fringed with long hairs and generally lies folded in the hollow formed by the concave psalisiform blades, where it evidently acts as a brush to arrange the food in position during the process of manducation. The whole of this important structure is attached to a long apophysis or lever that is moved on its longitudinal axis by a muscle attached to a tendon just below the base of the psalisiform plate, and diagonally by muscles at the extremity of the apophysis, which are attached to the antero-lateral extremity of the carapace.

There is very little variation in the form of the mandibles in the various species or genera, and what little there is exists in the serrate margin, which may be more or less coarsely or finely marked, so that the number of denticles in the central division may vary in number.

The first pair of siagnopoda or maxillæ (Pl. XVIII. *e*) consists of two small, longitudinally curved plates, as shown in the accompanying cut, that lie laterally outside the siagnos, but are pressed firmly against its posterior surface. Both the plates are flat, and the outer one is the larger, and terminates in one or two strong spines. At the base of the outer plate is a compact tuft of ciliated hairs. This fasciculus likewise exists attached to the first pair of siagnopoda in the Scyllaridæ, to which the whole appendage bears a greater resemblance than to that of any other of the Macrura; it is very unlike the same in the Astacidæ.

There is very little variation of this part in the various species, and what differences there may be appear to lie in a tendency for the outer branch to change in its relative proportion to the size of the inner.

The second pair of siagnopoda or maxillæ (Pl. XVIII. *f*) consists of two small plates, almost rudimentary in character, and a large squamose plate that is projected forwards as far as the anterior extremity of the mouth. The margin of the plate is fringed with short cilia, all directed towards the anterior extremity. The two small plates that are the rudiments of the normally formed appendage are tipped with long hairs, and are folded back against the great squamose plate. The second is implanted outside, and but little behind the first pair, and forms an efficient valve or doorway capable of shutting up the exit

passage from the branchial chamber, so that while the animal might safely burrow in the mud, pure water could be retained in the branchial chamber, and irritating detrital matter



FIG. 19.—First maxilla, $\times 3$, of *Pentacheles euthrix*. From a drawing by Willemoes-Suhm.



FIG. 20.—Second maxilla, $\times 3$. From a drawing by Willemoes-Suhm.

excluded. This valve is a thick and strong appendage, and seems to vary but little. The variation that does take place appears to be in the form of the mastigobranchiæ, or the posterior extremity of the great squamose plate; and in the smaller of the two branches, which in some species, as in *Stereomastis suhmi*, is short and pointed. The large branch is generally folded longitudinally on itself. This appendage, except in possessing a strong mastigobranchia, a part common to most forms of Crustacea, varies considerably from the corresponding member in the Scyllaridæ, and also in the Astacidæ, but approximates to that in Palinuridæ.

The third pair of siagnopoda (maxillipedes) (Pl. XVIII. *g*) appears to be an important pair, if we may judge by its relative proportion. It is situated behind the mouth, on one side of the median line, and reaches back into the branchial chamber as far as to the extremity of the anterior branchial plume, and anteriorly beyond the oral apparatus, so that its extremity is visible in advance of the frontal margin of the cephalon. It consists of several branches, flat and leaf-like in character, which are so differentiated from the typical form in Crustacea, that it is only by an analytical comparison that the several parts can be homologically determined. The chief or primary branch is of great tenuity, and is folded to form a spoon-like hollow, with its convex surface turned inwards. This siagnopod is implanted immediately behind the mandibles, having the anterior pair outside rather than anterior to it. The cup-like hollow, which is formed by the leaf being longitudinally folded on itself, is turned outwards, and its inner or deeper angle, being that which is nearest the body of the animal, is subapical to the anterior extremity; thus a freely articulating plate plays in the cavity with probably a more or less constant voluntary vibration. This vibrating plate keeps the water circulating within the branchial chamber; while the mastigobranchial plate, which is very long and broad, and generally free from hairs, overlies that of the second pair, and assists it not only in its function, but, by permitting a free space between them, allows the water that may have been confined within the branchial chamber to pass out with more or less rapidity.

These are the several appendages that belong to the cephalon or head. They are much compressed together, inasmuch as there is none in a direct line between the metastoma and the third pair of siagnopoda. The first and second being situated laterally and but slightly posterior to the mandible.

