

LIII.—*On the Classification of the Thalassinidea.* By L. A. BORRADAILE, M.A., Lecturer in Natural Sciences at Selwyn College, Cambridge.

WITH the one exception of the Penæidea, there is now no tribe of Decapod Crustaceans whose systematy is so uncertain as that of the Thalassinidea. This is in part owing to the lack of any monograph or revision of the group; but there can, unfortunately, be no doubt that it is also partly due to the Report on the 'Challenger' Macrura, which in many places parts company both with the facts and with the statements of other writers (as Boas, Claus, Ortmann, and Alcock), and is not to be relied upon, either in the text or in the figures, for information as to gill-formulæ, antennal spines, or even the shape of the legs, on all which points it has misled and puzzled later writers. In the following attempt to lay the groundwork of a better knowledge of this group—a detailed revision of which would need more material than I had before me—the facts have been gotten by an examination of the specimens in the British and Cambridge Museums and from the works of sundry writers, chiefly those mentioned above\*. For allowing me to examine the collections under his charge, and for his hospitality at the British Museum while I was doing so, my best thanks are due to Prof. F. Jeffrey Bell. I am also under great obligation to Dr. W. T. Calman for kindly examining several specimens for me.

I have not attempted a full list of references of the species or a detailed account of their distribution †, and in many

\* BOAS, J. V. "Studien over Dekapoderms Slægtskabsforhold," Kong. Danske Vidensk. Selskab. Skrifter, vi. i. (1880).

CLAUS, C. 'Neue Beiträge zur Morphologie der Crustaceen,' Wien, 1885 (Arb. Zool. Inst. Wien, vi.).

ORTMANN, A. E. "Die Decapoden-Krebse des Strassburger Museums," iii. Theil, Zool. Jahrb. vi. Syst. i. (1891).

———. Art. "Crustacea" in Bronn's 'Thierreich,' v. ii. (1901).

ALCOCK, A. 'Descriptive Catalogue of the Indian Deep-sea Crustacea Decapoda Macrura . . .' Calcutta, 1901.

† The letters which are placed after the names of species in the lists given in this paper show very roughly their distribution, as follows:—

- A. North Atlantic, to the Mediterranean and Cape Hatteras.
- B. Mediterranean.
- C. West Africa.
- D. South Atlantic, including South Africa.
- E. East America, from Cape Hatteras to the River Plate.
- F. Southern Australia, with Tasmania and New Zealand.

cases the information available has not been enough to enable me to place them satisfactorily. It follows, of course, that the diagnoses of the genera can only be approximately correct, and are liable to be altered in detail by the inclusion of other species. No doubt the discovery of new species will have the same result. The chief character on which our knowledge of the recorded forms is defective is the gill-formulæ, and, while the systematic value of these has been somewhat overrated, there can be no doubt that it is considerable and that they afford useful guidance in the more primitive family Axiidæ. In the Callianassidæ, on the other hand, and particularly in the Upogebiinæ, they will, I think, be found to give less help, since they are here more constant.

The Thalassinidea are a group of tailed Decapods which recall the hermit-crabs in some respects and the lobsters and crawfish in others. They are like the Nephropsidea in the shape of the tail-fin and of the first and often also the second leg. They differ from them in never having the third leg chelate, often in a reduction of the number of their gills, and in a tendency of their abdomen to become soft and lose its pleura. This is to be connected with their mode of life, which is in most cases a burrowing one. Herein they show the same habit of concealment as the Paguridea, to which they are also akin in the other points of difference from the Nephropsidea already mentioned, in the thorn-like shape of the antennal scale in such of them as have it well developed, in the freedom of the last thoracic sternite, and in their peculiar way of carrying the last pair of legs rather apart from and above the rest. They differ from the hermit-crabs in the fact that these legs are nevertheless shaped much like the rest, that their second pair of legs are usually chelate, and that their abdomen is symmetrical with a broad tail-fin. A remarkable feature, which recalls the prawns, is the presence in most of them of an *appendix interna* on the abdominal limbs. They may be divided into four families—Axiidæ, Laomediidæ, Thalassinidæ, and Callianassidæ. The characters and subdivisions of these are set forth below, and will be found summed up in key form on p. 549.

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G. West America, below California.

H. North Pacific to California and Vladivostock.

I. Indo-Pacific.

Of these divisions, A, B, and H together make up Ortmann's Arctic region, while D and F are his Antarctic region. The deep- and shallow-water forms are arranged by the same set of regions.

## Family Axiidæ, Bate, 1888.

Definition: "Thalassinidea with a *rostrum* of good size; without the groove or crack which runs lengthwise on each side of the cephalothoracic carapace in the other families of the group, and is known as the *linea thalassinica*; with the antennular flagella of a good length, the antennal scale present\* as a movable thorn-like structure between the second and third joints of the antennal stalk, and an immovable thorn outside the scale on the second joint; the first pair of legs chelate, large, unequal, the second pair ending in small equal chelæ, the third to fifth pairs simple, the fifth sometimes tending to be subchelate; no gill on the first maxilliped, mastigobranchs on legs 1-4, podobranchs on legs 1-3 †, pleurobranchs present or not; the gills trichobranch, with narrow filaments; the *pleura* of the abdominal segments well or moderately well developed; the abdominal limbs 1-5 with *appendix interna*, their branches narrow or fairly broad, and the last pair of limbs with the endopodite unjointed and the exopodite jointed or not."

Genera: *Axius*, *Axiopsis*, *Calocaris*, *Scytoleptus*.

## Genus AXIUS, Leach, 1815.

Definition: "Axiidæ in which the body is more or less compressed from side to side in front of the cervical groove, so that the back in this region shows a platform, which may be either flat or convex, and is often marked at its edges and along the middle line by ridges, though these do not, as in *Scytoleptus*, end short of the *rostrum* in strong teeth, but are continued on to it, and that at about the same level and without a steep fall; with or without pleurobranchs, and with no suture on the exopodite of the last limb."

The genus *Axius*, as thus defined, contains all the Axiidæ whose last limb has no suture, with the exception of *Scytoleptus*. Various groups of its species have from time to time been regarded as worthy of independent rank, and these, with another group of the same value, are kept as subgenera in the present scheme. This course has been taken because, on the one hand, there are undoubtedly considerable differences between any two of them, and, on the other hand, they are so connected with one another that it is as yet impossible to devise any satisfactory way of separating them into full genera. A number of characters seem to be of real morphological importance, as showing a primitive condition, and

\* Perhaps not in *Scytoleptus*.

