

carapace, armed on each side with two long teeth, and with a row of smaller ones that diverge and terminate over the gastric region. A prominent tooth is placed above the orbit, and another above the infero-anterior angle of the carapace, and the general surface is slightly papillose.

The pleon is scarcely as long as the carapace including the rostrum, it is dorsally smooth, and the coxal plates are produced to a sharp point, the anterior margin of each of the four anterior being armed with a sharp tooth near the base. The eyes are small and immature.

The first pair of antennæ has the peduncle half the length of the rostrum, and the flagella reaching about half as far beyond it: the first joint of the peduncle or coxa has an enlargement on the upper and outer surface enclosing the auditory apparatus.

The second pair of antennæ has lost the flagellum,¹ the peduncle is as long as that of the first pair, and articulates with, but is not anchylosed to the metope. The coxal joint is short and carries on the inferior surface a phymacerite, which is formed by a prolongation of the external tissue, and has its apex covered by a thin membrane, in which an elongated perforation exists; the succeeding joints, which form the peduncle, reach to the extremity of that of the first pair, or to about the middle of the rostrum, or as far as the anterior pair of teeth on its upper surface.

The siagnos, or mandible, has a smooth, cutting margin, and a strong molar ridge, and in the hollow between the two ridges the three-jointed synnhipod lies when at rest; the distal joint of the latter is the longest, and is fringed on the outer margin with short, strong, bristle-like hairs.

The first pair of siagnopoda (Pl. XXIII. fig. 3e) consists of two small foliaceous plates fringed on the distal margin with short, stiff, spine-like hairs, and on the inner margin with a few longer that are ciliated, and a robust basecephysis terminating in a long reversed lash, which probably ends in two long sweeping hairs, but the part is broken in our unique specimen; at the base of this branch is a large fasciculus of ciliated hairs. This appendage differs from the same in *Nephropsis rosea* in having the large foliaceous plate broader at the distal extremity, and the basecephysis less slender and fringed with fewer hairs, but has a larger fasciculus at the base externally.

The second pair resembles that of *Nephropsis rosea*, but has the several foliaceous rami slightly broader, and the mastigobranchia produced somewhat more posteriorly.

The third pair closely resembles that of *Nephropsis rosea*, and so also does the first and second pairs of gnathopoda.

The first pair of pereopoda is somewhat more slender, and has the dactylos and

¹ Dr. v. Willemoes-Suhm remarks in his notes on this species, "Also with this well-preserved specimen, every trace of the outer antennal lash is wanting, as in the specimen from Bermuda, so that I must now suppose that they are normally wanting;" an opinion which we cannot accept, as Mr. Wood-Mason has figured it in his species of *Nephropsis stewarti*, and it exists in the North Atlantic species.

pollex longer, and the apices pass more conspicuously beyond each other when closed. The carpos is armed above and below with a long, slightly bent tooth; so also is the meros, which has also two smaller ones on the upper margin.

The second pair of pereopoda is long, slender, and feeble, and terminates in a small chelate extremity, of which the carpos and propodos are subequally long and wide, having the upper and lower margins parallel throughout; the dactylos is short, bends upon, and when closed impinges against the pollex, or digital prolongation of the propodos, throughout their entire length.

The two posterior pairs of pereopoda are subequally long, and terminate in long styliform dactyli.

The branchial arrangement appears to be similar to that of *Nephiroopsis rosea*, and may be thus tabulated:—

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

The first pair of pleopoda is short and rudimentary, but I am not sure whether this be the permanent state, or only an immature sexual condition, as I have failed to determine whether the specimen be a male or a female. I closely examined the coxæ of the third and fifth pairs of pereopoda, but failed to find a foramen in either. The central position of the rudimentary first pair of pleopoda, together with the occurrence of cincinnuli or small hooklets attached to the long stylus of the second and succeeding pairs of pleopoda, the narrowness of the ventral surface of the pereion, and the large diameter of the primary branch of the flagella of the first antennæ, without being conclusive, suggest its being a male.

The sixth or posterior pair of pleopoda (Pl. XXIV. fig. 2z) are broad and foliaceous plates, the outer being armed with a short strong tooth at about half the distance between the base and the distal extremity of the terminal margin, but having no distinct diæresis or joint dividing the plate. The inner plate is likewise armed with a sharp tooth, longer than that on the outer plate, and nearer the extremity of the terminal margin, which in both plates is furnished with a fringe of long simple hairs.

The telson is long and quadrate, the sides slightly waved and reversely conformable; the posterior margin is rounded and fringed with long, simple hairs, and is separated from the lateral margins by a strong, sharp tooth.

Nephrops, Leach.

The anatomical characters of *Nephrops* almost coincide with those of the genus *Homarus*, and but for the great dissimilarity of form of the first pair of pereiopoda, the two genera would probably be classified as being only specifically separate.

The branchial arrangement is identical, the structure of *Nephrops* approximating to that of *Homarus* more nearly than to that of *Nephropsis*.

Development.—The brephalos of the species of this genus has hitherto escaped observation, but a short time since Professor Sars¹ captured what he considers to be the "second larval" stage of *Nephrops norvegicus*, L., about 8 mm. long, and a second form but little larger, 11 mm., that of a "young *Nephrops*," in its "first postlarval stage."

Of the latter specimen there can be no hesitation in accepting Professor Sars's diagnosis, and if the former should, by observation of the brephalos direct from the ovum, demonstrate the correctness of this also, we shall find the apparently universal plan of development in the Astacidea modified by a new arrangement in the middle of the tribe.

Assuming that Phyllosoma is only a peculiar form of Megalopa, the young of *Nephrops* as shown by Sars is an intermediate form between the two. Thus we find that a modified condition of the Megalopa stage characterises the brephalos of all the families of the Trichobranchiata as far as is known, excepting the genus *Spongicola*, in which it is hatched in the Zoca condition.

The discovery of Professor Sars is undoubtedly one of considerable interest, as hitherto the development of *Nephrops* has been unknown. I have long been making efforts to get possession of specimens carrying ova in an advanced condition, but in a large number that I have received from the Rev. Dr. Haughton and others, there was not a female so laden. Nor were there any attached to those of *Nephrops thomsoni*.

There are one or two points in Professor Sars's specimen that require notice.

First, in general appearance it bears a resemblance to that form which we have considered to be a stage in the development of *Aristeus*, figures of which may be seen on Pls. XLVI. and XLVII. of this Report.

Secondly, it is noticeable for having the appendages of the cephalon and pereion in an advanced stage of development.

Thirdly, the several pairs of pleopoda are as yet only in the bud condition, and the rhipidura does not exhibit any evidence of being present.

Fourthly, the telson is formed on the type of that in the Brachyura rather than on that of the Macrura.

It is remarkable that animals so nearly allied as *Nephrops* and *Homarus* should exhibit

¹ *Archiv f. Mathem. og Naturvidensk.*, p. 159, pl. i., Christiania, 1884.

a development so different. A parallel case, however, is to be found in the Alphæidæ, in species so closely resembling each other in adult characters as to be scarcely distinguishable, and yet producing the brephalos in the separate forms of a Zoea and a Megalopa.

Geographical Distribution.—Hitherto there has been only one species of *Nephrops* known, and that appears to be confined to the northern European seas from the Irish coast to the shores of Scandinavia. Milne-Edwards adds the Adriatic, but I know no other authority for the Mediterranean habitat. Our new species, *Nephrops thomsoni*, was taken, the male near the Philippine Islands, the female near New Zealand; so that it appears to have a tropical and subtropical range in the Pacific and Indian seas.

The genus appears to be represented geologically, according to Milne-Edwards, by *Astacus leachii*, Mantell.¹ It agrees closely with some forms of *Hoploparia*, while others approach that of *Homarus*, most of which come from the Green Sand and from the London clay-beds.

Nephrops thomsoni, n. sp. (Pls. XXV., XXVI.).

Carapace produced anteriorly to a long sharp-pointed rostrum, the margins of which are dentate and continued in a ridge nearly to the cervical fossa. Antennal tooth very large and strong. First pair of pereiopoda long, slender and subcylindrical; carpos having two or three teeth on the outer and one on the inner distal margin; meros armed with one outer and one inner tooth on the distal extremity. The two succeeding pereiopoda are short and very slender and terminate in small chelæ; the two posterior have the dactylos long and styliform. The outer ramus of the rhipidura has a delicately crenated diæresis. Telson quadrate.

Habitat.—Station 166, June 23, 1874; lat. 38° 50' S., long. 169° 20' E.; between Australia and New Zealand; depth, 275 fathoms; bottom, Globigerina ooze; bottom temperature, 50°·8.

Length (female) including rostrum, 138 mm. (5·5 in.).

Station 204A, November 2, 1874; lat. 12° 43' N., long. 122° 9' E.; between Samboangan and Manila; depth, 100 fathoms; bottom, green mud; temperature not recorded.

Length (male), 125 mm. (5 in.).

The carapace from the frontal margin is one-third of the length of the animal. The rostrum is half as long as the carapace, sharply pointed and slightly elevated anteriorly, armed with one strong anteriorly-directed acute tooth on the under surface, midway between the eyes and the apex, also with two similar teeth on each side on the upper surface anterior to the eyes, from which a strong ridge passes backwards on each side to near the cervical sulcus or the posterior extremity of the gastric region of the cara-

¹ Geol. of Sussex, p. 221, pl. xxix. figs. 1, 4, 5; *Clytia leachi*, Reuss, *Denkschr. d. k. Akad. Wiss. Wien*, Bd. vi. t. 5, 1854. Restored in Salter and Woodward's Chart of Fossil Crustacea, 1865.

pace. On this ridge, on each side of the base of the rostrum, is a very large and acute tooth directed anteriorly and outwards; behind which on the same ridge are two other sharp teeth that decrease in size posteriorly; behind the last tooth the ridge fades away. Between the two ridges over the gastric region is a central but less prominent elevation, which commences posterior to the base of the rostrum and terminates a little in advance of the cervical depression. On the frontal margin, beyond the outer angle of the orbit, is a strong sharp tooth, directed anteriorly as far as the base of the scaphocerite; its outer margin is thick and strong, and extends back as a prominent ridge to the anterior or hepatic sulcus. In the depression between the ridge formed by this large tooth and the dorsal carinæ are two small teeth, one immediately behind the orbit, the other obliquely posterior to it, and about half way between the two ridges. On the region bounded by the hepatic sulcus and the cervical groove, somewhat below the line of the great antennal tooth, is a small sharp tooth directed forwards and outwards between which and the dorsal carinæ are four or five small teeth standing equidistant from each other on the posterior margin of the hepatic sulcus; these gradually increase in size as far as the place where the sulcus fades away (Pl. XXVI. fig. 1).

The posterior half of the carapace comprises the cardiac and branchial regions and possesses traces of three or four semi-obliterated carinæ, each of which is defined anteriorly by a small sharp tooth, and traversed by a series of granulations that are of the same character as those that stud the branchial region, but larger. The median carina is double, and appears to be an imperfect continuation of the small central ridge on the median line of the anterior half of the carapace. It is furnished just behind the cervical sulcus with two anteriorly-directed sharp teeth, and four or five other less important ones in pairs, some of which are sharp, and others like small tubercles, and they continue almost to the posterior margin, which is bordered by a broad, flat, but elevated band that traverses the posterior and infero-lateral margins of the carapace to near the anterior extremity of the branchial region, gradually fading away as it extends forwards.

The first somite of the pleon is narrow, not reaching beyond, or even quite to, the second lateral carinal ridge of the carapace; the anterior half, when the animal is extended, underlies the carapace, while the posterior half is slightly more elevated throughout, and overlies the posterior margin of the carapace laterally, producing the pleocleis, which keeps down and secures the carapace in position.

The second somite is longer and broader than the first. The dorsal surface is divided into two portions. The anterior, when the animal is completely extended, underlies to half its extent the first somite; the posterior overlies the anterior portion of the next succeeding somite, and is divided by two narrow and deep sulcis that commence near the median line on each side, and runs obliquely to the postero-lateral angle, leaving a smooth division between them. The coxal plate, although fused with the true somite,

is distinctly defined and distinguishable from it. It is advanced over the postero-lateral angle of the corresponding plate of the first somite, where it is elevated into a tuberclose enlargement, from whence the margin slightly advances anteriorly, and then gradually and smoothly rounds to the postero-inferior angle, which terminates in a sharp, projecting, posteriorly oblique point. The plate has a central depression corresponding in form to that of the outer margin.

The third, fourth, and fifth somites resemble the second, being but slightly modified to correspond to the varying curvature of the animal in flexion. The dorsal sulcus of the posterior division gradually decreases in importance, and in each the anterior margin of the coxal plates, instead of overlapping the posterior margin of the preceding as in the second, underlies it. The coxal plates, moreover, become successively narrower and shorter, and all are fringed on the internal surface of the margin with long, plumose hairs directed inwards.

The sixth somite (Pl. XXV. fig. 3) is modified more than any of the preceding, to support its appendages as a portion of the rhipidura. The dorsal sulcus has entirely disappeared, and the posterior margin is centrally elevated into a minute carina, terminating in a tooth, and the lateral ridge that defines the separation between the true somite and the coxal plate is armed near the centre with a sharp posteriorly-directed tooth. The coxal plate has an anterior and a posterior angle; the former is obtusely pointed and directed downwards, the latter acute and posteriorly directed, and the space between the two is concave to receive the basal joint of the posterior pleopod when folded.

The large and reniform eyes are supported on a small and short peduncle that originates beneath the rostrum, and therefore in close contiguity to the corresponding appendage on the opposite side. The organ rests in a cavity formed by the orbital notch in the anterior margin of the carapace, by a slight hollow on the inferior side of the rostrum, and by a deep depression formed on the upper surface of the first joint of the anterior antennæ, and a slight corresponding one on the second joint of the second antennæ; it is protected by a blepharis or fringe of hairs that traverses the orbital notch of the carapace, the infero-lateral margin of the rostrum, and the upper distal surface of the first joint of the first antenna.

The first antenna has the peduncle shorter than the rostrum. The first joint is long, convex beneath, where it is armed with a sharp tooth at the inner distal angle, it is depressed on the upper surface, being somewhat concave to admit the eye, and has near its base a small, rounded, squamous expansion, furnished with cilia forming a row continuous with that which fringes the outer margin of this and the two succeeding joints; the second joint is subcylindrical, and is scarcely one-third the length of the first; and the third is about half the length of the first; the last two joints are thickly fringed with short plumose hairs on the lower angle of the inner margin; the third joint supports at its extremity two subequal filamentous appendages, which are twice

and a half as long as their peduncle; the outer is rather the more robust, and both are entirely free from hairs or cilia of any kind.

The second antenna has the peduncle reaching beyond that of the first, but not quite to the extremity of the rostrum, and the flagellum is longer than the entire length of the animal from the extremity of the rostrum to the posterior margin of the telson. The first joint of the peduncle is short and broad, and supports a not very prominent phymacerite, the aperture of which is directed anteriorly, and protected by a small but strong calcified ridge; the second joint is also broad, armed at the outer distal extremity with a short, sharp tooth, and supports at its extremity a scaphocerite, which is scarcely longer than broad, rounded on the inner margin, which is fringed with small, thickly-set, ciliated hairs, and straight on the outer, where it terminates in a short tooth; the third joint articulates with the second obliquely-longitudinally on the inner side for about one-half its length, the other half articulates reversely in a similar manner with the inner side of the fourth joint, and is armed with a small, sharp tooth on the under side; the fourth joint is subconical in form, having the smaller end towards the base, where it articulates with the second and third joints, the former at the centre, the latter obliquely on the inner side; the fifth joint is not so long as the fourth, and scarcely longer than broad; the outer side is rounded, while the inner is compressed to a carina-like margin, fringed with a row of thickly ciliated hairs, which commences at the distal extremity, beneath a short, broad-based, sharply pointed tooth, and continues along the inner margin to near the basal extremity of the third joint. At the extremity of the fifth joint the long, somewhat compressed flagellum is articulated.

The siagnos or mandibles (Pl. XXVI. *d*) are smooth, concavo-convex, spoon-shaped appendages, with a molar ridge traversing the base of the internal surface; into the hollow formed by it and the anterior incisive margin a three-jointed synaphipod folds. Posterior to the mandibles the metastoma (posterior lip) exists in the form of a double-lobed appendage; from the inner side of each a strong and firm process arises, that folds round the posterior surface of the mandible.

The first pair of siagnopoda (*e*) is small, and consists of two foliaceous plates, fringed on the distal extremity with small blunt spines, and laterally bearing a two-jointed, slender appendage.

The second pair (*f*) consists of four foliaceous plates, fringed with short fur-like hairs, and a broad, distended, foliaceous mastigobranchial plate, divided into an anterior and a posterior portion.

The third pair of siagnopoda (*g*) is formed of two foliaceous plates fringed with hair, a reduced flagelliform appendage, and a long mastigobranchia, fringed with minute hairs and short, sharp, spinules.

The first pair of gnathopoda (*h*) is subpediform, and consists of seven joints. The coxa carries a mastigobranchia sparsely covered with fine, long hairs, and at the base a

bundle of branchial filaments, the rudimentary podobranchial plume; the basis is short, and carries an unbranched ephysis, rudimentary in its character, and fringed with short hairs; the ischium is short and triangulate; the meros is very long, with the margins subparallel, approaching each other a little towards the distal extremity; the carpos is short and flat, narrow at the base, expanding distally, in the central depression of the extremity it articulates with the propodos, which expands in a similar manner, and similarly supports the dactylos, which is broad and spatuliform, and terminates in a blunt point, and like the preceding, is fringed with a brush of hairs.

The second pair of gnathopoda (*i*) is rather more pediform than the first, and consists of seven joints, the dactylos being styliiform. The coxa supports a mastigobranchia that is broader, but scarcely longer than that of the first gnathopod, but instead of a small fasciculus of branchial filaments, the bundle is developed into a well-formed but not large branchial plume.

The first pair of pereopoda is subequal in size and uniform in shape, that on the right side being very slightly larger, and the small tubercles that adorn the inner and lower surfaces are a little more conspicuous. The coxa is short, and articulates freely with the somite; the basis is short, and articulates freely with the coxa, but is fused with the ischium, which is moderately long and on the inferior side produced obliquely, beyond that of the upper surface; the meros is long, articulating laterally with the ischium, rounded on the outer, but flattened on the inner side, and widens towards the distal extremity, where it is armed with three large teeth, one on the lower, one on the inner and upper, and one on the outer angle, which last assists in forming the socket of the joint for the articulation of the carpos; the carpos is about half the length of the meros, it is nearly cylindrical, and armed on the outer surface near the centre with a sharp, strong tooth, one on the upper, and another on the inner distal angle; the propodos is long, compressed, with the outer margin smooth and the inner minutely tuberculated, near the centre of which is a short, sharp tooth, more pronounced on the left than on the right appendage from the smaller and less conspicuous character of the tubercular granulations.

The dactylos and pollex are very nearly as long as the palm in the male and a little longer in the female; they are smooth and continuous in a straight line with the joint on the outer surface, and fringed on the inner with two rows of closely-packed, short, plumose hairs; near the centre of the lower row stands a solitary, obtuse, strong tooth; another small one is situated at the anterior extremity of the same row of hairs, beyond which the tip suddenly curves to meet a similar opposing bend at the end of the dactylos, which is of the same length, and lies parallel to it, and is armed on the inner surface with a row of uneven, small, cusp-like teeth, forming a ridge that bites between the two rows of hairs on the pollex.