The first pair of gnathopoda (Pl. XVIII. *h*) shows an approach to the pediform character. It is flat, broad, and covered with hairs, and varies very little in the several species. In *Pentacheles euthrix* the basis is serrate on the inner margin, while in most forms it is smooth on that part. In *Pentacheles euthrix* also there is attached to the outer and upper angle of the coxa a small projecting process that I take to represent the



FIG. 21.—Maxillipede of *Pentacheles euthrix*, $\times 3$. From a drawing by Willemoes-Suhm.

rudiment of a mastigobranchia. I have seen nothing of the kind in any other species, and there is no ephysis or branch attached to any other part of the appendage, a circumstance that is characteristic of few Crustacea, and distinguishes the species of this family from those of other related families.



FIG. 22.—First gnathopod of *Pentacheles euthrix*; at the base a rudimentary palpus. From a drawing and note by Willemoes-Suhm.

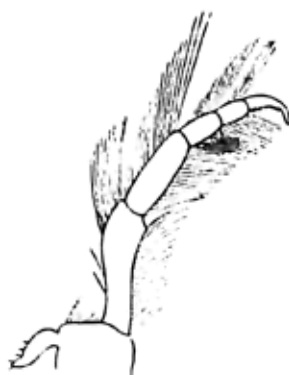


FIG. 23.—Second gnathopod of *Pentacheles euthrix*; at the base a rudimentary palpus. From a drawing by Willemoes-Suhm.

The second pair of gnathopoda (Pl. XVIII. *i*) is likewise devoid of an ephysis attached to any of its joints, except the mastigobranchia, which is always small, and sometimes rudimentary. This limb is also pediform, more decidedly so than the first; it is much longer and more slender, it terminates in a sharp unguis, and overlies the oral appendages. In *Willemæsia leptodactyla*, *Pentacheles lævis*, *Pentacheles gracilis*, and *Polycheles crucifera* the mastigobranchia exists as a decided feature, capable of fulfilling its duty. In *Pentacheles euthrix*, as shown in Suhm's fig. 23, it is scarcely more than rudimentary, while in *Stereomastis auriculata*, *Stereomastis suhmi*, and *Polycheles baccata*, it is reduced to an absolutely rudimentary condition. It varies a little in shape, and in some it is studded with hairs.

The pereopoda, with the exception of the posterior pair in the male of *Polycheles*, are all more or less chelate, and have little tendency to vary. The first pair (Pl. XVIII. *k*) is very long, being generally equal to the length of the entire animal. In *Polycheles crucifera*, however, it is not quite so long, a circumstance due to the shape of the carpos, which is short and broad, and approximates to the more common type in Crustacea, whereas in this family it is generally very long and slender—a character common to all the joints to a greater or less extent, and is especially marked in the dactylos and its antagonising pollex. The latter in the genus *Willemæsia* is armed with a strong and sharp tooth, which is absent in all the other genera.

The inner or impinging surfaces in the great chela are furnished with a sharp margin, peculiar in being formed by a series of microscopically small plates (k'''), placed erect and obliquely transverse. This structure, with some slight modification, appears to be common to all the species. The coxa generally carries a mastigobranchia and a podobranchial plume, that vary in their importance and in relative proportion. In *Polycheles baccata* and *Pentacheles euthrix* the mastigobranchia is small and of great tenuity. In *Stereo-*

mastis suhmi it is altogether wanting, and the podobranchia is reduced to an almost rudimentary condition.

The second pair of pereopoda is much shorter, and assumes more the form usual in a chelate appendage, the fingers being slender and apparently more perfectly adapted for secure prehension. It is probably with this pair of appendages that the animal usually feeds itself.

The two succeeding pairs (Pl. XX. *m*) are also always chelate, but the fingers are long and tapering; and are generally both curved in the same parallel direction posteriorly, a circumstance that gives them a very feeble appearance.

The fifth pair is shorter than the rest, and varies from the simple styliform condition to that of a small and perfect chela, varying sometimes with the sex and sometimes existing as a specific character.