† *Axius acanthus* has a podobranch on the fourth leg.

have been used in the definitions below; but the evidence of each of these as to the relationships of the subgenera contradicts that of the rest, and there are none of those special features which are so useful in separating groups of species in other cases. Sooner or later, however, a considerable rearrangement is likely to be necessary.

Subgenera: *Axius*, *Neaxius*, *Iconaxiopsis*, *Eiconaxius*, *Paraxius*.

Subgenus AXIUS, Leach, 1815.

Definition: "Species of *Axius* with the flat area of the back and the cervical groove well marked, the eyes well pigmented, the antennal thorns both of a good size, pleurobranches on the second to fifth legs, vestiges of a podobranch and an arthrobranch on the second maxilliped, and a shallow-water habitat."

Species:

Type. *A. stirhynchus*, Leach, 1815. Tr. Linn. Soc. xi. A.

Subgenus NEAXIUS, n.

Definition: "Species of *Axius* with the flat area of the back and the cervical groove well marked, the eyes well pigmented, the antennal thorns both of a good size, no pleurobranches, vestiges of gills sometimes present on the second maxillipeds\*, and a shallow-water habitat."

Species:

Type. *A. acanthus*, A. M.-Edw., 1879. Bull. Soc. Philom. [= *A. taliliensis* (Borradaile), 1900]. I.

*A. plectorhynchus*, Strahl, 1862. Mon.-Ber. Ak. Berlin, 1861. I.

? *A. glyptocercus*, Martens, 1869. " " " 1868. I.

? *A. Gundlachi* (Martens), 1872. Arch. Naturges. xxxviii. i. E.

Subgenus ICONAXIOPSIS, Alc., 1901.

Definition: "Species of *Axius* with the flat area of the back and the cervical groove indistinct, the eyes almost or quite without pigment, the antennal thorns both of a good size, pleurobranches on the second to fourth legs, vestigial gills on the second maxilliped, and a deep-water habitat."

Species:

Type. *A. laccadivensis*, Alc., 1894. J. As. Soc. Bengal, lxiii. I.

*A. andamanensis* (Alc.), 1901. Ind. Deep-sea Macrura and Anomala. I.

? *A. farræ* (Ortm.), 1891. Zool. Jahrb. vi. Syst. i. I.

Subgenus EICONAXIUS, Bate, 1888.

Definition: "Species of *Axius* with the flat area of the

\* *A. plectorhynchus*, specimens in Brit. Mus.; not *A. acanthus*.

back and the cervical groove more or less indistinct, the eyes pale, the antennal thorns both of a good size, pleurobranches on the second to fourth legs, no vestiges of gills on the second maxillipeds \*, and a deep-water habitat."

Species :

- Type. *A. acutifrons* (Bate), 1888. 'Challenger' Macrura. I.  
*A. kermadeci* (Bate), 1888. 'Challenger' Macrura. I.  
*A. parvus* (Bate), 1888. " " I.  
 ? *A. crista-galli*, Fax., 1893. Bull. Mus. Harvard, xxiv. G.

Subgenus PARAXIUS, Bate, 1888.

Definition: "Species of *Axius* with the flat area of the back and the cervical groove not sharply marked, the eyes pale, the antennal thorns both very small, no pleurobranches, no gills on the second maxilliped, and a deep-water habitat."

Species :

- Type. *A. altus* (Bate), 1888. 'Challenger' Macrura. I.

Lack of information makes it impossible to place the following species :—

- A. serratus*, Stimps., 1852. Proc. Boston Soc. Nat. Hist. iv. A.  
*A. armatus*, S. I. Smith, 1880. P. U.S. Nat. Mus. iii. A.  
*A. spinulicauda*, Rathb., 1902. P. U.S. Nat. Mus. xxiv. H.  
*A. elegans*.

Genus AXIOPSIS, n.

Definition: "Axiidæ with a flat area on the back in the fore part of the carapace well marked and continuous with the *rostrum*, no keel on the carapace behind the cervical groove, the eyes well pigmented, the antennal thorns long or of middle size, the legs of the second pair chelate, [an arthrobranch and a podobranch on the second maxilliped, no pleurobranches †], and a suture on the exopodite of the last limb."

Species :

- Type. *A. affinis* (de Man), 1887. Arch. Naturges. liii. i. I.  
*A. princeps* (Boas), 1880. Dansk. Vidensk. Selsk. Skrifter, (6) i. H.  
*A. spinipes* (de Man), 1887. Arch. Naturges. liii. i. I.  
 ? *A. biserratus* (Martens), 1869. Mon.-Ber. Ak. Berlin, 1868. I.  
 ? *A. serratifrons* (A. M.-Edw.), 1873. J. Mus. Godef. iv. I.

\* As it was very difficult to be certain of this point in the small specimens of *Eiconaxius* and *Paraxius*, from which the jaws of one side had sometimes been removed, it is possible that the above statement may be wrong. In that case the last difference between *Eiconaxius* and *Iconaxiopsis* will have gone, for the exopodite of the second maxilla of the former is longer than the endopodite, and not as Bate figures it.

† These particulars as to the gills refer to the type only. They may or may not be true of the other species, which I have not examined.

- ? *A. nodulosus* (Meinert), 1877. Naturh. Tidsskr. (3) xi. A.  
 ? *A. Brocki* (de Man), 1887. Arch. Naturges. liii. i. I.  
 ? *A. Picteti* (Zehntner), 1894. Rev. Suisse Zool. ii. I.  
 ? *A. defensus* (Rathb.), 1900. Bull. U.S. Fish Comm. E.  
 ? *A. inæqualis* (Rathb.), 1900. " " E.

The species described by de Man in 1887 (Arch. Naturges. liii. i.) as *Axius clypeatus* should probably become the type of a new genus, with the following characters:—

“Back arched in the fore part of the carapace, no keel behind the cervical groove, eyes well pigmented and with long stalks, and a small oval end-joint on the exopodite of the last limb.” The gills are unknown.