The second pair of pereopoda does not reach beyond the carpos of the first. It is

slender, feeble, and chelate. Like all the others except the first, there is a distinct articulation between the basis and ischium.

The third pair resembles the second in size and form, while the fourth and fifth correspond in size, but differ from the preceding in not being chelate, and in having a long, simple dactylos, while the distal extremity of the propodos is furnished on the inner side with a fasciculus of short hairs.

The branchiæ are similar to those of the European *Nephrops norvegicus*, as shown in the accompanying formula:—

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

In *Nephrops thomsoni* the podobranchiæ are smaller plumes than the pleurobranchiæ, and less than their homologues in *Nephrops norvegicus*.

The first pair of pleopoda (*p*) in the male is peculiarly modified for its requirements. It articulates with the ventral surface of the somite, considerably within the line of the posterior pairs, but this is probably due to a modification of the coxal plates. It consists of two joints; the first or basal supports the second, which, although not fused, is rigidly attached to its extremity. The first is transversely triangular; the lower angle running obliquely from the base to the apex; the second joint consists of a thin plate, compressed longitudinally so as to present four carinæ, the one which in the position of the living animal is directed forwards, and lies against the ventral surface of the pereion, having the extremity considerably produced; it is flattened on one side to correspond with the formation of the coxa of the posterior pair of pereiopoda, while the other side is curved into a deep hollow, which with the corresponding appendage forms a cylindrical tunnel. At the lower anterior extremity of this semitubular plate is a small wart-like excrescence, which, under a magnifying power, is seen to be a mass of small hook-like spines (cincinnuli). The upper division of the same joint is produced into a strong point. The whole arrangement appears to be modified so as to be capable of assisting in the process of copulation, the extended vas deferens being directed to its position by passing through the channel formed by the two converging pleopoda; the plan being similar to but less perfect than that which exists in the *Brachyura*.

The second pair of pleopoda (*q*) consists of a basal joint supporting two foliaceous plates of a long, flat, ovate form, fringed with long, ciliated hairs; the inner one supports a short, semilunate stylamblys, fringed on the convex margin with short hairs. The third, fourth, and fifth pairs of pleopoda resemble the second, but possess no stylamblys. The sixth pair of pleopoda forms the outer plates of the rhipidura (Pl. XXV. fig. 3); the basal joint is short, broad anteriorly and narrowing posteriorly, where it terminates in

a sharp point or tooth; it supports two broad plates that extend as far as but not beyond the extremity of the telson. The inner plate is scarcely longer than broad, ciliated on the posterior margin, and it carries a tooth-like process at the outer posterior angle; the outer plate, though longer, scarcely extends beyond the posterior extremity of the preceding; it is bisected at one-fourth its distance from the extremity by a serrate diæresis.

The telson is quadrate; the posterior angle on each side is produced into a sharp tooth, while two short prominent teeth stand near the middle of the dorsal surface, and long ciliated hairs fringe the posterior margin.

The specimen here described is a male taken off Manila; two others, both of which are females, were captured off the coast of New Zealand, and are probably of the same species, since they vary in non-essential details, which are probably only sexual. The great distance between the above localities justifies a description of the female, as far as its characters are distinct.

The specimen which I take to be the female of *Nepherops thomsoni* (Pl. XXV. fig. 2) is generally more slender. The rostrum is longer and somewhat broader anterior to the orbits, but the two rows of teeth corresponding with the lateral margins of the carapace are closer together and less conspicuous than in the male. The carapace is less granulose, and the median carina of the posterior division, behind the two sharp teeth, is smooth and free from granular markings. The somites of the pleon are smooth and free from the transverse depressed line that is conspicuous in the male on every somite except the sixth.

The first pair of antennæ is more slender, and the flagella taper gradually to fine extremities.

The second pair of antennæ is more slender than in the male; the scaphocerite is rather longer, and therefore not quite so square in form.

The oral appendages resemble each other. The denticular arrangement, especially on the inner margin of the second pair of gnathopoda, are less conspicuous.

The first pair of pereiopoda is more slender and less granulose than in the male, and the inner margin of the pollex is smooth, except that a solitary cusp or tooth is present near the centre; the double row of ciliated hairs on the inner margin in the male is wanting in the female, and a small sharp tooth is present at the external base of the dactylos. In all other respects the pereiopoda closely resemble those of the male; even the width between them on the ventral surface is not conspicuously greater.

The first pair of pleopoda is uni-branched, slender, and feeble, the four succeeding pairs resemble each other, and are biramose, having long, ovate plates, resembling the same in the male except that neither pair supports a stylamblys.

A second and smaller specimen, taken with the preceding female, differs from it in having a second tooth immediately behind the upper and outer tooth, at the distal extremity of the meros of the first pair of pereiopoda.

There can, I think, be little doubt that the three specimens taken are merely different sexes of one and the same species. It is, however, curious, that during the expedition the only females should be taken off New Zealand, while the only male taken should have been four thousand miles distant.

Family ASTACIDÆ.

The genera of this family are all inhabitants of fresh water rivers, lakes, and ponds.

The podobranchiæ are invariably six, and well developed. The plumes are attached to the mastigobranchial plates in their entire length. Posterior to each of these a sub-lunate process tipped with hairs is articulated. The anterior three pairs of pereopoda are chelate. The first pair is largest.

The term *Potamobius* was first used by Dr. Leach, in 1819,¹ for the genus *Astacus*, and *Astacus*,² for the marine genus to which Milne-Edwards, in his *Histoire des Crustacés*, afterwards gave the name of *Homarus*, by which it has ever since been recognised.

At that time Milne-Edwards retained the name of *Astacus* for the terrestrial or fresh-water species, by which it has since been universally known; and although, as Dana³ writes, "Leach has undoubted priority and exhibited his usual discrimination in proposing the subdivision of the old genus," yet to adopt now the name of *Potamobius* instead of *Astacus* would only create great confusion. It is to be regretted that to acknowledge Dr. Leach's claim would not only have this result, which he himself would deprecate, but would introduce terms not likely to be generally accepted.

The Astacidæ of the northern hemisphere have the first pair of pleopoda modified in the male for sexual purposes, and the dactylos of the first or large chelate pair of pereopoda has the outer margin straight or inflexed. They have never more than one pleurobranchial plume on each side fully developed.

There are two genera in this division, *Astacus*, in which a pleurobranchial plume is attached to the posterior somite of the pereion, and *Cambarus*, which has none. These are confined to the northern hemisphere, and may be found in Europe, Asia, and America.

Those that belong to the southern hemisphere have the first pair of pleopoda wanting, and the dactylos of the first or large chelate pair of pereopoda has the outer margin convex. There are always one or more pleurobranchial plumes on each side.

¹ *Potamobia fluviatilis*, Leach, Sam. Ent. u. Comp., p. 95, 1819. Mr. Walter Faxon, in his *Revision of the Astacidæ*, 1885, attributes this generic name to Sowerby in the continuation of Leach's *Malacostraca Podophthalmia Britannicæ*, No. 8, xviii., xix. Tab. xxxiv. fig. 1, 1875. Adam White in *Cat. Brit. Mus.*, 1850, uses it; and L. Agassiz in the *Nomenclatoris Zoologici, Index Universalis*, gives *Potamobia*, Leach, *Crust.*, 1818.

² *Astacus gammarus*, Leach, Sam. Ent. u. Comp., vol. vii. p. 398.

³ Dana, *U.S. Explor. Exped.*, p. 532.

This family consists of several genera, dependent rather on their external characteristics than on their branchial arrangement, as may be seen by the following table:—

	Pleurobranchiæ.	Arthrobranchiæ.	Podobranchiæ.	
NORTHERN HEMISPHERE—				
<i>Cambarus</i> ,	0	11	6	East North America.
<i>Astacus</i> ,	1 + 2r	11	6	West North America, Europe and Asia.
SOUTHERN HEMISPHERE—				
<i>Astacoides</i> ,	1	5 + 5r	6	Madagascar.
<i>Parastacus</i> ,	4	10 + 1r	6	South America.
<i>Paranephrops</i> ,	4	10 + 1r	6	New Zealand.
<i>Astacopsis</i> ,	4	11	6	Australia
<i>Engæus</i> ,	4	11	6	Tasmania.
<i>Cherops</i> ,	4	11	6	Van Dieman's Land.

These two groups correspond with *Astacus* and *Astacoides* of most authors, and with those of Dana, excepting that he eliminates *Paranephrops* from the latter, and places it near to the marine genus *Nephrops*.

With regard to the genera there is no species from the northern hemisphere in this collection, and only three from the southern group, and these belong to the genus *Astacopsis* (Huxley).

Geographical Distribution.—The range of this family is peculiar, the several genera being adapted each to its own locality, no two genera being known to exist in one habitat. Several species of *Astacus* have been found in many of the rivers of Europe and Asia, the islands of Japan, and, according to Faxon, five species exist in rivers in North America, west of the Rocky Mountains, as first noticed by Dana; whereas on the authority of the same writer fifty-two species of *Cambarus* inhabit most of the rivers and lakes of North America east of the same range of hills.

Geologically *Cambarus* has been found as early as the lower Tertiary deposits of the Bear River Valley, Western Wyoming, in North America, and *Astacus* in the Cretaceous beds of Europe, and approximating genera such as *Eryma* in still earlier formations.

Development.—The young quits the ovum in the Megalopa stage, having all its appendages present in a more or less perfect condition. This was shown by Rathke¹ in 1829, to whose account little has since been added.

Dr. Hagen² says, "it is easy to discriminate between the sexes of very young individuals of *Cambarus clarkii*. This is the case with those only 0·3 inch long, and while they still occupy the postabdomen of the mother. In the females the sexual aperture is visible at the base of the third set of legs. The first abdominal segment is without any appearance of abdominal legs; in all the other segments the abdominal legs are well developed, their length being nearly two-thirds of the breadth of the post-abdomen, the basal article being oblong, while the length of the double flagellum is a little greater."

¹ Entwicklung des Flusskrebses, 1829.

² Monograph of the North American Astacidae, p. 142.

"In the males the first segment has on each side a little knob, somewhat longer than broad, turning inward. In the interior the developing leg is visible, and its articulation seems marked. This oval knob with rounded tip is the beginning of the first pair of abdominal legs. I have seen the same form of the first abdominal legs in the young of *C. bartonii* even 0.55 inch long." Dr. Hagen also remarks that the ovisac in the true Astacidæ is always burst "into two parts perpendicularly, the segments remaining attached to the stem. This condition makes it probable that the *Astacus* embryo has a particular egg-burster similar to that in the insects," although these interesting parts are little observed or known even by entomologists.¹

According to Professor Huxley,² Roesel von Rosenhof says that "The young animal, though very similar to the parent, does not 'quite resemble it in all respects,' for not only are the first and the last pairs of abdominal limbs wanting, while the telson is very different from that of the adult;"

Although, at the time when the young quits the ovum, the posterior pair of pleopoda is not advanced to the permanent condition of the adult tail-fan, yet long before it is hatched, and while yet in an embryonic condition, the posterior pair of pleopoda is visible as a two-lobed appendage bearing a close resemblance to those preceding it.

The young, after they quit the egg, continue to grow under the fostering care of their parent, with which they continue attached by means of a small hook at the extremity of each finger of the large claw, which overlap each other when the hand is shut. "Hence when the chelæ have closed upon anything soft enough to allow of the imbedding of those hooks, it is very difficult, if not impossible, to open them again." The same author,³ again quoting Roesel, says, "when the mother of these little crayfishes, after they have begun to be active, is quiet for a while, they leave her and creep about a short way off. But if they spy the least sign of danger, or there is any unusual movement in the water, it seems as if the mother recalled them by a signal, for they all at once swiftly return under her tail, and gather into a cluster, and the mother hies to a place of safety with them as quickly as she can. A few days later, however, they gradually forsake her."

Peach⁴ says that the fishermen of Goran Haven, Cornwall, "have seen in the summer frequently the old lobsters with their young ones around them; some of the young have been noticed six inches long." The circumstance of the young being so large is suggestive of the gregarious habits of the lobster rather than of maternal instinct. In the Amphipod forms, both in *Gammarus*,⁵ *Podocerus*,⁶ and *Caprella*,⁷ as also in *Arcturus*⁸ among the Isopods, the young have been observed to cling around and attach themselves to the mother, and when frightened to return to the egg pouch.

¹ *Loc. cit.*, p. 20.

² *Loc. cit.*, p. 42.

³ Bate and Westwood, *British Sessile-eyed Crustacea*, vol. i. p. 380.

⁶ *Op. cit.*, vol. i. p. 443.

² Huxley, *Crayfishes*, p. 43.

⁴ Bell's *History of the British Crustacea*, p. 248.

⁷ *Op. cit.*, vol. ii. p. 59.

⁸ *Op. cit.*, vol. ii. p. 370.

According to Roesel and Huxley the young in *Astacus* are attached by means of the first pair of pereopoda, but according to Mr. Wood-Mason,¹ in the New Zealand species of *Paranephrops* the young are attached by the strong hooked claws of the two hindmost pairs of feet to the swimmerets beneath the pleon.

Astacopsis, Huxley.

Astacopsis, Huxley, Proc. Zool. Soc. Lond., 1878, p. 764.

This genus resembles *Astacoides* of Guérin² externally, but differs in having a second joint to the outer branch of the first pair of siagnopoda, in having a larger median ramus, and a longer second joint to the outer branch of the third pair of siagnopoda; in having a basecephysis that reaches to the extremity of the dactylos in the first pair of gnathopoda; in having a two-jointed basecephysis that reaches to the extremity of the ischium in the second pair of gnathopoda, and in having on each side four well-developed pleurobranchiæ, eleven arthrobranchiæ, besides six podobranchiæ, and four movable plates, one of which is attached to the podarthrodial membrane of each of the pereopoda except the posterior pair.

In *Astacopsis* there are four pleurobranchiæ, eleven arthrobranchiæ, and six podobranchiæ, while in *Astacoides* there are, besides the six podobranchiæ that are common to all the genera of the Astacidæ, ten arthrobranchiæ, five of which are rudimentary, and one pleurobranchiæ. Moreover, the basecephysis of the second pair of gnathopoda is unbranched, and approximating to a rudimentary condition, and that of the first pair is shorter than the limb to which it is attached. The second or terminal joint of the outer branch of the third siagnopoda is short and in a rudimentary condition, and the outer branch of the first siagnopoda has no second joint. The metabranchial plate attached to the fourth pair of pereopoda is rudimentary instead of being large as in *Astacopsis*.

Geographical Distribution.—Specimens of this genus have been taken in several of the rivers of the southern divisions of the Australian continent, whereas *Astacoides* is confined to Madagascar.

Astacopsis spinifer (Heller) (Pl. XXVIII.).

Astacoides spinifer, Heller, "Novara" Reise, Crustaceen, p. 102, tab. ix., 1865.

Astacus armatus, von Martens, Ann. and Mag. Nat. Hist., ser. 3, vol. xvii. p. 359, 1866.

Australian Crayfish, unnamed, Huxley, The Crayfish, p. 307, fig. 76.

Australian Crayfish, J. E. Gray, Eyre's Journ., Exped. Cent. Aust., vol. i. p. 407.

Rostrum sharp pointed and armed on either side with three sharp teeth near the anterior extremity. Dorsal surface of the carapace smooth and divided by a deep

¹ Ann. and Mag. Nat. Hist., ser. 4, vol. xviii. p. 307.

² Revus Zoologique, vol. ii. p. 109.

cervical sulcus. Lateral walls tuberculated, with two irregular rows traversing the upper portion of the branchial region and two or three sharp-pointed teeth on the anterior portion of the branchial and hepatic regions.

Pleon dorsally smooth and laterally furnished with numerous large spine-like teeth that increase in number and lessen in size on each somite posteriorly.

First pair of pereopoda large, chelate, subequal. Margins furnished with small teeth, a double row being on the outer side of the propodos.

Second and third pair chelate, fourth and fifth subchelate and spinous.

Pleopoda absent from the first somite. Those of the four following are biramose. That of the sixth somite is large and foliaceous and forms the outer plates of the rhipidura. The outer plate is furnished with a finely ciliated diæresis.

Telson broad, rounded posteriorly, dorsal surface having many small sharp teeth; posterior margin crenulate.

This species has been fully described and carefully figured by Dr. Camil Heller in the volume on the Crustacea taken during the cruise of the Austrian frigate "Novara," under the name of *Astacoides spinifer*. The year 1865 is appended to the several plates, but the publication of the volume took place in the year 1866. In the month of May in this latter year this same species was also described under the name of *Astacus armatus*, with considerable care and minuteness, by Dr. E. von Martens, who specially remarks on the resemblance of the scaphocerite of the second pair of antennæ, and of the diæresis of the outer plate of the rhipidura to the same parts in *Homarus*.

Both these accomplished zoologists were cognisant of *Astacoides nobilis*, Dana, with which they compared it, and they affirm that it was easily distinguished by the form of the rostrum, that of *Astacoides nobilis* being smooth at the sides and rounded at the extremity, that of *Astacopsis spinifer* being sharp at the extremity and armed with teeth along the sides.

In the Memoir on the Crayfish by Professor Huxley this species has again been figured, one-third of the natural size, under the title of an Australian Crayfish. He adds in a footnote, "The nomenclature of the Australian Crayfish requires thorough revision. I therefore, for the present, assign no name to this Crayfish. It is probably identical with *Astacoides nobilis* of Dana and the *Astacus armatus* of von Martens."

Length, measured from the extremity of the rostrum to that of the telson, 200 mm. (8 in.) male.

Habitat.—Paramatta River, Sydney, New South Wales. Heller gives New Holland as the locality of the specimen he has described, and Dr. von Martens states that his was taken from the Murray River in Australia. Thus it would appear that this species is tolerably well distributed in the provinces, and probably exists in many if not in all the rivers in the southern portion of the great Australian continent, and is probably identical with that mentioned by Dr. J. Gray in a paper on the Australian Crayfishes,

embodied in Eyre's *Journal of Expeditions of Discovery in Australia* (vol. i. p. 409, 1845), as "a large species living in the said river (Murray), weighing about two pounds, and possessing the same flavour as the European lobster." Dana records his *Astacopsis* (*Astacoides*) *nobilis* from New South Wales, with a query attached.

The carapace is one-half the length of the animal, anteriorly produced to a short rostrum that tapers to a sharp-pointed depressed tooth, on each side of which posteriorly are three distinct teeth that gradually lessen in size and then fade away leaving only rudimentary traces of denticulation. The ridge on which these teeth stand increases in size as the teeth diminish to a short distance behind the orbital margin. Between these ridges the median surface of the rostrum is depressed and forms a longitudinal groove that fades away on the gastric region. On each side of the base of the rostrum, posterior to the orbit, is a longitudinal tooth, but slightly projecting to a point, and grooved in its entire length, behind which another small cusp-like tooth projects anteriorly from a low tubercle. Lateral to the preceding, on the hepatic region, are four sharp strong teeth on one side, while on the other some of them are reduced to small tubercles. The dorsal surface of the carapace is smooth and almost polished on the gastric region, which is separated from the cardiac by a deep cervical sulcus. The dorsal surface of the cardiac region is smooth and separated from the branchial regions by a longitudinal furrow that traverses the dorsal surface from the cervical sulcus to a short distance from the posterior margin of the carapace. The whole of the branchial region is evenly covered with small tubercles, the upper portion being armed with two rows of large and prominent tubercles, the dorsal row having the appearance of being much worn down; near the anterior extremity of the branchial region, just behind the lateral portion of the cervical groove, are four or five rather long and sharp-pointed teeth.