In *Polycheles* the male has this pair of appendages simple, but in the female it has not been determined in any species except *Polycheles baccata*, where it is chelate, but stunted and imperfect in form. The female of *Polycheles crucifera* is not known; while that of *Polycheles helleri* is unfortunately injured, so that the termination of the appendage cannot be made out. Professor Camil Heller says that he only knew of a male specimen of *Polycheles typhlops*, and the specimens taken during the cruise of the "Porcupine" have not yet been determined in their specific relation to each other.¹

In the genus *Pentacheles* the posterior pair of pereopoda is chelate in both sexes, and in most species the fingers are of unequal length. They are more nearly equal in *Pentacheles euthrix* than in any other; but in those species in which both sexes have been determined, as *Stereomastis auriculata* and *Stereomastis suhmi*, the female has the fingers as unequally developed, or nearly so, as the male; and it is because of this feature that I have arranged the species *gracilis* and *obscura* under the genus *Pentacheles* rather than under *Polycheles*.

The branchial arrangement (Pl. XX. fig. 1) is based on the same type throughout, and consists of sixteen branchial plumes on each side, with or without mastigobranchial plates of more or less importance, being large in *Willemasia* and wanting in *Stereomastis suhmi* and *Stereomastis auriculata* in all the pereopoda, and reduced to a small or rudimentary condition on the second gnathopoda, and absent from the first in all excepting *Pentacheles euthrix*, where it is only imperfectly represented; while it is developed into large plates on the two posterior siagnopoda.

The podobranchial plumes are generally large and well developed, except in the first

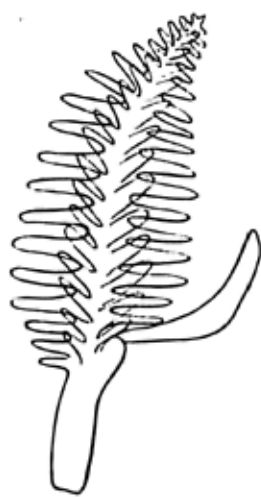


FIG. 24.—The lower and larger branchial plume of the first pair of pereopoda, with flagelliform appendage of *Pentacheles euthrix*. From note and drawing by Willemoes-Suhm.

¹ In his Remarks on the Recent Eryontidae, the Rev. Dr. Norman (*Ann. and Mag. Nat. Hist.*, ser. 5, vol. iv. p. 176, 1879) states that of the two specimens taken by H.M.S. "Porcupine" the female differs from the male in having "on front margin a pair of central spines (instead of a single spine)," besides indicating other differences that appear to be more than sexual characters.

pair of pereopoda, where they are usually small and sometimes rudimentary. They exist attached to all the pereopoda except the posterior, and are four in number. The arthropoda are similarly persistent, those attached to the anterior appendages being less developed than those situated posteriorly. There are eight in all—four anterior and four posterior plumes. There are also four pleurobranchiæ, but these are implanted between the somites above the four posterior pereopoda, the last being the only plume connected with the posterior pair of pereopoda. There are none above the first pair.

The branchial arrangement therefore differs from that of the Scyllaridæ, Palinuridæ, or Astacidæ.

In the posterior division or pleon the several appendages have a tendency to vary but little, but that little appears to be fixed and reliable. The most conspicuous and convenient feature for observation exists in the arrangement of the large dorsal median elevation. In *Polychæles crucifera* every somite except the first and last has two large teeth, one before the other.

In *Stereomastis suhmi* there are also two, but the posterior is much smaller than the anterior. In *Pentacheles obscura* there are also two on each somite, but these take the form of tubercles rather than teeth. In *Pentacheles auriculata* the teeth on the third and fourth somites are very long and slender; in most of the others they are more regular, but vary in number and proportion. Throughout all the species they are invariably directed forwards, a feature that is rare in other forms, and is suggestive of the idea that the animal normally creeps backward.

The first pair of pleopoda (Pl. XIV. fig. 1 p, ♀) is small, slender, and feeble in the female; in the male (fig. 2 p, ♂) it is large, strong, and well developed, evidently adapted for a sexual purpose. It is spatuliform and slightly curved, with the convex part towards the ventral surface of the pereion. The broad and curved blade lies anterior to the coxa or first joint of the posterior pair of legs (Pl. XIX. p ♂, o), so that the vas deferens, when projecting as it is capable of doing to a considerable extent (Pl. XV. fig. 3 o, ♂), falls upon the concave surface of the spoon-like pleopod, and is evidently held by it and directed against the ventral surface of the female, where its extremity rests in contact with or near the vulvar opening. That it does not enter the passage of this latter organ may be assumed from the circumstance that the foramen through which the vas deferens projects on the fifth pair of legs is much larger than that of the female on the third pair. We may