#### GENUS CALOCARIS, Bell, 1853.

Definition: “Axiidæ with the body subcylindrical and the back arched, the cervical groove distinct, a toothed ridge extending backwards from each edge of the *rostrum* towards the cervical groove, which it does not meet, a third ridge running the whole length of the carapace in the middle line, the eyes almost or quite without pigment, an arthrobranch on the second maxilliped\*, no pleurobranchs, and a suture on the exopodite of the first limb.” All the known species live in deep water.

Subgenera: *Calastacus*, *Calocaris*.

#### Subgenus CALASTACUS, Fax., 1893.

Definition: “Species of *Calocaris* in which the antennal thorns are of a good size.”

Species:

- Type. *C. stilirostris* (Fax.), 1893. Bull. Mus. Harvard, xxiv. G.  
*C. investigatoris* (And.), 1890. J. As. Soc. Bengal, lxxv. I.  
*C. felix* (Alc. & And.), 1899. Ann. & Mag. Nat. Hist. (7) iii. I.  
*C. longispinis* (McArdle), 1901. " " (7) viii. I.  
*C. quinqueseriatus* (Rathb.), 1902. P. U.S. Nat. Mus. xxiv. H.

#### Subgenus CALOCARIS, Bell, 1853.

Definition: “Species of *Calocaris* in which the antennal thorns are minute.”

Species:

- Type. *C. Macandreeæ*, Bell, 1853. Brit. Stalk-eyed Crust. A, B, I.  
*C. Alcocki*, McArdle, 1900. Ann. & Mag. Nat. Hist. (7) vi. I.

#### GENUS SCYTOLEPTUS, Gerst., 1856.

[= *Evaxius*, Kingsley, 1882.]

Definition: “Axiidæ whose back is arched in the fore part

\* Absent in *C. stilirostris* (?).

of the carapace, but marked off by a ridge on each side, bears a third ridge in the middle, each of the ridges ending short of the fore edge of the carapace in a strong tooth, and falls steeply to the *rostrum*; with pigmented eyes, without any vestige of scale or fixed thorn on the antenna (?), and with no suture on the exopodite of the last limb." The gills are not known.

Species :

Type. *S. serripes*, Gerst., 1850. Arch. Naturges. xxii. I.  
*S. tricarinatus* (Kingsley), 1882. Bull. Essex Inst. xiv. I.

Family **Laomediidæ**, n.

Definition: "Thalassinidea with the *rostrum* of a good size; *linea thalassinica* present; antennular flagella rather short, no vestige of antennal scale (?) or fixed thorn; the first pair of legs large, chelate, equal, the second pair simple or subchelate, the third and fourth simple, the fifth subchelate; mastigobranchs on all the thoracic limbs except the last, podobranchs at least on the third to sixth, arthrobranchs on the second to seventh; the gills trichobranch, with somewhat broadened filaments; the *pleura* of the abdominal segments fairly well developed; the abdominal limbs without *appendix interna*, and the last pair of limbs with a suture on both exopodite and endopodite."

Many points with regard to the two genera of this family are still unsettled. The gill-formula of *Laomedia* is as yet uncertain as regards the maxillipeds. The lack of an *appendix interna* on the abdominal limbs of *Jaxea* is only to be inferred indirectly from the fact that Heller does not mention it in his careful description, and from its absence in the allied *Laomedia*. Heller does not say that the endopodite of the last limb in *Jaxea* (his *Calliaxis*) has a suture, but he figures one clearly. Lastly, it may well be that here (and in *Scytoleptus* also) careful search would show that a trace of the antennal scale remains.

Genera: *Laomedia*, *Jaxea*.

GENUS **LAOMEDIA**, de Haan, 1849.

Definition: "Laomediidæ which have on the maxillipeds of the first pair no lash to the exopodite nor podobranch, the chelæ in the legs of the first pair stout, and those of the second pair simple."

Species :

Type. *L. astacina*, de Haan, 1849. Von Siebold's 'Fauna Japonica,' Crust. I.

Genus *JAXEA*, Nardo, 1847.[= *Calliaxis*, Heller, 1856.]

Definition: "Laomediidæ which have on the maxillipeds of the first pair a lash to the exopodite and a podobranch, the chelæ in the legs of the first pair slender, and those of the second pair subchelate."

Species :

Type. *J. nocturna*, Nardo, 1847. *Sinonimia moderna*\* [= *C. adriatica*, Heller, 1856]. B.

Family *Thalassinidæ*, Dana, 1852.

Definition: "Thalassinidea with a *rostrum* of fair size; a *linea thalassinica*; antennular flagella of moderate length, no vestige of antennal scale † or fixed thorn; the first and second pairs of legs subchelate ‡, the rest simple; mastigobranchs on legs 1-4, podobranchs on legs 1-3, no pleurobranchs, the gills partly trichobranch, partly with broad plates; the *pleura* of the abdominal segments small; the third to fifth abdominal limbs without *appendix interna*, the branches of the abdominal limbs narrow, and the last pair without suture on endopodite or exopodite."

Genus: *Thalassina*, Latr., 1806.

Species § :

Type. *T. anomala* (Hbst.), 1801. Naturges. Krabben u. Krebse, iii. ii. [= *T. scorpionoides*, Latr., 1806, = *T. maxima*, Hess, 1865, ? = *T. gracilis*, Dana, 1852.] I.

*T. chilensis*, Steenstrup & Lütken, 1861. Nat. Foren. Vidensk. Meddelelser. G.

Family *Callianassidæ*, Bate, 1888.

Definition: "Thalassinidea whose *rostrum* may be either of a good size or small; which have the *linea thalassinica*, the antennular flagella short or of moderate length, the antennal scale quite vestigial, and no antennal thorn; the legs of the first pair usually chelate or subchelate, but sometimes simple, those of the second pair chelate or simple, those of the third and fourth pairs simple, and those of the fifth pair simple, subchelate or chelate; the legs without podobranchs and

\* See also Ann. Ist. Venet. xiv.

† There are some small irregular knobs between the second and third joints of the antennal stalk, but Boas shows that neither of these represents the scale.

‡ Bate's figure is quite wrong in regard to the second leg.

§ According to Ortmann (Bronn's 'Thierreich,' v.) there is probably only one species.

usually without mastigobranchs, no pleurobranchs; the gills trichobranch or with filaments broadened in various degrees; the *pleura* of the abdominal segments almost wanting; the third to fifth abdominal limbs with or without *appendix interna*, their branches broad, and the last pair of limbs without suture on endopodite or exopodite."