The pleon has the anterior portion of each somite depressed and the posterior elevated; the dorsal surface is smooth in the median line, and is flanked on each side with a row of large tubercles, one to each somite, that on the fifth being the smallest and most pointed; on each side, standing on the coxal plates, is a series of long and strong spine-like teeth that are directed vertically from their base.

The first somite carries no appendage, consequently the coxal plate is wanting, and a single tooth stands near the margin.

The second somite has one large tooth standing near the middle of the lateral margin of the somite, and five others, smaller but still large teeth, in a line lying a little within the margin of the coxal plate.

The three following somites are armed with a large tooth near the centre of the lateral margin, and two below it, one above the other, in the median line.

The sixth somite has a bunch of five smaller teeth on each side of the narrow, smooth, median dorsal surface.

The ophthalmopoda are short, reaching but little beyond the frontal margin of the carapace, and are deeply situated in an almost circular orbit and protected by a deep fringe of hairs that spring from the lower margin of the rostrum, and from the distal outer and inner margins of the first joint of the first pair of antennæ.

The first pair of antennæ is situated beneath the rostrum and ophthalmopoda. The first joint of the peduncle is triangulate. The upper surface is flattened and formed into a hollow by the inner margin being raised into a perpendicular ridge for half its length, which represents the prosartema that forms such a peculiar structure in *Penæus*. The inner side is flat and corresponds with that of the opposite antenna, and is furnished with a small tooth on the lower margin. The under side is oblique, passing from the lower margin of the inner side to that of the outer margin of the upper. The first joint is longer than the ophthalmopoda, and longer than the two succeeding joints, which altogether do not reach to the extremity of the rostrum. The second and third joints project a little on the inner distal margin to a small cusp that is tipped with hairs. The flagella are subequally stout and about three times the length of the peduncle. In the centre of the upper surface of the first joint, where the ophthalmopod lies when at rest, is a small orifice, fringed with short hairs, leading to the internal auditory apparatus.

The second pair of antennæ occupies a large portion of the metope, or facial wall. The first joint is articulated, with a very slight power of movement, with the metope, and supports a prominent phymacerite that is strongly calcified, with the exception of a small membranous orifice; immediately above the phymacerite, standing on the margin, is a sharp and slender tooth, and the rudiment of another on the outer side. The second joint possessing only a slight lateral movement, articulates with the first by rotating on the small external tooth, and extends inwards as far as the inner or longer tooth; it is armed on the outer distal angle by a stout and powerful, obliquely directed, conical tooth, on the inner side of which stands a short and sharp-pointed scaphocerite, which is broad at the base and articulates by a process with its upper and lower margins. The outer margin projects at the base and is continued to the apex as a strong, rigid, and sharp tooth; it possesses only a lateral movement and that of little extent; the projection at the base on the outer side falls against the large tooth projecting from the outer distal angle of the second joint, and there rests and receives support that makes the tooth at the distal extremity of the scaphocerite an important and powerful weapon of offence: the third joint corresponds with the inner side of the second, and articulates with it in a longitudinal direction, the distal extremity, projecting anteriorly, articulates with the fourth joint obliquely on the outer side, thus giving it an upward, downward and slightly rotatory movement; the fifth joint articulates with the preceding at the distal extremity and has only a lateral movement, and therefore has its points of articulation on the upper and lower margins; the distal extremity supports a flagellum

that is abruptly smaller than the terminal joint of the peduncle, is slightly compressed, and is subequal in length to the carapace.

The ventral portion of the second antennal somite forms the metope and passes laterally beneath the frontal margin of the carapace, with which it is closely connected by membranous if not calcified attachments. The anterior portion is produced forwards as a projecting rostrum and sends a keel-shaped process up between the peduncles of the second pair of antennæ as far as the distal extremity of the third joints. It is generally furred with short hairs and armed on each side with four or five small tooth-like processes.

The lower margin is developed into a transverse bar-like epistoma, at the extremities of which is a cup-like hollow that receives the anterior articulating process of the mandibles.

The mandibles (*d*) are broad concavo-convex appendages, the convex surface from the extremity of the incisive margin to the distal articulating extremity of the apophysis is external, while the concave surface from the same articulation to the transverse molar ridge is internal. The mandible thus forms the inner wall of the channel of exit from the branchial chamber, and forms a partition between it and the internal viscera. The psalidoma has the margin rounded and armed with three cusps, of which the centre is the largest, and indications of others exist along the posterior margin, while the molar ridge is produced anteriorly as a long process, the extremity of which articulates in the cup at the lateral extremity of the epistoma; between this articulation and the base of the psalidoma articulates a three-jointed synnhipod which is short, hairy, and curved so as to correspond with and fall into the concave surface between the psalidoma and the molar ridge, which it occupies jointly with the lateral processes of the styloglossa. The articulation at the extremity of the apophysis is cup-shaped, and rolls upon a rounded tubercle that projects from the inner surface or ridge that corresponds with the cervical fossa upon the external surface of the carapace.

The first pair of siagnopoda (*e*) is three-branched, the inner ramus is short, rigid, and curved; the central is broad, flat and truncate, and the outer is cylindrical, slender, and biarticulate.

The second pair of siagnopoda (*f*) is three-branched and four-jointed; the first or coxal joint is short and supports a large mastigobranial plate that posteriorly reaches into the branchial chamber and anteriorly sweeps the channel of exit; the second or basal joint is of considerable tenuity and divided into two foliaceous branches; the third joint is similar to the second, but broader and more leaf-like; the fourth joint is long, slender, and tapering, and reaches beyond the anterior extremity of the mastigobranchia, but not as far as the distal extremity of the preceding branch.

The third pair of siagnopoda (*g*) is drawn of the natural size and therefore appears comparatively much smaller than the second, which is drawn two and a half times larger than its natural size. It consists of four joints that are obscurely

connected ; the first carries a large mastigobranchia that projects far into the branchial chamber, but is folded and not produced anteriorly ; the second and third joints are closely associated and form a long concavo-convex plate of considerable tenuity, fringed with hairs, the second being furnished on the outer side with a long biarticulate ephysis ; the basal joint is longitudinally triangulate, the margin of each angle being fringed with hairs, the second joint is multiarticulate and distally spatuliform ; the fourth joint is short, narrow, curved and tapering.

The first pair of gnathopoda (*h*) is subpediform, six-jointed, the dactylos probably being absent. The coxa carries a long mastigobranchia, to the outer margin of which the podobranchial plume is connected in its entire length ; the second joint carries a biarticulate ephysis, the basal joint of which is long and subcylindrical, and the terminal is multiarticulate and terminally spatuliform ; the ischium is long and broad, rather more so than figured ; the meros is short and reflexed, the carpos is broad and distally produced on the outer distal angle, and the propodos is small and ovate, the whole of the limb being thickly fringed with hair.

The second pair of gnathopoda (*i*) is pediform and seven-jointed. The first or coxal joint is broad, thin, concave below and projecting backwards, supports a long mastigobranchial plate fixed similarly to the preceding, and is furnished with a branchial plume on the outer surface ; on a small tubercle on the upper surface of the coxa is a fasciculus of very long hairs. The basis or second joint carries a biarticulate ephysis that resembles that of the first pair of gnathopoda, only it is relatively shorter since it does not reach beyond the distal extremity of the ischium or next succeeding joint : the ischium is long and longitudinally arcuate, the convex surface being below, the upper or concave surface smooth, narrower at the basal extremity than at the meral ; the inner margin is serrate with many small blunt cusps. The under surface is fringed within the inner or serrate margin by a row of closely planted fasciculi of hairs, in the median line of the same side is an obtuse carina, furnished with several distantly placed fasciculi of hairs : the meros articulates obliquely at the distal extremity of the ischium, than which it is much narrower ; distally it thickens in width and depth, becoming triangulate at the extremity, where it articulates with the carpos or fifth joint on the inner distal angle, which also increases in diameter distally and articulates with the propodos, which is long, narrow, and ovate, and fringed with hairs on the inner, upper, and lower margins : the dactylos is pointed, tapering, and fringed with hairs, but not unguiculate.

The first pair of pereopoda (*k*) is about two-thirds the length of the animal ; it is chelate, the fingers being subequal in length to the palm ; the propodos is ovate and fringed on the polliciform margin with a double row of longitudinal cusps, and on the dactyloid margin with a single row of six teeth, the posterior of which projects at a right angle and rests against the carpos, and the anterior projects over the dactyloid membranous articulation ; on the under and upper surface corresponding with the articu-

lar processes of the dactylos is a large cusp or blunt tooth, the inner side of which is hollowed to receive the tubercular articulation of the dactylos. The dactylos reversely corresponds with the pollex, but it is smooth on the outer margin excepting two or three teeth near the distal extremity; the inner surface is bordered by a row of cusps more numerous but less prominent than those on the pollex: the carpos is distally furnished with two strong cusps that correspond with the articulating processes of the propodos on the upper and lower distal margins, on the inner surface there is one sharp tooth near the middle of the anterior margin, two, one very large, on the upper margin, and two small cusps on the under: the meros is broader distally than at the ischial extremity, it is smooth and slightly arcuate longitudinally on the upper surface and convex on the lower, it is armed on the outer margin with a row of teeth that gradually increase in size anteriorly, and with two rows on the inner: the ischium is short, flat, unarmed, and articulates with the meros on the inner and outer distal angles by means of strong cusp-like processes, and at the outer coxal angle is a posteriorly projecting process that affords resistance to the too free backward movement of the joint: the coxa is triangulate and articulates at two points, one externally corresponding with the posterior angle of its own somite, and the other internally with a projecting process on each side of the median ventral carina; attached to the coxa on the outer surface is a large mastigobranchial plate, which is divided into two longitudinal processes, to the upper or median angle of which a podobranchial plume is attached throughout its entire length. The anterior process of the plate dips down longitudinally between the anterior and posterior arthrobranchiate plumes, its lower margin reaching to the pleurobranchial plume; the posterior passes over the posterior arthrobranchial plume and separates it from the podobranchial (*vide* sectional diagram of branchiæ in Pl. XXVIII.), the long hairs that cover the inner surface pass between the several filaments of the plumes and probably prevent them from pressing unduly against each other. This arrangement appears to be constant with all the appendages, excepting that the mastigobranchial plate is less pronounced posteriorly than anteriorly; the posterior pair carries a pleurobranchial plume only, attached to the posterior somite of the pereion.

Attached to the membranous articulation, between the coxa and the somite below the arthrobranchial plumes, is a lunate appendage (*mt*), the homology of which is difficult to interpret; there are four pairs, one attached to each pair of pereiopoda excepting the posterior. I have not been able to find it in our British species of *Astacus*, but it exists in the three species of *Astacopsis* in this collection, and also in *Astacoides madagascarensis*. I have not yet had the opportunity of examining other genera.

I know of nothing that these parts can be homologous with, unless they be the rudiments of the foliaceous appendages forming the incubatory pouch of those females that carry their ova beneath the pereion. It might seem an objection that in *Astacopsis* they exist in the males as well as in the females, but if they be rudimentary and

obsolete organs, there is no anatomical reason why they may not be present in the males as well as the rudimentary mammae in the males of the Mammalia.

The second pair of pereopoda is shorter and much more slender than the first, it is chelate, the propodos not being larger than the carpos; the fingers are slender and correspondingly curved and adorned with a series of distantly planted fasciculi of hairs, and the meros is armed with a few teeth on the outer margin, and two or three on the inner near the carpal articulation.

The third pair of pereopoda resembles the second but is more slender and less strongly armed.

The posterior two pairs of pereopoda are a little shorter than the preceding, they are more conspicuously armed on the outer side of the meros and carpos and on the upper side of the propodos, which is more slender, than in the preceding two pairs, and the inner distal angle is produced to a short pollex that is about one-third the length of the dactylos and therefore is only sub- or imperfectly chelate. The last four pairs of pereopoda, like the first, articulate with a process on each side of the median ventral carina, and these processes increase in size and importance, and separate slightly, as they proceed posteriorly.

The first pair of pleopoda is wanting; the second and succeeding resemble each other; they consist of a basal joint and two compressed branches, having parallel margins thickly fringed with hairs.

The posterior pair, which helps to form the rhipidura, is broad and corresponds in length with the telson. The inner branch is armed with three or four teeth longitudinally placed in the median line and corresponding with a slight elevation; the outer plate is ribbed in the median line and armed with a few teeth near the outer margin. A diæresis divides the plate one-third from the distal margin, and is fringed with a regular series of small sharp-pointed teeth, of which the largest exists on the outer margin, and one corresponds with the extremity of the median rib, whence they gradually diminish and disappear on the inner side. The distal portion of all the plates of the rhipidura is submembranous, finely corrugated, and fringed with hairs.

Astacopsis paramattensis, n. sp. (Pl. XXVII. fig. 1).

Carapace dorsally broad and smooth. Anterior division laterally dentate, posterior division laterally tuberculate.

Pleon dorsally smooth, laterally tuberculate. Telson denticulate, and posteriorly minutely corrugated.

First pair of pereopoda subequal; surface smooth, margin denticulate; carpos with two teeth on the inner margin; meros longitudinally denticulate on the upper and lower margin.

Length (female), 94 mm. (3.75 in.).

Habitat.—One specimen taken in the Paramatta River, Sydney, Australia.

The carapace is dorsally smooth, having very minute punctations, which are more numerous and smaller on the anterior division than on the posterior.

The rostrum is long, broad, and pointed, dentated with four or five small teeth on each side, the margins, which are pilose and more elevated than the intervening surface, continue posteriorly beyond the orbits, outside the line of which on each side are two teeth, placed slightly diagonally one behind the other; others not so large or important are situated on the outer side of the antennal angle. Posterior to the cervical suture the branchial regions are furnished near the upper surface with several large, flattened, dark brown tubercles, while between and below them the surface is studded with a considerable number of small light-coloured tubercles, and on each side behind the cervical suture are three short stout teeth.

The pleon is very smooth. The fourth and fifth somites have each two small fasciculi of short hairs on the posterior margin, while the sixth has four: the telson has two subcentral fasciculi of short hairs, and on each side an oblique row of small teeth, and posteriorly a row of three small teeth, while a strong one on each side forms the division between the straight lateral and the posterior semicircular margins; the surface of the posterior division is delicately and evenly corrugated.

The lateral margin of the first somite is armed with one strong cusp, which corresponds with the large internal cusp or tubercle on the second somite, outside which are three marginal teeth. The third, fourth, and fifth somites have each one internal and one marginal cusp, and the sixth only a rudimentary marginal one.

The first pair of antennæ has the peduncle shorter than or subequal to the rostrum.

The second pair of antennæ has the peduncle extending slightly beyond the rostrum, and the scaphocerite extends as far as the extremity of the peduncle and terminates in a sharp point; the outer margin on the lower side, and the inner or oblique margin, are fringed with thickly-set plumose hairs. The flagellum reaches as far back as the posterior margin of the fifth somite of the pleon. The second joint of the peduncle is armed with a strong tooth on the outer side (which is erroneously represented in the figure as being on the margin of the carapace).

The oral appendages and the two pairs of gnathopoda offer no distinguishing feature from those of other species.

The first pair of pereiopoda is large and subequal. The surface of the hands is smooth, slightly hirsute on the upper and lower surface of the pollex and dactylos, which, when closed, impinge together throughout their entire length, the dactylos falling into a small longitudinal groove in the pollex; the outer margin is fringed with a double row of depressed points, the inner with a solitary row on a distinct ridge: the carpos is armed on the upper surface with two small sharp teeth, beneath, on the anterior margin, with a strong tooth inside and one outside of the articulating process, and on the inner surface with one large and one small tooth: the meros has a row of three or

four teeth on the upper margin, of which the second is the most conspicuous; the lower divides into two, each being armed with a few conspicuous teeth.

The second and third pairs are slender and chelate and armed on the upper or outer margin of the meros with three or four sharp teeth.

The fourth and fifth pairs are subchelate and have two sharp teeth on the anterior part of the upper margin of the meros, and two or three on the lower. They have the propodos roughened on the outer side by numerous anteriorly-directed tubercles, the summits of which are crowned with a fasciculus of stiff hairs; that on the inferior distal extremity of the posterior pair is also armed with a small tooth and forms a rudimentary pollex; the dactylos in each is much longer than the pollex and narrower than the propodos.

The posterior pair of pleopoda, forming the lateral plates of the rhipidura has a distinct smooth ridge down the middle of the inner and outer plates. On the outer it is produced to the posterior margin, passing through the minutely serrate diæresis; on the inner it terminates in a sharp tooth within the margin.

Observations.—The specimen from which I have drawn the description is a female, apparently of mature growth, being nearly 4 inches in length. It has the vulva closed by a calcified operculum. In general aspect it more nearly resembles the specimens of *Astacopsis franklinii* of Gray than any others; but differs from them in several details, among which the most conspicuous are the absence of a strong cusp or tooth from the centre of the pollex of the first pair of pereopoda, the presence of conspicuous teeth on the first antennal region of the carapace, the large tubercles on the branchial region, and the absence of five or six sharp teeth on the lateral walls or coxal plates of the second somite of the pleon.

Astacopsis sydneyensis, n. sp. (Pl. XXVII. fig. 2).

Carapace smooth with microscopically small punctations and hairs. Rostrum having three small teeth on each side. Two teeth, one before the other, on each side behind the orbit. Pleon smooth. Telson slightly dentate and corrugated.

First pair of pereopoda slightly unequal, surface smooth, margins slightly roughened. Carpos with one tooth on the inner and one on the upper margin; meros with three on the upper and three on the lower margin.

Length (female), 50 mm. (2 in.).

Habitat.—Sydney, Australia. One specimen.

The carapace is smooth and minutely punctate over the entire dorsal surface, laterally sparsely covered with microscopically small hairs, which on the branchial region exist in small fasciculi. The rostrum tapers to a sharp point, and the sides are

fringed with short hairs, amongst which are three small sharp teeth on each side, of which the anterior is the most important. Behind the orbits are two sharp teeth one before the other, and more laterally is a third much smaller one. Two small teeth are also situated on the posterior margin of the lateral extension of the cervical depression.

The somites of the pleon are dorsally smooth, and have the lateral margins rounded, with but a slight tendency to come to a point infero-posteriorly.

The telson has the lateral margins parallel, and the terminal semicircular margin is defined by a strong tooth on each side and fringed with a copious brush of plumose hairs. The dorsal surface supports on each side of the median line a small fasciculus of hairs and two small sharp teeth, posterior to which the plate is submembranous and rugose.

The first pair of antennæ has the peduncle shorter than the rostrum, not reaching beyond the anterior teeth. The outer branch is longer but not stouter than the inner, which may be due to our specimen being a female.