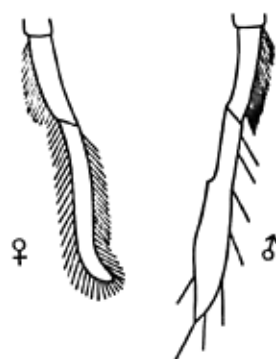


FIG. 25.—First pair of pleopoda, male and female, $\times 4$, of *Pentacheles euthriz*. From a drawing by Willemoes-Suhm.

therefore assume that the first pair of pleopoda conducts the extended vas deferens to its position and holds it there. This pleopod is the incipient representative of that organ which we see in the Brachyura, holding the vas deferens in an enclosed tube, and fulfilling the office of an intromittent organ.

The four succeeding pairs of pleopoda are biramose and resemble each other, differing in the male and female in having the first pair furnished with two stylamblydes on the inner margin of the inner branch in the male, and with one in the female, as in all the other pairs. Under a low magnifying power of the microscope the extremity of a stylamblys in either sex, with but few exceptions, is furnished with small, blunt, hook-like points, which Sars has named cincinnuli. They are mostly rudimentary in this group of animals; but in others, as we shall show in the Penæidæ, they efficiently fulfil an important office.



FIG. 26.—Third pair of pleopoda of *Pentacheles euthrix* ♀. From a drawing by Willemoes-Suhm.



FIG. 27.—Terminal portion of the Stylamblys.

The sixth pair of pleopoda is broad, large, and powerful, and goes to form the outer plates of the rhipidura or tail-fan, which in these animals is a powerful and much used appendage, of which the telson forms the central part.

The relation that this animal bears to other forms of recent Crustacea shows that, in its structure and in the depressed character, it lies near the genus *Arctus* of the Scyllaridæ, the chief distinctions being in the form of the second pair of antennæ, and in the direction of the antero-lateral angle of the carapace, which is thrown forwards instead of outwards. After this all resemblance appears to cease; for, with the exception of a modified resemblance of the first and second pairs of the oral appendages (siagnopoda), every appendage essentially differs.

There is an animal which has been alluded to in the present Report (p. 88) under the name of *Synaxes hybridica*,¹ that has much the character of a genus of the Scyllaridæ, but it possesses a long flagellum attached to the second pair of antennæ, which are large powerful organs without any scaphocerite, and are situated beneath the eyes, as in *Polycheles*; but the first pair, instead of being pressed close together as in that species, are forced down to a line horizontally lower than the second pair. The eyes are small but efficiently developed, and are situated in an orbit less perfectly formed than that of any of the Scyllaridæ, and more like that which exists in *Polycheles*, &c.; and is formed, as in that genus, by the anterior projection of the antennal angle of the carapace. All the other features of the animal—the pereopoda, pleopoda, rhipidura, &c.—resemble those of *Arctus*, except that in the female the fifth pair of pereopoda is simple in form, whereas in *Arctus*, and in the Scyllaridæ generally, it is chelate.

A near and interesting connection with *Synaxes* is to be found in the fossil described by Münster,² and reproduced by Woodward in his Chart of Fossil Crustacea, under the name of *Cancrinus clavigei*, from the Upper White Jurassic Limestone of Bavaria.

¹ *Ann. and Mag. Nat. Hist.*, ser. 5, vol. vii. p. 221, pl. xiv.

² Münster, pt. ii. t. 15, fig. 1.

The figure of the fossil specimen demonstrates that the form of the pereionie appendages bears a strong generic resemblance to *Synaxes*. I have not had an opportunity of examining any specimens, and gain my impressions of this genus from the published engravings. The first pair of antennæ has evidently been forced below the second pair, which is reduced in length and enlarged in diameter; the flagellum being short, broad, and multiarticulate, is suggestive of a gradual approximation to the form as it exists in the Scyllaridæ. The structure of the animal has yet, however, to be more thoroughly examined in detail before its true relation to recent Crustacea can be satisfactorily pronounced. In some of the earlier figures of *Polycheles*, the animal was represented as being blind and having a laterally compressed rostrum, but the eyes have since been demonstrated, and the supposed rostrum has been shown to be the result of inner margins of the first pair of antennæ being extended and forced upwards by lateral compression, and thus simulating the form of a narrow rostrum. Dr. Camil Heller, who has the privilege of being the earliest observer who described and figured *Polycheles*,¹ considers that in the general form of the body it "bears a strong resemblance to the Scyllaridæ, from which it differs essentially in the structure of the antennæ and the form of the chelæ; and corresponds with the Astacidæ only in the common possession of the "leaf-like appendage (scaphocerite) at the base of the second antennæ, and in the chelate character of the pereiopoda, but differs in all other respects."