Subfamilies: Upogebiinae, Callianassinæ.

Subfamily *UPOGEBIINÆ*, n.

Definition: "Callianassidæ with the *rostrum* of a good size; the legs of the first pair chelate, subchelate, or simple, but equal and not with a very broad wrist and palm, those of the second pair equal, simple (except in *Bigea*), those of the third pair with the propodite of normal width; no mastigobranchs (except sometimes vestiges on the maxillipeds of the first two pairs); and the second pair of abdominal limbs with broad branches like the third to fifth, which have no *appendix interna*."

Genera: *Upogebia*, *Gebicula*, *Bigea*.

Genus *UPOGEBIA*, Leach, 1814.

[= *Gebia*, Leach, 1815, = *Gebios*, Risso, 1826, ? = *Calliadne*, Strahl, 1862.]

Definition: "Upogebiinae with the legs of the first pair chelate or subchelate, those of the second pair simple, those of the fifth pair usually not chelate, and the two branches of the last limb broad and stout and not longer than the telson."

Subgenera: *Gebiopsis*, *Upogebia*.

Subgenus *GEBIOPSIS*, A. M.-Edw., 1868.

Definition: "Species of *Upogebia* in which the 'thumb' is almost or quite as long as the movable finger, and there is no small tooth on the fore edge of the carapace over the antenna."

Species:

- Type. *U. nitida* (A. M.-Edw.), 1868. *Nouv. Arch. Mus.* iv. C.  
*U. deltaura* (Leach), 1815. *Tr. Linn. Soc.* xi. A.  
*U. Darwini* (Miers), 1884. 'Alert' Report. [= *U. intermedia* (de Man), 1887.] I.  
*U. Bowerbanki* (Miers), 1884. 'Alert' Report. F.  
*U. isodactyla* (Ortm.), 1891. *Zool. Jahrb.* vi. Syst. i. I.  
*U. hexacerus* (Ortm.), 1894. *Jena Denkschr.* viii. v. I.  
 ? *U. Savignyi* (Strahl), 1862. *Mon.-Ber. Ak. Berlin*, 1861. B.

Subgenus *UPOGEBIA*, Leach, 1814.

Definition: "Species of *Upogebia* in which the 'thumb'

is distinctly shorter than the movable finger, and there is a small sharp tooth on the fore edge of the carapace over the antenna."

## Species :

- Type. *U. stellata* (Mont.), 1808. Tr. Linn. Soc. ix. A, B.  
*U. littoralis* (Risso), 1816. Crust. de Nice. [= *U. lacustris*, Costa, 1844, = *U. venitiarum*, Nardo, 1847.] A, B.  
*U. affinis* (Say), 1817. Journ. Ac. Philadelphia, i. E.  
*U. capensis*\* (Krauss), 1843. Südafrik. Crust. S.  
*U. hirtifrons* (White), 1847. P. Z. S. ? F.  
*U. major* (de Haan), 1849. Fauna Japonica, Crust. I.  
*U. pugettensis* (Dana), 1852. U.S. Expl. Exped., Crust. ii. [= *U. californica*, Stimps., 1854.] H.  
*U. carinicauda* (Stimps.), 1860. Proc. Ac. Philadelphia. I.  
*U. subspinosa* (Stimps.), 1860. I.  
*U. barbata* (Strahl), 1862. Mon.-Ber. Ak. Berlin, 1861. I.  
*U. longipollex* (Streets), 1871. Proc. Ac. Philadelphia. G.  
*U. spinigera* (S. I. Smith), 1871. Rep. Peabody Ac. 1869. G.  
*U. Danai* (Miers), 1876. Ann. & Mag. Nat. Hist. (4) xvii. [= *U. hirtifrons*, Dana, 1852.] F.  
*U. rugosa* (Lockington), 1878. Ann. & Mag. Nat. Hist. (5) ii. F.  
*U. Simsoni* (Thompson), 1893. Proc. Roy. Soc. Tasmania, 1892. F.  
*U. africana* (Ortm.), 1894. Jena Denkschr. viii. v. I.  
*U. furcata* (Aurivillius), 1898. Bih. Svenska Ak. xxiv. iv. i. C.  
? *U. spinifrons* (Haswell), 1882. Proc. Linn. Soc. N.S.W. vi. F.

## Genus GEBICULA, Alc., 1901.

Definition: "Upogebiinae with the legs of the first pair simple, those of the second pair also simple, those of the fifth pair chelate, and the two branches of the last limb foliaceous, larger than the telson."

The distinctness of this genus from *Upogebia* is doubtful. According to Haswell's figure (Cat. Austral. Crust.) the first leg of *U. spinifrons* would appear to be simple; but in his definition of the genus he makes no exception to the rule that the limb is subchelate, and in his definition of the species he does not allude to the point. The last leg is chelate in *Gebiopsis Darwini*, and in several other species is subchelate. The telson of *U. Simsoni* seems to be shorter than the last limb, but the figure given by Thompson is rather hard to understand, the limbs being drawn outwards from the telson. Alcock's description and his figure, which is from the side, are also not clear on this point, but, so far as they can be followed, the last limb in *Gebicula* seems to be of a more primitive shape than that of *Upogebia*.

## Species :

- Type. *G. exigua*, Alc., 1901. Ind. Deep-sea Macrura and Anomala. I.

\* The remarkable fact, mentioned by Stebbing (South Afric. Crust. i.), that this species has gills on the last pair of legs, will probably make it needful to separate it as a subgenus with such others as may share the character.

## Genus BIGEA, Nardo, 1869.

Definition: "Upogebiinæ with the legs of the second pair chelate and all the rest simple."

It is somewhat remarkable that this genus is only known by an old drawing, but there seems to be no reason to doubt its existence.

Species:

Type. *B. tipica* (sic), Nardo, 1869. Ann. Ist. Venet. xiv. B.

## Subfamily CALLIANASSINÆ, n.

Definition: "Callianassidæ with the *rostrum* small or almost wanting; the legs of the first pair chelate, unequal, the larger one usually with a very broad wrist and palm, those of the second pair equal, chelate, those of the third pair with a broad propodite; mastigobranchs present or not on the hinder thoracic limbs, but always a large one on the first maxilliped; and the second pair of abdominal limbs like or unlike the third to fifth, which have an *appendix interna*."