The second pair of antennæ carries a strong sharp tooth, on the outer side of the joint that supports the squamous appendage, the value of which may be appreciated from the description of the same under *Astacopsis spinifer* (erroneously figured on Pl. XXVII. as being part of the anterior margin of the carapace); the latter reaches rather beyond the apex of the rostrum, while the extremity of the peduncle scarcely reaches the same point. The flagellum is about two-thirds the length of the animal.

The appendages of the mouth vary but little from those of other species of the genus.

The first pair of gnathopoda is a little slighter than those in *Astacopsis paramattensis*. But there is very little variation in the second pair, while it differs from that of *Astacopsis spinifer* in having the basephysis or outer branch longer than the ischium.

The first pair of pereopoda has the right hand larger than the left, but otherwise they resemble each other; the surface is smooth, the inner and outer margins of the propodos are crested and slightly denticulate; the carpos is armed with a single sharp tooth on the inner margin and one on the inferior margin of the propodal articulation; the meros is armed with three sharp teeth on the superior margin and three on the inferior on the right side, on the left there are three teeth on the superior and only one on the inferior, the two posterior being rudimentary.

The second and third pairs are slender and chelate, the fourth and fifth simple, and have the distal extremity of the propodos fringed with a brush of hairs, but no polliciform process.

The first pair of pleopoda is absent; the four succeeding pairs are similar to each other, having the two rami subequally long, narrow, and fringed with plumose hairs.

The sixth pair which, with the telson, goes to form the caudal fan or rhipidura, has each branch or plate, the inner as well as the outer, armed on the outer side by a strong and sharp tooth, and the posterior margins fringed with plumose hairs.

Observations.—This specimen appears very closely to resemble *Astacus australasiensis*, Milne-Edwards, recorded from New Holland,¹ from which it appears to differ in several details, the most distinguishable being that it has three small teeth on each side of the rostrum instead of one, that it has two teeth longitudinally situated on the carapace on each side behind the orbit instead of being smooth, and one tooth instead of three on the inner margin of the carpos of the first pair of pereopoda, and that the inner margin of the propodos is less strongly serrate.

The inner margin of the second pair of gnathopoda is serrate, while the drawing of the part shown in Milne-Edwards' figure represents it as perfectly smooth.

Milne-Edwards' description is stated to be taken from a young animal. Ours is from a female, but whether fully grown or not there is no means of determining. The vulva appears to be imperforate, but whether this be due to the immature condition of the ovaries, or, as I am inclined to believe, from a recurring state of biannual rest, we are not at present able to determine. I have observed the calcified condition of the vulva in numerous instances where there was clear evidence of adolescence, a circumstance that induces me to believe in the probable correctness of the opinion that these animals may breed only every other year.

Tribe *Stenopidea*.

Anterior margin of the carapace produced to a laterally compressed rostrum. Anterior three pair of pereopoda chelate, of which the posterior pair is the longest and largest.

Branchiæ filamentous.

Brephalos, a Megalopa or a Zoea.

In this tribe there is but a single family.

Family STENOPIDÆ.

Podobranchial plume absent from all excepting the first pair of gnathopoda. Posterior pleurobranchial plume the largest. Basephysis of the second pair of gnathopoda small, slender, and almost rudimentary.

The two genera that are here grouped together in this family have by all preceding carcinologists, including Milne-Edwards, de Haan, and Dana, been placed in the family of the Penæidæ.

This was done, it appears to me, on the external evidence that *Penæus* has, in common with *Stenopus* and *Spongicola*, the anterior three pairs of pereopoda developed in the

¹ Hist. Nat. Crust., vol. ii. p. 332, pl. xxiv. figs. 1-5.

form of chelæ, of which the third pair is the longest as it is also the largest. There is no other external anatomical detail or feature of importance that supports this view, whereas there are some very decided ones that bring them both into the same group with the normal division of the Trichobranchiate Macrura, as for instance the trichobranchiate character of the gills.

Professor Huxley, in his Memoir on the Classification of the Crayfishes,¹ was the first to point out that "by the structure of its branchiæ *Stenopus* is sharply separated from *Penæus*, with which it has hitherto been associated, although it approaches *Penæus* in the almost complete abortion of the branchial element of the podobranchiæ."

This may be the case in comparison with some species, but the branchial arrangement in several genera of the Penæidæ varies from what has hitherto been considered characteristic of the family.

The anterior three pairs of pereiopoda characteristic of *Penæus* is common to all the Astacidæ, the only variation being that in *Astacus* the first pair is the largest, whereas in *Penæus*, *Stenopus* and *Spongicola* it is the smallest; in the Astacidea all the legs, especially in the females, have a tendency to form chelæ, whereas in the Penæidea this character never appears posterior to the third pair, and in the Phyllobranchiata never beyond the second. In all the Astacidea the brephalos is in the Megalopa stage, as probably is the case in *Stenopus*,² while that of *Spongicola* is in the Zœa form.

If we take the typical forms of the Astacidæ, and compare their several parts analytically with those of the genera in the family Stenopidæ, we shall find that the variations are of little more than generic importance :—

The animals generally are subcylindrical. In *Astacus* the rostrum is flattened horizontally, in *Spongicola* and *Stenopus* it is vertically compressed as it is in *Phoberus*.

The ophthalmopoda are short in both.

The first pair of antennæ supports two flagella in both.

The second pair supports a scaphocerite which is short in *Astacus*, not long in *Spongicola*, but long in *Stenopus*.

The mandible has a two-jointed synnaphipod in *Astacus*, and a three-jointed one in *Stenopus* and *Spongicola*. The first pair of siagnopoda in *Stenopus* has the outer branch single-jointed and reduced, a condition seen in *Astacus fluviatilis* and *Astacoides madagascarensis*.

The second pair of siagnopoda is almost identical with the same appendage in *Astacus fluviatilis* in having the inner lower plates broader than the upper, the reverse of what exists in *Astacopsis*.

¹ Proc. Zool. Soc. Lond., 1878, p. 780.

² Observations of an incomplete character induce me to believe that the brephalos of *Stenopus* is in the Megalopa stage.

The third pair of siagnopoda differs in having the mastigobranchial plate transversely divided by a rib, thus making an anterior and a posterior division in *Spongiicola* and *Stenopus*, whereas the posterior division alone exists in *Astacus*; and the central branch is uni-articulate, while in *Spongiicola* it is two-jointed, and in *Stenopus* four-jointed.

In both families the first pair of gnathopoda is six-jointed, and they resemble each other in form. In *Astacus* the podobranchial plume is developed as part of the mastigobranchial plate, a feature that is peculiar and, so far as we know, confined to the family Astacidae, whereas in the Stenopidae, the two genera which comprise the family have the podobranchial plumes absent from all the appendages of the pereion except the first pair of gnathopoda, where they are reduced to an almost rudimentary condition and attached at the base only to the mastigobranchial plate.

The second pair of gnathopoda is pediform in each family, but short and robust in *Astacus*, and comparatively long and slender in *Stenopus*; it carries in both families a basephysis, which in *Spongiicola* is small and rudimentary, as in *Astacoides madagascarensis*, while in *Stenopus* it is extremely short and feeble. The mastigobranchia is reduced to a rudimentary condition and the podobranchia is wanting in the Stenopidae, while in the Astacidae the podobranchia is developed on and forms part of the mastigobranchial ramus.

The pereopoda in the Stenopidae are long, and, with the exception of the third pair, slender, and possess the characteristic Penæid feature of having the carpos longer than the propodos, with the exception of the third pair, which is shorter in *Stenopus* and still more so in *Spongiicola*. The carpos in all the Astacidae is shorter than the propodos, and the legs have consequently a comparatively shorter and more robust appearance.

The first pair of pleopoda in the Astacidae is modified in form for sexual purposes in the males of the northern hemisphere and wanting in both sexes in the genera of the southern hemisphere. In the Stenopidae it is uni-branched and foliaceous.

The second and succeeding pairs in the Astacidae and Stenopidae are biramose, foliaceous, and possess not even the rudiment of a stylamblys; the posterior pair in the Stenopidae has the outer plates of the rhipidura without a diæresis, and the telson has no transverse division, while in all genera of the Astacidae there is a division or diæresis more or less perfectly defined.

By thus reviewing and comparing the two families we find that the Stenopidae correspond with the Astacidae in the structure of the branchiæ, in having eleven pairs of arthrobranchiæ, in having five pairs of pleurobranchiæ in comparison with four in the Australian genera; also in the form of the mandibles and first two pairs of siagnopoda, as compared with the genus *Astacus*, and in the subpediform condition of the two pairs of gnathopoda. On the other hand, distinctions exist in the character of the rostrum, which is compressed horizontally in the Astacidae, and vertically in the Stenopidae; in the scaphocerite being long or moderate in the Stenopidae, and short in Astacidae; in

the third pair of siagnopoda being uni-jointed in the Astacidæ, and two or more jointed in the Stenopidæ; in the first pair of pereiopoda being the largest in the Astacidæ, and the smallest in the Stenopidæ; in the carpos being longer than the propodos in the Stenopidæ, and shorter in the Astacidæ; in the rhipidura being without a diæresis in the Stenopidæ, thus corresponding with the Synaxidea, whereas in the Astacidæ there is always a diæresis in the outer plates, and more or less indication of one in the telson. In the Stenopidæ the podobranchial plume is wanting in all the pereiopoda and in the second pair of gnathopoda, the first pair alone having a branchial plume attached to the mastigobranchia, and this is diminished in size. In the Astacidæ the podobranchiæ are present, united with the mastigobranchial plate, from the first pair of gnathopoda to the penultimate pereiopoda.

In the Astacidæ the ova are large and numerous, and the brephalos produced in the Megalopa stage. In the Stenopidæ the ova are very numerous and small, and the brephalos produced in the Megalopa stage in *Stenopus* and in the Zoea stage in *Spongicola*.

Stenopus, Latreille.

- Stenopus*, Latreille, Règne anim. de Cuvier, ed. 2, vol. iv. p. 93.
 „ Desmarest, Consid. sur les Crust., p. 226.
 „ Milne-Edwards, Hist. Nat. Crust., vol. ii. p. 406.
 „ Dana, U.S. Explor. Exped., p. 601, 1852.

Carapace furnished with a rostrum laterally compressed.

First pair of antennæ having two flagella. Second pair having a long, flat, and obtusely pointed scaphocerite, the apex being continuous with the external margin. Flagellum long and slender. Siagnos (or mandible) furnished with a three-jointed synhipod, of which the terminal joint is the longest. Third pair of siagnopoda terminating in a small sharp dactylos.

The first pair of gnathopoda short, six-jointed; furnished with a long basecephysis, and the coxa supporting a small mastigobranchial plate, carrying a small, but well-formed podobranchial plume.

The second pair of gnathopoda long, slender, seven-jointed, supporting a small, slender, uniarticulate basecephysis, the coxa supporting a rudimentary mastigobranchial plate without any podobranchial plume.

The anterior three pairs of pereiopoda chelate, the posterior being the longest and largest. The first two pairs have the carpos longer than the propodos; in the third pair it is not quite so long.

The posterior two pairs are slender, having the carpos very much longer than the propodos, both of which are multiarticulate and terminate in a double-pointed dactylos. All the pereiopoda support rudimentary mastigobranchiæ without any podobranchial plume.

The first pair of pleopoda in the female is biarticulate, uni-branched and foliaceous; the second biramose and foliaceous, carrying no stylamblys; outer plates of the rhipidura without a diæresis. Telson long and tapering.

This genus is very closely related to *Spongicola* in most of its anatomical details.

The eyes and the first and second pairs of antennæ are of the same generic value. The scaphocerite in *Spongicola* is of moderate length, relatively broad at the base, and somewhat tapering towards the extremity, but not ending in an acute point, while in *Stenopus* it is long, with the margins subparallel. The mandible and first two pairs of siagnopoda are similar in the two genera, but the third has one more joint to the limb proper in *Stenopus* than in *Spongicola*. The two pairs of gnathopoda are also generically of the same value respectively as those of *Spongicola*. The form of the first pair is almost identical in the two genera. The second pair differs in relative length, and the basephysis in *Stenopus* is short, slender, unarticulate, and feeble, while in *Spongicola* it is short, two-jointed, and robust; so rudimentary that it escaped the observation of de Haan and other carcinologists, who state that it is wanting.

The pereopoda are mostly of the same generic value, and support a similar branchial arrangement. In both genera the third pair of pereopoda is the largest, in *Stenopus* it is long and slender, in *Spongicola* it is long, but the propodos is very broad, and the carpos short; the posterior two pairs are not multiarticulate, and terminate in a triunguiculate dactylos, whereas in *Stenopus* they are multiarticulate and terminate in a biunguiculate dactylos.

The pleopoda are also of the same generic value, and the telson is long and tapering almost to a point, whereas in *Spongicola* it terminates in a rounded or obtuse extremity.

In general character *Stenopus* is long, slender, and spinous. In *Spongicola* the animal is shorter, more robust and smooth. But, with the exception of the spinous condition of *Stenopus*, the feature that chiefly influences the general appearance is the shortness of the carpos, and the great thickness of the propodos in the third pair of pereopoda of *Spongicola* when compared with the same in *Stenopus*.

Geographical Distribution.—It has been chiefly recorded from the eastern seas and the shores of India by Desmarest, Milne-Edwards, and Sir Walter Elliott; from Japan by de Haan; from the "Coral Reef of Raraka, one of the Paumotu Islands; also Balabac Passage north of Borneo," by Dana, who has determined a second but somewhat less spinous species (*Stenopus ensiferus*) from the Fiji Islands; while the Challenger brought home one specimen from the Fiji Islands, as well as one from Bermuda; and, according to Risso, a species, *Stenopus spinosus*, has been taken in the Mediterranean Sea. Milne-Edwards¹ says, "*Squilla groenlandica* of Seba, which Herbst calls *Cancer astacus longipes*, and placed by Olivier in the genus *Palæmon*, appears to be a mutilated specimen of this species (*Stenopus hispidus*), of which the two large feet

¹ Hist. Nat. des Crust., vol. ii. p. 407.

have been broken off, an accident which might very easily happen. Latreille has represented, under the name of *Palemon* (?) *asper*, one of the figures of *Squilla groenlandica*, Seba, reproduced in the Atlas of the Encyclopædia Methodique (pl. cxciii. fig. 3, explanation, p. 3), and finally, the same figure has again been reproduced by Latreille, in his Histoire naturelle des Crustacés et des Insectes, under the name of *Crangon boreal*, in pl. liii. fig. 3, and under the name of *Penée boréal* in the text (vol. vi. p. 250)."

The genus thus appears to inhabit regions so widely apart as Greenland in the north, the Bermudas and Mediterranean in the west, and the southern coasts of India and the Fiji Islands in the east. It has been found in the cold water of the Arctic regions as well as in the warm shallow waters of the Tropics, but despite this cosmopolitan range it has not been recorded as having existed in any geological formation.

The species *Stenopus spinosus*, Risso, from the Mediterranean, according to Milne-Edwards, differs from *Stenopus hispidus* only in the absence of a median row of spines upon the external surface of the propodos of the large chelate pereopod.

Stenopus hispidus (Pl. XXX.).

Stenopus hispidus, Olivier, Encyclop., vol. viii. p. 666.

" " Latreille, Règne anim. de Cuvier, ed. 2, vol. iv. p. 93.

" " Desmarest, Consid. sur les Crust., p. 227.

" " Milne-Edwards, Règne anim. de Cuvier, Crust., ed. 3, pl. 1. fig. 2; Hist. Nat. Crust., vol. ii. p. 407, pl. xxv. fig. 1.

" " Dana, U.S. Explor. Exped., p. 607, pl. xl. fig. 8.

Entire animal covered with small, sharp, strong spines, vertical on the carapace and dorsal surface of the first three somites of the pleon, almost horizontal and directed posteriorly on the three posterior somites and telson. The peduncle of the second pair of antennæ is furnished with spines, so are the third pair of pereopoda, and the basal joints of the pleopoda; all the other appendages are smooth.

The posterior two pairs of pereopoda are multiarticulate from the commencement of the carpos to the extremity of the propodos. The third or largest pair of pereopoda is very long and freely covered with teeth, which run in several longitudinal rows, those of the upper and lower margins being laterally compressed and closely implanted, longitudinally touching each other at their base, the apex of each tooth being directed toward the dactylos. The pollex is furnished with two cusps with a cleft between them, into which fits a broad sharp cusp attached to the dactylos.

Habitat.—Kandavu, Fiji Islands, Bermuda, shallow water.

This species has long been known, but though attracting attention from its peculiar formation, was described only according to its external characters until Professor Huxley examined the nature of its branchial apparatus.

The podobranchial plume is absent from all the appendages except the first pair of gnathopoda (*h*), where it is short but well formed, and attached to the base of a small but efficient mastigobranchia that equals the podobranchial plume in length, and lies between and separates the plumes of the first from those of the second pair of gnathopoda.

Beneath the podobranchia lies one rather small and slender arthrobranchial plume, which, from its position, I consider to be the posterior. But the examination of two specimens, one from Bermuda, and the other from the Fiji Islands, has failed to show the second or anterior arthrobranchia attached to this articulation, or a pleurobranchia either.

The second pair of gnathopoda (*i*) has a small mastigobranchia, no podobranchia, two well-formed arthrobranchiæ, and a small pleurobranchia (omitted in the plate).

The pereiopoda are similar in arrangement, but increase in strength and development posteriorly, both as regards the mastigobranchial plates and the branchial plumes, until the fifth or posterior pair of pereiopoda, where, as is common in the *Macrura*, the pleurobranchia alone is present, and is more largely developed than any of the anterior plumes.

The branchial arrangement may be thus tabulated—

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

Thus there are six pleurobranchiæ, eleven arthrobranchiæ (five anterior, six posterior), one podobranchia, and six mastigobranchiæ, of which the first though small is the only efficient appendage, the others being more or less rudimentary, but increasing in importance posterior to the first pair of pereiopoda.



FIG. 40.—Embryo of *Stenopus hispidus*, as seen in the ovum.

Close observation of the specimens from the Eastern and Western Hemispheres has failed to show the slightest variation, except in the curvature of the posterior pair of pereiopoda, which, in the Bermudan specimen, from which our figure is taken, has the meros bent and the carpos, so far as preserved, not multiarticulate, features which I attribute to some accident to the appendage during development.

The ova are small in size, being only 0.5 mm. in diameter, and enormous in number. An examination of the immature embryo shows there is reason to believe, from the advanced stage in which it appears, that the brephalos may quit the ovum in the Megalopa stage, which circumstance, although it does not coincide with the form of the brephalos

in *Spongicola*, demonstrates the close relation of *Stenopus* to the Astacidæ. The ova, however, are not sufficiently well preserved, nor in a condition that will enable me to satisfactorily determine the point.

Spongicola, de Haan.

Spongicola, de Haan, *Crust. in v. Siebold, Fauna Japonica*, p. 189, 1850.

De Haan, in his description of the characters of this genus, states as an important feature that the second pair of gnathopoda has no basecephysis—"Max 5^{arum} art. tres apicales, inflexi, breviores quam tres anteriores; art. ultimus penultimo brevior; palpi nulli;" and supports his definition by a figure in table (P) of the same work.

I am, however, able to state, after having examined a number of specimens, that there is a distinct but very short ecephysis (or palpus) attached to the second joint or basis, and that it consists of a short basal and a short terminal multiarticulate joint, the latter rapidly tapering to a point and terminating in two or three long ciliated hairs.