Polycheles, he further says, "corresponds closely with the fossil Crustacean described by Desmarest, from the slate quarries of Solenhofen (*Eryon cuvieri*), since also in this are found a flattened carapace, and similarly-formed antennæ and pereiopoda. The hinder part of the body is much narrower than the anterior; and the leaf-like appendages" (scaphocerite) "of the second pair of antennæ are much enlarged. It forms a link between the Scyllaridæ on the one side and the Astacidæ on the other."

Dr. v. Willemoes-Suhm² says:—"Among the living Decapoda Macrura there is hardly a group with which *Willemæsia* could be said to be very closely allied. Nearest to it are undoubtedly the Scyllarinæ; but these, like all the genera of the family Palinuridæ, differ from it in the absence of the lamellar appendage of the second antennæ, and in the presence of palpi at the base of the gnathopoda, which, as we have seen, are wanting in this new genus. Nor can it, for this latter reason, be referred to the Astacidæ, with which it has in common the presence of the antennal scale."

"It is very astonishing, indeed, that among all crustaceans known to us, *Willemæsia* approaches most closely the fossil *Eyrontidæ*. If we compare, for example, our figure of *W. [Polycheles] crucifera*³ with a figure of *Eryon arctiformis*, and the description "Tribu des Eryons," given by Milne-Edwards⁴ (and probably taken especially from Desmarest's 'Crustacés Fossiles'), we find most striking resemblances between the

¹ Crustaceen des südlichen Europa, 1863, p. 209, pl. vii. fig. 1.

² Trans. Linn. Soc. Lond. vol. i. pl. xii. fig. 10.

³ Trans. Linn. Soc. Lond., vol. i. p. 55, 1875.

⁴ Hist. Nat. des Crust., tome ii. p. 278, Paris, 1837.

two forms. In *W. [Polycheles] crucifera*, as well as in *Eryon* the carapace has nearly half the length of the whole body and in both forms its lateral borders are wing-like expansions which are divided by two deep incisions into three portions. The anterior border of the carapace is nearly straight in both forms."

"*Eryon* was probably not blind; for the eye-stalks have been found in several specimens. Its antennæ seem to be somewhat more reduced than in *Willemæsia*; but the second pair of them has, according to Desmarest, 'une écaille assez large, ovoïde et fortement échancrée.' This is the chief difference between *Eryon* and the Palinuridæ, and the same in which *Willemæsia* also differs from that group."

"Milne-Edwards says nothing on the parts of the mouth; but according to Quenstedt they had a very large mandibula, one of the teeth of which was pre-eminently strong. This is very much like what we find in *Willemæsia*; but in the fossil genus palpi were present at the base of the first and second gnathopods, which are wanting in the living genus. The first pair of pereopoda is in both forms longer than the following ones, and terminated by a pair of long and slender chelæ. In *Eryon* three pairs of pereopoda, in *W. leptodactyla* five, and in *W. crucifera* four are terminated by chelæ. The form of the last pereopod in *E. arctiformis* is exactly the same as in *W. crucifera*; and the abdomen [pleon] of these two forms is, as the above-mentioned figures show, so very much alike in the two forms, that, if the last pair of pereopoda and the pleon of *Eryon* were presented to me without my knowing to what they belonged, I should undoubtedly declare them to be parts of the genus *Willemæsia*. There are the same line of spines at the top of the rings, the same wing-like expansions on both sides, and that characteristic 'nageoire caudale, dont la lame médiane est pointue et les quatres lames latérales moins longues que la médiane et hastiformes.' Also the fine fringe of hairs which distinguishes the caudal fin of *Willemæsia* is to be seen in the fossil crustacean."

"*Eryon* differs from the living genus chiefly by the presence of eye-stalks and of palpi at the base of the gnathopoda. According to Quenstedt the latter were observed only with some difficulty; and their presence seems not to be beyond all doubt. I shall only on my return be able to look myself over the original specimens and papers, and then, I hope, be able to give a more detailed account on the relations of *Willemæsia* to *Eryon*."