Genera: *Callianassa*, *Glypturus*, *Callianidea*.

## Genus CALLIANASSA, Leach, 1814.

Definition: "Callianassinæ with the eyes flattened against one another (except in *Scallasis*), the ischiopodite and mero-podite in the maxillipeds of the third pair broader than the carpopodite and propodite; the third pair of legs usually bearing a lobe on the hinder edge of the propodite, which thus takes on a characteristic shape; those of the fifth pair more or less distinctly subchelate; no mastigobranchs on the legs or third maxilliped, but a large one (epipodite) on the first and usually a small one on the second, no gill-like filaments on the third to fifth pairs of abdominal limbs, and the plates of the tail-fin not deeply graven."

The species of this genus are so many that it would be well if they could be grouped in subgenera. Unfortunately this is far from easy, partly because so little is known about most of them. In the following arrangement the characters made use of are the shape of the maxillipeds of the third pair and that of the tail-fin, on which great weight was laid by A. Milne-Edwards in his revision (Nouv. Arch. Mus. vi.), and the propodite of the legs of the third pair, which is needed for some species that have become known since he wrote. The most primitive members of the genus are those with a long narrow telson, narrow third pair of maxillipeds, and oval propodites on the legs of the third pair, such as

*C. securo*, *C. amboinensis*, and *C. cæcigena*. From these there stand off, on the one hand, the little group of *C. lignicola* and *C. rotundicaudata*, with shorter telson and a broader third pair of maxillipeds, and, on the other hand, the species, such as *C. subterranea*, which have narrow third maxillipeds and a long telson, but also a lobe on the hinder edge of the propodite in the third pair of legs, whereby this limb takes on the shape which is typical of the genus. Hence, again, two lines branch out: one leads to such forms as *C. gigas*, which have still long telsons, but very broad third maxillipeds; the other, containing such forms as *C. brevicaudata*, has a short telson, but often keeps the third maxillipeds fairly narrow. Between the two groups of which these species are typical there is, however, an almost complete series, and they cannot be sharply separated.

Subgenera: *Calliactites*, *Cheramus*, *Trypæa*, *Callichirus*, *Scallasis*.

Subgenus CALLIACTITES, n.

Definition: "Species of *Callianassa* with the maxillipeds of the third pair narrow or more or less broadened, no lobe on the hinder edge of the propodite in the legs of the third pair, the endopodite of the last limb of medium width or rather narrow, and the telson usually long, never very short." Three out of the six species are from deep water.

Species:

- Type. *C. securo*, Lanchester, 1902. P. Z. S. 1901. I.  
*C. amboinensis*, de Man, 1887. Arch. Naturges. liii. i. I.  
*C. cæcigena*, Alc. & And., 1894. J. As. Soc. Bengal, lxiii. I. (deep water).  
*C. lignicola*, Alc. & And., 1899. Ann. & Mag. Nat. Hist. (7) iii. I. (deep water).  
*C. rotundicaudata*, Stebbing, 1902. South African Crust. ii. S.  
 ? *C. goniophthalma*, Rathb., 1900. Proc. U.S. Nat. Mus. xxiv. H. (deep water).

Subgenus CHERAMUS\*, Bate, 1888.

Definition: "Species of *Callianassa* with the maxillipeds of the third pair narrow, a lobe on the hinder edge of the propodite on the legs of the third pair, the endopodite of the last limb of medium width or broad, and the telson long."

Species:

- Type. *C. subterranea* (Mont.), 1808 †. Tr. Linn. Soc. ix. A.  
*C. pachydactyla*, A. M.-Edw., 1870. Nouv. Arch. Mus. vi. C.

\* This name cannot be used for any genus which contains *C. subterranea*, as it must then be replaced by *Callianassa* on the ground of priority. As a subgeneric name it holds good.

† The true *C. subterranea* is a species which keeps both the primitive

- C. orientalis* (Bate), 1888. 'Challenger' Macrura. I.  
*C. minima*, Rathb., 1900. Bull. U.S. Fish Comm. E.  
*C. Batei*, nom. n. [= *C. occidentalis*, Bate, 1888, nom. præoc.\*] E.  
 (deep water).  
 ? *C. subterranea*, var. *minor*, Gourret, 1887. C. R. Ac. Fr. cv. B.

Subgenus *TRYPÆA* †, Dana, 1852.

Definition: "Species of *Callianassa* with the maxillipeds of the third pair very broad, a lobe on the hinder edge of the propodite on the legs of the third pair, the endopodite of the last limb broad and square-ended, and the telson as long as, usually longer than, it is broad, almost or quite as long as the endopodites of the last pair of limbs."

Species:

- Type. *C. australiensis* (Dana), 1852. U.S. Expl. Exped., Crust. ii. F.  
*C. uncinata*, H. M.-Edw., 1837. H. Nat. Crust. ii. G.  
*C. gigas*, Dana, 1852. U.S. Expl. Exped., Crust. ii. H.  
*C. californiensis*, Dana, 1854. Proc. Ac. Philadelphia, vii. [= *C. occidentalis*, Stimps., 1856.] H.  
*C. longimana*, Stimps., 1856. Proc. Boston Soc. Nat. Hist. vi. H.  
*C. porcellana* (Kinahan), 1858. Journ. Roy. Dublin Soc. i. F.  
*C. chilensis*, A. M.-Edw., 1860. Ann. Sci. Nat. (4) xiv. G.  
*C. brachyophthalma*, A. M.-Edw., 1870. Nouv. Arch. Mus. vi. I.  
*C. mauritiana*, Miers, 1882. P. Z. S. I.  
*C. truncata*, Giard & Bonnier, 1890. Bull. Sci. Fr. Belg. xxii. A.  
*C. japonica*, Ortm., 1891. Zool. Jahrb. vi. Syst. I.  
*C. Harmandi*, Bouvier, 1901. Bull. Mus. Paris. I.  
*C. maldivensis*, n. sp. See 'Fauna of the Maldives,' ed. Gardiner, ii. iii. I.  
 ? *C. petalura*, Stimps., 1860. Proc. Ac. Philadelphia, 1860. I.

Subgenus *CALLICHIRUS* ‡, Stimps., 1866.