I only know of one species of the genus, and this appears to be abundant in its habitat.

Geographical Distribution.—This genus is found in the Chinese and Japanese seas and along the Eastern Pacific as far south as the Philippine Islands. It is stated, on the authority of de Haan, Moor, and Morgan, as well as of the naturalists of the Challenger, that it inhabits *Euplectella* and other allied genera of sponges.

Spongicola venusta, de Haan (Pl. XXIX).

Spongicola venusta, de Haan, *loc. cit.*, p. 194, pl. xlv. fig. 9, 1850.

" " J. Miers, *Journ. Linn. Soc. Lond.*, vol. xiii. p. 507, pl. xxiv. figs. 1, 2.

This species has been described by de Haan in Von Siebold's great work on the Fauna of Japan. The figure that he has given is generally too smooth. The small denticles situated on the frontal and hepatic regions of the carapace, which vary slightly in number in different specimens, are not represented. The rostrum is serrate with from eight to eleven small teeth on the upper surface, and two exist on the inferior margin near the apex.

The eyes are well developed, and placed on a moderately long peduncle.

The first pair of antennæ has the first joint of the peduncle longer than the two succeeding, and is armed on the outer surface at the base with a short, stout, flat, anteriorly directed stylocerite; the two other joints are short, the ultimate, which is the shorter, supports two flagella, of which the outer, especially in the male, is the more robust.

The second pair of antennæ has the flagellum reaching as far back as the posterior

margin of the carapace; the first three joints of the peduncle appear to have completely coalesced, and are much broader than the next two, the former on the outer anterior margin carries a large bat-shaped scaphocerite, of which the outer margin is straight and armed with five denticles; the inner is rounded and fringed with long ciliated hairs articulated at the base. On the inner and upper surface of the same joint is a short, round, translucent bulb, shown in the annexed woodcut, to which I believe de Haan refers when he says, "Antennarum inferiorum articulus primus latere interno lobo membranaceo."



FIG. 41.—Second antenna of *Spongiicola venusta*.

The function or the homologue of this organ I am at a loss to determine; but it appears to pass beneath and rest on the under side of the flat lateral tooth at the base of the upper antenna.

The mandible is strong and powerful, but the incisive margin is smooth, with very slight indications of denticulation; it carries a strong, three-jointed synnhipod.

The first pair of siagnopoda (*e*) are small, feeble, and bilobed, each lobe being fringed on the inner side with short spines or stiff hairs; the outer lobe supports on

the outer side a short, slender branch tipped with one or two hairs.

The second pair of siagnopoda (*f*) consists of two bilobed foliaceous rami, tipped with short hairs, a rigid but slender ramus that gradually in a curve tapers to a blunt apex, and a long thick mastigobranchia fringed with ciliated hairs that are much longer on the anterior and posterior margins, in which last position they are much increased in length.

The third pair of siagnopoda (*g*) has a broad foliaceous lobe fringed with simple hairs, a small two-jointed branch fringed with hairs on the outer margin, a long branch that is slightly curved and terminates in a few hairs at the extremity, and at the base of the latter a broad mastigobranchial plate that is divided into an anterior and a posterior portion by a transverse ridge, and is entirely free from hairs.

The first pair of gnathopoda (*h*) is long, slender, and pediform; the meros is much longer than any other joint, and straight, the basephysis consists of a very short basal and a long, terminal joint fringed with a few ciliated hairs at the extremity. The coxa supports a small mastigobranchial plate, to which is attached a podobranchial plume of about the same length, at the base of which stands a small fasciculus of hairs.

The second pair of gnathopoda (*i* and *i''*) is long, slender, and pediform, having the ischium rather longer than the meros; the basis is short and carries a short and almost rudimentary ephysis, of which the first joint is short and supports a terminal flagellum

that is reduced to a rudimentary condition, and it differs in this from the basecephysis of the first pair. The coxa supports a rudimentary mastigobranchia that is reduced to a membranous condition, and the podobranchia is wanting.

The first pair of pereiopoda is slender, chelate, and has the carpos very long and slender and the propodos short.

The second pair of pereiopoda is also slender and chelate, but longer and more robust than the first, it has the carpos very long, nearly as long again as the propodos, the pollex of which is straight and continuous, as is also the external margin of the dactylos; the whole appendage is sparsely fringed with long hairs.

The third pair of pereiopoda is chelate, but has the carpos short, triangulate, the propodos large and thick, the palm being nearly as broad as long, and the anterior or outer margin serrate with teeth that gradually increase in size as they approach the dactyloid articulation. Minute denticulations arm the external margin of the dactylos as well as that of the pollex; intermingled with these are a few long hairs.

The two following pairs of pereiopoda are long, slender, and terminate in a tridentate dactylos. They have the carpos longer than the propodos.

The pleon is tolerably robust, and all the somites are acuminate at the centre of the lateral margin of the coxal plates, and the telson (z) is ovate, serrate at the margins and furnished with two serrate carinæ that longitudinally traverse the dorsal surface, one on each side of the central line.

The branchial arrangement is peculiar. The plumes increase considerably in size as they recede posteriorly. The podobranchial plume is wanting in each except the first pair of pereiopoda, where a feeble one is attached to a small mastigobranchial plate. The mastigobranchial plates are present in all except the posterior pair of pereiopoda; they gradually increase in size as they proceed backwards from the first pair of gnathopoda. The arthrobranchiæ and pleurobranchiæ, which are small and almost rudimentary on the first pair of gnathopoda, increase gradually in size until the fourth pair of pereiopoda is reached; with the fifth pair the pleurobranchial plume alone is present, but that has become so much developed that it reaches to the anterior margin of the branchial chamber, (3c); that of the fourth pair of pereiopoda, as well as the arthrobranchiæ, is nearly as large, and is horizontal and anteriorly directed. The arrangement may best be seen in the following table:—

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

Observations.—De Haan has classified this genus as belonging to the family Penæidæ,

whereas the character and arrangement of the branchiæ clearly demonstrate its approximation to the Astacidea. Mr. Miers, in his short Memoir published in the Linnæan Society's Journal, has followed the same classification, having been led to this

arrangement by the three anterior pairs of pereopoda being chelate, somewhat as they are in *Penæus*.

Among the numerous specimens captured some were carrying ova, and as those of one specimen had the embryo far advanced in development, I am able to give a description and a figure of the brephalos (Pl. XXIX. fig. 2), which may be compared with the annexed woodcut from a drawing of Dr. v. Willemoes-Suhm's, taken from the recently hatched animal.¹

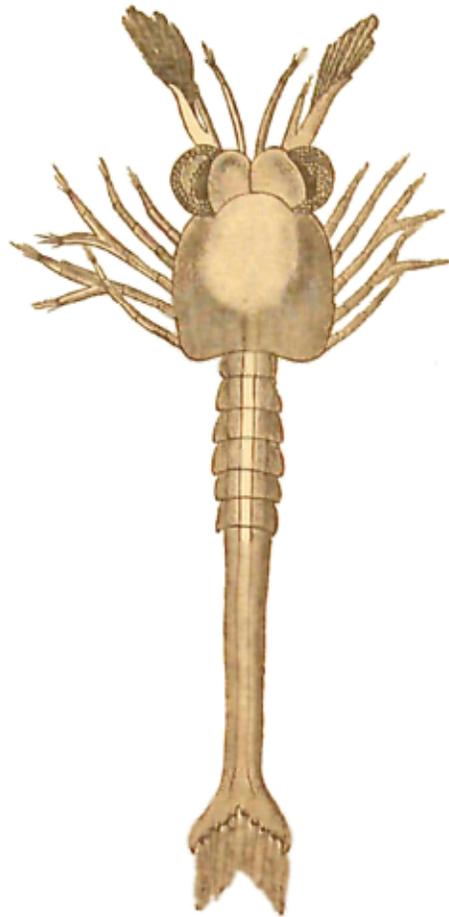


FIG. 42.—Zoea of *Spongiicola venusta*, from a drawing by Dr. v. Willemoes-Suhm.

The eyes are large, and in the embryonic condition sessile. The anterior antennæ are uni-branched and terminate in a small joint or lobe. The posterior antennæ are two-branched, standing on a robust base or peduncle, about half the length of the first joint of the first pair; the oral appendages are visible, and the two pairs of gnathopoda are biramose and well advanced in structure. The several somites of the pereion and pleon are defined, the anterior ones being very short, and the posterior long, the last or telson is the longest, and terminates in a bifurcate or fish-tail extremity, having the posterior margin crenated and fringed with five long hairs on each side, and the lateral angles defined by a sharp tooth.

This, so far as I am able to determine, bears some resemblance to the animal which Claus² has figured as the Protozoæa stage of *Penæus*, but which has not yet been fully determined.

Habitat.—Station 209, January 22, 1875; lat. 10° 14' N., long. 123° 54' E.; off Zebu, Philippines; depth, 95 fathoms; bottom, blue mud; bottom temperature, 71°. In a siliceous sponge (*Euplectella*).

¹ In a letter to Professor von Siebold (*Zeitschr. f. wiss. Zool.*, Bd. xxvi. p. lxxiv., 1876), Dr. v. Willemoes-Suhm says, "Palæmon sp., parasite inhabiting Euplectella. Very transparent and delicate species. I succeeded to get the Zocæ out of the eggs, by keeping the mother in a globe, and found that the young one is an ordinary Zocæ in which, however, some appendages are to be seen which, as a rule, come out only in a later stage." None of these have reached me among his numerous specimens of the kind, and Mr. Murray, in writing to me, says, "I cannot find any preparation of these Zocæ; in fact it is by no means sure that Suhm made any."

² Carl Claus, *Crustaceen-System*, Taf. ii. fig. 1.

Division DENDROBRANCHIATA.

This Division forms a natural and well-defined series of families that differ from the Trichobranchiata and Phyllobranchiata in anatomical structure, external form, development, and general habits, and may be divided into a Normal and an Aberrant group.

The branchial structure, instead of being developed in the form seen in the Normal group of the other two divisions, consists of a series of plumes, that in their more typical condition are attached by, or very near, their basal extremity to the animal, and from a long central stalk send off on each side a single row of branches that divide and subdivide in a more or less distinctly different manner in separate genera, and sometimes also in otherwise well-defined species.

In some genera this distinction is so great that in *Philonicus* the branchial petals on a casual inspection may be mistaken for those of a phyllobranchiate Macruran, but even here they differ in form on the same plume, being more decidedly typical of the Dendrobranchiata at the base, but falling off in character as they approach the apex.

In the Aberrantia the branchial plumes are fewer in number and more elementary in structure, but still characteristic of the division.

The nervous system exists as a series of separate ganglionic centres, corresponding to every somite posterior to the cephalic system, with the exception of that of the posterior somite of the pereion, which is absent, the nerve which supplies the fifth or ultimate pair of pereopoda being derived from the same ganglion as that which supplies the preceding pair. Examination of several genera induces me to believe that this is a very constant character throughout the division.

Corresponding to the depreciated condition of their nerve centre, the posterior two pairs of pereopoda are invariably of an enfeebled character as compared with the three preceding pairs, and they are never chelate in either sex during any period of the existence of the animal.

In the Trichobranchiata, as well as in the Phyllobranchiata, the ovum when liberated from the oviduct is connected with the pleopoda by a filamentous attachment, and is thus suspended until such time as the embryo is sufficiently advanced to be hatched, and to swim freely in the ocean. The brephalos appears either in the Zoea, Phyllosoma, or Megalopa stage.

In the Dendrobranchiata the form of the brephalos is unknown, except in *Lucifer*. In 1863 Fritz Müller observed great numbers of the young of Crustacea, of various forms, swimming about in the sea during the summer months. These he examined, and he was able to establish a chain of progressive forms that induced him to believe he had discovered the development of some prawn, which he supposed to be *Penæus*.

The first great link, the determination of the parent of the earliest form, was wanting, and it is remarkable that though more than twenty years have passed, not one of the

numerous observers has ever taken any specimen of the genus with ova, or procured the young animal immediately from the parent, or obtained a Nauplius, so as to establish the identity of the relationship, as has been accomplished with nearly every other group of Crustacea.

Not only is this the case, but among the large number of specimens that have passed through my hands in connection with the Challenger collection, and among all those preserved in the National Museums in London and Paris, not one specimen that I have seen carried a single ovum or even showed a trace of their attachment, yet such traces are very commonly found in the various genera in the Trichobranchiata and Phyllobranchiata of the same order.

This circumstance has led me to infer that the ova of *Penæus* and its allies are not attached to the parent or carried about as in the Phyllobranchiata, but deposited in the open waters soon after they are extruded, although Risso says¹ that *Aristeus* (*Penæus*) *antennatus* and *Penæus* *mars* carry their ova in July, and that those of the latter species are of an orange colour, "roux aurore."

This idea appears to receive support from the recent researches of Professor Brooks on the genus *Lucifer*, in which he shows that the ova are not attached to the parent by any viscous membrane, but appear to be entangled amongst the pereopoda, where they remain for a day or two only, and are then hatched in the Nauplius form.

The difficulty of artificially preserving these delicate young forms in life has not yet been overcome. Those of the commonest species, and consequently we may assume the hardiest in character, have not been preserved alive beyond the second stage. It is therefore the more desirable that we should be able to determine a very close resemblance of form in order to enable us to accept the observation as conclusive.

Professor Brooks has taken the embryo from the ovum procured from *Lucifer*, and found it to be in a Nauplius condition. This fact having been established, there is no reason why the brephalos of *Penæus*, which has never been demonstrated, and which we assume to be incubated in the surface waters of the ocean, may not also be hatched in the form of a Nauplius. But Dr. v. Willemoes Suhm's observation tends to the opinion that the brephalos of *Sergestes* is hatched as *Xylaphocaris* in an eyeless condition.

These several points, namely, the variation in the nervous system, the difference in the structure of the branchiæ, the manner in which the ova are deposited, the way in which they are probably impregnated, together with the early condition of the brephalos, demonstrate clearly a broad demarcation from those families in which the gills are either trichobranchiate or phyllobranchiate. Like them they may be separated into two groups, the Normalia and the Aberrantia. The former contains the families Penæidæ and Sergestidæ, the latter, the Eucopidæ, and such Schizopoda as have the branchiæ arborescent, and hatch the brephalos in a Nauplius stage, as shown in the annexed table.

¹ Hist. Nat. des Crust. des Environs de Nice, pp. 96, 97.

	Tribe.	Family.	Subfamily.	Genus.	Brephalos.		
NORMALIA.	Penæideæ,	PENÆIDÆ,		<i>Penæus.</i> <i>Philonicus.</i> <i>Artemesia.</i> <i>Haliporus.</i> <i>Sicyonia.</i> <i>Hemipenæus.</i> <i>Aristeus.</i> <i>Hepomachus.</i> <i>? Peteinura.</i> <i>Benthesicymus.</i> <i>Gennadas.</i>	Nauplius?		
				SERGESTINÆ,		<i>Petalidium.</i> <i>Sergestes.</i> <i>Sciacarus.</i> <i>Acetes.</i>	Elaphocaris?
				LUCIFERINÆ,		<i>Lucifer.</i>		Nauplius.
ABERRANTIA.	Schizopoda,	EUPHAUSIDÆ,			Nauplius? Metanauplius.		
		LOPHOGASTRIDÆ,					
		EUCOPIDÆ,		<i>Eucopeia.</i>			
		MYSIDÆ,					

Group NORMALIA.

The species of this Group differ considerably from one another in their appearance and general structure, but throughout these many changes there is a gradual depreciation of certain parts. Thus in the Penæidæ the anterior three pairs of pereopoda are chelate. In the Sergestinæ there are only two, and in the Luciferinæ there is only one in this condition. The first pair loses the chelate condition in the Sergestinæ; the first and second in the Luciferinæ. The third is largest in the Penæidæ, and is the last that retains the chelate condition in the Luciferinæ, where the chela has become microscopic.

Those species that approach nearest in appearance to other groups have the posterior two pairs of pereopoda best developed. This is well seen in *Sicyonia* and *Penæus*, but in *Benthesicymus*, *Gennadas*, and *Sergestes* they gradually diminish in size and power, and in *Acetes* and *Lucifer* they disappear altogether.

The branchiæ are well developed in the Penæidæ. They diminish in number and importance in the Sergestinæ, and disappear in *Lucifer*.

The form of the brephalos is supposed to be that of a Nauplius in the Penæidæ. It is thought to be the same in the Sergestinæ, but has not been traced nearer than an Elaphocaris with a Nauplius eye, while Mr. Brooks has demonstrated it to be of the Nauplius form in the genus *Lucifer*.

Thus widely separated as *Lucifer* may be from *Penæus*, they both possess the same structural character, the one highly developed, the other in a depauperised condition.

Tribe Penæidea.

The numerous genera which belong to the several families that form this tribe possess in common certain peculiarities of form and structure that distinguish them essentially from all others.

The earlier writers, including Professor Milne-Edwards, grouped within it all species in which the several legs posterior to the oral appendages carry more or less perfectly developed branches attached to the second or basal joint. This he thought to be so important and distinguishing a feature, that he considered it sufficient to determine the tribe, and recently Professor Sars, in his Report on the Schizopoda of the Challenger collection, considers it as "perhaps the most striking feature distinguishing" the Schizopoda as a distinct suborder. Thus the genus *Oplophorus*, which in most other respects approximates to the Palæmonidæ, was by Milne-Edwards associated with the Penæids, as well as other less known forms, such as *Euphema*, *Ephyra*, *Pasiphæa*, &c., but which de Haan, and following him, Dana, have excluded. Still more recently, Professor Huxley, in his article on the classification and distribution of the Crayfishes,¹ has suggested the elimination of *Stenopus* also, on account of the dissimilarity of the branchial structure; and upon the same evidence the genus *Spongicola* must also be excluded.

Family PENÆIDÆ.

The structure of the Penæidæ offers so many points of interest, that it appears to afford an instructive lesson to compare their several parts with those of the Astacidea and Caridea, so as to recognise the points in which they agree, as well as those in which they differ.

Taking the genera of this family as being the most perfectly developed of the tribe, from which others are but departures to a greater or less degree, we generally find that the animals are laterally compressed, and that this compression increases posteriorly to the last somite of the pleon.

The carapace is well developed, and laterally deeply produced; posteriorly it is carried further back at the sides than in the median dorsal line, and passes under the anterior margin of the coxal plates of the first somite of the pleon.

The dorsal median line is carinated, but in some forms the carina terminates with the posterior extremity of the rostral crest. The rostrum is always laterally compressed, and is generally long and frequently strengthened on the sides by a longitudinal ridge. In some genera, such as *Gennadas* and *Benthesicymus*, the rostrum is short, and

¹ *Proc. Zool. Soc. Lond.*, vol. iv. p. 780, 1878.

the structure of the tissue soft and membranous, but in others, where the structure is hard and rigid, the rostrum is long and slender, as in most of the species of *Aristeus*. The teeth on the rostrum, whether on the upper or the lower surface, exhibit a tendency to be constant, even in those genera where there is a considerable variation in the structure of more important organs.