But that anticipation, unhappily, was never fulfilled. Dr. v. Willemoes-Suhm, the talented naturalist of the Challenger, died on his way home; hence I thought it my duty to quote his remarks in full.

The fossil genus *Eryon*, from the lithographic limestone quarries of Bavaria, and from the Lias of England, has long been known to geologists. According to Desmarest it was first figured by Knorr and Walch in 1775, and named *Locusta marina* by Bajer in 1757. Schlotheim described it in 1820 under the name of *Cancer macrourites arcti-*

formis, and that of *Astacus* was given by Richter. It has also been figured by Desmarest under the name of *Eryon cuvieri*, in his *Crustacés Fossiles*, and the figure was afterwards reproduced in his *Considérations des Crustacés*. Since that Count Münster, as well as Mr. Woodward, has described and published the figures of several species, in a monograph on the Merostomata.¹

The general resemblance in form of the species belonging to the genus *Eryon* to *Polycheles crucifera* is very close, both in the dorsal aspect of the carapace and in the character and arrangement of the pereopoda. The pleon also with its terminal rhipidura bears a closely corresponding relationship.

An analytical examination of the several parts of the recent form demonstrates a variation in structure of a very decided and distinguishing character, when compared with the Solenhofen specimens.

Except in the recent forms related to *Polycheles*, the eyes are so impoverished as to be overlooked except on close examination, and then they are observed to pass beneath the outer or frontal angle of the carapace as in the annexed woodcut (fig. 28).

If we turn to *Eryon*, the appendage that is supposed to be the foot-stalk of the eye is situated at the extremity of a prominence projecting from the frontal margin of the carapace external to the antennæ. This is so constant among the specimens that, abnormal as it may appear, we must accept it as being a feature in the structure of at least one genus of the group. The outer or antennal angle is, therefore, not produced anteriorly as in *Polycheles*, or externally as in *Ibaccus* and *Arctus*, but recedes posteriorly from the orbit.

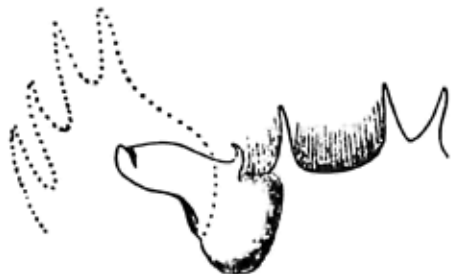


FIG. 28.—*Pentacheles gracilis*. Ophthalmopod and frontal margin of carapace.

The first pair of antennæ in *Eryon* has three cylindrical joints terminating in two flagella, not so short as in the Scyllaridæ, but very much shorter than in *Polycheles*. In this latter form the first joint of the peduncle of this antenna is developed on the inner side into a broad thin plate that is forced upwards by lateral pressure, while in *Eryon* the joint is simply sub-cylindrical.

The second pair of antennæ is robust, and, according to Desmarest, with a large scale at the base, which is not shown in his figure, but is understood by naturalists to mean the scaphocerite.

An examination of the specimens in the British Museum, which were courteously placed at my disposal by Dr. Woodward, F.R.S., has convinced me that "une écaille assez large, ovoïde et fortement échancrée du côté interne" does not always mean the scaphocerite, but sometimes refers to a squamiform extension in the breadth of the penultimate joint of the peduncle. This is well seen in *Eryon latus*, Münster (No. 44818 in the

¹ *Trans. Palæont. Soc.*, 1866; and *Quart. Journ. Geol. Soc.*, vol. xxii. p. 494, 1866.

British Museum Collection), as well as in other specimens less distinctly pronounced. In an unnamed specimen (No. 44930) this squamose enlargement exists on the preceding as well as on the penultimate joint, especially on the inner side. In some species it is not present at all, the penultimate joint of the peduncle being subcylindrical, but I have not seen any species among the numerous specimens in the British Museum Collection in which the scaphocerite can authoritatively be pronounced to be present, except in *Eryon speciosus* (Münster) (No. 44808), where it appears to exist on each side; but the condition of the specimen is fragmentary.