Definition: "Species of *Callianassa* with the maxillipeds of the third pair usually narrow as compared with those of *Trypæa*, a lobe on the hinder edge of the propodite in the

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characters of this subgenus, but seems, by the hook on its arm, to be near the ancestor which gave rise to *Trypæa*, where this is a common feature.

\* Doubly preoccupied, first by Stimpson in 1856 as a synonym for *C. californica*, Dana, and later by Bate himself in 1888.

† According to the recognized rules of zoological nomenclature (for instance, by Art. V. 5, of the Code of Rules adopted by the last Zoological Congress), this name must be given to the subgenus before us, although the most striking feature of Dana's *Trypæa*—the extreme shortness of the antennular flagella—is not characteristic of it as now constituted. *C. australiensis* must remain the type species, although *C. uncinata* or *C. gigas* would have been more suitable.

‡ *Callichirus* becomes the name and *C. major* the type of this subgenus by the same rule that makes *Trypæa* the name and *C. australiensis* the type of the foregoing one. *C. brevicaudata* would probably be a better type.

legs of the third pair, the endopodite of the last limb narrow and pointed or rounded at the end, and the telson as broad as or broader than it is long, distinctly shorter than the endopodites of the last pair of limbs.”

## Species :

- Type. *C. major*, Say, 1817. Journ. Ac. Philadelphia, i. E.  
*C. laticauda*, Otto, 1828. Nov. Act. Leop. Carol. xiv. A, B.  
*C. mucronata*, Strahl, 1862. Mon.-Ber. Ak. Berlin, 1861. I.  
*C. Turnerana*, White, 1861. P. Z. S. C.  
*C. tridentata*, Martens, 1869. Mon.-Ber. Ak. Berlin, 1868. I.  
*C. armata*, A. M.-Edw., 1870. Nouv. Arch. Mus. vi. I.  
*C. brevicaudata*, A. M.-Edw., 1870. „ „ I.  
*C. longiventris*, A. M.-Edw., 1870. „ „ I.  
*C. Bocourti*, A. M.-Edw., 1870. „ „ I.  
*C. madagassa*, Long & Richters, 1882. Abh. senck. Ges. I.  
*C. Martensi*, Miers, 1884. P. Z. S. I.  
*C. novæ-guinææ*, Thallwitz, 1890. Abh. Mus. Dresden. I.  
*C. diademata*, Ortm., 1891. Zool. Jahrb. vi. Syst. C.  
*C. Grandidieri*, Coutière, 1899. Bull. Mus. Paris. I.  
*C. novæ-britanniæ*, Borradaile, 1900. Willey's Zool. Results, iv. I.  
*C. marginata*, Rathbun, 1900. Bull. U.S. Fish Comm. E.  
*C. Kraussi*, Stebbing, 1900. South African Crust. i. S.  
*C. affinis*, Holmes, 1900. Pap. Calif. Acad. vii. H.  
*C. Stebbingi*\*, nom. nov. [= *C. subterranea*, auct.] A, B.

## Subgenus SCALLASIS, Bate, 1888.

Definition : “Species of *Callianassa* with the eyes rounded, bearing the cornea at the end, the maxillipeds of the third pair fairly broad, the endopodites of the last pair of limbs narrow, rounded at the end, and the telson about as broad as long, almost as long as the last pair of limbs.”

## Species :

- Type. *C. amboinæ* (Bate), 1888. I.

The shape of the eyes is not, I think, a primitive feature in this species, but it must, for the present at least, remain in a separate subgenus. The third to fifth abdominal limbs are narrower than is common in *Callianassa*, and somewhat recall *Callianidea*. Bate's statements respecting the gills in this subgenus and in *Cheramus* are unreliable. The specimens are now much damaged, but each had probably nine pairs of gills (arthrobranchs). The third pair of maxillipeds are broader in *Scallasis* than this author implies.

\* Named after Mr. Stebbing, who has shown [Hist. Crust. p. 184 (1893)] that Leach's species is distinct from the form usually called *C. subterranea*. Details of the latter and of *C. laticauda* are given by Giard and Bonnier (Bull. Sci. Fr. Belg. xxii. p. 362), and it is probably the species figured by H. Milne-Edwards in the great illustrated edition of Cuvier's 'Règne Animal.'

Not having seen specimens or descriptions of the following species, I am unable to place them :—

- C. Krukenbergi*, Neumann, 1878. Syst. Uebersicht Gatt. *Oxyrhynch.*, &c., Leipzig, 1878.  
*C. Filholi*, A. M.-Edw., 1878. Bull. Soc. Philom.  
*C. Stimpsoni*, Smith, 1874.  
*C. celebica*, de Haan.

The following, being known only by the chela, also cannot be placed :—

- C. occidentalis*, Bate, 1888. 'Challenger' Macrura. E. (Nom. præoc.)

#### Genus GLYPTURUS, Stimps., 1866.

Definition : "Callianassinæ with the eyes flattened against one another, the ischiopodite and meropodite in the maxillipeds of the third pair not broader than the carpopodite and propodite ; no gill-like filaments on the abdominal limbs, the second pair of which have narrow branches ; the endopodites of the last pair of limbs broad and triangular, the telson very small, and the plates of the tail-fin deeply graven."

Species :

- Type. *G. acanthochirus*, Stimps., 1866. Proc. Ac. Sci. Chicago, i. E.  
*G. grandimana* (Gibbes), 1850. Proc. Am. Assoc. iii. E.  
*G. Branneri*, Rathb., 1900. Bull. U.S. Fish Comm. E.

#### Genus CALLIANIDEA, H. M.-Edw., 1837.

[= *Isea*, Guérin, 1832, = *Callianisea*, H. M.-Edw., 1837, = *Callisea*, Dana, 1852.]

Definition : "Callianassinæ without *linea thalassinica*, with the eyes flattened against one another, bearing the cornea on the outside ; the ischiopodite and meropodite in the maxillipeds of the third pair not broader than the carpopodite and propodite, the propodite in the legs of the third pair without a lobe on the hinder edge ; mastigobranchs on all the thoracic limbs except the last ; gill-like filaments on the second to fifth abdominal limbs, which are all alike, with moderately broad oval branches, the branches of the last pair of limbs rather narrow and oval, not deeply graven, and the telson long."