In *Penæus* the teeth are generally numerous, but vary from seven or eight to twice the number, and in some species they appear on the lower margin, but more commonly they are absent from that position. In *Aristeus* three teeth are the almost constant armature of the upper surface of the rostrum, and we know of only one species that departs from this character. In *Aristeus rostridentatus* a number of small teeth arm the rostrum to the apex. In *Benthescymus*, where the rostrum is very short, the crest is elevated, and most species carry two small teeth, but in *Gennadas* there is only one. Thus the number and arrangement of the teeth on the rostrum of the Penæidea may be considered as sufficiently constant and important to be accepted as a ready and convenient guide to the determination and classification of species.

In *Penæus* there is constantly a small tooth situated at the anterior extremity of the hepatic region, just behind the furrow that is formed by the remains of the cervical fossa. This tooth is absent in *Aristeus* in all species except *Aristeus rostridentatus*. It is present in *Benthescymus*, and absent in *Gennadas*. In *Sicyonia* it appears as a formidable armature, and in *Solenocera* and its near allies, not only is it present, but there are others which are post-orbital and post-antennal, that appear to be constant and determining features. The frontal margin slightly recedes and has no distinct orbit, but a small tooth that overhangs the base of the first pair of antennæ defines the limit, whence the frontal margin recedes still more obliquely, and passes behind the base of the second pair of antennæ. Here is frequently situated a strong tooth that forms the anterior extremity of a strong ridge that runs backwards, and meets, without uniting with, another ridge that defines the limit between the cardiac and branchial regions. The frontal margin still recedes posteriorly until, at a short distance below, it forms another ridge that longitudinally traverses the branchial region to the posterior extremity of the carapace. This perhaps is the more constant ridge, and it is best seen in *Aristeus*, but it is reduced to a minimum in *Benthescymus*. Although the structure of the carapace may be firm and rigid, as in *Aristeus*, the portion below the ridge is soft, flexible, and membranous; to such an extent does this exist in some species, as in *Hemipenæus semidentatus*, that the vascular ramifications may be seen in the tissues beneath.

In some species of *Penæus* very peculiar fissures may be seen traversing the carapace, one in a longitudinal direction from the orbital margin, in a slightly waved line to near the posterior margin, the other vertically, commencing near the centre of the infra-lateral margin, and passing up halfway through the branchial region. It cannot be taken

as a feature belonging to any one species, because I have seen it in two distinct forms, but I have utilised it in naming *Penæus fissurus* in order to draw attention to it.

The somites of the pleon, more particularly the first three, are each divided into two portions, an anterior and a posterior, a deep groove separating them; the posterior portion carries the coxal plate of the pleopod; it is large, broad, and anteriorly overlaps the posterior extremity of the carapace, and posteriorly the anterior margin of the second somite of the pleon. In this it differs from the species of the Palæmonidæ, in which the second somite of the pleon overlaps the one before as well as the next behind. In the Penæidæ the anterior three somites are never carinated, but those that are posterior to them are always extremely so; even when not produced to the form of a tooth, the posterior extremity of the carinated somites is longitudinally cleft for the reception of the carina of the next succeeding somite, and the telson is generally dorsally flattened or grooved, and has the sides compressed and frequently fringed with small spines and hairs.

The ophthalmopod is two-jointed, and is attached to a base that freely articulates with the frontal surface or metope, which represents the first somite of the cephalon; the first joint articulates with the somite, the second with the eye. The stalk is flattened in *Penæus*, but it is cylindrical and single-jointed in *Aristeus*, as it is in the other families of the group. In *Benthescymus* the stalk is flattened transversely, more especially on the upper side, in conformity with the plane of the surface when the ophthalmopod is ensconced in the depression of the first pair of antennæ; and the ophthalmus or visual extremity of the ophthalmopod is very large and reniform. In some species the eyes are so arranged as to expose the surface of all the numerous lenses to the light, bringing the ophthalmopoda with their blind sides contiguous to each other. In *Benthescymus* and *Gennadas* the visual portion of the eye is not broader than the stalk on which it stands; the pigment is reduced in many species to a small black or brown spot, and the lenses, which are few and not closely packed, are situated at a considerable distance from the spot of dark pigment. This kind of eye appears to be one of weakened power, and when at rest, or indeed at any time, has only a limited range of vision, to compensate for which some species, more especially those of the genus *Gennadas*, in which it is larger than in most others, have a supplementary eye in the form of a small tubercle which encloses a single lens. This appears to be mostly adapted to those animals that inhabit the greater depths of the ocean, where only the feeblest rays of light penetrate.

Mr. John Murray¹ has suggested that these secondary eyes may be, and probably are, phosphorescent organs, he having seen them brilliantly luminous in some species of Crustacea.

In all Crustacea above the Entomostracous forms the first pair of antennæ consists of a peduncle of three joints and two terminal flagella. In some cases the outer branch

¹ Narr. Chall. Exp., p. 743.

is reduced to a rudimentary condition, or is visible only in the brephalos stage, except in those forms, such as the terrestrial Isopoda, where the entire organ is deteriorated in character. The first joint of the peduncle is the most important of the three, since it contains the acoustic organ, and is also modified in different genera to support and protect the eye.

In *Penæus* this organ is more perfect in its several parts than in any other genus of the family group, where the tendency is generally to diminish the value of its parts. In its more perfect condition it is about one-third as broad as it is long, the form being something like a flattened cylinder; this shape is caused chiefly by the depression for the lodgment of the ophthalmopod, and the surface is thinned out accordingly; in some genera, as *Aristeus*, and some species of *Gennadas*, the depression is great; in others, as in *Sergestes* and its allies, it is almost wanting. In these genera the first joint is short, and the second and third are proportionately increased in length. In *Penæus* this joint is stout at the base where it has a free articulation with the metope; the thickness is continued on the inner side to the extremity, and the margin is straight and lies in contact with that of its fellow. Near the base of the joint on the same side, within the margin, there arises an appendage that is first laterally, and at its distal extremity vertically, compressed; it has the margins, especially towards the distal extremity, copiously fringed with hairs. In some genera this appendage, which for distinction I call the prosartema, varies in length and form, and sometimes is rudimentary or absent. In *Sicyonia* it is short, rigid, and sharply pointed. In *Aristeus* it is represented by a small tubercle supporting a tuft of hairs; while it is absent in *Benthesicymus*, *Gennadas*, and *Sergestes*.

The upper surface of the same joint, as it exists in *Penæus*, is of extreme tenuity, but the inner and outer margins are strengthened by a longitudinal rib that reaches to the distal extremity, where on the outer side it terminates in a sharp tooth or stylocerite of more or less importance, and is frequently fringed on the upper and lower sides with long hairs. This styloform tooth varies in form and length in different species and genera, being sometimes short and thick, as in *Benthesicymus*, but always terminating in a sharp point, even in *Sergestes*, where it is the least developed. In others it extends beyond the distal extremity of the joint, and frequently lies so closely in contact with the margin as at first sight to appear to be in connection with it. Between the two margins is a depression into which the ophthalmopod falls when at rest, a prosartema on the inner side overlying and protecting it, and a copious fringe of hairs surrounding it on all sides, their direction being always towards the eye. The hairs, which at the base are very numerous and closely packed, form a thick mat, protecting both that portion of the eye and also a small orifice that opens into the chamber containing the auditory apparatus, which is enclosed within a calcified fold of the external tissue. The second and third joints are generally cylindrical in form, but in *Penæus* they are rounded on

the upper side, transversely concave on the lower, and longitudinally flattened in correspondence with the surface of the preceding joint. These joints are fringed with hairs that vary in different species, but as a whole they are of little importance except as carriers of the terminal flagella.

These flagella are always two in number. In some genera they are of equal length, while in others they are unequal; they are evidently of different degrees of importance, as one is liable to vary with the sex, and is generally furnished with peculiar organs that are evidently connected with some special sense.¹ Though one flagellum may in different species vary in length it never becomes rudimentary, as the diminution is due to the shortness, rather than to the numerical decrease, of the articuli, whereas the second is always slender and constructed of articuli that are long, and the diminution generally takes place by their numerical reduction.

In an adult specimen of *Penæus japonicus*, where both flagella are short and of equal length, neither being longer than 5 mm., the primary flagellum consists of fifty articuli, and the secondary only of twenty. In *Aristeus*, the primary is very short and the secondary very long; the former is flattened and hollowed on the lower side, which latter character is emphasised in *Solenocera* to such a degree that the more slender flagellum when at rest is lodged within the longitudinal hollow of the larger.

The second pair of antennæ articulates freely with the metope, and consists of a peduncle of five joints and a long flagellum. The first joint is generally short and broad, and carries on the inner side a large phymacerate, at the extremity of which is a passage closed by a soft membrane. This is the external passage connected with the green gland, the function of which has not yet been determined. The second joint is longer but not so broad, and supports at its extremity a scaphocerite, which in this tribe of Crustacea is large, being broad, thin, and foliaceous, and on an average about one-fourth the length of the entire animal. The outer margin is strengthened by a longitudinal rib that terminates in a sharp tooth more or less distant from the distal extremity. The form varies in different genera. In some it is long and broad as in *Aristeus*; in *Sergestes* it is long and narrow, and in *Sicyonia* it is broad at the base, and gradually but obviously narrows from its greatest diameter to the apex. The scaphocerite is strengthened at the outer margin, sometimes by one, but in others, as in *Sicyonia*, by two longitudinal ribs that converge towards the extremity, where they unite and form the external distal tooth; from the inner or median rib a series of parallel ribs or raised lines run obliquely to the margin, and, when they approach it, widen and divide into two or three others. In *Penæus* the median longitudinal rib does not converge towards the subapical tooth, but runs down the centre and fades away before it reaches the distal

¹ These organs I believe to be endowed with acoustic properties, but Claus suggests that they may be olfactory organs. They are not so constant in the Penæidea as among other Crustacea, where, when present, they exist as translucent membranous cilia of variable form.

margin. The oblique ribs in *Penæus* commence near the margin and divide at a certain distance, and after a space again subdivide and terminate at the margin where a single hair articulates with every rib at its extremity. The intermediate spaces between the longitudinal ribs are occupied by strong muscles, and those formed by the marginal ribs are occupied by vessels that communicate with the hairs which fringe the inner margin of the scaphocerite; those on the outer side are upon the under surface, on the inner side of the ribs, whence they probably receive their nourishment.

This plan is best observable in *Hemipenæus* (Pl. L.), in which the circulating vessels are seen to traverse the appendage longitudinally in two lines, and to ramify over the surface in numerous capillaries that are traceable to the small direct lines leading to the marginal hairs. The joint on which the scaphocerite stands is the largest of the second pair of antennæ, and its dimensions show the importance of this appendage in the economy of the animal. Its purpose I take to be chiefly to balance the animal in a vertical position when swimming, but it appears also to be useful in folding over and enclosing or hugging objects against itself, and which may account for a condition that is met with in some specimens, the hairs being lost and the margins thickened as if diseased by much friction. In some this is increased to a larger extent than in others, and sometimes is accompanied by a constriction of the margin (fig. c.) that is suggestive of a permanent variation in form. On the inner distal angle in *Penæus* there is a tubercular process, which in other genera, as *Benthescymus*, is developed into a hook with a blunt extremity, and its apex is lodged in a depression on the inner surface of the first pair of antennæ; in those species in which the process is sufficiently developed to be unciform, there is a hollow above, in the ridged structure of the under side of the stylocerite, that does not exist in those species where the process is present only as a tubercle. This hook-like process, which may conveniently be named the "ancecerite,"¹ enables the animal, by the assistance of the powerful muscles of the second pair of antennæ, to hold the first pair down more firmly than it otherwise could. In *Penæus*, where this structure exists only as a tubercle, the animal does not roll itself up as it does in *Benthescymus*, in which the external tissues are soft, and consequently have less protection.

The three succeeding joints of the peduncle are small, and only important as being the carriers of a long and slender flagellum, that in some genera, as *Aristeus*, is three or four times as long as the animal, a feature that appears to be common to those forms obtained from very great depths.

The mandibles in all the Penæidæ are large and powerful organs; the external portion consists of an incisive margin, which is generally smooth or but slightly dentate, and beneath it a broad, circular, molar tubercle; when the incisive margins meet there is a space between them and the molar tubercles that is occupied by a process from a fleshy mass that overlies them anteriorly. The posterior process of this mass fulfils the

¹ ἀγκύη, a hook.

duty of a tongue in passing and keeping the food between the grinding tubercles of the mandibles, and the portion which covers the apparatus anteriorly aids the double metastoma posterior to the mandible in enclosing the organs of mastication within a membranous orifice, whose margins undoubtedly fulfil the duties of lips. The mandibles carry an appendage which differs in form and size in several genera, but is never more than two-jointed in any genus of the tribe; generally they are larger and longer, and apparently of more importance and use, than in the Trichobranchiata or the Phyllobranchiata. In those species of Penæidea where it is large, broad and foliaceous, it suggests that the habit of the animal is, while swimming, to feed on small creatures, that are by means of these large, spreading plates directed within its mouth. I have proposed to use the term *synnhipod* for this appendage rather than any other suggested, because it can, I think, be readily demonstrated to be the continuation or representative of the joints of the true appendage, and not a branch of it.

The next pair of appendages is the first pair of *siagnopoda*, which bears a resemblance to the type of the same pair of organs as seen in the young and undeveloped forms of the *Astacidea* and the *Brachyura*. It consists of three joints, two of which are broad and foliaceous, having their inner margins fringed with hairs, while the third or outer is narrow, and in some species single-jointed and terminating in a point, in others two-jointed, the second joint tapering and tipped with a few hairs.

The second and third pairs of *siagnopoda*, although varying specifically in form, are yet modifications of the same general type as in other groups.

The second pair consists of three branches, two of which are flat and foliaceous, generally longitudinally divided, and having their inner free margins fringed with hairs; the third is subcylindrical, varies in length specifically, and sometimes consists of three or four joints, and on the outer margin is a broad *mastigobranchial* plate that varies in form in different species. The third pair perhaps undergoes more change than the second, but still retains the same fundamental plan of arrangement, consisting of one large foliaceous branch furnished on the inner free margin with hairs, a subcylindrical one formed of several articulations, and on the outer side at the base a long and broad *mastigobranchial* plate that is transversely divided into an anterior and a posterior portion.

The two pairs of *gnathopoda* are the anterior appendages belonging to the pereion, and assume a greater or less pediform character all through the tribe.

The first pair is generally broader and has the fourth joint or *meros* long and the *ischium* short; the second joint, or *basis*, carries a long multiarticulate branch, and the *coxa* supports a long *mastigobranchial* plate, to which a *podobranchial* plume is in some genera attached. The three terminal joints lie reflexed against the inner side of the preceding ones, and the inner or antagonising margin is invariably furnished with a mat of strong hairs, among which stiff spines are occasionally intermingled. The entire organ bears a close resemblance to the same appendage as it exists in the higher *Brachyura*.

In *Sergestes* and its congeners it is elongated and pediform, and if not the longest is certainly the most efficient appendage attached to the pereion.

The second pair of *gnathopoda* is long, pediform, and invariably supports a multi-articulate branch that springs from the basis or second joint, while the first or coxa carries a long mastigobranchial lash, that in *Penæus* is more or less divided in a fork-like manner; in some genera it is long and leaf-like, in others it is oval, but generally the body of the lash is supported by a stalk to which it is attached at an angle.

In many genera this lash supports a well-formed branchial plume, but it is absent in *Penæus*, *Sicyonia*, and *Artemesia*, whereas in *Haliporus* it is present in a reduced condition.

The first three pairs of pereiopoda are formed on the same typical plan; they gradually increase in length as they recede posteriorly, and also slightly decrease in diameter. One feature that distinguishes them from those of nearly all other forms is the great length of the carpos in relation to the propodos, and outside of this tribe, I only know of three genera, the recently found *Nematocarcinus*, belonging to the Trichobranchiata, and *Stenopus* and *Spongicola*—genera that belong to the Phyllobranchiata, and have long been supposed to be associated with the Penæidæ—that possess this feature, which they do in each pair of pereiopoda except the third, and here the great increase of development of the chela is the apparent cause of its absence. All the true Penæidæ carry a mastigobranchial plate, while the Sergestidæ have none except in those genera where a rudimentary plate is attached to the first pair of *gnathopoda*. In *Penæus* and its near congeners there is no podobranchial plume, while in *Benthosicymus* there is one to each pair of appendages except the posterior pair. The two posterior pairs in this genus are simple, and terminate in a styliform dactylos. *Penæus* carries neither lash nor podobranchial plume, but a mastigobranchial lash appears in several other genera, but never a podobranchial plume.

In the Sergestidæ there is neither lash nor plumes attached to the legs, but the rudiments of both are sometimes attached to the first pair of *gnathopoda*.

The branchial arrangement in the several genera of the Penæidæ may best be appreciated by being shown in a tabulated form:—

Penæus.

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

Penæopsis.

No species in the collection.

Philonicus.

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

Artemesia.

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

Haliporus.

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

Solenocera.

No species in the collection.

Sicyonia.

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

Hemipenæus.

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

Aristeus.

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

Hepomadus.

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

Benthesicymus.

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

Gennadas.

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

Penæus, Fabricius.

The body laterally compressed, particularly towards the posterior portion of the animal. Carapace armed with a laterally compressed rostrum that is more or less dorsally serrated.

The ophthalmopod is two-jointed, and the eyes are large and longitudinally ovate.

The first pair of antennæ has the first joint deeply excavate on the upper surface, and furnished on the inner side with a prosartema, and on the outer with a sharp-pointed stylocerite. It terminates in two flagella, and is never longer than the carapace.

The second pair of antennæ carries a large scaphocerite, rigid on the outer margin, where it terminates in a sharp tooth, thin, foliaceous and fringed with long ciliated hairs on the inner margin. The first joint carries a small phymacerite on the inner side, and the third is furnished with a small hook (ancecerite) on the upper surface.

The mandibles are strong and powerful, smooth on the psalisiform margin, furnished with a flat, discoid, molar tubercle, and carry a large, foliaceous, two-jointed synaphipod.

The first pair of siagnopoda is three-branched, the last or outer branch being biarticulate, long, slender, cylindrical, and tapering.

The second pair is three-branched; the first branch carries a broad mastigobranchial plate, the next two are biramose and foliaceous, and the third is truncate.

The third pair of siagnopoda is five-branched. The first branch carries a broad but not very large mastigobranchial plate; the second is biramose and foliaceous, and supports externally a foliaceous ephysis, and the terminal one is narrow, slender, cylindrical and triarticulate.

The first pair of gnathopoda is seven-jointed, short, and subpediform; the terminal three joints are reflexed, and flattened on the inner or approximating margin. The second joint or basis carries a very long two-jointed ephysis, which has the first joint short and cylindrical, the second long, flat, multiarticulate, and fringed on each side with long ciliated hairs.

The second pair of gnathopoda is seven-jointed, pediform, and long; it frequently reaches nearly as far as the distal extremity of the ophthalmopod.

The first three pairs of pereopoda are chelate, gradually increasing in length, and each of them carries a basephysis.

The posterior two pairs are not longer than the preceding, are subequally slender, and terminate in simple dactyli.

The pleopoda are large and powerful, terminating in two foliaceous branches in every pair except the first, which in the male carries attached to the base a large membranous appendage that I call "petasma," which in the female is reduced to a small and rudimentary condition.

The rhipidura is large and powerful; the lateral plates are broad and foliaceous, and strengthened by a longitudinal ridge that traverses the external margin of the outer plate, and terminates in a sharp tooth.