The oral appendages, so far as my own observations go, have not been made out; but Dr. v. Willemoes-Suhm quotes Quenstedt as having stated that *Eryon* had a very large mandible, one of the teeth of which was preeminently strong, and that the palpi were present at the base of the first and second gnathopoda. They are reduced but not wanting in *Polycheles* and its allies, but are homologous not with the basecephysis but with the mastigobranchia, originating as they do in the coxal joint. No other observer since Quenstedt has seen them in *Eryon*; we are not, however, justified in excluding his evidence until the specimens from which he obtained his information have been re-examined. The second and third siagnopoda are broad, foliaceous, of extreme tenuity, whereas the basecephyses, judging from what we know of other forms, are more or less long, narrow, and tapering, unless degraded to a rudimentary condition, when they retain a more or less distinctive rod-like character. Quenstedt could scarcely have mistaken them for any other parts, as the Rev. Dr. Norman suggests, if we are to assume any resemblance in their structure to those of other Crustacea.

The pereopoda are extremely like those of *Polycheles crucifera*. The first pair is long, having the carpos short, the fingers of the chela long, slender, and overlapping at their extremities; the three succeeding pairs are short and chelate, with narrow propodos and slender fingers; the fifth pair is short, and not chelate, the dactylos being long and styliform.

One great anatomical distinction between *Polycheles* and *Eryon* appears to lie in the character of the ophthalmopoda, which occupy the same position in relation to the antennæ in both fossil and recent forms. In the recent genera, with the exception of *Eryoneicus*, the latero-anterior angle of the carapace is largely developed and overrides and covers a large portion of the peduncle of the eye, leaving only a deeply incised orbit that allows a portion only of the base to become visible on the dorsal surface. Even this is entirely obliterated in *Willemaesia*.

In *Eryon* the increased development of the antennal region of the carapace is wanting, consequently the organ of vision, instead of being covered and hidden from view, is exposed upon a peduncle, which in some species appears to be projected on a prominence.

If we examine the specimens from the Lias of England, we shall find that the latero-

frontal angle of the carapace is produced anteriorly to a considerable extent in some specimens, as for instance in *Eryon brodei* (Woodward), *Eryon wilmcotensis* (Woodward), and *Eryon barrovensis* (M'Coy), and in others, as *Eryon crassicheles* and *Eryon moorei* (Woodward) it is less so. Consequently, in those specimens in which the lateral angle is more developed, a depression corresponding to the orbit or orbital notch in *Polycheles* is present. Another feature in the British fossil specimens that distinguishes them from those of the Bavarian lithographic limestone, is the presence (according to Woodward) of a well-defined diæresis or line of division in the outer plate of the rhipidura.

This feature is common in *Astacus* and allied genera, but is not present in *Polycheles*, nor any of its congeners. Nor is it to be found in any of the Scyllaridæ or Palinuridæ. Among the Eryons I am only aware of its having been found in one species, and that is *Eryon barrovensis*, as restored by Mr. Woodward.

The eye is but rarely if ever preserved, and Woodward says "has never been positively determined," and the peduncle on which it is supposed to stand frequently appears as if it were biarticulated; but I have never seen a specimen or the figure of one in which the perfectly-formed eye has been found so as clearly to determine its form and character. In *Eryon brodei* the preserved orbit is moderately deep and the latero-anterior angle well advanced. It is the same, but rather less marked, in *Eryon wilmcotensis*, but in *Eryon moorei* and *Eryon crassicheles*, both orbital notch and antennal angle are reduced to a minimum value. All these are from the Lower Liassic rocks of England, except *Eryon moorei*, which is from the Upper White Lias of Ilminster.

The several species of *Eryon* appear to be distinguishable into separate genera, which are as definable from one another as they are distinct from the recent *Polycheles*, but the variability appears not to be greater in those that are separated in time through geological æons, than in those that are contemporaneous in geographical distribution.

While studying the fossil forms of the Eryonidæ in comparison with those recently brought to our knowledge through the deep-sea explorations, I have found in the collection of Mr. J. Edw. Lee of Torquay a specimen from the Lias of Lyme Regis, that appears to connect the two more intimately than has been shown in the comparison made with any previously known fossil specimen.

The specimen is fragile and imperfect. One half of the dorsal surface is tolerably well preserved, while the other exhibits only the impression of the form in the matrix. The two conditions are shown in the accompanying figure by a difference in the degree of shading, the darker being that of the external texture, the lighter where the impression of the form is alone retained, whereas the merely outlined portions exhibit the restoration of structure in conformation with known parts.