Species :

- Type. *C. typa*, H. M.-Edw., 1837. H. Nat. Crust. ii. I.  
 ? = *C. elongata* (Guérin), 1832. Ann. Soc. Entom. France, (1) i. I.  
*C. lævicauda*, Gill, 1859. Proc. Ac. Philadelphia, xi. E.  
*C. Steenstrupi*, Boas, 1880. Danske Vidensk. Selsk. Skrifter, (6) i. E.  
*C. mucronata*, Kossm., 1880. Reise Roth. Meer. ii. I.

The number of genera in the four families is 13,—4 in the Axiidæ, 2 in the Laomediidæ, 1 in the Thalassinidæ, and 6 in the Callianassidæ. If subgenera be counted in, the total

will rise to 23. The number of species is about 125, these, like the genera, being more numerous in the more specialized family Callianassidæ than in the others. The greater number of the species in all the families are Indo-Pacific. The species are generally restricted to one region, but the genera are well distributed, showing no tendency to restriction to particular regions in any case except that of the little genus *Glypturus* from the West-Indian region. Most of the known species live in shallow water, but, with the exception of the widespread *Calocaris Macandreae*, the deep-sea forms (below 200 fath.) can conveniently be arranged by means of the same set of regions; and this has been done above. The deep-water species are chiefly concentrated in *Eiconaxius*, *Iconaxiopsis*, *Paraxius*, and *Calocaris*, which have no shallow-water forms, but there are a few scattered among the other genera, and these have been noted in the lists. *Thalassinia anomala* makes its burrows on land, but they probably always go down to water.

*Key to the Families of the Thalassinidea.*

- I. No *linea thalassinica*. Both movable and fixed antennal thorns present, though sometimes minute (? absent in *Scytoleptus*). Abdominal *pleura* large ..... **Axiidæ.**
- II. *Linea thalassinica* present (except in *Callianidea*). Fixed antennal thorn wanting, scale reduced to a flattened vestige or wanting. Abdominal *pleura* usually small.
  - 1. Sutures on both exopodite and endopodite of last limb. Abdominal *pleura* of a good size.. **Laomedidæ.**
  - 2. No sutures on the last limb. Abdominal *pleura* small.
    - a. Second leg chelate or simple. No podobranchs on legs. Abdominal limbs 3-6 broad. A vestige of antennal scale remains. **Callianassidæ.**
    - b. Second leg subchelate. Podobranchs on legs 1-3. Abdominal limbs all narrow. No vestige of antennal scale ..... **Thalassinidæ.**

*Key to the Genera of the Axiidæ.*

- I. A suture on the exopodite of the last limb. [Antennal thorns present, large or small.]
  - 1. Eyes pigmented. Back flat. No keel in the hinder part of the carapace at least..... *Axiopsis.*
  - 2. Eyes pale. Back arched. A keel runs the whole length of the carapace in the middle line ..... *Calocaris.*
- II. No suture on the exopodite of the last limb.
  - 1. Back not falling steeply to *rostrum*. Antennal thorns present, large or small ..... *Axius.*
  - 2. Back falling steeply to *rostrum*. Antennal thorns lost (?) ..... *Scytoleptus.*

*Key to the Subgenera of Axius.*

- I. Eyes pigmented. Flat area of back and cervical groove well marked. [Antennal thorns large.]
1. Pleurobranches on legs 2-4 ..... *Axius.*
2. No pleurobranches ..... *Neaxius.*
- II. Eyes pale. Flat area of back and cervical groove more or less indistinct.
1. Pleurobranches on legs 2-4. Antennal thorns large.
- a. Gills on second maxilliped ..... *Iconaxiopsis.*
- b. No gills on second maxilliped ..... *Eiconaxius.*
2. No pleurobranches. Antennal thorns small .... *Paraxius.*

*Key to the Subgenera of Calocaris.*

- I. Antennal thorns large ..... *Calastacus.*
- II. Antennal thorns small ..... *Calocaris.*

*Key to the Genera of the Laomediidæ.*

- I. No lash to exopodite of first maxilliped. First leg with stout chela. Second leg simple ..... *Laomedia.*
- II. A lash to exopodite of first maxilliped. First leg with slender chela. Second leg subchelate .... *Jaxea.*

*Key to the Subfamilies of the Callianassidæ.*

- I. *Rostrum* large. Legs of first pair equal. No *appendix interna* on abdominal limbs 3-5 ..... *UPOGEBIINÆ.*
- II. *Rostrum* small. Legs of first pair unequal. An *appendix interna* on abdominal limbs 3-5 ..... *CALLIANASSINÆ.*

*Key to the Genera of the Upogebiinæ.*

- I. Legs of second pair simple.
1. Legs of first pair chelate or subchelate. Last limb not longer than telson ..... *Upogebia.*
2. Legs of first pair simple. Last limb longer than telson ..... *Gebicula.*
- II. Legs of second pair chelate ..... *Bigea.*

*Key to the Subgenera of Upogebia.*

- I. Legs of first pair chelate. No tooth on the fore edge of the carapace over the antenna ..... *Gebiopsis.*
- II. Legs of first pair with "thumb" distinctly shorter than movable finger. A tooth on the fore edge of the carapace over the antenna ..... *Upogebia.*