The telson is tapering, and liable to variation in its length and armature.

Observations.—This description coincides with the first division of the genus according to M. Milne-Edwards, or with those in which the first pair of antennæ does not reach beyond the posterior margin of the carapace. As here limited the branchial arrangement differs from those species in which the flagella of the first pair of antennæ reach beyond the posterior margin of the carapace.

This genus was founded by Fabricius on the Mediterranean species, *Penæus caramotus*, which in external character is so closely allied to *Penæus canaliculatus* from Japan, described by so many naturalists, that I have accepted it as the type of my description.

Geographical Distribution.—This genus appears chiefly to inhabit the warmer seas. Species exist in the Atlantic and Pacific Oceans; in the former, ranging as far north as to be occasionally met with on the southern shores of Britain, and as far south as Brazil; in the latter, from Japan to the southern shores of New Zealand.

The Development of Penæus is only approximately known. Fritz Müller's statement¹ that the brephalos is a Nauplius has been fully accepted by some and cautiously received by others, and the recent researches of Professor Brooks on the genus *Leucifer* have strengthened the belief that the brephalos of *Penæus* may be in the Nauplius form also.

The observations made on the development of other forms of Macrurous Crustacea have shown that many closely associated species produce their young in very distinct stages of development. Thus the brephalos of *Crangon vulgaris* differs largely from that of *Crangon arcticus*, the former being in the Zoea, and the latter in the Megalopa stage, and that of *Homaralphæus* differs in the same degree from that of *Alphæus*, and yet the parents cannot be distinguished from each other.

Fritz Müller described a Nauplius which he found in the open sea, and supposed to be the young of *Penæus*.² It is destitute of distinct somites, pyriform in shape, rounded in front, 0·4 mm. in length, and 0·2 mm. in breadth at the widest part, which is just behind the head, and gradually narrowing posteriorly until at its caudal extremity the breadth is just one-fifth of the length of the animal, and it terminates on each side in one long and one short spine. In the centre of the anterior margin is a small, black, clearly defined ocellus. To the ventral surface are attached three pairs of appendages. The first is single-branched, furnished with a few simple hairs, and situated close to the frontal margin; the second is immediately behind the first, it is biramose, and has both its branches furnished with ciliated hairs. These two pairs of appendages are nearly as long as the animal, but the third pair is only half that length, and like the second it is biramose and furnished with ciliated hairs on each branch.

The animal at this stage is rather opaque and of a brownish colour, darkest towards the extremities of the appendages. It is by these little appendages that the young creature swims, lashing the water, as Fritz Müller says, like a man swimming perpendicularly with outstretched arms, and having slender willow branches in his hands.

In the next developmental stage the animal is 0·5 mm. in length. The colour and appendages are the same, but the posterior extremity of the animal is prolonged into two thick processes, at the apices of which there still exist the two long spines as in the previous stage; to these several less prominent ones have been added. The number of hairs attached to the anterior appendages has increased also. At this stage the first indication of the carapace is seen in the presence of a transverse line across the dorsal surface of the animal.

¹ Fritz Müller, Die Verwandlung der Garneelen, Erster Beitrag., pp. 8-23, Taf. xi., 1863; *Archiv f. Naturgesch.*, Jahrg. xxix. Bd. i. pp. 8-23, 1863; *Ann. and Mag. Nat. Hist.*, vol. xiv. p. 104, 1864.

² Fritz Müller, *loc. cit.*, p. 9, pl. xi. fig. 1.

After this stage the link is missing and the chain is again taken up when the young creature has doubled its previous length. Ten or eleven new somites are now found defined, with a pair of appendages attached to the first, the rudiments of others to the five succeeding, and with the posterior pair of pleopoda. It is now in the Zoea condition. From this period the animal can apparently be traced through the several forms that are figured in this Report to that of the adult condition.

On Pl. XLVIII. fig. 1 is that of a specimen taken and labelled "*Sergestes l.*, young, off New Guinea."

Length, 4 mm. (0.16 in.).

It was mounted and initialled by Suhm as if for especial reference. The rostrum exists as a small point, and the carapace covers the whole of the pereion. The pleon has the five anterior somites subequal and unarmed; the third somite is rather longer than the others, and dorsally slightly arched longitudinally; the sixth somite is nearly as long as the five preceding. The dorsal and ventral margins are parallel, and the telson is bifurcate, each branch terminating in two naked hairs or long spinules.

The ophthalmopoda are pyriform and well developed.

The first pair of antennæ has a peduncle of three joints, of which the first is longest, and broad at the base, but the otocyst is not yet visible, and the third supports two uniarticulate branches.

The second pair of antennæ has a peduncle that supports a scaphocerite, which increases slightly in breadth towards the distal extremity, where it is armed on the outer side with a small tooth, and fringed on the inner and distal margins with a row of fine hairs.

The mandibles are well formed but do not carry a synnhipod.

The two succeeding pairs of oral appendages are not definable in the mounted specimen, but the gnathopoda and the three following pairs of pereopoda are, the two posterior pairs being as yet in an immature or bud-like condition. The pleopoda are present in an early stage, in a budding condition, except the ultimate pair, which has increased so as to equal in length the bifurcate telson.

I now pass to the consideration of a series of observations made by Dr. v. Willemoes-Suhm on the development of what he held to be *Sergestes tenuis*, of which the earliest stage is shown in figure 43; but a comparison of the figure with those of Fritz Müller and Claus induces me to believe that Willemoes-Suhm is mistaken in attributing it to *Sergestes* instead of to *Penæus*. I give, however, his own notes with each figure.

"C. Mature zoea. Letters as before. Length 2 mm. North of New Guinea, and on the voyage along the Marianne Islands.

"All seen on the ventral surface. 55 × nat. size. H. $\frac{1}{7}$."

Claus, in his *Crustaceen System*,¹ pl. ii., gives three figures of what he states to be the *Zoea* of *Penæus*, the second figure representing only the pleon. The telson corresponds with that in Willemoes-Suhm's figure (fig. 43), which agrees in general

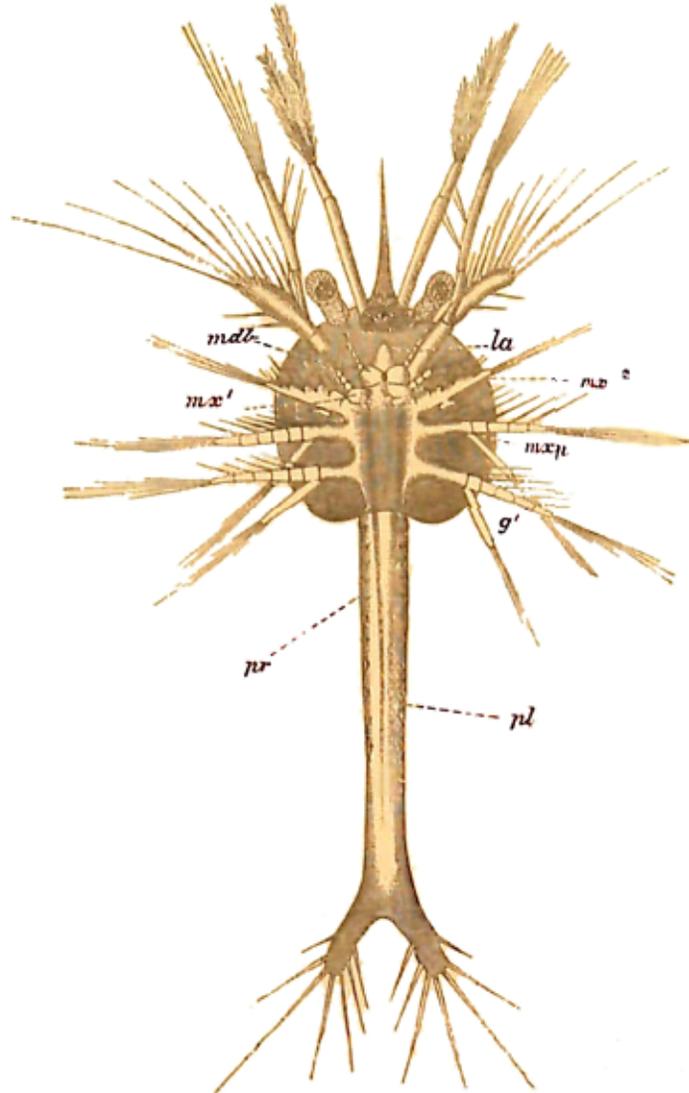


FIG. 43 (C).—Zoea of *Sergestes tenuis* (l). From a drawing by Dr. v. Willemoes-Suhm. *la*, Anterior lip; *mdb*, mandibles; *mx*¹, first maxilla; *mx*², second maxilla; *mxp*, maxilliped; *g*¹, first gnathopod; *tr*, telson; *pl*, pleon.

structure with Claus's fig. 1, excepting that Willemoes-Suhm's animal has pedunculated eyes and a frontal rostrum, whereas Claus's has the ophthalmopoda sessile, without any evidence of a rostrum, and as Claus says that his fig. 2 is the same as fig. 1, only larger, we must presume that it also has the ophthalmopoda in an undeveloped condition, whereas his fig. 3 shows the ophthalmopoda largely developed, and the posterior pair of pleopoda also in an advanced condition. There is, however,

¹ Untersuchungen zur Erforschung der genealogischen Grundlage des Crustaceen-Systems, 114 pp., 19 pls. Wien, 1876.

no frontal rostrum to the carapace. It would therefore appear that v. Willemoes-Suhm's figure corresponds with one later than fig. 2 and earlier than fig. 3 of Claus.

The next figure (D) in Suhm's series (fig. 44) is labelled :—

“Development of *Sergestes tenuis*. On the larva are developed tail appendages and



FIG. 44 (D).—Zoea of *Sergestes tenuis* (?). From a drawing by Dr. v. Willemoes-Suhm. *p*², three pairs of pereiopoda. Other lettering as before.

three pairs of pereiopoda. The outer antennæ have now three joints. The scale is likewise jointed and has long hairs upon the inner side.

“Drawn from life ; nat. size, 2 mm.

“Pacific Ocean. Lat. 18°.”

The animal has not increased in length. The carapace seen vertically is less circular than in fig. 43, and is furnished with a rostrum as long as the carapace. The ocellus is still present and the ophthalmopoda are longer and more club-shaped. The first pair of antennæ is three-jointed, and the second has a multiarticulate scaphocerite. The oral appendages and gnathopoda appear to be in the same relative stages as in the previous specimen, but the pereion has three pairs of appendages existing in a biramose saccular condition. The two following somites are developed, but exhibit no appearance of future appendages.

The pleon has the postero-lateral angles of each somite developed into long spines, but only the posterior possesses a pair of appendages, and these are biramose and in a saccular condition.

The telson exists as in the previous figure and corresponds with that of Claus's specimen, but the animal differs from the most advanced stage of the latter author in having a long rostrum to the carapace, and in having only three pairs of incipient pereiopoda instead of five. Claus's animal, moreover, has the postero-lateral spines attached only to the fifth somite, whereas Suhm's species has them attached to each somite of the pleon.

The next figure (fig. 45) (E) in the series is still more advanced, as shown by the following notes of the author:—

"E. The caudal appendages are further advanced, and five pairs of pereiopoda have become visible. The carapace has on each side in front one large spine.

"The eyes are large.

"The inner antennæ four-jointed.

"According to the specimen the increase is just 2.3 mm.

"Pacific Ocean. 18° lat.

"Carapace,	0.8 mm.
Pleon,	1.2 "
Rostrum,	0.3 "
Diameter of carapace,	0.56 "
Length of ophthalmopoda,	0.35 "
Width of ophthalmopoda,	0.17 " "

In this figure the carapace is seen to have thrown out a long spine or tooth on each side at the fronto-lateral angle, and the rostrum still retains its great length.

The ocellus still continues visible, and the ophthalmopoda are longer and more clavate.

The first pair of antennæ is four-jointed, the first joint being much the longest; the second and third are short and subequal, while the fourth, which represents the future flagellum, is slightly longer than the third and tipped with three or four hairs.

The second pair of antennæ has the basal joint long and robust, the scaphocerite has lost the multiarticulate character shown in figs. 43 and 44, and has become single-

jointed; it is also figured as possessing the unusual feature of being furnished with hairs both on the inner and outer margins. The other branch is two-jointed, the first joint probably representing the terminal joints of the peduncle; the second, that of the flagellum, is tipped with four or five long hairs.

The oral appendages and gnathopoda bear the same characteristic features as are shown in the preceding figure.



FIG. 45 (E).—Zoea of *Sergestes tenuis*. From a drawing by Dr. v. Willemoes-Suhm; p^5 , five pairs of pereiopoda.

The pereiopoda have now increased to five biramous pairs, of which the first is the largest and the last the smallest.

Each somite of the pleon is armed at the postero-lateral angles with a long spine. One somite more than is normal has erroneously been figured.

None of the pleopoda are represented, even in an incipient condition, excepting the posterior pair, which is short, biramose, and furnished with a few short hairs.

This specimen was taken in the same locality as the last, and is larger by three-tenths of a millimetre.

On Pls. XLVI. (fig. 1), XLVII. (figs. 1, 2, 3), and XLVIII. (figs. 1, 2, 3, 4), are several illustrations of what I believe to be the young of one or more species of *Penæus*, or of some closely allied genus.

Although I have not had the opportunity of tracing the continuous development in the life history of the animal, I feel assured that these are the young of this or some closely allied genus. This also is the opinion of Claus concerning his younger specimens, and I believe that the three figures given from Dr. v. Willemoes-Suhm's drawings are those of the same, and not of *Sergestes* as labelled by him. Assuming this, we have a probable series in very close connection, from the earliest forms given by Claus, which correspond with the later series of figures given by Fritz Müller, to that of the adult as shown in some of the younger specimens illustrated in this Report.

Claus, in his Crustacean System, has on pl. ii. given figures of the *Zoea* of *Penæus*. The first (fig. 1) is a stage earlier than the youngest given by Suhm. The third (fig. 3) corresponds with the third, or E, of Suhm. They differ in having no frontal rostrum, and in not having any spines attached to the lateral margins of the somites of the pleon as in the first and second stages, in having the ophthalmopoda undeveloped, and in having one lateral tooth on each side of the fifth somite of the pleon.

On Pl. XLVIII. (fig. 2) of this report, there is given an illustration of an animal that I consider to be the young of *Penæus* at the same stage of development as in the last of the drawings of Suhm (fig. 45) (E). It is represented as showing the dorsal surface, and therefore exhibits such features as the central spines on the somites of the pleon, and the two frontal spines which are here shown as being on the dorso-frontal surface of the carapace rather than on the margin.

Length, 3 mm. (0·12 in.).

Habitat.—Taken on the 3rd of April 1875, in the Pacific, south of Japan, between Stations 229 and 230.

Rostrum as long as the carapace. Pereion developed posteriorly to the carapace, and equal to it in length. Pleon about as long as the carapace and pereion combined. Carapace armed with two long teeth, one on each side posterior to the first antennæ, and none upon the margin.

The somites of the pereion are short, smooth, subequal, and unarmed.

Pleon dorsally armed with a sharp central tooth on the posterior margin of each

somite, of which those on the second and sixth somites are the longest. Each of the six somites is also armed on each side with a strong tooth, of which the anterior is the smallest, and the others gradually increase in length until the posterior, which is armed with two longer ones on each side.

The telson is broadly bifurcate and armed with six spine-like hairs on each ramus.

The ocellus is still visible.

The ophthalmopoda are club-shaped and well developed.

The first pair of antennæ appears to be three-jointed, and represents only the peduncle, it is narrow, cylindrical, and has the apex tipped with a few hairs.

The second pair of antennæ carries a long and well-formed scaphocerite, furnished on the outer margin with a row of short hairs, as shown in Suhm's drawing (E) (fig 45), and on the inner and distal margins with a series of longer ones.

The mandible is not furnished with a synhipod, and the two succeeding pairs of oral appendages are not distinguishable.

The first maxillipede or third pair of siagnopoda (fig. 2, *g*) is single-branched, the posterior margin being even and unarmed, and the anterior divided into numerous lobes (six or eight), each of which supports a series of short stiff hairs, radiating perpendicularly to the surface of each lobe.

The two pairs of gnathopoda (fig. 2, *h*) are biramose and fringed with a series of delicate hairs.

The pereopoda (fig. 2, *m*) are in an early stage of development, the anterior being the most advanced; they are biramose and tipped with a few delicate hairs.

The pleopoda are not developed, nor is the germ of one visible until we come to the sixth pair, which is formed to the extent that it reaches halfway down the telson, and is biramose, saccular, and as yet unfringed with hairs.

From the same locality is another specimen, about 2.5 mm. in length, from which the drawings of the maxillipede (fig. 2, *g*), the first gnathopod (fig. 2, *h*), and third pereopod (fig. 2, *m*), on Pl. XLVIII. were taken. The pereopoda are not so far advanced, and none of the pleopoda, not even the posterior pair, are distinguishable.

These two specimens are mounted on one slide, and labelled by Willemoes-Suhm, and I should have supposed it probable that his figure (E) was taken from the specimen showing the ventral surface, had he not stated that it was drawn from a specimen taken in lat. 18° N., whereas these must have been, from the date on the slide, taken in lat. 25° N.

On Pl. XLVII. (fig. 3) is a specimen possessing all the features characteristic of the genus *Aristeus*, as far as can be judged by external form only.

This was taken at Sydney, Wellington.

Length, about 6 mm. (0.25 in.).

It has the rostrum long, strong, and pointed, and armed at the base of the dorsal

surface with four strong teeth, one being posterior to the frontal margin. The carapace is produced to an angle at the infero-frontal margin and projects posteriorly beyond the pereion. The third somite of the pleon is armed on the dorsal surface with a large tooth a little in advance of the posterior margin; the fourth, fifth, and sixth are armed with similar teeth on the posterior margin, of which the one on the fourth somite is smaller than that on the third or fifth, whereas that on the sixth is larger. The telson is nearly as long as the sixth somite, which is equal in length to the four preceding somites.

The ophthalmopoda are large and pyriform. The first pair of antennæ has a three-jointed peduncle supporting two short terminal rami, of which one is biarticulate and the other uniarticulate; both are tipped with fine hairs, and at their base there is the bud of some undeveloped organ (fig. 3, *b*).

The second pair of antennæ carries a well-developed scaphocerite that is armed on the outer distal extremity with a strong tooth, and fringed on the inner margin with hairs. The flagellum is immature, being not quite so long as the scaphocerite.

The mandibles (fig. 3, *d*) are well-developed but carry no synhipod.

The two pairs of gnathopoda are small and rather feeble.

The three anterior pairs of pereopoda (fig. 3, *k*) are chelate, increase in length posteriorly, and each carries a long baseophysis. The fourth and fifth pairs are simple, seven-jointed, and carry a long baseophysis.

None of the pleopoda are as yet visible, excepting the sixth pair, and they are well developed and as long as the telson, which is long, slender, and forked at the extremity.

A specimen in a similar stage to that shown in fig. 3 was taken off Samboangan on October 27, 1874. It differs from that on the Plate in having the rostrum furnished with three teeth instead of four, in having the anterior extremity depressed instead of horizontal; instead of being rounded and smooth, the lateral margins of the pleonic somites are pointed and fringed with small sharp points. The pleopoda are in an incipient condition.