Archæastacus willemæsi,¹ the name by which I propose to call this fossil specimen

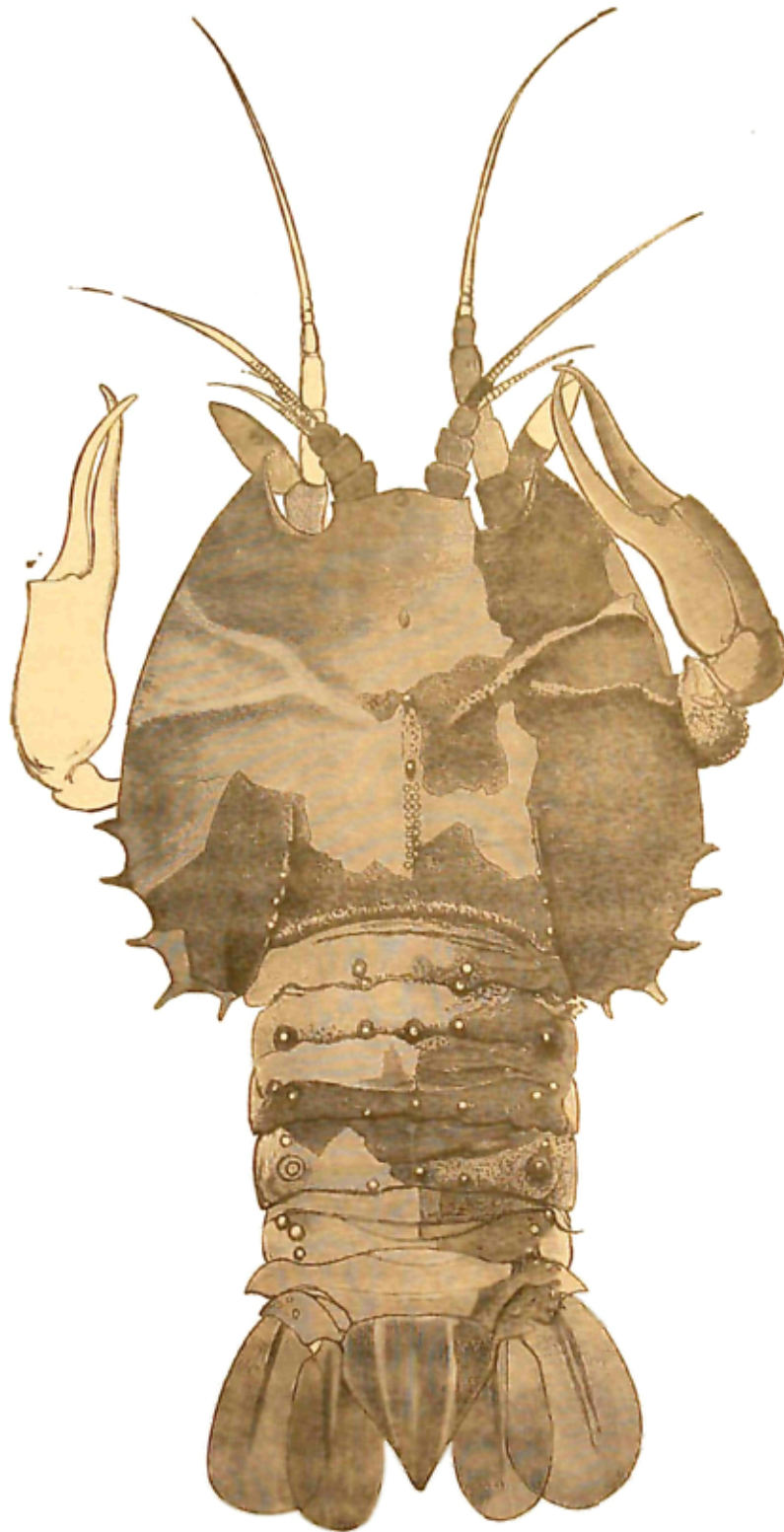


FIG. 29.—*Archæastacus willemæsi*, Sp. B., from the Lias of Lyme Regis.

has the dorsal surface of the carapace almost circular. The anterior or frontal margin being nearly straight between the orbital notches, while beyond them the lateral angles

¹ *Brit. Assoc. Report*, 1883; *Geol. Mag.*, dec. iii., vol. i. p. 307, pl. x., 1884. Beneath the plate in the Geological