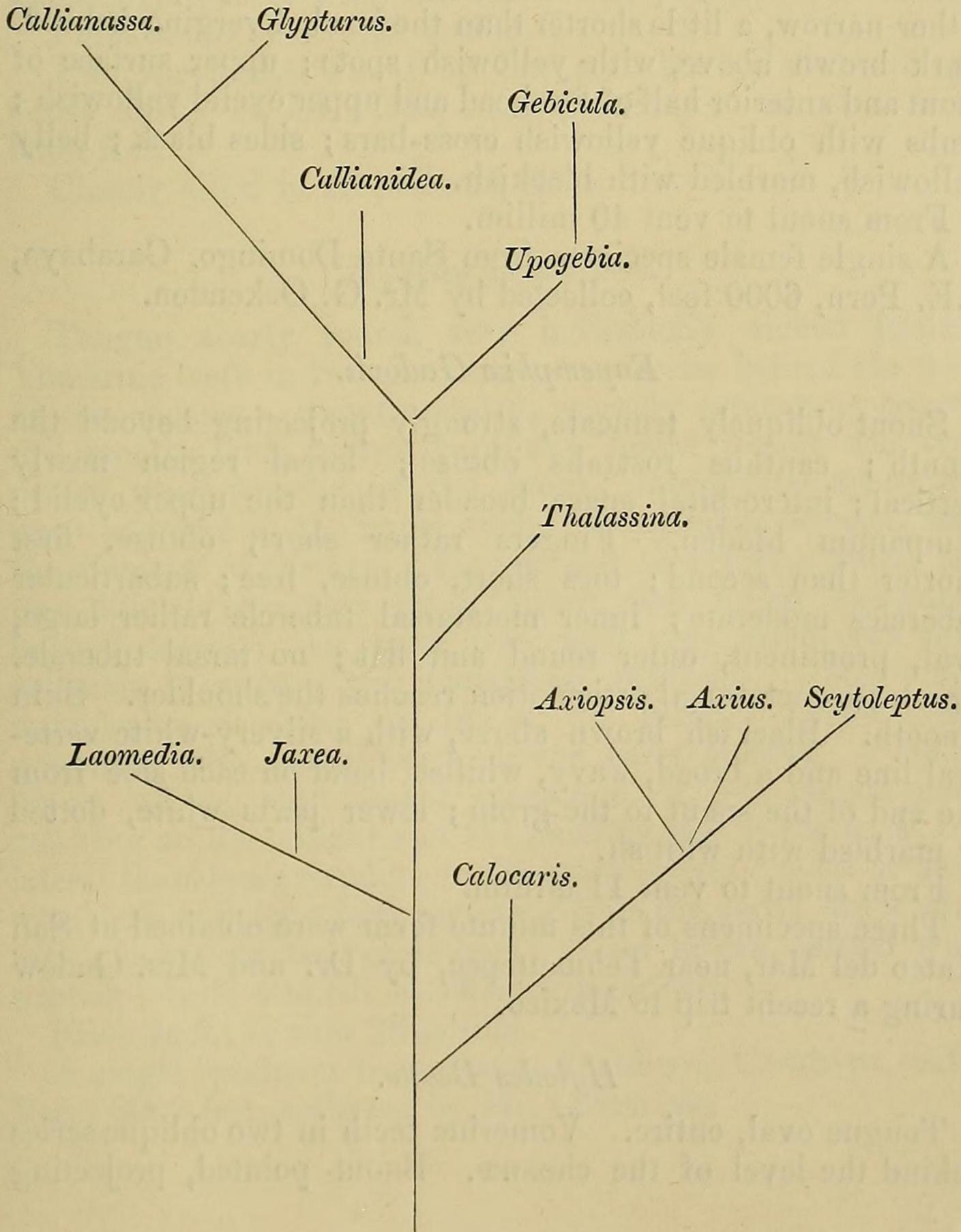
*Key to the Genera of the Callianassinæ.*

- I. No gill-like filaments on abdominal limbs. Second abdominal limb unlike third to fifth. No mastigobranchs on legs.
- a. Plates of tail-fin not deeply sculptured. Ischiopodite and meropodite of third maxilliped broader than carpopodite and propodite ..... *Callianassa.*
- b. Plates of tail-fin deeply sculptured. Ischiopodite and meropodite of third maxilliped not broader than carpopodite and propodite ..... *Glypturus.*
- II. Gill-like filaments on abdominal limbs 2-5, which are all alike. Mastigobranchs on legs 1-4 .... *Callianidea.*

Key to the Subgenera of Callianassa.

- I. Eyes flattened against one another, with the cornea usually on the outside.
  - 1. Propodite of the third leg without a lobe on the hinder edge..... *Calliactites.*
  - 2. Propodite of the third leg with a lobe on the hinder edge.
    - a. Telson long.
      - a. Third maxillipeds narrow ..... *Cheramus.*
      - b. Third maxillipeds very broad..... *Trypæa.*
    - b. Telson short and broad ..... *Callichirus.*
- II. Eyes rounded, bearing the cornea at the end .... *Scallasis.*

The genealogical relations between the genera of Thalassinidea are probably those shown in the following tree:—



Occasionally M. Fabre sees reason to question the observations of former writers. Thus he has been unable to confirm the statement that *Pentatoma griseum* watches over its young like a hen over her chickens, or that the favourite prey of *Reduvius personatus* is the bed-bug; nor does he regard the superficial resemblance between *Volucella* and a wasp as having anything to do with mimicry. The relation of *Volucella* to the wasp seems to be that of a simple scavenger. We have not space to quote M. Fabre's observations, but one interesting point which he discusses, not for the first time, is the limitations of instinct. This is illustrated in the case of the common wasp. When its nest is covered with a bell-glass, the enclosed wasps never dig a passage out, but remain cooped up till they die; and though stragglers left outside will dig their way in, they are equally unable either to show their companions the way out or even to make their own escape.

*Index Animalium, 1758-1800.* A CAROLO DAVIES SHERBORN confectus. Cambridge University Press, 1902.

"THE objects of this work," says the author, "are (a) to provide zoologists with a complete list of all the generic and specific names that have been applied by authors to animals since January the first 1758; (b) to give an exact date for each page quotation; (c) to give a quotation for each reference sufficiently exact to be intelligible alike to the specialist and to the layman."

Although Mr. Sherborn has received help from many quarters, this has but lightened in some small degree a truly colossal task, which, indeed, the author scarcely hopes to finish in his lifetime.

The value of this undertaking to zoologists cannot be easily estimated. A solid foundation has at last been laid on which to base a definite system of nomenclature, though, having regard to the wilfulness displayed in certain quarters, this seems almost too much to hope for!

This first volume, in the matter of binding and printing, is in every respect worthy of the Cambridge University Press. It is a bulky book, embracing no less than 1195 pages.

#### MISCELLANEOUS.

*On the Classification of the Thalassinidea.*

By L. A. BORRADAILE, M.A. &c.

#### ADDENDUM.

On p. 540, to the list of genera of the Laomediidæ, add: *Naushonia*.

On p. 541, after the definition of the genus *Jaxea*, add:

Genus NAUSHONIA, Kingsley, 1897.

Definition: "Laomediidæ which have on the maxillipeds of the first pair a lash to the exopodite and a podobranch, the first pair of legs stout and subchelate, the second pair very short and simple, and a well-developed, flat scale on the antenna."

Species:

Type. *N. crangonoides*, Kingsley, 1897. Bull. Essex Inst. xxvii.