Fig. 2 on Pl. XLVII. represents a rather smaller specimen than fig. 3. It seems, however, to be further advanced in the development of the pleopoda, which are present in the form of small bud-like processes, but it is less advanced in relation to the pereopoda. It is most probably the young of another species, inasmuch as it was taken in the Atlantic Ocean, off the coast of Africa, on the 10th of April 1876.

The rostrum, which is about as long as the carapace, is armed at the base of the dorsal surface, anterior to the frontal margin of the carapace, with a strong tooth.

The second somite of the pleon is armed with a long and strong tooth, projecting posteriorly, equal in length to the two succeeding somites, which are armed with a small sharp point at the posterior margin, as is also the fifth and sixth, of which four the posterior is the largest.

The telson is nearly as long as the sixth somite (fig. 2*v*), and is forked at the extremity.

The appendages correspond in character with those of fig. 3, excepting that the

pereiopoda are scarcely so far advanced, and the animal as a whole does not appear so mature in form, although the pleopoda are more advanced.

This specimen, together with one taken on the 20th of April, 1876, corresponds very closely with that shown on Pl. XLVI. fig. 1, which differs in having a small cusp behind the one on the dorsal base of the rostrum, in having the pleopoda more advanced in development, and in having the lateral plates of the rhipidura longer than the telson.

The following is the description of another specimen (fig. 46) taken at the surface on February 5, 1875, near Mindanao, Samboangan, Philippines, associated with *Leucifer*, and with the young of *Alphæus* and *Penæus*.

Length, 6 mm. (0.25 in.).

Carapace one-third the length of the animal, produced anteriorly to a smooth rostrum, nearly as long as the carapace, and flanked on each side of the base with a strong ophthalmic tooth; dorsally furnished on the postgastric region with a small tubercle (or the remains of a broken tooth), and armed on each side of the median line of the

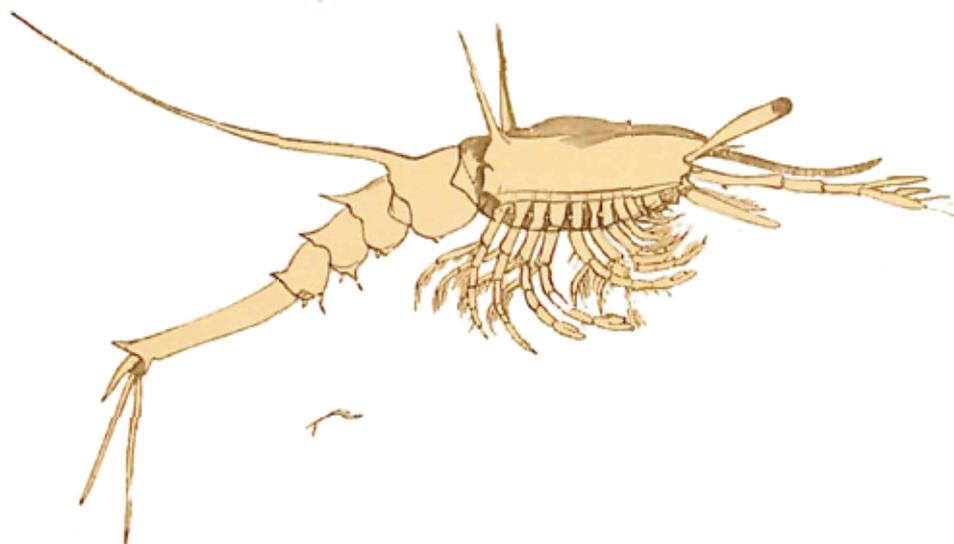


FIG. 46.—Young of a species of *Aristeus* (?).

posterior margin with a long, straight, spine-like tooth; the lateral margin consists of a rigid, longitudinal border, commencing in the outer antennal tooth, and terminating posteriorly in two small marginal points or teeth.

The first somite of the pleon is dorsally smooth, furnished laterally with a pleocleis or small tooth that is directed anteriorly, and overlies the posterior margin of the carapace. The second somite is dorsally armed near the posterior margin with a strong tooth that is more than half the length of the animal.

The third somite is also furnished with a dorsal tooth, short and strong, the two next with a tooth still shorter, and the infero-lateral margin is produced to a long tooth. The sixth somite is nearly equal in length to the three preceding, subcylindrical, and armed posteriorly with a dorsal tooth and one on each side at the postero-lateral angle. The telson is short and posteriorly produced at each angle to a small tooth.

The ophthalmopod is long, subcylindrical, and has the ophthalmus scarcely larger than the peduncle.

The first pair of antennæ has the peduncle as long as the rostrum, and carries two small subcylindrical flagella.

The second pair is biramose, the scaphocerite being longer but not broader than the incipient flagellum. The oral appendages have not been determined, but the pereopoda are subequally developed; each of the three anterior pairs has an incipient chela, while the last two are simple, and each pereopod, like the gnathopoda, carries a long, well-developed basephysis.

The pleopoda are all in an incipient condition, except the posterior pair, which forms the outer plates of the rhipidura, and these are long, slender, and cylindrical.

Another specimen very similar in form was taken in the Pacific on the 17th of July 1875, at Station 254; lat. $35^{\circ} 13' N.$, long. $154^{\circ} 43' W.$

The form represented on Pl. XLVII. fig. 1, was taken in the North Atlantic, April 29, 1876.

Its length is about 10 mm. (0.4 in.), and yet in some features it appears to belong to a younger stage than either of the preceding, as will be seen by the following description:—

The rostrum is as long as the carapace and is studded throughout its whole length with small tooth-like points, and flanked on each side at the base, just over the antennal region and within the frontal margin, with a long and strong tooth. The fronto-lateral angle of the carapace is also produced to a strong spine-like tooth, and the lateral walls are produced posteriorly beyond the pereion. The pleon has each somite dorsally armed with a strong tooth, of which that on the second somite is much the largest, and is studded with small denticles similar to those on the rostrum; the others are sharp-pointed and smooth, that on the sixth somite being longer than any, except that on the second.

The telson is long and slender, dorsally flat, forked at the extremity, and furnished on each side with a small denticle.

The ophthalmopoda are well developed and pear-shaped.

The first pair of antennæ has a three-jointed peduncle, and supports two long and slender flagella that reach a little beyond the extremity of the rostrum.

The second pair of antennæ carries a broad and well-developed scaphocerite, and a long and slender flagellum that equals in length two-thirds of the animal, or twice that of the rostrum.

The two pairs of gnathopoda are developed as simple pediform appendages, and the first three pairs of pereopoda (fig. 1 k) are immaturesly chelate, the dactylos being produced more in the character of an immature joint, rounded and blunt at the apex: the pollex

exists as an obtuse process of the propodos, the two lying in juxtaposition, without having the characteristic movement of a chela, and the basecephysis is longer than the limb.

The posterior two pairs of pereopoda are simple, having the seven joints visible, and support a short basecephysis.

The first pair of pleopoda is in a bud-like condition, but the four following pairs are long, slender and biramose, the branches being membranous, flexile, and free from hairs.

The posterior pair of pleopoda is well developed, armed on the outer margin near the distal extremity with a small tooth, and fringed on the inner with small hairs; it reaches beyond the extremity of the telson.

Pl. XLVIII. fig. 3, represents the rhipidura of a specimen taken in the Western Pacific.

Length, 10 mm. (0.4 in.).

This form differs from the others in having the rostrum, which is as long as the carapace, serrate towards the extremity, and it has no tooth on the dorsal crest. The pleon is armed with a strong tooth, projecting posteriorly from the third somite, all the other somites being smooth. The telson is long, with parallel sides, and becomes suddenly acuminate distally; it is fringed on the distal margin with four hairs on each side of the central point, and each lateral margin is furnished with two small points or teeth. The lateral branches of the rhipidura are scarcely as long as the telson.

The branchiæ (fig. 3br) are well developed. The three anterior pairs of pereopoda possess well-formed chelæ, but shorter than the basecephysis. The posterior two pairs are simple, but short and support a long basecephysis. The pleopoda are moderately developed and well formed, and the whole animal is characteristic of a true *Penæus*, and probably becomes mature in the next stage.

Pl. XLVIII. fig. 4, represents what appears to be a mature but young form of some such species as *Penæus monodon*, or, judging from the unequal length of the two flagella of the first pair of antennæ, of *Hemipenæus tomentosus*.

Its length is 6 mm. It was taken in the surf off Samboangan.

Tracing the above series of young animals from Fritz Müller's and Claus's earlier Protozoæa stage, we find that each successive form corresponds with a higher stage of development. In one or two instances, where there has been a deviation in relative size compared with the degree of development, it may be assumed that the young of larger species attain greater dimensions in their successive stages than those of smaller species. Thus it appears that we may accept the history of the progressive development of the young in a family as corresponding with that of a single genus, and if so it may be accepted as being parallel with the development of a single species.

Two links of importance are yet wanting: the one is that which connects the earliest Protozoæa form with Fritz Müller's Nauplius, and the other that which connects the

Nauplius with *Penæus*; either of these being demonstrated will prove the connection, and establish the splendid hypothesis of Fritz Müller.

The recent discovery of Professor Brooks that the brephalos of *Leucifer* is a Nauplius, brings the supposition in relation to *Penæus* within the range of probability. But as the youngest form of *Sergestes* that has been observed is believed to be an *Elaphocaris*, and this so early that the yolk-cells were still visible, and as *Sergestes* is nearer in family relationship to *Penæus* than to *Leucifer*, I think it is advisable still to wait before asserting that the young of *Penæus* is a Nauplius.

Professor Brooks states¹ that having captured and kept in confinement a specimen, he witnessed every moult between the youngest Protozoa and the young *Penæus*, and that consequently all the metamorphoses of *Penæus* have been observed, and there is no longer any ground for the attitude which certain over-cautious naturalists have assumed in refusing to accept Fritz Müller's conclusions until more complete proof should be furnished.

Mr. Walter Faxon of Cambridge, Mass.,² in commenting on Professor Brooks' researches, says that the latter "has proved the connection between the stages older than the Nauplius. That the Nauplius belongs to the same series he has not shown. In fact, his youngest Protozoa is an older stage than the youngest stage secured by Fritz Müller. He has riveted the links in Müller's chain that were closely joined before, but has not touched the weak spot." Mr. Faxon further remarks that "The larval stages of Penæidæ seem to be not uncommon in the warm seas. Besides the published figures of Müller and Claus, I have seen the drawings of the developmental stages, from the Protozoa onwards, made by Mr. Alexander Agassiz at the Tortugas Islands, in 1881, and by Mr. J. W. Fewkes at the Bermudas in 1882. No observer has rediscovered Müller's Nauplius; yet in the light of our knowledge of the development of *Mysis*, *Euphausia* and *Leucifer*, I see no good ground for refusing to accept Müller's reason for believing his Nauplius and Zoea stages to be parts of one life-history."

Penæus canaliculatus, Olivier (Pl. XXXII. figs. 1, 2).

Penæus canaliculatus, Olivier, *Encycl. Méthod.*, vol. viii. p. 660.

" " Milne-Edwards, *Hist. Nat. Crust.*, tom. ii. p. 414.

" " Sp. B., *Ann. and Mag. Nat. Hist.*, ser. 5, vol. viii. p. 174, pl. xi., 1881.

Rostrum slightly arched, furnished on the upper surface with nine teeth, the posterior of which stands on the gastric region a little unequally distant from the preceding, and one tooth on the lower margin, immediately below the most anterior of those on the upper. Dorsal carina gradually lessening to near the posterior margin, channelled in

¹ *Johns Hopkins University Circular*, vol. ii., No. 19, p. 6, 1882.

² *General Notes, Zoology U.S., Mass.*, May 1883.

the median line posterior to the last tooth, and also channelled on each side, commencing at the apex of the rostrum and terminating abruptly within the posterior margin of the carapace. Pleon having the last three somites compressed and dorsally carinated, but not elevated to a tooth posteriorly. Telson acuminate and fringed with hairs at the sides. Dorsal median line longitudinally channelled to the apex.

Length, 76 mm. (3 in.) (male and female).

Habitat.—Fiji Islands.

Observations.—The specimens in the Challenger collection correspond in every detail with that described by Milne-Edwards from the Mauritius, except that the largest specimens of both males and females are only 76 mm. in length, whereas those taken at the Mauritius, and with which we have compared our specimen, were 125 mm.

Professor Milne-Edwards says that it is very like *Penæus caramote*, from which it differs in having the dorsal crest less elevated towards the base of the rostrum, and in having no tooth on the basis of the third pair of pereiopoda, and also in having none on the lateral margins of the telson. It has been frequently described by various authors, but I think that Stimpson¹ is justified in attaching "vix de-Haanii," to a specimen he records from Loo Choo.

This species differs from *Penæus caramote* in having the longitudinal ridges running parallel from near the frontal margin to the posterior extremity of the dorsal carina, whereas in *Penæus caramote* they are decidedly waved. *Penæus caramote* is also described as having twelve teeth on the dorsal crest, whereas *Penæus canaliculatus* has only nine, and the posterior is distant from the others and implanted over the gastric region. In *Penæus caramote* the stylocerite reaches to the extremity of the eye, whereas in *Penæus canaliculatus* it does not extend more than half the length.

The ventral plate or thelycum² in the female also differs to a certain degree: in this species it consists of two plates that meet in the central line at the posterior extremity, and gradually opens anteriorly over a projecting floor, thus forming a cavity or hollow space, whereas in *Penæus caramote* the two plates do not meet in the central line. There is also a tooth on the basal joint of the third pair of pereiopoda in *Penæus caramote*, but none in the same position in *Penæus canaliculatus*. *Penæus caramote* has, moreover, two teeth on each side of the telson, whereas in *Penæus canaliculatus* there is none.

The coxæ of the pereiopoda on each side are not very distinct, and the fifth pair is furnished with a foramen for the passage of the vas deferens. The anterior pair of pleopoda is single-branched; attached to the basal joint is a pair of membranous plates or curtain-like organs, the petasma, which are connected in the median line by a series of small hooks or cincinnuli (Pl. XXXII. fig. 1" ♂). These two foliaceous plates are folded

¹ Prodrômus description. anim. evertéb., *Proc. Acad. Nat. Sci. Philad.*, 1866, p. 113.

² From *θηλυκόν*, peculiar to the female.

longitudinally, and project anteriorly so that their extremity reaches as far forwards as the base of the penultimate pair of pereopoda.

In the male specimen from Fiji the petasma corresponds precisely with that of the male taken at the Mauritius, and now in the Museum of the Jardín des Plantes.

Penæus canaliculatus, var. *japonicus* (Pls. XXXI., XXXII. fig. 4, XXXVII. fig. 2).

Penæus canaliculatus, de Haan, Crust. in v. Siebold, Fauna Japonica, p. 190.

This variety differs from Milne-Edwards's typical specimen and description of *Penæus canaliculatus* in having the telson terminating more acutely, and in having three small spines on each lateral margin, but more especially in the peculiar formation of the complementary external female apparatus which I propose to call thelycum.

Length (female), 175 mm. (7 in.). There is no male of this variety in the collection.

Habitat.—Japan.

The carapace has a central, narrow, longitudinal groove extending from the posterior extremity of the rostral carina to near the posterior margin of the carapace, and on each side another that extends from the anterior extremity of the rostrum to the posterior margin of the carapace. The rostrum is about half the length of the carapace, the dorsal crest, reaching posteriorly to nearly the middle of the carapace, is armed with nine teeth interspersed with fine hairs, and with one tooth on the under surface, situated immediately beneath the anterior rostral tooth. The two posterior somites of the pleon are laterally compressed, forming an acute dorsal angle that is produced to a small tooth at the posterior extremity of the sixth somite. The telson is centrally grooved with a longitudinal furrow that reaches from the anterior margin to the posterior extremity, and is armed with three small spines on the lateral margin.

The eyes (Pl. XXXI. *a*) are large and ovate, with the inner side flattened and the outer rounded, projecting on a biarticulate peduncle, and reaching as far anteriorly as the tooth on the inferior margin of the rostrum.

The first pair of antennæ (*b*) has the peduncle reaching as far as the apex of the rostrum; the first joint is long, wide, and scale-like; the inner margin is longitudinally straight, deepest posteriorly, where it is furnished on the inner side, near the base, with a long slender prosartema copiously fringed with hairs, and thinning anteriorly; on the outer side it is armed at the extremity with a sharp-pointed tooth, and a stylocerite lying closely against the side and directed forwards (not shown in the figure); the upper margin is longitudinally curved, and fringed with a linear row of delicate cilia, the lower is nearly straight; the outer and inner margins of the joint are subparallel, slightly approximating at their anterior extremity; the surface between the two lateral margins is deeply excavate, especially towards the base, where the auditory apparatus

lies; in this hollow the ophthalmopod rests, protected on the inner side from contact with its fellow by the thick and bushy prosartema, and on the outer by the thickly-set fringe of hairs on the margin of the joint: the second joint is short, about one-third the length of the first, longitudinally arched above and curved below; fringed on the inner and outer sides with short, thickly-packed hairs: the third or terminal joint is very short, scarcely half the length of the second, and terminates in two short, subequal, multiarticulate flagella, which are only about twice as long as the third or terminal joint of the peduncle.

The second pair of antennæ (*c*) has a very short peduncle, and all the joints articulating; the first joint is short, and on the inner side, just in front of and immediately before the mouth, it carries a phymacerite in the form of a small, circular, membranous plate; the next two joints, closely compressed together, are short and thick, and carry at their upper extremity a large scaphocerite, of which the outer margin is rigid, long, and terminating in a sharp point; the inner side is foliaceous, broad at the base, slightly tapering and rounded at the extremity, and reaches beyond the external point; the whole plate is of extreme tenuity and is longitudinally and obliquely ribbed, the lines increasing in number suddenly as they approach the margin, where they appear in connection with the several hairs of the fringe. The terminal joints of the peduncle are short, of small diameter, and are lodged on the under surface of the scaphocerite. The terminal flagellum is slender, flexible, and rather longer than the animal.

The mandible (*d*) is short and broad, having a large molar tubercle and a large, squamous, biarticulate synsaphipod.

The first pair of siagnopoda (*e*) is three-jointed, two of the joints being foliaceous, and terminally fringed with spines, whereas the third is biarticulate, cylindrical, and continuously tapering.

The second pair (*f*) consists of three joints, of which the first two are biramose and foliaceous, and the third cylindrical and irregularly truncate; externally there is a broad, flat, mastigobranchial plate, anteriorly and posteriorly produced, and fringed with cilia.

The third pair of siagnopda (*g*) consists of five or six joints, of which the first two are biramose and foliaceous, increasing in size as they proceed distally; the third and following joints are cylindrical and gradually taper to the extremity. Attached to the second joint or basis is a large squamiform plate (basecephysis) projecting considerably forwards, and fringed with cilia, while attached to the first joint or coxa is another squamous plate that is broader than the preceding, projects backwards, and is fringed with fine and soft cilia.

The first pair of gnathopoda (*h*) is subpediform, having the meros long, broad and marginate: the propodos is reflexed, and, like the dactylos, which is spatuliform, is fringed with a mat of hairs and rests against the inner margin of the meros: the basis carries a long two-jointed ephysis, the first joint of which is short, and the second long, multi-